FLORIDA DEPARTMENT OF TRANSPORTATION

Standard Specifications for Road and Bridge Construction

2000

These Florida Department of Transportation Standard Specifications for Road and Bridge Construction, 2000, are hereby approved for application on highway and related construction contracts as referenced in the contract plans or specifications, and they shall apply as noted and amended by those documents.

Approved,

Freddie Simmons, P.E.
Director, Office of Design

I hereby certify that this Standard Specifications Book was prepared by me or under my direct supervision and that I am a duly registered professional engineer under the laws of the State of Florida.

Duane F. Brautigam, P.E.
State Specifications Engineer

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DIVISION I

SECTION 1

DEFINITIONS AND TERMS

1-1 General.

Portions of Divisions I and II of these Standard Specifications for Road and Bridge Construction (specifications) are written in the Active Voice writing style as further described below. All divisions of these Specifications have been prepared to show both Non-SI (English) and their accepted equivalent SI (Metric) Units of Measure. Non-SI (English) Units of Measure appear first, followed by SI (Metric) values within brackets. For clarity, some Tables have been separated into Non-SI values followed by a Table of accepted equivalent SI values.

These Specifications are written to the bidder, prior to award of the Contract, and to the Contractor. Within Divisions I and II of the specifications, sentences that direct the Contractor to perform work are written in the active voice-imperative mood. These directions to the Contractor are written as commands. In the imperative mood, the subject "the bidder" or "the Contractor" is understood.

All other requirements to be performed by others, with the exception of the Method of Measurement and the Basis of Payment Articles, have been written in the active voice, but not in the imperative mood. Sentences written in the active voice identify the party responsible for performing the action. For example, "The Engineer will determine the density of the compacted material." Certain requirements of the Contractor may also be written in the active voice, rather than active voice-imperative mood.

Division III of the Specifications (Materials) is written in the passive voice writing style.

1-2 Abbreviations.

The following abbreviations, when used in the Contract Documents, represent the full text shown.

AAN	American Association of Nurserymen, Inc.
AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute
AGC	The Associated General Contractors of America, Inc.
AGMA	American Gear Manufacturers Association
AIA	American Institute of Architects.
AISI	American Iron and Steel Institute
ANSI	American National Standards Institute, Inc.
AREA	American Railway Engineering Association
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers

ASTM	American Society for Testing and Materials
AWG	American Wire Gauge
AWPA	American Wood Preservers Association
AWS	American Welding Society
AWWA	American Water Works Association
CRSI	Concrete Reinforcing Steel Institute
EASA	Electrical Apparatus Service Association
EPA	Environmental Protection Agency of the United States Government
FDOT	Florida Department of Transportation
FHWA	Federal Highway Administration
FSS	Federal Specifications and Standards
IEEE	Institute of Electrical and Electronics Engineers
IES	Illuminating Engineering Society
IPCEA	Insulated Power Cable Engineers Association
ISO	International Organization for Standards
MSTCSD	Minimum Specifications for Traffic Control Signals and Devices
MUTCD	Manual on Uniform Traffic Control Devices
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NIST	National Institute for Standards and Technology
NOAA	National Oceanic and Atmospheric Administration
OSHA	Occupational Safety and Health Administration
SAE	Society of Automotive Engineers
SI	International System of Units
SSPC	Steel Structures Painting Council
UL	Underwriters' Laboratories

Each of the above abbreviations, when followed by a number or letter designation, or combination of numbers and letters, designates a specification, test method, or other code or recommendation of the particular authority or organization shown.

Use standards, specifications, test methods, or other codes as specified in the current edition at the time of the bid opening.

1-3 Definitions.

The following terms, when used in the Contract Documents, have the meaning described.

Advertisement.

The public announcement, as required by law, inviting bids for work to be performed or materials to be furnished, usually issued as "Notice to Contractors," or "Notice to Bidders."

Architect.

The Architect as defined in s.481.203(3) Florida Statutes.

Architect of Record.
The Architect or Architectural Firm registered in the State of Florida that performs services for the Department in connection with the design and construction of buildings.

Architecture.
The practice of architecture as defined in s.481.203(6) Florida Statutes.

Article.
The numbered prime subdivision of a Section of these Specifications.

Bidder.
An individual, firm, or corporation submitting a proposal for the proposed work.

Bridge.
A structure, including supports, erected over a depression or over an obstruction such as water, highway or railway, or for elevated roadway, for carrying traffic or other moving loads, and having a length, measured along the center of the roadway, of more than 20 feet [6 m] between the inside faces of end supports. A multiple-span box culvert is considered a bridge, where the length between the extreme ends of the openings exceeds 20 feet [6 m].

Calendar day.
Every day shown on the calendar, ending and beginning at midnight.

Change Order.
A written order issued by the Department and accepted by the Contractor, covering minor changes in the plans, specifications, or quantities of work, within the scope of the Contract, when prices for the items of work affected are previously established in the Contract.

Consultant.
The Professional Engineer or Engineering Firm, or the Architect or Architectural Firm, registered in the State of Florida and under contract to the Department to perform professional services. The consultant may be the Engineer or Architect of Record or may provide services through and be subcontracted to the Engineer or Architect of Record.

Contract.
The term "Contract" means the entire and integrated agreement between the parties thereunder and supersedes all prior negotiations, representations, or agreements, either written or oral. The Contract Documents form the Contract between the Department and the Contractor setting forth the obligations of the parties thereunder, including, but not limited to, the performance of the Work and the basis of payment.

Contract Claim (Claim).

A written demand submitted to the Department by the Contractor in compliance with 5-12.3 seeking additional monetary compensation, time, or other adjustments to the Contract, the entitlement or impact of which is disputed by the Department.

Contract Documents.

The term "Contract Documents" includes: Advertisement for Proposal, Proposal, Certification as to Publication and Notice of Advertisement for Proposal, Appointment of Agent by Nonresident Contractors, Noncollusion Affidavit, Warranty Concerning Solicitation of the Contract by Others, Resolution of Award of Contract, Executed Form of Contract, Performance Bond and Payment Bond, Standard Specifications, Supplemental Specifications, Special Provisions, plans, Addenda, or other information mailed or otherwise transmitted to the prospective bidders prior to the receipt of bids, change orders, field orders, and supplemental agreements, all of which are to be treated as one instrument whether or not set forth at length in the form of contract.

Note: As used in Sections 2 and 3 only, Contract Documents do not include change orders, field orders, and supplementary agreements. As used in Section 2 only, Contract Documents also do not include Resolution of Award of Contract, Executed Form of Contract, and Performance and Payment Bond.

Contract Bond.

The security furnished by the Contractor and the surety as a guaranty that the Contractor shall fulfill the terms of the Contract and pay all legal debts pertaining to the construction of the project.

Contract Letting.

The date that the Department opened the bid proposals.

Contract Time.

The number of calendar days allowed for completion of the Contract work, including authorized time extensions.

Contractor.

The individual, firm, joint venture, or company contracting with the Department to perform the work.

Controlling Work Items.

Those work items that are directly interrelated such that each has a definite influence on progress of the overall work.

Culverts.

Any structure not classified as a bridge that provides an opening under the roadway.

Delay.

Any unanticipated event, action, force or factor which extends the Contractor=s time of performance of any controlling work item under the Contract. The term Adelay≅ is intended to cover all such events, actions, forces or factors, whether styled Adelay≅, Adisruption≅, Ainterference≅, Aimpedance≅, Ahindrance≅, or otherwise, which are beyond the control of and not caused by the Contractor, or the Contractor=s subcontractors, materialmen, suppliers or other agents. This term does not include Aextra work≅.

Department.

State of Florida Department of Transportation.

Designer of Record.

The Architect of Record or the Engineer of Record.

Developmental Specification.

See definition for Specifications.

Engineer.

The State Construction Engineer, acting directly or through duly authorized representatives; such representatives acting within the scope of the duties and authority assigned to them.

Note: In order to avoid cumbersome and confusing repetition of expressions in these Specifications, it is provided that whenever anything is, or is to be done, if, as, or, when, or where "acceptable, accepted, approval, approved, authorized, condemned, considered necessary, contemplated, deemed necessary, designated, determined, directed, disapproved, established, given, indicated, insufficient, ordered, permitted, rejected, required, reserved, satisfactory, specified, sufficient, suitable, suspended, unacceptable, or unsatisfactory," it shall be understood as if the expression were followed by the words "by the Engineer," "to the Engineer," or "of the Engineer."

Engineer of Record.

The Professional Engineer or Engineering Firm registered in the State of Florida that develops the criteria and concept for the project, performs the analysis, and is responsible for the preparation of the Contract Documents. The Engineer of Record may be Departmental in-house staff or a consultant retained by the Department.

The Contractor shall not employ the Engineer of Record as the Specialty Engineer.

Equipment.

The machinery and equipment, together with the necessary supplies for upkeep and maintenance thereof, and all other tools and apparatus necessary for the construction and acceptable completion of the work.

Extra Work.

Any Awork≅ which is required by the Engineer to be performed and which is not otherwise covered or included in the project by the existing Contract Documents, whether it be in the nature of additional work, altered work, deleted work, work due to differing site conditions, or otherwise. This term does not include a Adelay≅.

Highway, Street, or Road.

A general term denoting a public way for purposes of vehicular travel, including the entire area within the right-of-way.

Holidays.

Days designated by the State Legislature or Cabinet as holidays, which include, but are not limited to, New Year's Day, Martin Luther King's Birthday, Memorial Day, Independence Day, Labor Day, Veterans' Day, Thanksgiving Day and the following Friday, and Christmas Day.

Inspector.

An authorized representative of the Engineer, assigned to make official inspections of the materials furnished and of the work performed by the Contractor.

Laboratory.

The official testing laboratory used by the Department.

Major Item of Work.

Any item of work having an original Contract value in excess of 5% of the original Contract amount.

Materials.

Any substances to be incorporated in the work under the Contract.

Median.

The portion of a divided highway or street separating the traveled ways for traffic moving in opposite directions.

Plans.

The approved plans, including reproductions thereof, showing the location, character, dimensions, and details of the work.

Proposal (Bid, Bid Proposal).

The offer of a bidder, on the prescribed form, to perform the work and to furnish the labor and materials at the prices quoted.

Proposal Form.

The official form or the CEB program generated bid item sheets on which the Department requires formal bids to be prepared and submitted for the work.

Proposal Guaranty.

The security furnished by the bidder as guaranty that the bidder will enter into the Contract for the work if the Department accepts the proposal.

Right-of-Way.

The land that the Department has title to, or right of use, for the road and its structures and appurtenances, and for material pits furnished by the Department.

Roadbed.

The portion of the roadway occupied by the subgrade and shoulders.

Roadway.

The portion of a highway within the limits of construction.

Secretary.

Secretary of Transportation, State of Florida Department of Transportation, acting directly or through an assistant or other representative authorized by him; the chief officer of the Department of Transportation.

Section.

A numbered prime division of these Specifications.

Shoulder.

The paved or unpaved portion of the roadbed outside the edges of the traveled way or back of curb, and extending to the top of front slopes.

Special Provisions.

See definition for Specifications.

Specialty Engineer.

A Professional Engineer registered in the State of Florida, other than the Engineer of Record or his subcontracted consultant, who undertakes the design and drawing preparation of components, systems, or installation methods and equipment for specific portions of the project work. The Specialty Engineer may be an employee or officer of the Contractor or a fabricator, an employee or officer of an entity providing components to a fabricator, or an independent consultant.

The Specialty Engineer must be qualified in accordance with the Rules of the Department of Transportation, Chapter 14-75. Any Corporation or Partnership offering engineering services must hold a Certificate of Authorization from the Florida Department of Business and Professional Regulation.

For items of work not specifically covered by the Rules of the Department of Transportation, a Specialty Engineer is qualified if he has the following qualifications:

(1) Registration as a Professional Engineer in the State of Florida.

(2) The education and experience necessary to perform the submitted design as required by the Florida Department of Business and Professional Regulation.

Specifications.

The directions, provisions, and requirements contained herein, together with all stipulations contained in the Contract Documents, setting out or relating to the method and manner of performing the work, or to the quantities and qualities of materials and labor to be furnished under the Contract.

A. Developmental Specification: A specification developed around a new process, procedure, or material.

B. Special Provisions: Specific clauses adding to or revising the Standard Specifications, setting forth conditions varying from or additional to the Standard Specifications for a specific project.

C. Supplemental Special Provisions: Additions and revisions to the Contract Documents issued prior to the bid opening.

D. Supplemental Specifications: Additions and revisions to the Standard Specifications.

E. Technical Special Provisions: Specifications prepared, signed, and sealed by an Engineer registered in the State of Florida other than the State Specifications Engineer or his designee, that are made part of the Contract as an attachment to the Contract Documents.

State.

State of Florida.

Subarticle.

A headed and numbered subdivision of an Article of a Section of these Specifications.

Subgrade.

The portion of the roadbed immediately below the base course or pavement, including below the curb and gutter, valley gutter, shoulder and driveway pavement. The subgrade limits ordinarily include those portions of the roadbed shown in the plans to be constructed to a design bearing value or to be otherwise specially treated. Where no limits are shown in the plans, the subgrade section extends to a depth of 12 inches [300 mm] below the bottom of the base or pavement and outward to 6 inches [150 mm] beyond the base, pavement, or curb and gutter.

Substructure.

All of that part of a bridge structure below the bridge seats, including the parapets, backwalls, and wingwalls of abutments.

Superintendent.

The Contractor's authorized representative in responsible charge of the work.

Superstructure.

The entire bridge structure above the substructure, including anchorage and anchor bolts, but excluding the parapets, backwalls, and wingwalls of abutments.

Supplemental Agreement.

A written agreement between the Contractor and the Department, and signed by the surety, modifying the Contract within the limitations set forth in these Specifications.

Supplemental Special Provisions.

See definition for Specifications.

Supplemental Specifications.
See definition for Specifications.

Surety.
The corporate body that is bound by the Contract Bond with and for the Contractor and responsible for the performance of the Contract and for payment of all legal debts pertaining thereto.

Technical Special Provisions.
See definition for Specifications.

Traveled Way.
The portion of the roadway providing for the movement of vehicles, exclusive of shoulders and auxiliary lanes.

Unilateral Payment.
A payment of money made to the Contractor by the Department pursuant to Section 337.11(11), Florida Statutes (1997), for sums the Department determines to be due to the Contractor for work performed on the project, and whereby the Contractor by acceptance of such payment does not waive any rights the Contractor may otherwise have against the Department for payment of any additional sums the Contractor claims are due for the work.

Work.
All labor, materials and incidentals required to execute and complete the requirements of the Contract including superintendence, use of equipment and tools, and all services and responsibilities prescribed or implied.

Working Day.
Any calendar day on which the Contractor works or is expected to work in accordance with the approved work progress schedule.

SECTION 2

PROPOSAL REQUIREMENTS AND CONDITIONS

2-1 Prequalification of Bidders.

Except as noted below, prequalify with the Department to be eligible to bid. The Department publishes regulations covering prequalification of bidders under separate cover.

The Department does not require the Contractor to be prequalified if bidding contracts of $250,000 or less or if constructing buildings.

For contracts exceeding $250,000 in amount, file an application for qualification on forms furnished by the Department, giving detailed information with respect to financial resources, equipment, past record, personnel, and experience. For qualified applicants, the Department will issue a certificate fixing the types of work and the aggregate amount of work that the Department allows the prequalified bidder to have under contract at any one time.

A person or affiliate who has been placed on the convicted vendor list following a conviction for a public entity crime may not submit the following:

(a) A bid on a contract to provide any goods or services to a public entity.

(b) A bid on a contract with a public entity for the construction or repair of a public building or public work.

(c) Bids on leases of real property to a public entity.

A person or affiliate who has been placed on the convicted vendor list following a conviction for a public entity may not be awarded or perform work as a contractor, supplier, subcontractor, or consultant under a contract with any public entity, and may not transact business with any public entity in excess of the threshold amount provided in Section 287.017 F.S., for Category Two. All restrictions apply for a period of 36 months from the date of placement on the convicted vendor list.

2-2 Proposal Forms.

Obtain a proposal form under the conditions stipulated in the Advertisement. The proposal form states the location and description of the work to be performed; the estimate of the various quantities; the items of work to be performed; the Contract Time; the amount of proposal guaranty; and the date, time, and place of the opening of proposals.

The plans, Standard Specifications, Specifications Package, Supplemental Special Provisions and other documents designated in the proposal form are part of the proposal, whether attached or not. Do not detach any papers bound with or attached to the proposal form.

When ordering proposal forms, the Department will provide a computer diskette for use on a personal computer that is suitable for preparing the bid. This diskette contains the Department's Contract Electronic Bidding (CEB) program, user instructions, and proposal form. The CEB program produces a bid item sheet containing items identical to those listed in the proposal form. The Contractor may use the CEB program to prepare the bid and print a proposal form for submittal. The program operates on IBM personal computers or IBM compatible computers with a minimum 512K RAM and at least one, 53 inch [133 mm], dual side, dual density (DSDD) floppy drive using PC-DOS or MS-DOS operating systems, version 2.0 [5.0] or higher.

In order to produce an official proposal using the CEB program, enter only the company name, vendor number, reason code, addendum number, and unit or lump sum prices for items that must be bid. The program performs all extensions of the unit or lump sum prices and calculates the total bid. After completing all entries, the program automatically summarizes the total bid and provides a complete proposal form, including the total bid price.

Print bid item sheets generated from the CEB program on letter paper. Ensure that all computer generated sheets are legible. Do not submit computer generated sheets using a font size smaller than 9 point. The Department prefers 12 point font size and recommends a minimum of 20 pound [9 kg] paper.

The Department will accept as the official bid this set of proposal forms, generated from the program provided by the Department, along with a complete proposal package, signed in the title block, and delivered to the Department in accordance with 2-5 and 2-8 as the official bid.

If the bidder submits CEB program-generated bid item sheets, do not use the proposal form sheets included in the proposal. If the bidder completes and submits both, the Department will recognize only the CEB program proposal form generated sheets as the official bid.

Return the diskette furnished by the Department, or a copy thereof, used to generate the official bid with the proposal. The Department will furnish computer diskettes that are 32 inches [90 mm], double-sided, high-density (DS, HD), formatted at the standard MS-DOS/PC-DOS (DOS) capacity of 1.44 megabytes. The Department will accept only 53 inch [133 mm], DSDD diskettes formatted at 360 kilobytes, 53 inch [133 mm] double-sided, high-density diskettes formatted at the standard DOS capacity of 1.2 megabytes, 32 inch [90 mm] low-density diskettes formatted at the standard DOS capacity of 720 kilobytes, or 32 inch [90 mm] high-density diskettes formatted at the standard DOS capacity of 1.44 megabytes. The Department will not accept diskettes that have been physically altered to format at a higher capacity. Submit computer-generated bid item sheets printed from the diskette that is returned. When submitting a diskette other than the one furnished by the Department, label it with the Contractor's Name, Vendor Number, Letting Date, Revision Date (if applicable) and the State Project Number. Failure to follow proper diskette-handling and shipping procedures could result in the Department being unable to process the diskette and cause the bid to be declared irregular.

In case of a discrepancy between the unit or lump sum prices submitted on the program- printed bid item sheets and those contained on the diskette returned to the Department, the Department will use the unit or lump sum prices submitted on the program-printed bid item sheets.

The Department will apply all provisions of 2-5, except the requirement for written words, to the preparation of bids that are submitted on CEB program-generated proposal form sheets. The Department will make any necessary changes to entries on the CEB program-generated proposal form sheets in accordance with 2-5.1.

The Department is not responsible for loss of or damage to a bid diskette after it has been mailed or delivered to the bidder. If loss or damage occurs, the bidder may order another bid diskette.

2-3 Interpretation of Estimated Quantities.

For those items constructed within authorized plan limits or dimensions, use the quantities shown in the plans and in the proposal form as the basis of the bid. The Department will also use these quantities for final payment as limited by the provisions for the individual items. For those items having variable final pay quantities that are dependent on actual field conditions, use and measurement, the quantities shown in the plans and in the proposal form are approximate and provide only a basis for calculating the bid upon which the Department will award the Contract. Where items are listed for payment as lump sum units and the plans show estimates of component quantities, the Department is responsible for the accuracy of those quantities limited to the provisions of 9-3.3. Where items are listed for payment as lump sum units and the plans do not show estimates of component quantities, the Contractor is solely responsible for his own estimates of such quantities.

The Department may increase, decrease, or omit the estimated quantities of work to be done or materials to be furnished.

2-4 Examination of Plans, Specifications, Special Provisions and Site of Work.

Examine the Contract Documents and the site of the proposed work carefully before submitting a proposal for the work contemplated. Investigate the conditions to be encountered, as to the character, quality, and quantities of work to be performed and materials to be furnished and as to the requirements of all Contract Documents.

The Department does not guarantee the details pertaining to borings, as shown on the plans, to be more than a general indication of the materials likely to be found adjacent to holes bored at the site of the work, approximately at the locations indicated. The Contractor shall examine boring data, where available, and make his own interpretation of the subsoil investigations and other preliminary data, and shall base his bid on his own opinion of the conditions likely to be encountered.

The bidder's submission of a proposal is prima facie evidence that the bidder has made an examination as described in this Article.

2-5 Preparation of Proposals.

2-5.1 General: Submit proposals on the form described in 2-2. Show unit or lump sum prices for all bid items in both words and figures, and carry out all extensions. Fill in the prices and amounts with ink or typewriter. Initial changes made to words or figures that are typewritten or written in ink. Any pay item that will be provided free or at no cost to the Department shall be indicated as Afree≅ or A$.00" (fill in the words and figures column). If the pay item is left blank or n/a is used the bid may be declared irregular. Show the total of the bid on the face of the proposal.

If the proposal is made by an individual, either in the bidder's own proper person or under a trade or firm name, the bidder shall execute the proposal under his signature and indicate the firm's bidding office street address. If made by a partnership, execute the proposal by setting out in full the names of the partners and the firm name of the partnership, if any, and have two or more of the general partners sign the proposal. Also, indicate the firm's bidding office street address. If made by a corporation, execute the proposal by setting out in full the corporate name and have the president or other legally authorized corporate officer or agent sign the proposal. Also, affix the corporate seal, and indicate the corporation's bidding office street address.

2-5.2 Declaration of Noncollusion: File with the Department Form 375-020-08, contained in the proposal, which includes an unsworn statement executed by, or on behalf of, the person, firm, association, or corporation submitting the bid certifying that such person, firm, association, or corporation has not, either directly or indirectly, entered into any agreement, participated in any collusion, or otherwise taken any action in restraint of free competitive bidding in connection with the submitted bid. The Department will not consider any bid unless such form is properly completed in accordance with the requirements shown thereon.

2-6 Rejection of Irregular Proposals.

A proposal is irregular and the Department may reject it if it shows omissions, alterations of form, additions not specified or required, conditional or unauthorized alternate bids, or irregularities of any kind; or if the unit prices are obviously unbalanced, either in excess of or below the reasonable cost analysis values.

When the Department provides for alternate bids in the proposal form and the bidder submits non-computer-generated proposal form sheets, make only one entry in each design group. A proposal that provides for alternative bids is irregular and the Department may reject it if the bidder makes entries for more than one alternate.

2-7 Guaranty to Accompany Proposals.

The Department will not consider any proposal unless it is accompanied by a proposal guaranty of the character and amount indicated in the Notice to Contractors, and unless it is made payable to the Florida Department of Transportation. Submit proposals with the understanding that the successful bidder shall furnish a Contract Bond pursuant to the requirements of 3-5.

2-8 Delivery of Proposals.

Submit all bids in sealed envelopes, bearing on the outside the name of the bidder, the bidder's address, and the number of the project for which the bidder submitted the bid. For proposals that are submitted by mail, enclose the proposal in a sealed envelope, marked as directed above. Enclose the sealed envelope in a second outer envelope addressed to the Department, at the place designated in the Notice to Contractors. For a proposal that is not submitted by mail, deliver it to the Contracts Office of the Department, or to the place as designated in the Notice to Contractors. The Department will return proposals received after the time set for opening bids to the bidder unopened.

2-9 Withdrawal or Revision of Proposals.

A bidder may withdraw or revise a proposal after submitting it, provided the Department receives a written request to withdraw or revise the proposal prior to the time set for opening of bids. The resubmission of any proposal withdrawn under this provision is subject to the provisions of 2-8.

Legible facsimile (FAX) proposal changes will be accepted if received in full at the fax number listed in the Bid Solicitation Notice by the time proposals are due on the day of the letting and provided that all of the following conditions are met:

1. The Bidder=s name is the same on the faxed proposal change as shown on the original proposal.

2. The proposal change includes the following:

The correct Financial Project Number.

The correct bid item number being changed and the respective unit price change.

The correct revised total per item.
The revised total bid amount.
The signature of the President or Vice President of the Company.

Faxed proposal changes failing to meet all of these requirements will not be considered and will not change the original bid.

The Department will not be responsible for any communications or fax machine breakdowns, transmission interruptions, delays, or any other problems that interfere with the receipt of faxed proposal changes as required above either at the Bidder=s fax location, at the Department=s fax location, or anywhere between these locations. Receipt or non-receipt of a faxed proposal change will not be considered grounds for a bid protest.

2-10 Opening of Proposals.

The Department will open and publicly read proposals at the time and place indicated in the Notice to Contractors. The Department invites bidders, their authorized agents, and other interested parties to attend.

2-11 Disqualification of Bidders.

The Department may disqualify any bidder and reject the bidder's proposal or proposals for any of the following reasons:

(a) The submission of more than one proposal for the same work from an individual, firm, or corporation under the same or a different name.

(b) Evidence that one bidder has a financial interest in the firm of another bidder for the same work.

(c) Evidence of collusion among bidders. The Department will not recognize a participant in such collusion as a bidder for any future work of the Department until the Department reinstates such participant as a qualified bidder.

(d) Failure to qualify in accordance with 2-1.

(e) Uncompleted work on other projects that, in the judgment of the Department, could hinder or prevent the prompt completion of the proposed work.

(f) Failure to pay or satisfactorily settle all bills due for labor and material on other contracts in force at the time of advertisement for bids.

(g) Default under a previous contract.

(h) Employment of unauthorized aliens in violation of Section 274A (e) of the Immigration and Nationalization Act.

2-12 Material, Samples and Statement.

The Department may require that the bidder furnish a statement of the origin, composition, and manufacture of any and all materials to be used in the construction of the work, together with samples that may be subjected to the tests provided for in these Specifications to determine the materials' quality and fitness for the work.

SECTION 3

AWARD AND EXECUTION OF CONTRACT

3-1 Consideration of Bids.

For the purpose of award, after opening and reading the proposals, the Department will consider as the bid the correct summation of each unit bid price multiplied by estimated quantities shown in the proposal form. On this basis, the Department will compare the amounts of each bid and make the results of such comparison available to the public. Until the actual award of the Contract, however, the Department reserves the right to reject any or all proposals and to waive technical errors that the Department may deem best for the interest of the State. In the event of any discrepancy in the three entries for the price for any item, the Department will evaluate the bid based on the unit price as shown in words unless the extension and the unit price shown in figures are in agreement with each other, in which case, the Department will evaluate the bid based on the amounts in agreement over the unit price shown in words.

The Department reserves the right to delete the bid portion of the utility relocation work from the Contract. When the Department deletes utility relocation work from the Contract, the Department will recalculate the Contract bid tabulations based on the remaining project quantities.

In the event that the Department deletes utility relocation work from the Contract, the utility owner will relocate such utilities in accordance with the utility Relocation Schedule attached to the Specifications Package.

3-2 Award of Contract.

3-2.1 General: If the Department decides to award the Contract, the Department will award the Contract to the lowest responsible bidder whose proposal complies with all the Contract Document requirements. If awarded, the Department will award the Contract within 50 days after the opening of the proposals, unless the Special Provisions change this time limit or the bidder and the Department extend the time period by mutual consent.

3-2.2 Bids Exceeding Contractor's Rating: The Department will address bids exceeding a Contractor's rating, and the resulting impact on the Contractor's qualification to bid, in accordance with Florida Administrative Code Rules 14-22.003 and 14-22.009.

The bidder's proposal guaranties are binding for all projects awarded to the Contractor pursuant to the provisions of this Subarticle.

3-3 Cancellation of Award.

The Department reserves the right to cancel the award of any contract at any time before the execution of the contract by all parties, with no compensation due any of the bidders.

3-4 Release of Proposal Guaranty.

The Department will release all proposal guaranties except those of the two lowest bidders immediately following the opening and checking of the proposals. The Department will immediately release the proposal guaranties of the two lowest bidders after the successful bidder delivers the executed contract and a satisfactory bond to the Department, except that the Department will not retain the proposal guaranty of the next-to-lowest bidder longer than 50 days after the opening of the proposals unless the Department awards the contract to the next lowest bidder prior to the expiration of this time limit.

3-5 Contract Bond Required.

3-5.1 General Requirements of the Bond: Upon award, furnish to the Department, and maintain in effect throughout the life of the Contract, an acceptable surety bond in a sum at least equal to the amount of the Contract. Execute such bond on the form furnished by the Department. Obtain a surety that has a resident agent in the State of Florida, meets all of the requirements of the laws of Florida and the regulations of the Department, and has the Department's approval. Ensure that the surety's resident agent's name, address, and telephone number is clearly stated on the face of the Contract Bond.

On contracts of $150,000 or less, the Department may waive the requirement for all or a portion of a surety bond if it determines that the project is of a noncritical nature and nonperformance will not endanger the public health, safety, or property. The Department may require alternate means of security if it waives the requirement for a surety bond.

3-5.2 Continued Acceptability of Surety: Provide a surety bond that remains acceptable to the Department throughout the life of the Contract. In the event that the surety executing the bond, although acceptable to the Department at the time of execution of the Contract, subsequently becomes insolvent or bankrupt, or becomes unreliable or otherwise unsatisfactory due to any cause that becomes apparent after the Department's initial approval of the company, then the Department may require that the Contractor immediately replace the surety bond with a similar bond drawn on a surety company that is reliable and acceptable to the Department. In such an event, the Department will bear all costs of the premium for the new bond, after deducting any amounts that are returned to the Contractor from his payment of premium on the original bond.

3-5.3 Default by Contractor: In case of default on the part of the Contractor, the Department will charge against the bond all expenses for services incidental to ascertaining and collecting losses under the bond, including accounting, engineering, and legal services, together with any and all costs incurred in connection with renegotiation of the Contract.

3-5.4 Surety to Furnish Legal Defense: The surety company shall indemnify and provide defense for the Department when called upon to do so for all claims or suits against the Department arising out of the Contract. The amount of the Contract price is the sole limitation of this indemnification.

3-5.5 Liability for Wrongful or Criminal Act by Contractor: The principal and surety executing the bond shall be liable to the State in any civil action that might be instituted by the Department or any officer of the State authorized in such cases, for double any amount in money or property the State might lose, or be overcharged, or otherwise be defrauded of by any wrongful or criminal act of the Contractor, his agent or his employees.

3-6 Execution of Contract and Bond.

Within 20 days after contract award, execute the necessary agreements to enter into a contract with the Department and return the agreement along with a satisfactory surety bond to the Department's Contracts Office at Tallahassee. For each calendar day that the successful bidder is late in delivering to the Department's Contracts Office all required documents in properly executed form, the Department will deduct one day from the allowable Contract Time as specified in 8-7.1. The Department will not be bound by any proposal until it executes the associated Contract. The Department will execute the Contract and bond in the manner stipulated in 2-5.1.

The Department will execute the Contract within 15 days after receipt of the necessary agreements and bond from the Contractor.

3-7 Failure by Contractor to Execute Contract and Furnish Bond.

In the event that the bidder fails to execute the awarded Contract and to file an acceptable bond, as prescribed in 3-5 and 3-6, within 20 days of Contract award, the Department may annul the award, causing the bidder to forfeit the proposal guaranty to the Department; not as a penalty but in liquidation of damages sustained. The Department may then award the Contract to the next lowest responsible bidder, re-advertise, or accomplish the work using day labor.

3-8 Audit of Contractor's Records.

Upon execution of the Contract, the Department reserves the right to conduct an audit of the Contractor's records pertaining to the project. The Department or its representatives may conduct an audit, or audits, at any time prior to final payment, or thereafter pursuant to 5-13. The Department may also require submittal of the records from either the prime contractor, the subcontractor, or both. As the Department deems necessary, records include all books of account, supporting documents, and papers pertaining to the cost of performance of the project work.

If the Contractor fails to comply with these requirements, the Department may disqualify or suspend the Contractor from bidding on or working as a subcontractor on future Contracts.

Ensure that the subcontractors provide access to their records pertaining to the project upon request by the Department.

SECTION 4

SCOPE OF THE WORK

4-1 Intent of Contract.

The intent of the Contract is to provide for the construction and completion in every detail of the work described in the Contract. Furnish all labor, materials, equipment, tools, transportation, and supplies required to complete the work in accordance with the Contract Documents.

4-2 Work not covered by Standard Specifications.

Proposed construction and any contractual requirements not covered by these

Standard Specifications may be covered by Contract plan notes or by Supplemental Specifications or Special Provisions for the Contract, and all requirements of such Supplemental Specifications or Special Provisions shall be considered as a part of these Specifications.

4-3 Alteration of Plans or of Character of Work.

4-3.1 General: The Engineer reserves the right to make, at any time prior to or during the progress of the work, such increases or decreases in quantities, whether a significant change or not, and such alterations in the details of construction, whether a substantial change or not, including but not limited to alterations in the grade or alignment of the road or structure or both, as may be found necessary or desirable by the Engineer. Such increases, decreases or alterations shall not constitute a breach of Contract, shall not invalidate the Contract, nor release the Surety from any liability arising out of this Contract or the Surety bond. The Contractor agrees to perform the work, as altered, the same as if it had been a part of the original Contract.

The term "significant change" applies only when:

(A) The Engineer determines that the character of the work as altered differs materially in kind or nature from that involved or included in the original proposed construction, or

(B) A major item of work, as defined in 1-3, is increased in excess of 125% or decreased below 75% of the original Contract quantity. The Department will apply any price adjustment for an increase in quantity only to that portion in excess of 125% of the original Contract item quantity, or in case of a decrease below 75% to the actual amount of work performed, such allowance to be determined in accordance with 4-3.2, below.

In the instance of (A) above, the determination by the Engineer shall be conclusive and shall not subject to challenge by the Contractor in any forum, except upon the Contractor establishing by clear and convincing proof that the determination by the Engineer was without any reasonable and good-faith basis.

4-3.2 Increase, Decrease or Alteration in the Work: The Engineer reserves the right to make alterations in the character of the work which involve a substantial change in the nature of the design or in the type of construction or which materially increases or decreases the cost or time of performance. Such alteration shall not constitute a breach of Contract, shall not invalidate the Contract or release the Surety. The Engineer may direct in writing that the work be done and, at the Engineer=s sole discretion, the Contractor will be paid pursuant to an agreed Supplemental Agreement or in the following manner:

(a) Labor: The Contractor will receive payment for direct labor and burden on the actual costs of the additional or unforeseen work, plus a mark-up of 25%.

(b) Materials and Supplies: For materials accepted by the Engineer and used on the project, the Contractor will receive the actual cost of such materials incorporated into the work, including Contractor paid transportation charges (exclusive of equipment as hereinafter set forth), plus 17.5%. For supplies reasonably needed for performing the work, the Contractor will receive the actual cost of such supplies, plus 17.5%.

(c) Equipment: For any machinery or special equipment (other than small tools), including fuel and lubricant, the Contractor will receive 100% of the ARental

Rate Blue Book≅ for the actual time that such equipment is in operation on the work, and 50% of the ARental Rate Blue Book≅ for the time the equipment is directed to standby and remain on the project site, to be calculated as indicated below. The equipment rates will be based on the latest edition (as of the date the work to be performed begins) of the ARental Rate Blue Book for Construction Equipment≅ or the ARental Rate Blue Book for Older Construction Equipment,≅ whichever is applicable, as published by Machinery Information Division of PRIMEDIA Information, Inc. (version current at the time of bid), using all instructions and adjustments contained therein and as modified below. On all projects, the Engineer will adjust the rates using regional adjustments and Rate Adjustment Tables according to the instructions in the Blue Book.

Allowable Equipment Rates will be established as set out below:

(1) Allowable Hourly Equipment Rate = Monthly Rate/176 x Adjustment Factors x 100%.

(2) Allowable Hourly Operating Cost = Hourly Operating Cost x 100%.

(3) Allowable Rate Per Hour = Allowable Hourly Equipment Rate + Allowable Hourly Operating Cost.

(4) Standby Rate = Allowable Hourly Equipment Rate x 50%.

The Monthly Rate is The Basic Machine Rate Plus Any Attachments. Standby rates will apply when equipment is not in operation and is directed by the Engineer to standby at the project site when needed again to complete work and the cost of moving the equipment will exceed the accumulated standby cost. Standby rates will not apply on any day the equipment operates for eight or more hours. Standby payment will be limited to only that number of hours which, when added to the operating time for that day equals eight hours. Standby payment will not be made on days that are not normally considered work days on the project.

The Department will allow for the cost of transporting the equipment to and from the location at which it will be used. If the equipment requires assembly or disassembly for transport, the Department will pay for the time to perform this work at the rate for standby equipment.

(d) The Contractor will be allowed a markup of 10% on the first $50,000 and a markup of 5% on any amount over $50,000 on any subcontract directly related to the additional or unforeseen work. A subcontractor mark-up will be allowed only by the prime Contractor and a first tier subcontractor.

(e) General Liability Insurance and Bond: The Contractor will receive a mark-up of 1.5% on the overall total cost of the additional or unforeseen work for insurance and bond.

The markups in (a), (b), (c) and (e) above include all indirect costs and expenses of the Contractor, including but not limited to overhead of any kind, and reasonable profit.

The monetary compensation provided for above constitutes full and complete payment for such additional work and the Contractor shall have no right to any additional monetary compensation for any direct or indirect costs or profit for any such additional work beyond that expressly provided above. The Contractor shall be entitled to a time extension only to the extent that the performance of any portion of the additional work is a controlling work item and the performance of such controlling work item actually delays completion of the project due to no fault of the Contractor. All time related costs for actual performance of such additional work are included in the compensation already provided above and any time extension entitlement hereunder will be without additional monetary compensation. The Contractor shall have no right to any monetary compensation or damages whatsoever for any direct or indirect delay to a controlling work item arising out of or in any way related to the circumstances leading up to or resulting from additional work, except (a) as is provided above when the performance of any portion of the additional work is a controlling work item and the performance of such controlling work item actually delays completion of the project due to no fault of the Contractor or (b) only as provided for under 5-12.5.2.1 and 5-12.5.2.2.

4-3.3 No Waiver of Contract: Changes made by the Engineer will not be considered to waive any of the provisions of the Contract, nor may the Contractor make any claim for loss of anticipated profits because of the changes, or by reason of any variation between the approximate quantities and the quantities of work actually performed. All work shall be performed as directed by the Engineer and in accordance with the Contract Documents.

4-3.4 Conditions Requiring a Supplemental Agreement or Unilateral Payment: A Supplemental Agreement or Unilateral Payment will be used to clarify the plans and specifications of the Contract; to document quantity overruns that exceed 5% of the original Contract amount; to provide for unforeseen work, grade changes, or alterations in plans which could not reasonably have been contemplated or foreseen in the original plans and specifications; to change the limits of construction to meet field conditions; to provide a safe and functional connection to an existing pavement; to settle documented Contract claims; to make the project functionally operational in accordance with the intent of the original Contract and subsequent amendments thereto.

A Supplemental Agreement or Unilateral Payment may be used to expand the physical limits of the project only to the extent necessary to make the project functionally operational in accordance with the intent of the original Contract. The cost of any such agreement extending the physical limits of the project shall not exceed $100,000 or 10% of the original Contract price, whichever is greater.

Perform no work to be covered by a Supplemental Agreement or Unilateral Payment before written authorization is received from the Engineer. The Engineer=s written authorization will set forth sufficient work information to allow the work to begin. The work activities, terms and conditions will be reduced to written Supplemental Agreement or Unilateral Payment form promptly thereafter. No payment will be made on a Supplemental Agreement or Unilateral Payment prior to the Department=s approval of the document.

4-3.5 Extra Work: Extra work authorized in writing by the Engineer will be paid in accordance with the formula in 4-3.2. Such payment will be the full extent of all monetary compensation entitlement due to the Contractor for such extra work. Any entitlement to a time extension due to extra work will be limited solely to that provided for in 4-3.2 for additional work.

4-3.6 Connections to Existing Pavement, Drives and Walks: Generally adhere to the limits of construction at the beginning and end of the project as detailed in the plans. However, if the Engineer determines that it is necessary to extend the construction in order to make suitable connections to existing pavement, the Engineer will authorize such a change in writing.

For necessary connections to existing walks and drives that are not indicated on the plans, the Engineer will provide direction regarding the proper connections in accordance with the Roadway and Traffic Design Standards.

4-3.7 Differing Site Conditions: During the progress of the work, if subsurface or latent physical conditions are encountered at the site differing materially from those indicated in the Contract, or if unknown physical conditions of an unusual nature differing materially from those ordinarily encountered and generally recognized as inherent in the work provided for in the Contract are encountered at the site, the party discovering such conditions shall promptly notify the other party in writing of the specific differing conditions before the Contractor disturbs the conditions or performs the affected work.

Upon receipt of written notification of differing site conditions from the Contractor, the Engineer will investigate the conditions, and if it is determined that the conditions materially differ and cause an increase or decrease in the cost or time required for the performance of any work under the Contract, an adjustment will be made, excluding loss of anticipated profits, and the Contract will be modified in writing accordingly. The Engineer will notify the Contractor whether or not an adjustment of the Contract is warranted.

The Engineer will not allow a Contract adjustment for a differing site condition unless the Contractor has provided the required written notice.

The Engineer will not allow a Contract adjustment under this clause for any effects caused to any other Department or non-Department projects on which the Contractor may be working.

4-3.8 Changes Affecting Utilities: The Contractor shall be responsible for identifying and assessing any potential impacts to a utility that may be caused by the changes proposed by the Contractor, and the Contractor shall at the time of making the request for a change notify the Department in writing of any such potential impacts to utilities.

4-3.9 Value Engineering Incentive:

4-3.9.1 Intent and Objective:

(1) This Subarticle applies to any cost reduction proposal (hereinafter referred to as a Value Engineering Change Proposal or VECP) that the Contractor initiates and develops for the purpose of refining the Contract to increase cost effectiveness or significantly improve the quality of the end result. This Subarticle does not, however, apply to any such proposal unless the Contractor identifies it at the time of its submission to the Department as a proposal submitted pursuant to this Subarticle.

(2) The Department will consider VECPs that would result in net savings to the Department by providing either: (a) a decrease in the cost of performance of the Contract; or (b) a reduction in cost of ownership (hereinafter referred to as collateral costs) of the work provided by this Contract, regardless of acquisition costs. VECPs must result in savings without impairing essential functions and characteristics such as safety, service, life, reliability, economy of operation, ease of maintenance, aesthetics and necessary standard design features. However, nothing herein prohibits the Contractor from submitting VECPs when the required functions and characteristics can be combined, reduced or eliminated

because they are nonessential or excessive. The Department will not recognize the Contractor's correction of plan errors that result in a cost reduction, as a VECP.

(3) The Department reserves the right to reject at its discretion any VECP submitted that proposes a change in the design of the pavement system or that would require additional right-of-way. The Department will not allow the substitution of another design alternate, on which the Contractor could have bid, that is detailed in the plans for the one on which the Contractor has bid, under this Subarticle. Pending the Department's execution of a formal supplemental agreement implementing an approved VECP, the Contractor shall remain obligated to perform the work in accordance with the terms of the existing Contract. The Department will not grant any time extensions to allow for the time required to review a VECP.

4-3.9.2 Subcontractors: The Department encourages the Contractor to include the provisions of this Subarticle in Contracts with subcontractors and to encourage submission of VECPs from subcontractors. However, it is not mandatory to submit VECPs to the Department or to accept or transmit subcontractor proposed VECPs to the Department.

4-3.9.3 Data Requirements: As a minimum, submit the following information with each VECP:

(1) a description the difference between the existing Contract requirement and the proposed change, and the comparative advantages and disadvantages.

(2) separate detailed cost estimates for both the existing Contract requirement and the proposed change. Break down the cost estimates by Contract item numbers indicating quantity increases or decreases and deleted pay items. Identify additional proposed work not covered by Contract items, by using current Department pay item numbers. In preparing the estimates, include overhead, profit, and bond. The Department will not allow any separate pay item(s) for the cost of overhead, profit, and bond.

(3) an itemization of the changes, deletions or additions to plan details, plan sheets, design standards and specifications that are required to implement the VECP if the Department adopts it. Provide preliminary plan drawings sufficient to describe the proposed changes.

(4) an estimate of the effects the VECP would have on collateral costs to the Department.

(5) engineering or other analysis in sufficient detail to identify and describe specific features of the Contract that must be changed if the Department accepts the VECP with a proposal as to how these changes can be accomplished and an assessment of their effect on other project elements. The Department may require that engineering analyses be performed by a prequalified consultant in the applicable class of work. Support all design changes that result from the VECP with prints of drawings and computations signed and sealed by the Specialty Engineer.

(6) state the time by which the Department must approve the VECP to obtain the total estimated cost reduction during the remainder of the Contract, noting any effect on the Contract completion time or delivery schedule.

4-3.9.4 Processing Procedures: Submit two copies of each VECP to the Engineer or his duly authorized representative. The Department will process VECPs expeditiously; however, the Department is not liable for any delay in acting upon a

VECP submitted pursuant to this Subarticle. The Contractor may withdraw, in whole or in part, a VECP not accepted by the Department within the period specified in the VECP. The Department is not liable for any VECP development cost in the case where the Department rejects or the Contractor withdraws a VECP.

The Engineer is the sole judge of the acceptability of a VECP and of the estimated net savings in construction and collateral costs from the adoption of all or any part of such proposal. In determining the estimated net savings, the Department reserves the right to disregard the Contract bid prices if, in the judgement of the Engineer, such prices do not represent a fair measure of the value of work to be performed or to be deleted.

Prior to approval, the Engineer may modify a VECP, with the concurrence of the Contractor, to make it acceptable. If any modification increases or decreases the net savings resulting from the VECP, the Department will determine the Contractor's fair share upon the basis of the VECP as modified and upon the final quantities. The Department will compute the net savings by subtracting the revised total cost of all bid items affected by the VECP from the total cost of the same bid items as represented in the original Contract.

Prior to approval of the VECP that initiates the supplemental agreement, provide acceptable Contract-quality plan sheets revised to show all details consistent with the VECP design.

4-3.9.5 Computations for Change in Contract Cost of Performance: The Department will not pay for the Contractor's VECP development and implementation costs. If the VECP is adopted, the Contractor's share of the net savings as defined hereinafter represents full compensation to the Contractor for the VECP.

The Department will not include its costs to process and implement a VECP in the estimate. However, the Department reserves the right, where it deems such action appropriate, to require the Contractor to pay the Department's cost of investigating and implementing a VECP as a condition of considering such proposal. When the Department imposes such a condition, the Contractor shall accept this condition in writing, authorizing the Department to deduct amounts payable to the Department from any monies due or that may become due to the Contractor under the Contract.

4-3.9.6 Computations for Collateral Costs: To determine any collateral cost savings, prepare separate estimates for collateral costs of both the existing Contract requirement and the proposed change. Provide estimates that consist of an itemized breakdown of all costs and the basis for the data used in the estimate. Cost benefits to the Department include, but are not limited to, reduced costs of operation, maintenance or repair, and extended useful service life. Increased collateral costs include the converse of such factors.

Compute collateral costs as follows:

(1) Calculate costs over a 20-year period on a uniform basis for each estimate.

(2) If the difference in the estimates as approved by the Department indicates a savings, divide the resultant amount by 20 to arrive at the average annual net collateral savings. The Department will share the average annual net collateral savings as stipulated in 4-3.5.7.

4-3.9.7 Sharing Arrangements: If the Department approves a VECP, the Contractor may be entitled to share in both construction savings and collateral savings to the full extent provided for in this Subarticle. The Contractor shall receive 50% of the net reduction in the cost of performance of the Contract due to an approved VECP, except for innovative ideas.

For innovative ideas, as determined by the Engineer, the Contractor and the Department shall share the reduction in the cost of performance as follows:

Accrued Net Savings	Contractor's Share %	Department's Share %
Less than $25,000	100	0
$25,000 to $50,000	75	25
Over $50,000	50	50

The Department will not consider an approved change that is identical or similar to a previously submitted VECP or an idea previously used by the Department as an innovative idea.

When collateral savings occur, the Department will provide the Contractor with 20% of the average annual net collateral savings.

4-3.9.8 Department's Future Rights to a VECP: In the event of acceptance of a VECP, the Contractor hereby grants to the Department all rights to use, duplicate or disclose, in whole or in part, in any manner and for any purpose whatsoever, and to have or to permit others to do so, royalty free and without fee, other costs or surcharge, data reasonably necessary to fully utilize such proposal on this and any other Department Contract.

4-4 Unforeseeable Work.

When the Department requires work that is not covered by a price in the Contract and such work does not constitute a "Significant Change" as defined in 4-3.2.1, and the Department finds that such work is essential to the satisfactory completion of the Contract within its intended scope, the Department will make an adjustment to the Contract. The Engineer will determine the basis of payment for such an adjustment in a fair and equitable amount.

4-5 Rights in and Use of Materials Found on the Site of the Work.

4-5.1 Ownership and Disposal of Existing Materials: Take ownership and dispose of all materials that are not designated as the property of other parties, in both roadway and structures, found on the right-of-way, and all material in structures designated for removal. Such materials do not include earth or other excavated material required for the construction of the project. During construction, the Contractor may use materials from existing structures that are required to be removed and that are designated to remain the property of the Department. Do not cut or otherwise damage such material during removal unless the Engineer gives permission to do so. Store material in an accessible location as the Engineer directs. The Department is not responsible for the quality or quantity of any material salvaged.

4-5.2 Ornamental Trees and Shrubs: Take ownership of all ornamental trees or shrubs existing in the right-of-way that are required to be removed for the construction operations and which are not specifically designated on the plans to be reset, or to be removed by others prior to the construction operations.

4-6 Final Cleaning Up of Right-of-Way.

Upon completion of the work, and before the Department accepts the work and makes final payment, remove from the right-of-way and adjacent property all falsework, equipment, surplus and discarded materials, rubbish and temporary structures; restore in an acceptable manner all property, both public and private, that has been damaged during the prosecution of the work; and leave the waterways unobstructed and the roadway in a neat and presentable condition throughout the entire length of the work under Contract. Do not dispose of materials of any character, rubbish or equipment, on abutting property, with or without the consent of the property owners. The Engineer will allow the Contractor to temporarily store equipment, surplus materials, usable forms, etc., on a well-kept site owned or leased by the Contractor, adjacent to the project. However, do not place or store discarded equipment, materials, or rubbish on such a site.

Shape and dress areas adjacent to the project right-of-way that were used as plant sites, materials storage areas or equipment yards when they are no longer needed for such purposes. Grass these areas when the Engineer directs. The Department will pay for directed grassing work under the appropriate Contract items.

SECTION 5

CONTROL OF THE WORK

5-1 Plans and Working Drawings.

5-1.1 Plans and Contract Documents: The Department will furnish the Contractor copies of the plans and Special Provisions as required for the particular project. The Contractor may purchase copies of the Standard Specifications and Roadway and Traffic Design Standards from the Department. Have available on the worksite, at all times, one copy of the Contract Documents.

5-1.2 Department's Plans: The Department will furnish plans that consist of general drawings showing such details as are necessary to give a comprehensive idea of the construction contemplated. In general, roadway plans will show alignment, profile grades, typical cross-sections and general cross-sections. In general, structure plans will show in detail all dimensions of the work contemplated. When the structure plans do not show the dimensions in detail, they will show general features and such details as are necessary to give a comprehensive idea of the structure.

Grades shown are finished grades, and B.M. Datum is National Geodetic Vertical Datum of 1929 (NGVD-1929) unless otherwise noted in the plans.

5-1.3 Alterations in Plans: The Department will issue, in writing, all authorized alterations affecting the requirements and information given on the approved plans.

5-1.4 Shop Drawings (for Structures):

5-1.4.1. Definitions:

(a) Shop Drawings: All working, shop and erection drawings, associated trade literature, calculations, schedules, manuals and similar documents submitted by the Contractor to define some portion of the project work. The type of work includes both permanent and temporary works as appropriate to the project.

(b) Permanent Works: All the permanent structures and parts thereof required of the completed Contract.

(c) Temporary Works: Any temporary construction work necessary for the construction of the permanent works. This includes falsework, formwork, scaffolding, shoring, temporary earthworks, sheeting, cofferdams, special erection equipment and the like.

(d) Construction Affecting Public Safety: Construction that may jeopardize public safety such as structures spanning functioning vehicular roadways, pedestrian walkways, railroads, navigation channels of navigable waterways and walls or other structure foundations located in embankments immediately adjacent to functioning roadways. It does not apply to those areas of the site under the Contractor's control and outside the limits of normal public access.

(e) Major and Unusual Structures: Bridges of complex geometry and/or complex design. Generally, this includes the following types of structures:

1. Bridges with an individual span longer than 300 feet [100 m].
2. Structurally continuous superstructures with spans over 50 feet [15 m].
3. Steel box and plate girder bridges.
4. Steel truss bridges.
5. Concrete segmental and longitudinally post-tensioned continuous girder bridges.
6. Cable stayed or suspension bridges.
7. Curved girder bridges.
8. Arch bridges.
9. Tunnels.
10. Movable bridges (specifically electrical and mechanical components).
11. Rehabilitation, widening, or lengthening of any of the above.

(f) Special Erection Equipment includes launching gantries, beam and winch equipment, form travelers, stability towers, strong-backs, erection trusses, launching noses or similar items made purposely for construction of the structure. It does not apply to commonly available proprietary construction equipment such as cranes.

(g) Falsework includes any temporary construction work used to support the permanent structure until it becomes self-supporting. Falsework includes steel or timber beams, girders, columns, piles, and foundations, and any proprietary equipment including modular shoring frames, post shores, and adjustable horizontal shoring.

(h) Formwork includes any structure or mold used to retain plastic or fluid concrete in its designated shape until it hardens. Formwork comprises common materials such as wood or metal sheets, battens, soldiers and walers, ties, proprietary forming systems such as stay-in-place metal forms, and proprietary supporting bolts, hangers, and brackets. Formwork may be either permanent formwork requiring a shop drawing submittal such as stay-in-place metal or concrete forms, or may be temporary formwork which requires certification by the Specialty Engineer for Construction Affecting Public Safety and for Major and Unusual Structures.

(i) Scaffolding is an elevated work platform used to support workmen, materials, and equipment, but not intended to support the structure.

(j) Shoring is a component of falsework such as horizontal, vertical, or inclined support members. In this Section, this term is interchangeable with falsework.

5-1.4.2 Work Items Requiring Shop Drawings: For guidance, the Department identifies work that may require shop drawings in the Summary of Pay Items with a pound (#) symbol. However, items so identified do not necessarily represent the only items of work requiring shop drawings, nor do items so identified necessarily require shop drawings for the particular project. Also, other provisions of the Contract Documents may waive the requirement for submittals for certain items so identified; i.e., items constructed from standard drawings or those complying with alternate details for prestressed members under Section 450. Review the Contract Documents to determine the submittals required.

The following signing and lighting items are structural items:

(a) Lighting: Poles, bracket arms, frangible bases, and foundations.

(b) Signing: Mounting brackets for bridge-mounted signs, overhead cantilever structures, overhead truss structures, overhead sequential sign structures, and multiple post sign supports, along with applicable foundations.

In general, the Department requires shop drawings for:

(a) Bridge, bulkhead and retaining wall structures, cofferdams, and lighting and signing structural items, along with the applicable foundations.

(b) Signing, lighting, drainage structures, attenuators, and other nonstructural items.

(c) Building structures.

(d) Contractor-originated re-design.

(e) Design and structural details furnished by the Contractor in compliance with the Contract.

(f) Special erection equipment.

(g) Falsework and shoring.

Additional clarification for certain types of bridge structures is provided in 5-1.4.9.

5-1.4.3 Schedule of Submittals: When required in the Contract Documents or when requested by the Department, prepare and submit a schedule of submittals that identifies the work for which shop drawings apply. For each planned submittal, define the type, and approximate number of drawings or other documents that are included and the planned submittal date, considering the processing requirements herein. When required, submit the schedule of submittals to the Department within 60 days of the start of the Contract, and prior to the submission of any shop drawings.

Coordinate subsequent submittals with construction schedules to allow sufficient time for review, approval, and re-submittal as necessary.

5-1.4.4 Style, Numbering, and Material of Submittals:

5-1.4.4.1 Drawings: Furnish all shop drawings that are necessary to complete the structure in compliance with the design shown on the plans. Prepare all shop drawings using the same units of measure as those used in the Department=s plans. Prepare or reproduce drawings on permanent material made for that purpose, such as tracing cloth, plastic, mylar, or xerographic bond paper, hereafter referred to as "masters". Use sheets no larger than 24 by 36 inches [610 by 915 mm]. Consecutively number each sheet in the submittal series, and indicate the total number in the series (i.e., 1 of 12, 2 of 12, . . ., 12 of 12). Include on each shop drawing the following items as a minimum requirement: the complete State Project Number, drawing title and number, a title block showing the names of the fabricator or producer and the Contractor for which the work is being done, the initials of the person(s) responsible for the drawing, the date on which the drawing was prepared, the location of the item(s) within the project, the Contractor's approval stamp with date and initials, and, when applicable, the signature and embossed seal of the Specialty Engineer. The Department may request a re-submittal when any of this minimum information is not included.

5-1.4.4.2 Other Documents: Provide original documents or clearly legible photographic or xerographic copies of documents other than drawings, such as trade literature, catalogue information, calculations, and manuals. Provide sheets no larger than 11 by 17 inches [280 by 432 mm]. Clearly label and number each sheet in the submittal to indicate the total number of sheets in the series (i.e., 1 of 12, 2 of 12, . . ., 12 of 12).

Prepare all documents using the same units of measure as those used in the Department=s plans. Bind and submit all documents with a Table of Contents cover sheet. List on the cover sheet the total number of pages and appendices, and include the complete State Project Number, a title referencing the submittal item(s), the name of the firm and person(s) responsible for the preparation of the document, the Contractor's approval stamp with date and initials, and, when applicable, the signature and embossed seal of the Specialty Engineer.

Submit appropriately prepared and checked calculations and manuals that clearly outline the design criteria. Include on the internal sheets the complete State Project Number and the initials of the person(s) responsible for preparing and checking the document.

Clearly label trade literature and catalogue information on the front cover with the title, State Project Number, date and name of the firm and person(s) responsible for that document.

Provide these other shop drawing documents listed above on drawing, xerographic, or glossy paper material as appropriate.

5-1.4.5 Submittal Paths and Copies:

5-1.4.5.1 Bridge, Bulkhead, and Retaining Wall Structures, Cofferdams, and Lighting and Signing Structural Items, and Applicable Foundations: The Department does not require shop drawings for prequalified items, except for their corresponding foundations. Determine the number of copies and the submittal path to be followed based upon the identity of the Engineer of

Record as shown adjacent to the title block on the structural plan sheets, and on the key sheets of roadway plans, signing, and pavement marking plans, and/or lighting plans.

(a) When the Florida Department of Transportation is the Engineer of Record, submit one set of prints along with the set of masters for each series of shop drawings to the appropriate FDOT Shop Drawing Review Office with a copy of the letter of transmittal sent to the Resident Engineer. For work requiring other information (e.g., catalog data, material certifications, material tests, procedure manuals, fabrication/welding procedures, and maintenance and operating procedures), submit 11 copies of each document to the appropriate FDOT Shop Drawing Review Office. If not shown on the plans, the Department will furnish the mailing address of the appropriate FDOT Shop Drawing Review Office.

(b) When the consultant is the Engineer of Record, submit one set of prints along with the set of masters for each series of shop drawings to the consultant with a copy of the letter of transmittal sent to both the Resident Engineer and the appropriate FDOT Shop Drawing Review Office. For work requiring other documentation (e.g., catalog data, material certifications, material tests, procedure manuals, fabrication/welding procedures, and maintenance and operating manuals), submit to the consultant 11 copies of each document with the prints. If not shown on the plans, the Department will furnish the mailing address of the Consulting Engineer of Record and the appropriate FDOT Shop Drawing Review Office.

5-1.4.5.2 Signing, Lighting, Drainage Structures and Attenuators, and Other Nonstructural Items: Determine the number of copies and the submittal path to be followed based upon the identity of the Engineer of Record as shown on the key sheets of roadway plans, signing and pavement marking plans, and/or lighting plans.

(a) When the Florida Department of Transportation is the Engineer of Record, submit seven sets of prints of each shop drawing to the FDOT Shop Drawing Review Office with a copy of the transmittal letter sent to the Resident Engineer for approval. Address all submittals and correspondence to the Engineer of Record as noted on the key sheet.

(b) When the consultant is the Engineer of Record, submit seven sets of prints of each shop drawing to the consultant listed as the Engineer of Record on the key sheet with a copy of the transmittal letter sent to both the Resident Engineer and the appropriate FDOT Shop Drawing Review Office.

5-1.4.5.3 Building Structures: Submit one set of prints and one set of masters for each series of working, shop and erection drawings, and all correspondence related to building structures, such as Rest Area Pavilions, Office Buildings, and Maintenance Warehouses, to the Architect of Record for review and approval. Send a copy of the transmittal to the Resident Engineer.

5-1.4.5.4 Contractor-Originated Design or Redesign: Submit to the Engineer of Record one set of prints along with the set of masters for each series of shop drawings and four copies of applicable calculations. Ensure that each print and the cover sheet of each copy of applicable calculations is signed and sealed by the Specialty Engineer. Transmit the submittal and copies of the transmittal letters in accordance with the requirements of 5-1.4.5.1 through 5-1.4.5.3, as appropriate.

5-1.4.5.5 Special Erection Equipment: For Construction Affecting

Public Safety and for Major and Unusual Structures, submit to the Engineer of Record one set of prints along with the set of masters for each series of shop drawings and four copies of applicable calculations. Ensure that each print and the cover sheet of each copy of applicable calculations is signed and sealed by the Specialty Engineer. Transmit the submittal and copies of the transmittal letters in accordance with the requirements of 5-1.4.5.1 through 5-1.4.5.3, as appropriate.

5-1.4.5.6 Falsework and Shoring: For Construction Affecting Public Safety and for Major and Unusual Structures, submit to the Engineer of Record one set of prints along with the set of masters for each series of shop drawings and four copies of applicable calculations. Ensure that each print and the cover sheet of each copy of applicable calculations is signed and sealed by the Specialty Engineer. Transmit the submittal and copies of the transmittal letters in accordance with the requirements of 5-1.4.5.1 through 5-1.4.5.3, as appropriate.

5-1.4.5.7 Formwork and Scaffolding: The Contractor is solely responsible for the safe installation and use of all formwork and scaffolding. The Department does not require any formwork or scaffolding submittals.

5-1.4.5.8 Other Miscellaneous Design and Structural Details Furnished by the Contractor in Compliance with the Contract: Submit to the Engineer of Record one set of prints along with the set of masters for each series of shop drawings and four copies of applicable calculations. Ensure that each print and the cover sheet of each copy of applicable calculations is signed and sealed by the Specialty Engineer. Transmit the submittal and copies of the transmittal letters in accordance with the requirements of 5-1.4.5.1 through 5-1.4.5.3, as appropriate.

5-1.4.6 Certifications:

5-1.4.6.1 Special Erection Equipment: Prior to its use, ensure that the Specialty Engineer personally inspects the special erection equipment and certifies to the Engineer in writing that the equipment has been fabricated in accordance with the submitted drawings and calculations. In addition, after assembly, ensure that the Specialty Engineer observes the equipment in use and certifies to the Engineer in writing that it is being used as intended and in accordance with the submitted drawings and calculations. In each case, ensure that the Specialty Engineer also signs and seals the letter of certification.

5-1.4.6.2 Falsework and Shoring Requiring Shop Drawings: After its erection or installation but prior to the application of any superimposed load, ensure that the Specialty Engineer personally inspects the falsework and certifies to the Engineer in writing that the falsework has been constructed in accordance with the materials and details shown on the submitted drawings and calculations. Ensure that the Specialty Engineer also signs and seals the letter of certification.

5-1.4.6.3 Temporary Formwork: For Construction Affecting Public Safety and for Major and Unusual Structures, prior to the placement of any concrete, ensure that the Specialty Engineer inspects the formwork and certifies to the Engineer in writing that the formwork has been constructed to safely withstand the superimposed loads to which it will be subjected. Ensure that the Specialty Engineer signs and seals the letter of certification.

5-1.4.7 Processing of Shop Drawings:

5-1.4.7.1 Contractor Responsibility for Accuracy and Coordination of Shop Drawings: Coordinate, schedule, and control all submittals, with a regard for the required priority, including those of the various subcontractors, suppliers, and engineers, to provide for an orderly and balanced distribution of the work.

The Contractor shall coordinate, review, date, stamp, approve and sign all shop drawings prepared by the Contractor or his agents (subcontractor, fabricator, supplier, etc.) prior to submitting them to the Engineer of Record for review. The Contractor, by signing his approval of the drawings submitted, confirms that he has verified the work requirements, units of measurement, field measurements, construction criteria, sequence of assembly and erection, access and clearances, catalog numbers, and other similar data. Indicate on each series of drawings the specification section and page or drawing number of the Contract plans to which the submission applies. Indicate on the shop drawings all deviations from the Contract drawings and itemize all deviations in the letter of transmittal. Likewise, whenever a submittal does not deviate from the Contract plans, clearly state so in the transmittal letter.

Schedule the submission of shop drawings to allow the Department a 45-day review period. The review period commences upon the Engineer of Record's receipt of the Contractor's valid submittal or re-submittal and terminates upon the FDOT Shop Drawing Review Office's transmittal of the submittal back to the Contractor. The Department considers a valid submittal as including all the minimum requirements outlined in 5-1.4.4.

Submit shop drawings to facilitate expeditious review. The Department discourages the Contractor from transmitting voluminous submittals of shop drawings at one time. For submittals transmitted in this manner, allow for the additional review time that may result.

Only Department approvals of miscellaneous submittals and "red ink" stamps on shop drawings are valid and all work that the Contractor performs in advance of approval will be at the Contractor's risk.

5-1.4.7.2 Scope of Review by Engineer: The Engineer of Record shall review the shop drawings for conformity to the requirements of the Contract Documents and to the intent of the design, and for the adequacy of the means, methods, techniques, sequences, and procedures proposed for construction. Review by the Engineer does not relieve the Contractor of responsibility for dimensional accuracy to ensure field fit and for conformity of the various components and details.

5-1.4.7.3 Special Review by Engineer of Shop Drawings for Construction Affecting Public Safety: For Construction Affecting Public Safety, the Engineer of Record, or other Engineer as the Department appoints for this purpose, will make an independent review of all relevant shop drawings and similar documents. Do not proceed with construction of the permanent works until receiving the Engineer of Record's approval.

5-1.4.8 Avoidance of Conflict of Interest: Do not engage either the Engineer of Record or any design engineer who participated in the design of the project to perform work for the project as the Specialty Engineer.

5-1.4.9 Other Requirements for Shop Drawings for Bridges:

5-1.4.9.1 Shop Drawings for Structural Steel and Miscellaneous Metals: Furnish shop drawings for structural steel and miscellaneous metals. Shop drawings shall consist of working, shop, and erection drawings, welding procedures, and other working plans, showing details, dimensions, sizes of material, and other information necessary for the complete fabrication and erection of the metal work.

5-1.4.9.2 Shop Drawings for Concrete Structures: Furnish shop drawings for concrete components that are not cast-in-place and are not otherwise exempted from submittal requirements. Also, furnish shop drawings for all details that are required for the effective prosecution of the concrete work and are not included in the Contract Documents such as: falsework, shoring, special erection equipment, bracing, centering, formwork, masonry layout diagrams, and diagrams for bending reinforcing steel, in addition to any details required for concrete components for the permanent work.

5-1.4.9.3 Shop Drawings for Major and Unusual Structures: In addition to any other requirements, within 60 days from the Notice to Proceed, submit information to the Engineer outlining the integration of the Major and Unusual Structure into the overall approach to the project. Where applicable to the project, include, but do not limit this information to:

(1) the overall construction program for the duration of the Contract. Clearly show the Milestone dates. (For example, the need to open a structure by a certain time for traffic operations.)

(2) the overall construction sequence. The order in which individual structures are to be built, the sequence in which individual spans of girders or cantilevers are erected, and the sequence in which spans are to be made continuous.

(3) the general location of any physical obstacles to construction that might impose restraints or otherwise affect the construction, and an outline of how to deal with such obstacles while building the structure(s). (For example, obstacles might include road, rail, and waterway clearances, temporary diversions, transmission lines, utilities, property, and the Contractor's own temporary works, such as haul roads, cofferdams, plant clearances, and the like.)

(4) the approximate location of any special lifting equipment in relation to the structure, including clearances required for the operation of the equipment. (For example, crane positions, operating radii, and the like.)

(5) the approximate location of any temporary falsework, and the conceptual outline of any special erection equipment. Provide the precise locations and details of attachments, fixing devices, loads, etc. in later detailed submittals.

(6) an outline of the handling, transportation, and storage of fabricated components, such as girders or concrete segments. Provide the precise details in later detailed submittals.

(7) any other information pertinent to the proposed scheme or intended approach.

Clearly and concisely present the above information on as few drawings as possible in order to provide an overall, integrated summary of the intended approach to the project. The Department will use these drawings for information, review planning, and to assess the Contractor's approach in relation to the intent of the original design. The delivery to and receipt by the Engineer does not constitute any Department acceptance or approval of the proposals shown thereon. Include the details of such proposals on subsequent detailed shop drawing submittals. Submit timely revisions and re-submittals for all variations from these overall scheme proposals.

5-1.4.10 Corrections for Construction Errors: For work that the Contractor constructs incorrectly or does not meet the requirements of the Contract Documents, the Contractor has the prerogative to submit an acceptance proposal to the Engineer for review and disposition. The acceptance proposal shall describe the error or defect and either describe remedial action for its correction or propose a method for its acceptance. In either case, the acceptance proposal shall address structural integrity, aesthetics, maintainability, and the effect on Contract Time. The Department will judge any such proposal for its effect on these criteria and also for its effect on Contract Administration.

When the Engineer judges that a proposal infringes on the structural integrity or maintainability of the structure, the Department will require the Contractor to engage a Specialty Engineer to perform a technical assessment and submit it as described in 5-1.4.5.4.

Carry out all approved corrective construction measures at no expense to the Department.

Notwithstanding any disposition of the compensation aspects of the defective work, the Engineer's decision on the technical merits of a proposal is final.

5-1.4.11 Modifications for Construction: Where the Engineer allows the Contractor to make modifications to the permanent works for the purposes of expediting the Contractor's chosen construction methods, the Contractor shall submit proposals to the Engineer of Record for review and approval prior to modifying the works. Submit proposals for minor modifications under the shop drawing process. The Department may require additional submittals and/or submittal under a Value Engineering Change Proposal for major modifications.

Minor modifications are those items that, in the opinion of the Engineer, do not significantly affect the quantity of measured work, or the integrity or maintainability of the structure or its components. (For example, adjusting concrete dimensions, substituting steel plate sizes, changing reinforcing bar size and spacing, etc., all within the acceptable limits of the design.)

Major modifications are any modifications that, in the opinion of the Engineer, significantly affect the quantity of measured work, or the integrity or maintainability of the structure or its' components. (For example, substituting alternative beam sizes and spacings, changing material strength or type, and the like.)

The Engineer's decision on the delineation between a minor and a major modification and the disposition of a proposal is final.

5-1.4.12 Cost of Shop Drawings: Include the cost of furnishing shop and working drawings in the Contract prices for the work requiring the shop and working drawings. The Department will not pay the Contractor additional compensation for such drawings.

5-2 Coordination of Contract Documents.

These Specifications, the plans, Special Provisions, and all supplementary documents are integral parts of the Contract; a requirement occurring in one is as binding as though occurring in all. All parts of the Contract are complementary and describe and provide for a complete work. In addition to the work and materials specified in the Specifications as being included in any specific pay item, include in such pay items additional, incidental work, not specifically mentioned, when so shown in the plans, or if indicated, or obvious and apparent, as being necessary for the proper completion of the work under such pay item and not stipulated as being covered under other pay items.

In cases of discrepancy, the governing order of the documents is as follows:

1. Special Provisions.
2. Technical Special Provisions.
3. Plans.
4. Road Design, Structures, and Traffic Operations Standards.
5. Developmental Specifications.
6. Supplemental Specifications.
7. Standard Specifications.

Computed dimensions govern over scaled dimensions.

5-3 Conformity of Work with Contract Documents.

Perform all work and furnish all materials in reasonably close conformity with the lines, grades, cross-sections, dimensions, and material requirements, including tolerances, as specified in the Contract Documents.

In the event that the Engineer finds that the Contractor has used material or produced a finished product that is not in reasonably close conformity with the Contract Documents, but that the Contractor has produced reasonably acceptable work, the Engineer will determine if the Department will accept the work in place. In this event, the Engineer will document the basis of acceptance by Contract modification, which provides for an appropriate reduction in the Contract price for such work or materials included in the accepted work as deemed necessary to conform to the determination based on engineering judgment.

In the event that the Engineer finds that the Contractor has used material or produced a finished product that is not in reasonably close conformity with the Contract Documents, and that the Contractor has produced an inferior or unsatisfactory product, the Contractor shall remove and replace or otherwise correct the work or materials at no expense to the Department.

For base and surface courses, the Department will allow the finished grade to vary as much as 0.1 foot [30 mm] from the grade shown in the plans, provided that the Contractor's work meets all templates and straightedge requirements and contains suitable transitions.

5-4 Errors or Omissions in Contract Documents.

Do not take advantage of any apparent error or omission discovered in the Contract Documents, but immediately notify the Engineer of such discovery. The Engineer will then make such corrections and interpretations as necessary to reflect the actual spirit and intent of the Contract Documents.

5-5 Authority of the Engineer.

Perform all work to the satisfaction of the Engineer.

The State Construction Engineer will decide all questions, difficulties, and disputes, of whatever nature, that may arise relative to the interpretation of the plans, construction, prosecution, and fulfillment of the Contract, and as to the character, quality, amount, and value of any work done, and materials furnished, under or by reason of the Contract.

5-6 Authority and Duties of Engineer's Assistants.

The State Construction Engineer may appoint such assistants and representatives as he desires. These assistants and representatives are authorized to inspect all work done and all materials furnished. Such inspection may extend to all or any part of the work and to the manufacture, preparation, or fabrication of the materials to be used. Such assistants and representatives are not authorized to revoke, alter, or waive any requirement of these Specifications. Rather, they are authorized to call to the attention of the Contractor any failure of the work or materials to meet the Contract Documents, and have the authority to reject materials or suspend the work until any questions at issue can be referred to and decided by the Engineer. The Engineer will immediately notify the Contractor in writing of any such suspension of the work, stating in detail the reasons for the suspension. The presence of the inspector or other assistant in no way lessens the responsibility of the Contractor.

5-7 Engineering and Layout.

5-7.1 Control Points Furnished by the Department: The Engineer will provide centerline control points (Begin Project, End Project, PIs, PTs, etc.) and bench marks at appropriate intervals along the line of the project to facilitate the proper layout of the work. Normally, the Engineer will furnish only one bench mark for water crossings. Preserve all reference points and bench marks that the Department furnishes.

As an exception to the above, for projects where the plans do not show a centerline or other survey control line for construction of the work (e.g., resurfacing, safety modifications, etc.) the Engineer will provide only points marking the beginning and ending of the project, and all exceptions.

5-7.2 Furnishing of Stake Materials: Furnish all stakes, templates, and other materials necessary for establishing and maintaining the lines and grades necessary for control and construction of the work.

5-7.3 Layout of Work: Utilizing the control points furnished by the Department in accordance with 5-7.1, establish all horizontal and vertical controls necessary to construct the work in conformity to the Contract Documents. Perform all calculations required, and set all stakes needed such as grade stakes, offset stakes, reference point stakes, slope stakes, and other reference marks or points necessary to provide lines and grades for construction of all roadway, bridge, and miscellaneous items.

When performing utility construction as part of the project, establish all horizontal and vertical controls necessary to carry out such work.

5-7.4 Specific Staking Requirements: When performing new base construction as part of the project, set stakes to establish lines and grades for subgrade, base, curb, and related items at intervals along the line of the work no greater than 50 feet [15 m] on tangents and 25 feet [7.5 m] on curves. Set grade stakes at locations that the Engineer directs to facilitate checking of subgrade, base, and pavement elevations in crossovers, intersections, and irregular shaped areas.

For bridge construction stakes and other control, set references at sufficiently frequent intervals to ensure construction of all components of a structure in accordance with the lines and grades shown in the plans.

For projects where the plans do not show a centerline or other survey control line for construction of the work (resurfacing, safety modifications, etc.), provide only such stakes as necessary for horizontal and vertical control of work items.

For resurfacing and resurfacing-widening type projects, establish horizontal controls adequate to ensure that the asphalt mix added matches with the existing pavement. In tangent sections, set horizontal control points at 100-foot [30 m] intervals by an instrument survey. In curb sections, set horizontal control points at 25-foot [7.5 m] intervals by locating and referencing the centerline of the existing pavement.

Establish by an instrument survey, and mark on the surface of the finished pavement at 25-foot [7.5 m] intervals, the points necessary for striping of the finished roadway. As an exception, for resurfacing and resurfacing/widening projects, establish these points in the same manner as used for horizontal control of paving operations. Mark the pavement with white paint. If performing striping, the Engineer may approve an alternate method for layout of striping provided that the Contractor achieves an alignment equal to or better than the alignment that would be achieved using an instrument survey.

For projects that include temporary or permanent striping of "no passing zones", provide the location and length of these zones as shown in the plans, except projects where the vertical or horizontal alignment is new or altered from preconstruction alignment. For projects that consist of new or altered vertical or horizontal alignment, the Department will provide the location and length of the "no passing zones" during construction. For these projects, notify the Engineer not less than 21 calendar days prior to beginning striping.

For all projects, set a station identification stake at each right-of-way line at 100-foot [30 m] intervals and at all locations where a change in right-of-way width occurs. Mark each of these stakes with painted numerals, of a size readable from the roadway, corresponding to the project station at which it is located. As an exception to the above, for projects where plans do not show right-of-way lines, set station identification stakes at locations and intervals appropriate to the type of work being done. For resurfacing and resurfacing/widening projects, set station identification stakes at 200-foot [60 m] intervals.

5-7.5 Personnel, Equipment, and Record Requirements: Employ only competent personnel and shall use only suitable equipment in performing layout work. Do not engage the services of any person or persons in the employ of the Department for performance of layout work.

Keep adequate field notes and records while performing as layout work. Make these field notes and records available for the Engineer's review as the work progresses, and furnish copies to the Engineer at the time of completion of the project. The Engineer's inspection, checking, or acceptance of the Contractor's field notes or layout work does not relieve the Contractor of his responsibility to achieve the lines, grades, and dimensions shown in the Contract Documents.

Prior to final acceptance of the project, mark, in a permanent manner on the surface of the completed work, all horizontal control points originally furnished by the Department.

5-7.6 Payment: Include the cost of performing layout work as described above in the Contract unit prices for the various items of work that require layout.

5-8 Contractor's Supervision.

5-8.1 Prosecution of Work: Give the work the constant attention necessary to ensure the scheduled progress, and cooperate fully with the Engineer and with other contractors at work in the vicinity.

5-8.2 Contractor's Superintendent: Maintain a competent superintendent at the site at all times while work is in progress to act as the Contractor's agent. Provide a superintendent who is a competent superintendent capable of properly interpreting the Contract Documents and is thoroughly experienced in the type of work being performed. Provide a superintendent with the full authority to receive instructions from the Engineer and to execute the orders or directions of the Engineer, including promptly supplying any materials, tools, equipment, labor, and incidentals that may be required. Furnish such superintendence regardless of the amount of work sublet.

Provide a superintendent who speaks and understands English, and maintain at least one other responsible person who speaks and understands English, on the project during all working hours.

5-8.3 Supervision for Emergencies: Provide a responsible person, who speaks and understands English, and who is available at or reasonably near the worksite on a 24-hour basis, seven days a week. Designate this person as the point of contact for emergencies and in cases that require immediate action to maintain traffic or to resolve any other problem that might arise. Submit, by certified mail, the phone numbers and names of personnel designated to be contacted in cases of emergencies, along with a description of the project location, to the Florida Highway Patrol and all other local law enforcement agencies.

5-8.4 Worksite Traffic Supervisor: Provide a Worksite Traffic Supervisor who is responsible for initiating, installing, and maintaining all traffic control devices as described in Section 102 and in the plans. Ensure that the Worksite Traffic Supervisor has at least one year of experience directly related to worksite traffic control in a supervisory or responsible capacity and is certified by the American Traffic Safety Services Association Worksite Traffic Supervisor Certification Program or an equal approved by the Department. Use approved alternate Worksite Traffic Supervisors when necessary.

Provide a Worksite Traffic Supervisor who is available on a 24-hour per day basis, and who reviews the project on a day to day basis and participates in all changes to traffic control. Provide the Worksite Traffic Supervisor with access to all equipment and materials needed to maintain traffic control and handle traffic-related situations. Ensure that the Worksite Traffic Supervisor immediately corrects all safety deficiencies Do not allow minor deficiencies that are not immediate safety hazards to remain uncorrected for more than 24 hours. Ensure that the Worksite Traffic Supervisor is present to direct the initial setup of the traffic control plan and any changes to it.

Ensure that the Worksite Traffic Supervisor is available on the site within 45 minutes after notification of an emergency situation and is prepared to positively respond to repair the work zone traffic control or to provide alternate traffic arrangements.

The Department may decertify and remove from the project a Worksite Traffic Supervisor that fails to comply with the provisions of this Subarticle. The Department may temporarily suspend all activities, except traffic and erosion control and such other activities that are necessary for project maintenance and safety, for failure to comply with these provisions.

5-9 General Inspection Requirements.

5-9.1 Cooperation by Contractor: Do not perform work or furnish materials without obtaining inspection by the Engineer or his representative. Furnish the Engineer with every reasonable facility for ascertaining whether the work performed and materials used are in accordance with the requirements and intent of the Contract Documents. If the Engineer so requests at any time before final acceptance of the work, remove or uncover such portions of the finished work as directed. After examination, restore the uncovered portions of the work to the standard required by the Contract Documents. If the Engineer determines that the work so exposed or examined is unacceptable, perform the uncovering or removal, and the replacing of the covering or making good of the parts removed, at no expense to the Department. However, if the Engineer determines that the work thus exposed or examined is acceptable, the Department will pay for the uncovering or removing, and the replacing of the covering or making good of the parts removed in accordance with Section 4-4.

5-9.2 Failure of Engineer to Reject Work During Construction: If, during or prior to construction operations, the Engineer fails to reject defective work or materials, whether from lack of discovery of such defect or for any other reason, such initial failure to reject in no way prevents the later rejection when such defect is discovered, or obligates the Department to final acceptance. The Department is not be responsible for losses suffered due to any necessary removals or repairs of such defects.

5-9.3 Failure to Remove and Renew Defective Materials and Work: If the Contractor fails or refuses to remove and renew any defective materials used or work performed, or to make any necessary repairs in an acceptable manner and in accordance with the requirements of the Contract within the time indicated in writing, the Engineer has the authority to repair, remove, or renew the unacceptable or defective materials or work as necessary, all at the Contractor's expense. The Department will obtain payment for any expense it incurs in making these repairs, removals, or renewals, that the Contractor fails or refuses to make, by deducting such expenses from any moneys due or which may become due the Contractor, or by charging such amounts against the Contract bond.

5-9.4 Inspection by Federal Government: When the United States Government pays a portion of the cost of construction, its representatives may inspect the construction work as they deem necessary. However, such inspection will in no way make the Federal Government a party to the Contract.

5-10 Final Inspection.

5-10.1 Maintenance until Acceptance: Maintain all Work until the Engineer has given final acceptance in accordance with 5-11.

5-10.2 Inspection for Acceptance: Upon notification that all Contract Work, or all Contract Work on the portion of the Contract scheduled for acceptance, has been completed, the Engineer will make an inspection for acceptance. The inspection will be made within seven days of the notification. If the Engineer finds that all work has been satisfactorily completed, the Department will consider such inspection as the final inspection. If any or all of the Work is found to be unsatisfactory, the Engineer will detail the remedial work required to achieve acceptance. Immediately perform such remedial work. Subsequent inspections will be made on the remedial work until the Engineer accepts all Work.

Upon satisfactory completion of the Work, the Department will provide written notice of acceptance, either partial, conditional or final, to the Contractor.

Until final acceptance in accordance with 5-11, replace or repair any damage to the accepted Work. The cost of such Work will be negotiated.

5-10.3 Partial Acceptance: At the Engineer=s sole discretion, the Engineer may accept any portion of the Work under the provisions of 5-10.2.

5-10.4 Conditional Acceptance: At the Engineer=s sole discretion, the Engineer may make conditional acceptance under the provisions of 5-10.2, when specific items of Work are to be performed or maintained after the completion of all other items of Work. Upon satisfactory completion of the specific items of work, the Engineer will make an inspection for final acceptance.

5-11 Final Acceptance.

When, upon completion of the final construction inspection of the entire project, the Engineer determines that the Contractor has satisfactorily completed the work, the Engineer will give the Contractor written notice of final acceptance.

5-12 Claims by Contractor.

5-12.1 General: When the Contractor deems that extra compensation or a time extension is due beyond that agreed to by the Engineer, whether due to delay, additional work, altered work, differing site conditions, breach of Contract, or for any other cause, the Contractor shall follow the procedures set forth herein for preservation, presentation and resolution of the claim.

5-12.2 Notice of Claim:

5-12.2.1 Claims For Extra Work: Where the Contractor deems that additional compensation or a time extension is due for work or materials not expressly provided for in the Contract or which is by written directive expressly ordered by the Engineer pursuant to 4-3, the Contractor shall notify the Engineer in writing of the intention to make a claim for additional compensation before beginning the work on which the claim is based, and if seeking a time extension, the Contractor shall also submit a preliminary request for time extension pursuant to

8-7.3.2 within ten calendar days after commencement of a delay. If such notification is not given and the Engineer is not afforded the opportunity for keeping strict account of actual labor, material, equipment, and time, the Contractor waives the claim for additional compensation or a time extension. Such notice by the Contractor, and the fact that the Engineer has kept account of the labor, materials and equipment, and time, shall not in any way be construed as establishing the validity of the claim or method for computing any compensation or time extension for such claim. On projects with an original Contract amount of $3,000,000 or less within 90 calendar days after final acceptance of the project in accordance with 5-11, and on projects with an original Contract amount greater than $3,000,000 within 180 calendar days after final acceptance of the project in accordance with 5-11, the Contractor shall submit full and complete claim documentation as described in 5-12.3. However, for any claim or part of a claim that pertains solely to final estimate quantities disputes the Contractor shall submit full and complete claim documentation as described in 5-12.3, as to such final estimate claim dispute issues, within 90 or 180 calendar days, respectively, of the Contractor=s receipt of the Department=s final estimate.

Submission of timely notice of intent to file a claim, preliminary time extension request, time extension request, and the claim, together with full and complete claim documentation, are each a condition precedent to the Contractor bringing suit against the Department for the items and for the sums or time set forth in the Contractor=s written claim, and the failure to provide such notice of intent, preliminary time extension request, time extension request, claim and full and complete claim documentation within the time required shall constitute a full, complete, absolute and irrevocable waiver by the Contractor of any right to additional compensation or a time extension for such claim.

5-12.2.2 Claims For Delay: Where the Contractor deems that additional compensation or a time extension is due on account of delay, differing site conditions, breach of Contract, or any other cause other than for work or materials not expressly provided for in the Contract (Extra Work) or which is by written directive of the Engineer expressly ordered by the Engineer pursuant to 4-3, the Contractor shall submit a written notice of intent to the Engineer within ten days after commencement of a delay to a controlling work item expressly notifying the Engineer that the Contractor intends to seek additional compensation, and if seeking a time extension, the Contractor shall also submit a preliminary request for time extension pursuant to 8-7.3.2 within ten calendar days after commencement of a delay to a controlling work item, as to such delay and providing a reasonably complete description as to the cause and nature of the delay and the possible impacts to the Contractor=s work by such delay. The timely providing of a written notice of intent or preliminary time extension request to the Engineer are each a condition precedent to any right on behalf of the Contractor to request additional compensation or an extension of Contract Time for that delay, and the failure of the Contractor to provide such written notice of intent or preliminary time extension request within the time required shall constitute a full, complete, absolute and irrevocable waiver by the Contractor of any right to additional compensation or a time extension for that delay. On projects with an original Contract amount of $3,000,000 or less within 90 calendar days after final acceptance of the project in accordance with 5-11, and on projects with an original Contract amount greater than $3,000,000 within 180 calendar days after final acceptance of the project in accordance with 5-11, the Contractor shall submit full and complete documentation as described in 5-12.3. There shall be no Contractor entitlement to any monetary compensation or time extension for any delays or delay impacts, whatsoever, that are not to a controlling work item, and then as to any such delay to a controlling work item entitlement to any monetary compensation or time extension shall only be to the extent such is otherwise provided for expressly under 4-3 or 5-12, except that in the instance of delay to a non-controlling item of work the Contractor may be compensated for the direct costs of idle labor or equipment only, at the rates set forth in 4-3.2(c), and then only to the extent the Contractor could not reasonably mitigate such idleness.

5-12.3 Content of Written Claim: As a condition precedent to the Contractor being entitled to additional compensation or a time extension under the Contract, for any claim, the Contractor shall submit a written claim to the Department which will include for each individual claim, at a minimum, the following information:

(a) A detailed factual statement of the claim providing all necessary dates, locations, and items of work affected and included in each claim;

(b) The date or dates on which actions resulting in the claim occurred or conditions resulting in the claim became evident;

(c) Identification of all pertinent documents and the substance of any material oral communications relating to such claim and the name of the persons making such material oral communications;

(d) Identification of the provisions of the Contract which support the claim and a statement of the reasons why such provisions support the claim, or alternatively, the provisions of the Contract which allegedly have been breached and the actions constituting such breach;

(e) A detailed compilation of the amount of additional compensation sought and a breakdown of the amount sought as follows:

(1) documented additional job site labor expenses;

(2) documented additional cost of materials and supplies;

(3) a list of additional equipment costs claimed, including each piece of equipment and the rental rate claimed for each;

(4) any other additional direct costs or damages and the documents in support thereof;

(5) any additional indirect costs or damages and all documentation in support thereof.

(f) A detailed compilation of the specific dates and the exact number of calendar days sought for a time extension, the basis for entitlement to time for each day, all documentation of the delay, and a breakout of the number of days claimed for each identified event, circumstance or occurrence.

Further, the Contractor shall be prohibited from amending either the bases of entitlement or the amount of any compensation or time stated for any and all issues claimed in the Contractor=s written claim submitted hereunder, and any circuit court, arbitration, or other formal claims resolution proceeding shall be limited solely to the bases of entitlement and the amount of any compensation or time stated for any and all issues claimed in the Contractor=s written claim submitted hereunder. This shall not, however, preclude a Contractor from withdrawing or reducing any of the bases of entitlement and the amount of any compensation or time stated for any and all issues claimed in the Contractor=s written claim submitted hereunder at any time.

5-12.4 Action on Claim: The Engineer will respond on projects with an original Contract amount of $3,000,000 or less within 90 calendar days of receipt of a complete claim submitted by a Contractor in compliance with 5-12.3, and on projects with an original Contract amount greater than $3,000,000 within 120 calendar days of receipt of a complete claim submitted by a Contractor in compliance with 5-12.3. Failure by the Engineer to respond to a claim within 90 or 120 days, respectively, after receipt of a complete claim in compliance with 5-12.3 constitutes a denial of the claim by the Engineer. If the Engineer finds the claim or any part thereof to be valid, such partial or whole claim will be allowed and paid for to the extent deemed valid and any time extension granted, if applicable, as provided in the Contract. No circuit court or arbitration proceedings on any claim, or a part thereof, may be filed until after final acceptance per 5-11 of all Contract work by the Department or denial hereunder, whichever occurs last.

5-12.5 Pre-Settlement and Pre-Judgment Interest: Entitlement to any pre-settlement or pre-judgment interest on any claim amount determined to be valid subsequent to the Department=s receipt of a certified written claim in full compliance with 5-12.3, whether determined by a settlement or a final ruling in formal proceedings, the Department shall pay to the Contractor simple interest calculated at the Prime Rate (as reported by the Wall Street Journal as the base rate on corporate loans posted by at least 75% of the nations 30 largest banks) as of the 60th calendar day following the Department=s receipt of a certified written claim in full compliance with 5-12.3, such interest to accrue beginning 60 calendar days following the Department=s receipt of a certified written claim in full compliance with 5-12.3 and ending on the date of final settlement or formal ruling.

5-12.6 Compensation for Extra Work or Delay:

5-12.6.1 Compensation for Extra Work: Notwithstanding anything to the contrary contained in the Contract Documents, the Contractor shall not be entitled to any compensation beyond that provided for in 4-3.2.

5-12.6.2 Compensation for Delay: Notwithstanding anything to the contrary contained in the Contract Documents, the additional compensation set forth in 5-12.6.2.1 and 5-12.6.2.2 shall be the Contractor=s sole monetary remedy for any delay other than to perform extra work caused by the Department unless the delay shall have been caused by acts constituting willful or intentional interference by the Department with the Contractor=s performance of the work and then only where such acts continue after Contractor=s written notice to the Department of such interference. The parties anticipate that delays may be caused by or arise from any number of events during the term of the Contract, including, but not limited to, work performed, work deleted, change orders, supplemental agreements, disruptions, differing site conditions, utility conflicts, design changes or defects, time extensions, extra work, right-of-way issues, permitting issues, actions of suppliers, subcontractors or other contractors, actions by third parties, suspensions of work by the Engineer pursuant to 8-6.1, shop drawing approval process delays, expansion of the physical limits of the project to make it functional, weather, weekends, holidays, special events, suspension of Contract time, or other events, forces or factors sometimes experienced in construction work. Such delays or events and their potential impacts on the performance by the Contractor are specifically contemplated and acknowledged by the parties in entering into this Contract, and shall not be deemed to constitute willful or intentional interference with the Contractor=s performance of the work without clear and convincing proof that they were the result of a deliberate act, without reasonable and good-faith basis, and specifically intended to disrupt the Contractor=s performance.

5-12.6.2.1 Compensation for Direct Costs of Delay: For any delay claim, the Contractor shall only be entitled to monetary compensation for the actual idle labor, equipment and materials costs incurred beyond what reasonable mitigation thereof the Contractor could have undertaken, nor shall any indirect costs be recoverable for any delay, except as provided for in 5-12.6.2.2.

5-12.6.2.2 Compensation for Indirect Impacts of Delay: When the cumulative total number of calendar days granted for time extension due to delay of a controlling work item caused solely by the Department is, or the cumulative total number of calendar days for which entitlement to a time extension due to delay of a controlling work item caused solely by the Department is otherwise ultimately determined in favor of the Contractor to be, greater than ten calendar days the Department will compensate the Contractor for jobsite overhead and other indirect impacts of delay, such indirect impacts including but not being limited to unabsorbed and extended home office overhead, according to the formula set forth below and solely as to such number of calendar days of entitlement that are in excess of ten calendar days. No other jobsite overhead and other indirect impacts of delay shall be compensable under any circumstances whatsoever, nor shall the Contractor be entitled under any circumstances to receive compensation for jobsite overhead and other indirect impacts of delay beyond the amount provided for herein. Further, in the event there are concurrent delays to one or more controlling work items, one or more being caused by the Department and one or more being caused by the Contractor, the Contractor shall be entitled to a time extension for each day that a controlling work item is delayed by the Department but shall have no right to nor receive any monetary compensation for any indirect impacts for any days of concurrent delay. No compensation, whatsoever, will be paid to the Contractor for any jobsite overhead and other indirect impacts when the total number of calendar days granted for time extension due to delay of a controlling work item caused solely by the Department is, or the total number of calendar days for which entitlement to a time extension due to delay of a controlling work item caused solely by the Department is otherwise ultimately determined in favor of the Contractor to be, equal to or less than ten calendar days and the Contractor also fully assumes all monetary risk of any and all partial or single calendar day delay periods, due to delay of a controlling work item caused solely by the Department, that when cumulatively totaled together are equal to or less than ten calendar days and regardless of whether monetary compensation is otherwise provided for hereunder for one or more calendar days of time extension entitlement for each calendar day exceeding ten calendar days. All calculations under this provision shall exclude weather days, days used for performing additional work, days included in supplemental agreements, and days of suspended work.

$$D = \frac{AxC}{B}$$

Where: A = Original Contract Amount
B = Original Contract Time
C = 8%
D = Average Overhead Per Day

5-12.7 Mandatory Claim Records: After giving the Engineer notice of intent to file a claim for extra work or delay, the Contractor must keep daily records of all labor, material and equipment costs incurred for operations affected by the extra work or delay. These daily records must identify each operation affected by the extra work or delay and the specific locations where work is affected by the extra work or delay, as nearly as possible. The Engineer may also keep records of all labor, material and equipment used on the operations affected by the extra work or delay. The Contractor shall, once a notice of intent to claim has been timely filed, and not less than weekly thereafter as long as appropriate, provide the Engineer a copy of the Contractor=s daily records and be likewise entitled to receive a copy of the Department=s daily records. The copies of daily records to be provided hereunder shall be provided at no cost to the recipient.

5-12.8 Claims For Acceleration: The Department shall have no liability for any constructive acceleration of the work, nor shall the Contractor have any right to make any claim for constructive acceleration nor include the same as an element of any claim the Contractor may otherwise submit under this Contract. If the Engineer gives express written direction for the Contractor to accelerate its efforts, such written direction will set forth the prices and other pertinent information and will be reduced to a written Contract Document promptly. No payment will be made on a Supplemental Agreement for acceleration prior to the Department=s approval of the documents.

5-12.9 Certificate of Claim: When submitting any claim, the Contractor shall certify under oath and in writing, in accordance with the formalities required by Florida law, that the claim is made in good faith, that the supportive data are accurate and complete to the Contractor=s best knowledge and belief, and that the amount of the claim accurately reflects what the Contractor in good faith believes to be the Department=s liability. Such certification must be made by an officer or director of the Contractor with the authority to bind the Contractor.

5-12.10 Non-Recoverable Items: The parties agree that for any claim the Department will not have liability for the following items of damages or expense:

a. Loss of profit, incentives or bonuses;

b. Any claim for other than extra work or delay;

c. Consequential damages, including, but not limited to, loss of bonding capacity, loss of bidding opportunities, loss of credit standing, cost of financing, interest paid, loss of other work or insolvency;

d. Acceleration costs and expenses, except where the Department has expressly and specifically directed the Contractor in writing Ato accelerate at the Department=s expense≅; nor

e. Attorney fees, claims preparation expenses and costs of litigation.

5-12.11 Exclusive Remedies: Notwithstanding any other provision of this Contract, the parties agree that the Department shall have no liability to the Contractor for expenses, costs, or items of damages other than those which are specifically identified as payable under 5-12. In the event any legal action for additional compensation, whether on account of delay, acceleration, breach of contract, or otherwise, the Contractor agrees that the Department=s liability will be limited to those items which are specifically identified as payable in 5-12.

5-12.12 Settlement Discussions: The content of any discussions or meetings held between the Department and the Contractor to settle or resolve any claims submitted by the Contractor against the Department shall be inadmissible in any legal, equitable, arbitration or administrative proceedings brought by the Contractor against the Department for payment of such claim. Dispute Resolution Board, State Arbitration Board and Claim Review Committee proceedings are not settlement discussions, for purposes of this provision.

5-12.13 Personal Liability of Public Officials: In carrying out any of the provisions of the Contract or in exercising any power or authority granted to the Secretary of Transportation, Engineer or any of their respective employees or agents, there shall be no liability on behalf of any employee, officer or official of the Department for which such individual is responsible, either personally or as officials or representatives of the Department. It is understood that in all such matters such individuals act solely as agents and representatives of the Department.

5-12.14 Auditing of Claims: All claims filed against the Department shall be subject to audit at any time following the filing of the claim, whether or not such claim is part of a suit pending in the Courts of this State. The audit may be performed, at the Department=s sole discretion, by employees of the Department or by any independent auditor appointed by the Department, or both. The audit may begin after ten days written notice to the Contractor, subcontractor, or supplier. The Contractor, subcontractor, or supplier shall make a good faith effort to cooperate with the auditors. As a condition precedent to recovery on any claim, the Contractor, subcontractor, or supplier must retain sufficient records, and provide full and reasonable access to such records, to allow the Department=s auditors to verify the claim and failure to retain sufficient records of the claim or failure to provide full and reasonable access to such records shall constitute a waiver of that portion of such claim that cannot be verified and shall bar recovery thereunder. Further, and in addition to such audit access, upon the Contractor submitting a written claim, the Department shall have the right to request and receive, and the Contractor shall have the affirmative obligation to provide to the Department, copies of any and all documents in the possession of the Contractor or its subcontractors, materialmen or suppliers as may be deemed relevant by the Department in its review of the basis, validity or value of the Contractor=s claim.

Without limiting the generality of the foregoing, the Contractor shall upon written request of the Department make available to the Department=s auditors, or upon the Department=s written request for copies provide copies at the Department=s expense, any or all of the following documents:

1. Daily time sheets and foreman=s daily reports and diaries;
2. Insurance, welfare and benefits records;
3. Payroll register;
4. Earnings records;
5. Payroll tax return;
6. Material invoices, purchase orders, and all material and supply acquisition contracts;
7. Material cost distribution worksheet;
8. Equipment records (list of company owned, rented or other equipment used);
9. Vendor rental agreements and subcontractor invoices;
10. Subcontractor payment certificates;
11. Canceled checks for the project, including, payroll and vendors;
12. Job cost report;
13. Job payroll ledger;
14. General ledger, general journal, (if used) and all subsidiary ledgers and journals together with all supporting documentation pertinent to entries made in these ledgers and journals;
15. Cash disbursements journal;
16. Financial statements for all years reflecting the operations on this project;
17. Income tax returns for all years reflecting the operations on this project;
18. All documents which reflect the Contractor=s actual profit and overhead during the years this Contract was being performed and for each of the five years prior to the commencement of this Contract;
19. All documents related to the preparation of the Contractor=s bid including the final calculations on which the bid was based;
20. All documents which relate to each and every claim together with all documents which support the amount of damages as to each claim;
21. Worksheets used to prepare the claim establishing the cost components for items of the claim including, but not limited to, labor, benefits and insurance, materials, equipment, subcontractors, and all documents that establish which time periods and individuals were involved, and the hours and rates for such individuals.

5-13 Recovery Rights, Subsequent to Final Payment.

The Department reserves the right, if it discovers an error in the partial or final estimates, or if it discovers that the Contractor performed defective work or used defective materials, after the final payment has been made, to claim and recover from the Contractor or his surety, or both, by process of law, such sums as may be sufficient to correct the error or make good the defects in the work and materials.

Retain all records pertaining to the project for a period of three years from the date of the Engineer's final acceptance of the project. Upon request, make all such records available to the Department or its representative. For the purpose of this Article, records include all books of account, supporting documents, and papers that the Department deems necessary to ensure compliance with the Contract provisions.

SECTION 6

CONTROL OF MATERIALS

6-1 Information on Materials.

6-1.1 Location of Laboratory: The Department's laboratory is located at Gainesville. Address correspondence to the laboratory and samples for tests to: State Materials Engineer, State of Florida Department of Transportation, 2006 N.E. Waldo Rd., Gainesville, Florida, 32609.

6-1.2 Standard Operating Procedure: Department Standard Operating Procedures govern approval and production control requirements for sources of supply of certain materials. Each Section of these Specifications pertaining to a material states whether a Standard Operating Procedure (SOP) is in effect for the material specified by that Section.

6-1.3 Qualified Products List: The Product Evaluation Section in the State Specifications Office publishes and maintains a Qualified Products List (QPL). The list provides assurance to Contractors, consultants, designers, and Department personnel that specific products and materials are approved for use on Department facilities. These items have basic approval but are subject to additional testing of individual LOTs, batches, or shipments.

The Department will limit the Contractor's procurement and use of products and materials that require pre-approval in these Specifications to only those items listed on the QPL that is effective at the time of procurement.

Manufacturers seeking evaluation in accordance with Departmental procedures of an item must submit a Product Evaluation Application with a certified test report from an independent test laboratory, that shows that the material meets all applicable specifications, to the Product Evaluation Section in Tallahassee. In the absence of applicable specifications, the manufacturers must submit specifications and certified test reports with the application.

Manufacturers successfully completing the Department's evaluation are eligible for inclusion on the QPL.

The Department will consider any marked variations from original test values for a material or any evidence of inadequate field performance of a material as sufficient evidence that the properties of the material have changed, and the Department will remove the material from the QPL.

6-1.4 Definitions:

(a) Aggregate Source: A physical location, including mines, recycled material processing sites, and redistribution terminals.

(b) Aggregate Point of Use: The point of incorporation into the project, such as the actual project site, asphalt plant, or concrete plant.

6-1.5 Warranty and Guaranty: The Department may require the Contractor to warrant and guaranty that certain materials used in the construction of the project meet all specification requirements for a specified time period. The Department will specify the warranty and guaranty requirement in the appropriate Sections governing the materials.

6-1.6 Approved Products List: The State Traffic Engineering Office maintains the Approved Products List (APL) of Traffic Control Signal Devices. Traffic Monitoring Site Equipment and Materials are also included on the APL. This list provides assurance to Contractors, consultants, designers, and Department personnel that the specific items listed are approved for use on Department facilities.

The Department will limit the Contractor=s procurement and use of Traffic Control Signal Devices, and Traffic Monitoring Site equipment and materials to only those items listed on the APL that is effective at the time of procurement, except as provided in 603-2.2.

The approval process is described in detail in Section A601 of the Minimum Specifications for Traffic Control Signal Devices (MSTCSD). Manufacturers seeking evaluation of a specific device must submit an application on form number 750-010-12, which can be obtained from the Department=s State Traffic Engineering Office.

6-2 Designation of a Specific Project as a Criterion ("Or Equal" Clause).

Reference in the Contract Documents to any proprietary article, device, product, material or fixture, or any form or type of construction, by name, make, or catalog number, with or without the words "or equal," establishes a standard of quality and is not intended to limit competition. The Contractor may use any article, device, product, material or fixture, or any form or type of construction, that, in the judgment of the Engineer (expressed in writing), is equal, for the purpose intended, to that named.

6-3 Source of Supply and Quality Requirements.

6-3.1 Only Approved Materials to be Used: Use only materials in the work that meet the requirements of these Specifications, and have the Engineer's approval. The Engineer may inspect or test any materials proposed for use at any time during their preparation and use. Do not use any material that, after approval, has in any way become unfit for use in the work. Do not use materials containing asbestos.

6-3.2 Notification of Placing Order: Give sufficient notification prior to placing orders for materials, and order materials sufficiently in advance of their incorporation in the work to allow time for sampling and testing.

6-3.3 Approval of Source of Supply: Before delivering material, obtain the Engineer's approval of the source of supply. Submit for examination representative preliminary samples, of the character and quantity prescribed. The Department will test the samples in accordance with the method referred to under 6-5, and in Division III. If, after trial, the Department determines that an approved source of supply does not contain a uniform, acceptable product, or the product from any source is unacceptable at any time, furnish material from other approved sources.

Use only mineral aggregates that are produced under a Department-approved Producer Quality Control Program (QC) that is in accordance with the

Department's requirements and procedures for obtaining and maintaining Department approval of developed and operational mineral aggregate sources (mines and redistribution terminals), and with the Department's Mineral Aggregate Manual. Furnish an individual certification with each haul unit load of materials shipped, attesting that those specific materials were produced under a Department-approved QC and that they fully meet the requirements of these Specifications.

Do not use materials that were produced after July 1, 1991, by convict labor for Federal-aid highway construction projects unless the prison facility has been producing convict-made materials for Federal-aid highway construction projects before July 1, 1987. Use materials that were produced prior to July 2, 1991, by convicts on Federal-aid highway construction projects free from the restrictions placed on the use of these materials by 23 U.S.C. 114.

The Department will limit the use of materials produced by convict labor for use in Federal-aid highway construction projects to: (1) materials produced by convicts on parole, supervised release, or probation from a prison or (2) materials produced in a qualified prison facility. The amount of such materials produced for Federal-aid highway construction during any 12-month period shall not exceed the amount produced in such facility for use in such construction during the 12-month period ending July 1, 1987.

6-3.4 Source of Supply, Steel (Federal-Aid Contracts Only): For Federal-aid Contracts, only use all steel and iron produced in the United States. Ensure that all manufacturing processes for this material occur in the United States, except as noted below. When using steel and iron as a component of any manufactured product incorporated into the project (e.g., concrete pipe, prestressed beams, corrugated steel pipe, etc.), use only steel and iron produced in the United States, except that the manufacturer may use minimal quantities of foreign steel and iron when the cost of such foreign materials does not exceed 0.1% of the total Contract amount or $2,500, whichever is greater. The coating of steel is part of the manufacturing process.

These requirements are not applicable to steel and iron items that the Contractor uses but does not incorporate into the finished work.

Provide a certification from the producer of steel or iron, or any product containing steel or iron as a component, stating that all steel or iron furnished or incorporated into the furnished product, with the exception of the allowable quantity of foreign steel or iron, was manufactured in the United States. Furnish such certification to the Engineer prior to incorporating the material into the project.

When FHWA allows the use of foreign steel on a project, furnish invoices to document the cost of such material, and obtain the Engineer's written approval prior to incorporating the material into the project.

6-4 Inspection and Tests at Source of Supply.

6-4.1 General: If the volume, progress of the work, and other considerations warrant, the Engineer may inspect the materials at the source of supply.

6-4.2 Cooperation by Contractor: Provide the Engineer with free entry at all times to such parts of the plant that concern the manufacture or production of the materials ordered, and bear all costs incurred in providing all reasonable facilities to assist the Engineer in determining whether the material furnished meets the requirements of these Specifications.

6-4.3 Department Not Obligated to Make Inspection at Source: The Department is not obligated to make an inspection of materials at the source of supply. The Contractor is fully responsible for supplying satisfactory materials.

6-4.4 Retest of Materials: The Department may retest materials that it has tested and accepted at the source of supply, after they have been delivered to the project. The Department will reject all materials that, when retested, do not meet the requirements of these Specifications.

6-5 Control by Samples and Tests.

6-5.1 Materials to be Tested, Samples: The Engineer may test materials by means of samples, or otherwise, at production points and after delivery. The Department will perform and pay for such tests. Afford such facilities as the Engineer requires for collecting and forwarding samples, and do not make use of, or incorporate in the work, any materials represented by the samples until the Engineer tests and finds the materials acceptable. Furnish and deliver the required material necessary to take samples, to the point that the Engineer designates, at no expense to the Department. The Department will furnish boxes for shipping concrete cylinders.

6-5.2 Pavement Samples: For both base course and surface course pavements, furnish samples taken from the completed work at any location that the Engineer indicates, and immediately replace the areas so removed with materials and construction that meet the requirements of these Specifications and to the line and grade of the immediate surrounding pavement surface. The Department will not allow additional compensation for furnishing such samples and replacing the areas with new pavement.

6-5.3 Applicable Standards: Methods of sampling and testing materials are in accordance with Florida Methods so far as covered therein. Otherwise, they shall be in accordance with standards of AASHTO, ASTM, or other criteria as specifically designated. Where an AASHTO, ASTM or other non-Florida Method is designated, and a Florida Method which is similar exists, the Department will require sampling and testing in accordance with the Florida Method.

Whenever any Florida, AASHTO, ASTM, or other standards are referenced in these Specifications without identification of the specific time of issuance, use the most current issuance, including interims or addendums thereto, at the time of advertisement for bids for a project.

6-5.4 Soil Bearing Tests: The Department will determine the bearing value of soils using the Department's Florida Soil Bearing Tests or by the methods required for the Limerock Bearing Ratio Method, whichever is designated in the plans.

6-5.5 Sieves: Use sieves meeting the requirements of AASHTO M 92.

6-5.6 Acceptance on Tests of Producer's Samples: The Department, in order to expedite the work, may accept certain materials on the basis of tests made on advance samples taken and submitted by the producer, provided that the Engineer tests a representative number of samples of the material after the material arrives at the worksite and the Department confirms that the material meets the requirements of these Specifications. In the event that the Engineer's tests of these samples do not substantiate those made on the advance samples submitted by the producer, and the Engineer determines that there is evidence that this privilege of expediting the use of the material is being abused, then the Department will no longer extend this privilege to such producer.

6-5.7 Preparation and Shipping of Samples: Attach a card to each producer's sample, showing the following information: Project designation, intended use of material, name of producer, source of supply, quantity represented by sample, date sampled, and any other information pertinent to the material or work. Use care in preparing and shipping samples. Check that packages are clean before placing material therein. Tie or close and securely wrap the packages.

6-5.8 Inspection at Plants: Provide the Engineer with access to all parts of all paving or other plants connected with the work to verify weights or proportions and character of materials, and to determine temperatures used in preparing materials and mixtures. Facilitate and assist in the Engineer's verification of the accuracy of all scales, measures, and other devices, and protect such devices from the wind and elements whenever such protection is necessary.

6-5.9 Aggregate Samples: The Engineer will select and take all samples from all aggregates entering into asphaltic concrete mixes. Advise the Engineer as to location and source three weeks prior to the time the aggregates are needed for the design of the mix, so that the Engineer can arrange to take the samples.

6-5.10 Asphaltic Concrete Mix Designs: For the designs of asphaltic concrete mixes that are to be provided by the Department, the Department will establish not more than three design mixes, without charge, for each type of mixture on any one contract.

6-5.11 Materials Accepted Based on Producers' Certification: Identify materials that the Engineer has accepted based on producers' certification by production LOT or other acceptable means that shows a direct tie between the certification and the material being used. The Department will use such identification when doing verification testing. Ensure that the certification is signed by a legally responsible person from the producer and is provided on the producer's letterhead.

6-6 Storage of Materials.

6-6.1 Method of Storage: Store materials in such a manner as to preserve their quality and fitness for the work, to facilitate prompt inspection, and to minimize noise impacts on sensitive receivers. More detailed specifications concerning the storage of specific materials are prescribed under the applicable Sections. The Department may reject improperly stored materials.

6-6.2 Use of Right-of-Way for Storage: If the Engineer allows, the Contractor may use a portion of the right-of-way for storage purposes and for placing the Contractor's plant and equipment. Use only the portion of the right-of-way that is outside the clear zone, which is the portion not required for public vehicular or pedestrian travel. Provide any additional space required at no expense to the Department.

6-6.3 Department Not Responsible for Stored Materials: The protection of stored materials is the Contractor's responsibility. The Department is not liable for any loss of materials, by theft or otherwise, or for any damage to the stored materials.

6-7 Defective Materials.

The Department will consider the following materials as defective: all materials not meeting the requirements of these Specifications; segregated materials, even though previously tested and approved; materials that are or have been improperly stored; and materials that are mixed with an excess of clay, coal, sticks, burlap, hay, straw, loam or earth, or other debris. The Engineer will reject all such materials, whether in place or not. Remove all rejected material immediately from the site of the work and from storage areas, at no expense to the Department. Do not use rejected material, the defects of which have been subsequently corrected, until the Engineer has approved the material's use. Upon failure to comply promptly with any order of the Engineer made under the provisions of this Article, the Engineer will remove and replace defective material and deduct the cost of removal and replacement from any moneys due or to become due the Contractor.

The Engineer will consider any haul unit load of mineral aggregates received for a Department project as defective without an individual certification as required by 6-3.3.

SECTION 7

LEGAL REQUIREMENTS AND

RESPONSIBILITY TO THE PUBLIC

7-1 Laws to be Observed.

7-1.1 General: Become familiar with and comply with all Federal, State, county, and city laws, by-laws, ordinances, and regulations that control the action or operation of those engaged or employed in the work or that affect materials used. Pay particular attention called to the safety regulations promulgated by the State of Florida Department of Labor and Employment Security. In addition, comply with Chapter 403, of the Florida Statutes, regarding control of air pollution. Direct special attention to that portion of Chapter 17-5 of the Rules and Regulations, pertaining to open burning in land clearing operations. Where work or structures included in the Contract are in "Navigable Waters of the U.S.," (reference 33 of the Code of Federal Regulations, Part 329); "Waters of the U.S.," (reference 33 of the Code of Federal Regulations, Part 323); or "Waters of the State," (reference Section 403.817 of the Florida Statutes and Section 17-4.02 of the Florida Administrative Code); comply with the regulatory provisions of Section 404 of the Federal Clean Water Act of 1977; Sections 9 and 10 of the Federal River and Harbor Act of 1899; Chapters 161, 253, 373, and 403 of the Florida Statutes; and any local authority having jurisdiction over such waters. The Department will procure all environmental permits required by Federal, State, county, and local regulatory agencies.

Comply with Part IV, Chapter 378, of the Florida Statutes regarding land reclamation. Direct special attention to Chapters 16c-36 and 16c-39 of the Florida Administrative Code. Submit the Notice of Intent to Mine to:

Department of Environment Protection
Bureau of Mine Reclamation

2051 East Paul Dirac Drive
Tallahassee, Florida 32310

with a copy to:

Department of Transportation
Environment Office
605 Suwannee Street
Tallahassee, Florida 32399-0450

Obtain certification from the Construction Industry Licensing Board as required by Part I, Chapter 489, of the Florida Statutes, regardless of exemptions allowed by Section 489.103, prior to removing underground pollutant storage tanks. Dispose of tanks and pollutants in accordance with the requirements and regulations of any Federal, State, or local, agency having jurisdiction.

Prior to building construction or renovation, provide copies of current registrations or certifications issued by the Florida Construction Industry Licensing Board in accordance with Chapter 489, for the appropriate category of construction.

Corporations must be registered with the State of Florida, Department of State, Division of Corporations, and hold a current State Corporate Charter Number in accordance with Chapter 607, Florida Statutes.

The Contractor or the authorized subcontractor applying the roofing material must be licensed or be an approved dealer and applicator of the proposed roofing material.

Indemnify, defend, and save harmless the Department and all of its officers, agents, and employees, in the amount of the Contract price, against all claims or liability arising from or based on the violation of any such laws, by-laws, ordinances, regulations, order, or decrees; whether by himself or his employees.

Comply with all provisions of all Dredge Permits, or Dredge and Fill Permits, issued by various governmental agencies in conjunction with the work. Construct dikes prior to filling submerged land, and maintain the dikes throughout the filling period.

The Contractor shall exert every reasonable and diligent effort to ensure that all labor employed by the Contractor and his subcontractors for work on the project work harmoniously and compatibly with all labor used by other building and construction contractors now or hereafter on the site of the work covered by this Contract. Include this provision in all subcontracts, and require all subcontractors to include it in their subcontracts with others. However, do not interpret or enforce this provision so as to deny or abridge, on account of membership or non-membership in any labor union or labor organization, the right of any person to work as guaranteed by Article I, Section 6 of the Florida Constitution.

Comply with Chapter 556 of the Florida Statutes during the performance of excavation or demolition operations.

7-1.2 Plant Quarantine Regulations: The U.S. Department of Agriculture and the Florida Department of Agriculture and Consumer Services have issued quarantine regulations pertaining to control of the nematodes of citrus, Rule 5B-44, Florida Administrative Code, and other plant pests. Contact the local (or other available) representatives of the Animal and Plant Health Inspection Service of the U.S. Department of Agriculture, and the Division of Plant Industry of the Florida Department of Agriculture and Consumer Services to ascertain all current restrictions regarding plant pests that are imposed by these agencies. Keep advised of current quarantine boundary lines throughout the construction period.

These restrictions may affect operations in connection with such items as clearing and grubbing, earthwork, grassing and mulching, sodding, landscaping, and other items which might involve the movement of materials containing plant pests across quarantine lines.

Obtain quarantine regulations and related information from the following:

Animal and Plant Health Inspection Service
U.S. Department of Agriculture
3031 Lake Alfred Road
Winter Haven, Florida 33881

Director, Division of Plant Industry
Florida Department of Agriculture and Consumer Services
Post Office Box 147100
Gainesville, Florida 32614-7100

7-1.3 Introduction or Release of Prohibited Aquatic Plants, Plant Pests, or Noxious Weeds: Do not introduce or release prohibited aquatic plants, plant pests, or noxious weeds into the project limits as a result of clearing and grubbing, earthwork, grassing and mulching, sodding, landscaping, or other such activities. Immediately notify the Engineer upon discovery of all prohibited aquatic plants, plant pests, or noxious weeds within the project limits. Do not move prohibited aquatic plants, plant pests, or noxious weeds within the project limits or to locations outside of the project limits without the Engineer's permission. Maintain all borrow material brought onto the project site free of prohibited aquatic plants, plant pests, noxious weeds, and their reproductive parts. Refer to Rule 16C-52 and Rule 5B-57, of the Florida Administrative Code for the definition of prohibited aquatic plants, plant pests, and noxious weeds.

Furnish the Engineer, prior to incorporation into the project, with a certification from the Florida Department of Agriculture and Consumer Services, Division of Plant Industry, stating that the sod, hay, straw, and mulch materials are free of noxious weeds, including Tropical Soda Apple.

7-1.4 Compliance with Federal Endangered Species Act: The Federal Endangered Species Act requires that the Department investigate the potential impact to an endangered species prior to initiating an activity performed in conjunction with a highway construction project. If the Department's investigation identifies that there is a potential impact on an endangered species, the Department will make a biological assessment to determine what measures are necessary to mitigate such impact.

Prior to establishing any off-project activity in conjunction with a project, notify the Engineer of the proposed activity. Covered activities include but are not necessarily limited to borrow pits, concrete or asphalt plant sites, and material or equipment storage sites. Include in the notification the State Job Number, a description of the activity, the location of the site by township, range, section, county, and city, a site location map including the access route, and the name of the property owner. Provide this notification sufficiently in advance of planned commencement of the off-site activity to allow a reasonable period of time for the Engineer to conduct an investigation without delaying job progress.

Do not perform any off-project activity without obtaining written clearance from the Engineer. In the event that the Department's biological assessment indicates that mitigation measures are necessary, cooperate as necessary to comply with such measures.

7-1.5 Occupational Safety and Health Requirements: The Contractor shall take all precautions necessary for the protection of life, health, and general occupational welfare of all persons, including employees of both the Contractor and the Department, until the Contractor has completed the work required under the Contract as provided in 5-10 and 5-11.

Comply at all times with applicable Federal, State, and local laws, provisions, and policies governing safety and health, including 29 CFR 1926, including all subsequent revisions and updates.

7-1.6 Discovery of an Unmarked Human Burial: When an unmarked human burial is discovered, immediately cease all activity that may disturb the unmarked human burial and notify the Engineer. Do not resume activity until specifically authorized by the Engineer.

7-1.7 Insecticides and Herbicides: Contact the Local County Extension Office for a list of approved Insecticides or Herbicides.

Adhere to all labeling instruction.

Exercise extreme caution to prevent damage to vegetation adjacent to the treated area. Replace any damage as the result of these materials being applied outside the designated treatment area at no expense to the Department.

7-2 Permits and Licenses.

7-2.1 General: Except as noted for certain permits, procure all permits and licenses, pay all charges and fees, and give all notices necessary and incidental to the due and lawful prosecution of the work.

7-2.2 Work or Structures in Navigable Waters of the U.S., Waters of the U.S., and Waters of the State: In general, one or more governmental agencies will exercise regulatory authority over work or structures, including related construction operations, in all tidal areas (Channelward of the mean high water lines on the Atlantic and Gulf Coast); in the ocean and gulf waters to the outer limits of the continental shelf; in all rivers, streams, and lakes to the ordinary high water line; in marshes and shallows that are periodically inundated and normally characterized by aquatic vegetation capable of growth and reproduction; in all artificially created channels and canals used for recreational, navigational, or other purposes that are connected to navigable waters; and in all tributaries of navigable waters up to their headwaters.

Whenever the work under or incidental to the Contract requires structures or dredge/fill/construction activities in "Navigable Waters of the U.S.," "Waters of the U.S.," and "Waters of the State," the Federal, State, county, and local regulatory agencies may require the Department to obtain a permit. For such dredge/fill /construction specified in the plans to be accomplished within the limits of the project, or for any dredge/fill/construction within the limits of Department-furnished borrow areas, the Department will procure the necessary permits prior to advertising for bids.

The Department will also acquire any modifications or revisions to an original permit when the Contractor requires such modifications or revisions to complete the construction operations specified in the plans or Special Provisions and within the right-of-way limits.

Acquire all permits for work performed outside the right-of-way or easements for the project.

In carrying out the work in the Contract, when under the jurisdiction of any environmental regulatory agency, comply with all regulations issued by such agencies and with all general, special, and particular conditions relating to construction activities of all permits issued to the Department as though such conditions were issued to the Contractor. Post all permit placards in a protected location at the worksite.

In case of a discrepancy between any permit condition and other Contract Documents, the more stringent condition shall prevail.

If the permit conditions require work or the furnishing of materials not specifically provided for in the basis of payment clause for a pay item contained in the proposal, the Engineer will consider such work or the furnishing of such materials as unforeseen work and will compensate the Contractor under the provisions of 4-4. The special sequencing or scheduling of operations required by permit conditions is not unforeseen work.

7-3 Patented Devices, Materials and Processes.

Include all royalties and costs arising from patents, trademarks, and copyrights, in any way involved in the work in the Contract price. Whenever using any design, device, material, or process covered by letters patent or copyright, obtain the right for such use by suitable legal agreement with the patentee or owner of the copyright. File a copy of such agreement with the Engineer. However, whether or not such agreement is made or filed as noted, the Contractor and the surety in all cases shall indemnify, defend, and save harmless, the Department from all claims for infringement by reason of the use of any such patented design, device, material, or process on work under the Contract, and shall indemnify the Department for all costs, expenses, and damages that it may be obliged to pay by reason of any such infringement, at any time during the prosecution or after the completion of the work.

7-4 Right-of-Way Furnished by the Department.

Except as otherwise stipulated in these Specifications or as shown in the plans, the Department will furnish all rights-of-way necessary for the proper completion of the work at no expense to the Contractor.

Should Department-furnished areas for obtaining borrow material, contain limerock material, do not remove such material from the pit unless the Engineer gives specific approval.

7-5 Restoration of Surfaces Opened by Permit.

Upon the presentation of a duly authorized and satisfactory permit that provides that all necessary repair work will be paid for by the party holding such permit, the Engineer may authorize the Contractor to allow parties bearing such permits to make openings in the highway. Upon the Engineer's written order, perform, in an acceptable manner, all necessary repairs due to such openings, and such necessary work that the Engineer orders, subject to the same conditions as the original work performed. The Department will pay the Contractor for such work either under applicable Contract items or in accordance with 4-4 when Contract items are not applicable.

7-6 Sanitary Provisions.

The Contractor shall provide and maintain, in a neat and sanitary condition, such accommodations for the use of his employees as are necessary to comply with the requirements and regulations of the State and local boards of health. Commit no public nuisance.

7-7 Control of the Contractor's Equipment.

7-7.1 Traffic Interference: Do not allow equipment, while it is on or traversing a road or street, to unreasonably interfere with traffic.

7-7.2 Overloaded Equipment: Do not operate on any road or street any hauling unit or equipment loaded in excess of (1) the maximum weights specified in the Florida Uniform Traffic Control Law, or (2) lower weights legally established for any section of road or bridge by the Department or local authorities. The governmental unit having jurisdiction over a particular road or bridge may provide exceptions by special permit under the provisions of 7-7.3. This restriction applies to all roads and bridges inside and outside the Contract limits as long as these roads and bridges are open for public use. The Contractor may overload roads and bridges which are to be demolished after they are permanently closed to the public. The Contractor is responsible for all loss or damages resulting from equipment operated on a structure permanently closed to the public.

7-7.3 Crossings: Where it is necessary to cross an existing road or street, including specifically the existing traveled lanes of a divided highway within the limits of the project, obtain permits from the Department, for crossing overloaded or oversized equipment. Cross existing roads or streets only at Engineer-designated points. The Engineer may require the Contractor to protect the pavement or Roadway at the crossing by using lumber, planks, or fill. Provide flagging and watchman service, or approved signal devices, for the protection of traffic at all such crossings, in accordance with an approved written plan for that activity.

7-7.4 Protection from Damage by Tractor-Type Equipment: Take positive measures to ensure that tractor-type equipment does not damage the road. If any such damage should occur, repair it without delay, at no expense to the Department and subject to the Engineer's approval.

7-7.5 Contractor's Equipment on Bridge Structures: The Specialty Engineer shall analyze the effect of imposed loads on bridge structures, within the limits of a construction contract, resulting from the following operations:

(1) Overloaded Equipment as defined in 7-7.2:

(a) Operating on or crossing over completed bridge structures.

(b) Operating on or crossing over partially completed bridge structures.

(2) Equipment within legal load limits:

(a) Operating on or crossing over partially completed bridge structures.

(3) Construction cranes:

(a) Operating on completed bridge structures.

(b) Operating on partially completed bridge structures.

Any pipe culvert(s) or box culvert(s) qualifying as a bridge under 1-3 is excluded from the requirements above.

A completed bridge structure is a bridge structure in which all elemental components comprising the load carrying assembly have been completed, assembled, and connected in their final position. The components to be considered shall also include any related members transferring load to any bridge structure.

The Specialty Engineer shall determine the effect that equipment loads have on the bridge structure and develop the procedures for using the loaded equipment without exceeding the structure's design load capacity.

Submit to the Department for approval eight copies of design calculations, layout drawings, and erection drawings showing how the equipment is to be used so that the bridge structure will not be overstressed. The Specialty Engineer shall sign and seal one set of the eight copies of the drawings and the cover sheet of one of the eight copies of the calculations for the Department's Record Set.

7-7.6 Posting of the Legal Gross Vehicular Weight: Display the maximum legal gross weight, as specified in the Florida Uniform Traffic Code, in a permanent manner on each side of any dump truck or dump type tractor-trailer unit hauling embankment material, construction aggregates, road base material, or hot bituminous mixture to the project over any public road or street. Display the weight in a location clearly visible to the scale operator, in numbers that contrast in color with the background and that are readily visible and readable from a distance of 50 feet [15 m].

7-8 Structures over Navigable Waters.

7-8.1 Compliance with Federal and Other Regulations: Where erecting structures in, adjacent to, or over, navigable waters, observe all regulations and instructions of Federal and other authorities having control over such waters. Do not obstruct navigation channels without permission from the proper authority, and provide and maintain navigation lights and signals in accordance with the Federal requirements for the protection of the structure, of false work, and of navigation.

In the event of accidental blocking of the navigation channel, immediately notify the U.S. Coast Guard of the blockage and upon removal of the blockage.

7-8.2 Maintenance of Channel: Where the work includes the excavation of a channel or other underwater areas to a required section, maintain the section from shoaling or other encroachment until final acceptance of the project.

7-9 Use of Explosives.

When using explosives for the prosecution of the work, exercise the utmost care not to endanger life or property, including new work. The Contractor is responsible for all damage resulting from the use of explosives.

Store all explosives in a secure manner in compliance with all laws and ordinances, and clearly mark all such storage places with the words:"DANGEROUS

- EXPLOSIVES". Place such storage in the care of a competent watchman. Where no local laws or ordinances apply, provide storage satisfactory to the Engineer and, in general, not closer than 1,000 feet [300 m] from the road or from any building, camping area, or place of human occupancy.

Notify each public utility company having structures in proximity to the site of the work of the intention to use explosives. Give such notice sufficiently in advance to enable the companies to take precautionary steps to protect their property from injury.

7-10 Forest Protection.

7-10.1 Compliance with State and Federal Regulations: In carrying out work within or adjacent to State or National forests or parks, comply with all of the regulations of the State or Federal authority having jurisdiction, governing the protection of and the carrying out of work in forests or parks, and observe all sanitary laws and regulations with respect to the performance of work in these areas. Keep the areas in an orderly condition, dispose of all refuse, and obtain permits for the construction, installation, and maintenance of any construction camps, living quarters, stores, warehouses, sanitary facilities, and other structures; all in accordance with the requirements of the forest or park official.

7-10.2 Prevention and Suppression of Forest Fires: Take all reasonable precautions to prevent and suppress forest fires. Require employees and subcontractors, both independently and at the request of forest officials, to do all reasonably within their power to prevent and suppress forest fires. Assist in preventing and suppressing forest fires, and make every possible effort to notify a forest official at the earliest possible moment of the location and extent of all fires. Extinguish the fire if practicable.

7-11 Preservation of Property.

7-11.1 General: Preserve from damage all property which is in the vicinity of or is in any way affected by the work, the removal or destruction of which is not specified in the plans. This applies to public and private property, public and private utilities (except as modified by the provisions of 7-11.6), trees, shrubs, crops, signs, monuments, fences, guardrail, pipe and underground structures, and public highways (except natural wear and tear of highway resulting from legitimate use thereof by the Contractor), etc., Whenever the Contractor's activities damage or injure such property, immediately restore it to a condition similar or equal to that existing before such damage occurred, at no expense to the Department.

Protect existing bridges during the entire construction period from damage caused by the construction operations or equipment. The Department will not require the Contractor to provide routine repairs or maintenance for such structures. However, immediately repair, at no expense to the Department, all damage occasioned by the construction operations. In the event that the Contractor's construction operations result in damage to a bridge requiring repairs, the Contractor shall make such repairs with any equipment, materials, or labor at the Contractor's disposal prior to continuing Contract work.

Direct special attention to the protection of all geodetic monuments, horizontal or vertical, located within the limits of construction.

7-11.2 Failure to Restore Damaged Property: In case of failure on the part of the Contractor to restore such property, bridge, road or street, or to make good such damage or injury, the Engineer may, upon 48 hours notice, proceed to repair, rebuild, or otherwise restore such property, road, or street as may be deemed necessary, and the Department will deduct the cost thereof from any monies due or which may become due the Contractor under the Contract. Nothing in this clause prevents the Contractor from receiving proper compensation for the removal, damage, or replacement of any public or private property, not shown on the plans, that is made necessary by alteration of grade or alignment. The Engineer will authorize such work, provided that the Contractor, or his employees or agents, have not, through their own fault, damaged such property.

7-11.3 Contractor's Use of Streets and Roads:

7-11.3.1 On Systems Other than the State Highway System: When hauling materials or equipment to the project over roads and bridges on the State park road system, county road system, or city street system, and such use causes damage, immediately, at no expense to the Department, repair such road or bridge to as good a condition as before the hauling began.

The Department may modify the above requirement in accordance with any agreement the Contractor might make with the governmental unit having jurisdiction over a particular road or bridge, provided that the Contractor submits written evidence of such agreement to the Engineer.

7-11.3.2 On the State Highway System: The Department is responsible for the repair of any damage that hauling materials to the site causes to roads outside the limits of the project, that are either on the State highway system (roads under the jurisdiction of the Department) or specifically designated in the plans as haul roads from Department-furnished material pits, except in the event damage is due to failure to comply with 7-7.2. The Contractor is responsible for all damages to any road or bridge caused by the Contractor's failure to comply with 7-7.2.

7-11.3.3 Within the Limits of a Construction Project: The Department will not allow the operation of equipment or hauling units of such weight as to cause damage to previously constructed elements of the project, including but not necessarily limited to bridges, drainage structures, base course, and pavement. Do not operate hauling units or equipment loaded in excess of the maximum weights specified in 7-7.2 on existing pavements that are to remain in place (including pavement being resurfaced), cement-treated subgrades and bases, concrete pavement, any course of asphalt pavement, and bridges. The Engineer may allow exceptions to these weight restrictions for movement of necessary equipment to and from its worksite, for hauling of offsite fabricated components to be incorporated into the project, and for crossings as specified in 7-7.3.

7-11.4 Traffic Signs, Signal Equipment, Highway Lighting and Guardrail: Protect all existing roadside signs, signal equipment, highway lighting and guardrail, for which permanent removal is not indicated, against damage or displacement. Whenever such signs, signal equipment, highway lighting or guardrail lie within the limits of construction, or wherever so directed by the Engineer due to urgency of construction operations, take up and properly store the existing roadside signs, signal equipment, highway lighting and guardrail and subsequently reset them at their original locations or, in the case of widened pavement or roadbed, at locations designated by the Engineer.

If the Department determines that damage to such existing or permanent installations of traffic signs, signal equipment, highway lighting or guardrail is caused by a third party(ies), and is not otherwise due to any fault or activities of the Contractor, the Department will, with the exception of any damage resulting from vandalism, compensate the Contractor for the costs associated with the repairs. Repair damage caused by vandalism at no expense to the Department.

If appropriate, repairs will be paid for at the Contract unit price. If not, payment for repairs will be made in accordance with 4-3.2.3.

7-11.5 Operations Within Railroad Right-of-Way:

7-11.5.1 Notification to the Railroad Company: Notify the superintendent of the railroad company, as shown on the plans, and the Engineer at least 72 hours before beginning any operation within the limits of the railroad right-of-way; any operation requiring movement of employees, trucks, or other equipment across the tracks of the railroad company at other than an established public crossing; and any other work that may affect railroad operations or property.

7-11.5.2 Contractor's Responsibilities: Comply with whatever requirements an authorized representative of the railroad company deems necessary in order to safeguard the railroad's property and operations. The Contractor is responsible for all damages, delays, or injuries and all suits, actions, or claims brought on account of damages or injuries resulting from the Contractor's operations within or adjacent to railroad company right-of-way.

7-11.5.3 Watchman or Flagging Services: The railroad company will furnish protective services (i.e., watchman or flagging services) to ensure the safety of railroad operations during certain periods of the project. The Department will reimburse the railroad company for the cost thereof. Schedule work that affects railroad operations so as to minimize the need for protective services by the railroad company.

7-11.6 Utilities:

7-11.6.1 Arrangements for Protection or Adjustment: Do not commence work at points where the construction operations are adjacent to utility facilities or other property, until making arrangements with the utility facilities to protect against damage that might result in expense, loss, disruption of service, or other undue inconvenience to the public or to the owners. The Contractor is solely and directly responsible to the owners and operators of such properties for all damages, injuries, expenses, losses, inconveniences, or delays caused by the Contractor's operations.

The Department will make the necessary arrangements with utility owners for removal or adjustment of utilities where the Engineer determines that such removal or adjustment is essential to the performance of the required construction. The Department will not consider relocation or adjustment requests based on the Contractor's proposed use of a particular method of construction or a particular type of equipment as essential to the construction of the project if the Contractor could use other common methods and equipment without relocating or adjusting the utility. The Engineer will determine the responsibility for any such required adjustments of utilities. The Contractor shall make all requested relocations or adjustments because of delivery to the job site of Contractor-furnished materials, at no expense to the Department.

The Department considers relocations and adjustments (or other protection) under the following circumstances as essential to the construction of the project:

(1) Utilities lying within the vertical and horizontal construction limits, plus the reasonably required working room necessary for operation of equipment normally used for the particular type of construction, all as determined by the Engineer (and except as provided in paragraph (4) below). (In the case of overhead electrical conductors that carry more than 400 V, a minimum of 10 feet [3 m] clearance between the conductor and the nearest possible approach of any part of the equipment is required, except where the utility owner effects safeguards approved by the Florida Department of Labor and Employment Security.)

(2) Utilities lying within the horizontal limits of the project and within 12 inches [300 mm] below the ground surface or the excavation surface on which the Contractor operates construction equipment, or within 12 inches [300 mm] below the bottom of any stabilizing course specified in the plans.

(3) Utilities lying within the normal limits of excavation for underground drainage facilities or other structures (except as provided in paragraph (4) below). Such normal limits shall extend to side slopes along the angle of repose, as established by sound engineering practice, unless the Contract Documents require support of the excavation sides by sheeting or the Contractor elects to sheet such excavation for his own convenience.

(4) Where utilities cross pipe trenches transversely within the excavation area, but not within positions from which relocation or removal is necessary, the utility owner is responsible for providing and effecting all reasonable measures for their support and protection during construction operations. Cooperate with the utility owner in the owner's effecting of such support and protective measures. The Contractor is responsible for all damage to the utility that is caused by the Contractor's neglect or failure to cooperate or to use proper precaution in performing his work.

In the event that a temporary relocation of a utility or a particular sequence of timing in the relocation of a utility is necessary, the Engineer will direct such relocation so as to cause the least impediment to the overall construction operations. The Department is not responsible for utility adjustments or temporary relocation work, or for the conditions resulting therefrom, where such adjustments are (1) not necessitated by the construction of the project, (2) done solely for the benefit or convenience of the utility owner or its contractor, or the highway contractor where the Department considers his construction procedures to be other than normal, or (3) not shown on the approved plans for the utility relocation or the construction of the project.

7-11.6.2 Cooperation with Utility Owners: Cooperate with the owners of all underground or overhead utility lines in their removal and rearrangement operations in order that these operations may progress in a reasonable manner, that duplication or rearrangement work may be reduced to a minimum, and that services rendered by the utility owners will not be unnecessarily interrupted.

In the event of interruption of water or other utility services as a result of accidental breakage, exposure, or lack of support, promptly notify the proper authority and cooperate with the authority in the prompt restoration of service. If water service is interrupted and the Contractor is performing the repair work, the Contractor shall work continuously until the service is restored. Do not begin work around fire hydrants until the local fire authority has approved provisions for continued service.

7-11.6.3 Utility Adjustments: Certain utility adjustments and reconstruction work may be underway during the progress of the Contract. Cooperate with the various utility construction crews who are maintaining utility service. Exercise due caution when working adjacent to relocated utilities. The Contractor shall repair all damage to the relocated utilities resulting from his operations at no expense to the Department. The requirements of 7-11.1 and 7-11.6.2 outline the Contractor's responsibility for of protecting utility facilities. The Department will include in the Contract the utility authorities who are scheduled to perform utility work on the project.

7-11.6.4 Weekly Meetings: Conduct weekly meetings on the job site with all the affected utility companies and the Engineer in attendance to coordinate project construction and utility relocation. Submit a list of all attendees one week in advance to the Engineer for approval.

Provide the approved Work Progress Schedule and Work Plan for the project, as specified in 8-3.2, to document the schedule and plan for road construction and utility adjustments.

When utility relocations no longer affect construction activities, the Contractor may discontinue the meetings with the Engineer's approval.

7-12 Responsibility for Damages, Claims, etc.

7-12.1 Contractor to Provide Defense against Claims and Suits: The Contractor shall indemnify, defend, and hold harmless the Department and all of its officers, agents and employees, from all claims, losses, damages, costs, charges, or expenses arising out of any acts, action, neglect, or omission by the Contractor during the performance of the Contract, whether direct or indirect, and whether to any person or property to which the Department or said parties may be subject, except that neither the Contractor nor any of its subcontractors are liable under this Subarticle for damages arising out of the injury or damage to persons or property directly caused or resulting from the sole negligence of the Department or any of its officers, agents or employees. The indemnification referenced above is capped and limited to the amount of the Contract.

The Contractor's obligation to indemnify, defend, and pay for the defense or at the Department's option, to participate and associate with the Department in the defense and trial of any damage claim or suit, and any related settlement negotiations, arises within seven days of the Contractor's receipt of the Department's notice of claim for indemnification to the Contractor. The Department will serve the notice of claim for indemnification by certified mail. The Contractor's obligation to defend and indemnify the Department within seven days of receipt of such notice is not excused because of the Contractor's inability to evaluate liability, or because the Contractor denies liability or determines the Department is solely negligent. Only a final adjudication or judgement finding the Department solely negligent excuses the Contractor from the performance of this provision. If a judgement finding the Department solely negligent is appealed and the finding of sole negligence is reversed, then the Contractor is obligated to indemnify the Department for the cost of the appeal(s). Pay all costs and fees related to this obligation and to the Department's enforcement of this obligation.

It is specifically agreed between the parties executing this Contract that it is not intended by any of the provisions of any part of the Contract to create in the public or any member thereof, a third party beneficiary hereunder, or to authorize anyone not a party to this Contract to maintain a suit for personal injuries or property damage pursuant to the terms or provisions of this Contract.

7-12.2 Guaranty of Payment for Claims: The Contractor guaranties the payment of all just claims for materials, supplies, tools, or labor and other just claims against him or any subcontractor, in connection with the Contract. The Department's final acceptance and payment does not release the Contractor's bond until all such claims are paid or released.

7-13 Insurance.

7-13.1 Worker=s Compensation Insurance: Provide Worker's Compensation Insurance in accordance with the laws of the State of Florida and in amounts sufficient to secure the benefits of the Florida Worker's Compensation Law for all employees. If subletting any of the work, ensure that the employees of the subcontractors are covered by similar insurance. The Engineer will accept equivalent approved protection in lieu of insurance.

7-13.2 Contractors' Public Liability and Property Damages Liability Insurance: Furnish evidence to the Department that, with respect to the operations performed, regular Contractors' Public Liability Insurance providing for a limit of not less than $1,000,000 for all damages arising out of bodily injuries to, or death of, one person and, subject to that limit for each person, a total limit of $5,000,000 for all damages arising out of bodily injuries to, or death of, two or more persons in any one occurrence; and regular Contractors' Property Damage Liability Insurance providing for a limit of not less than $50,000 for all damages arising out of injury to, or destruction of, property in any one occurrence and, subject to that limit per occurrence, a total (or aggregate) limit of $100,000 for all damages arising out of injury to, or destruction of, property during the policy period is carried.

Cause the Department to be an additional insured party on the Contractor=s Public Liability and Property Damages Liability Insurance policies that insure the Contractor for the described work that it performs under the Contract.

7-13.3 Contractors' Protective Public Liability and Property Damage Liability Insurance: Furnish evidence to the Department that, with respect to the operations performed by subcontractors, regular Contractors' Protective Public Liability Insurance providing for a limit of not less than $1,000,000 for all damages arising out of bodily injuries to, or death of, one person and, subject to that limit for each person, a total limit of $5,000,000 for all damages arising out of bodily injuries to, or death of, two or more persons in any one occurrence; and regular Contractors' Protective Property Damage Liability Insurance providing for a limit of not less than $50,000 for all damages arising out of injury to, or destruction of, property in any one occurrence and, subject to that limit per occurrence, a total (or aggregate) limit of $100,000 for all damages arising out of injury to, or destruction of, property during the policy period is carried.

Cause the Department to be an additional insured party on the Contractor=s Protective Public Liability and Property Damage Liability Insurance policies that insure the Contractor for the described work that it performs under the Contract.

7-13.4 Insurance Required for Construction at Railroads:

7-13.4.1 General: In addition to any other forms of insurance or bonds required under the terms of the Contract, when the Contract includes the construction of a railroad grade crossing, overpass, or underpass structure, or a railroad crossing signal installation, or any other work or operations by the Contractor within the limits of the railroad right-of-way, including any encroachments thereon from work or operations in the vicinity of the railroad right-of-way, provide insurance of the types set forth below and in amounts not less than specified herein.

7-13.4.2 Railroads' Protective Public Liability and Property Damage Liability Insurance: Furnish the Department with an original insurance policy that, with respect to the operations performed, will provide for and in behalf of the railroad company regular liability insurance providing coverage for bodily injury, death, and property damage limited to a combined single limit of $2,000,000 per occurrence with an aggregate limit of $6,000,000 for the term of the policy.

7-13.5 Insurance for Protection of Utility Owners: When the work under the Contract involves work on or in the vicinity of utility-owned property or facilities, furnish the Department with evidence that, with respect to the operations performed, General Comprehensive Liability Insurance or its equivalent providing for a limit of not less than $1,000,000 for bodily injury or death to person(s) per occurrence and $300,000 property damage each occurrence is carried. The Department and Utility Company are to be Additional Named Insureds, and the policy will be primary to any coverage maintained by the Department or Company. Do not make any material change or cancellation to the policy without providing the Department with ten days prior written notice.

7-13.6 Submission and Approval of Policies; Termination: Furnish two copies of each required policy to the Engineer at the Preconstruction Conference.

Provide all insurance policies in such form and with insurers that are acceptable to the Department, and to the railroad company or the utility owner. Keep insurance in behalf of a railroad company in force until the Department accepts that the Contractor has satisfactorily completed all work required under the Contract. Keep insurance in behalf of a utility owner in force, in the full amount specified herein, until 30 days after the Department accepts the work.

7-14 Contractor's Responsibility for Work.

Until the Department's acceptance of the work, take charge and custody of the work, and take every necessary precaution against injury or damage to the work by the action of the elements or from any other cause whatsoever, arising either from the execution or from the nonexecution of the work. Rebuild, repair, restore, and make good, without additional expense to the Department, all injury or damage to any portion of the work occasioned by any of the above causes before its completion and acceptance, except that in case of extensive or catastrophic damage. The Department may, at its discretion, reimburse the Contractor for the repair of such damage due to unforeseeable causes beyond the control of and without the fault or negligence of the Contractor, including but not restricted to Acts of God, of the public enemy, or of governmental authorities.

7-15 Opening Sections of Highway to Traffic.

Whenever any bridge or section of roadway is in acceptable condition for travel, the Engineer may direct the Contractor to open it to traffic. The Department's direction to open a bridge or roadway does not constitute an acceptance of the bridge or roadway, or any part thereof, or waive any Contract provisions. Perform all necessary repairs or renewals, on any section of the roadway or bridge thus opened to traffic under instructions from the Engineer, due to defective material or work or to any cause other than ordinary wear and tear, pending completion and the Engineer's acceptance of the roadway or bridge, or other work, at no expense to the Department.

7-16 Wage Rates for Federal-Aid Projects.

For all projects that include Federal-aid participation, the Contract Documents contain requirements with regard to payment of predetermined minimum wages. Predetermined Wage Rate Decisions (U.S. Department of Labor provided Wage Rate Tables) exist for Heavy, Highway, and Building Construction Projects, and are included in the Specifications Package as applicable. The Department will include other Specialty Decisions when required. The Department will include Heavy Decisions in Contracts for bridge construction over commercially navigable waters. The Department will include Highway Decisions in Contracts for highway and/or bridge construction (other than over commercially navigable waters). The Department will include Building Decisions in Contracts for building construction.

Review Wage Rate Tables for completeness. Request additional classifications when needed. Initiate requests for additional wage rate classifications through the Engineer's Office.

7-17 Supplemental Agreements.

Section 337.11 of the Florida Statutes as amended, which prescribe certain limitations on the use of supplemental agreements, are a part of the Contract.

7-18 Scales for Weighing Materials.

7-18.1 Applicable Regulations: When determining the weight of material for payment, use scales meeting the requirements of Chapter 531 of Florida Statutes, pertaining to specifications, tolerances, and regulations, as administered by the Bureau of Weights and Measures of the Florida Department of Agriculture.

7-18.2 Base for Scales: Place such scales on a substantial horizontal base to provide adequate support and rigidity and to maintain the level of the scales.

7-18.3 Protection and Maintenance: Maintain all scale parts in proper condition as to level and vertical alignment, and fully protect them against contamination by dust, dirt, and other matter that might affect their operation.

7-19 Source of Forest Products.

As required by Section 255.20 of the Florida Statutes, where price and quality are equal, and when available, use only timber, timber piling, or other forest products that are produced and manufactured in the State of Florida. This provision does not apply to Federal-aid projects.

7-20 Regulations of Air Pollution from Asphalt Plants.

7-20.1 General: Perform all work in accordance with all Federal, State, and local laws and regulations regarding air pollution and burning. In particular, pay attention to Chapters 17-2 and 17-5 of the Rules and Regulations of the Department of Environmental Protection, and to any part of the State Implementation Plan applicable to the project. See also 110-9.2 regarding burning of debris.

7-20.2 Dust Control: Ensure that excessive dust is not transported beyond the limits of construction in populated areas. The Contractor may control dust for embankments or other cleared or unsurfaced\ areas by applying water or calcium chloride, as directed by the Engineer. Use calcium chloride in accordance with 102-5. When included in the plans, install mulch, seed, sod, or temporary paving as early as practical. Control dust during the storage and handling of dusty materials by wetting, covering, or other means as approved by the Engineer.

7-20.3 Asphalt Material: Use only emulsified asphalt, unless otherwise stated in the plans and allowed by Chapter 17-2 of the Rules and Regulations of the Department of Environmental Protection. Store and handle asphalt materials and components so as to minimize unnecessary release of hydrocarbon vapors.

7-20.4 Asphalt Plants: Operate and maintain asphalt plants in accordance with Chapter 17-2 of the Rules and Regulations of the Department of Environmental Protection. Provide the plant site with a valid permit as required under Chapter 17-2 prior to start of work.

7-21 Dredging and Filling.

Section 370.033 of the Florida Statutes, requires that all persons, who engage in certain dredge or fill activities in the State of Florida, obtain a certificate of registration from the Florida Department of Environmental Protection, Tallahassee, Florida 32301, and that they keep accurate logs and records of all such activities for the protection and conservation of the natural resources. Obtain details as to the application of this law from the Department of Environmental Protection.

7-22 Available Funds.

For Contracts in excess of $25,000 or a term for more than one year, comply with the following provisions of Chapter 339 of the Florida Statutes:

The Department will not, during any fiscal year, expend money, incur any liability, or enter into any Contract that, by its terms, involves the expenditures of money in excess of the amounts budgeted as available for expenditure during such fiscal year. If the Department enters into such a Contract, verbal or written, in violation of this subsection, such Contract is null and void, and the Department will not make any payments thereon. The Department will require a statement from the Department's comptroller that funds are available prior to entering into any such Contract or other binding commitment of funds. Nothing herein contained prevents the Department from executing Contracts for a period exceeding one year, but the Department will make such Contracts executory only for the value of the services to be rendered or agreed to be paid for in succeeding fiscal years. The Department will incorporate this paragraph verbatim in all Contracts in excess of $25,000 or having a term for more than one year.

7-23 Submittal of Wage Rate Summary.

It is a condition of this Contract, and the Contractor shall make it a condition of all subcontracts entered into pursuant to this Contract, that the Contractor submit to the Engineer's Office, by the tenth of the each month, the original Monthly Summary of Wage Rates, including those of all subcontractors. Review Monthly Summaries of Wage Rates for completeness before submitting them to the Engineer.

7-24 Contractor's Motor Vehicle Registration.

The Contractor shall provide the Department with proof that all motor vehicles operated or caused to be operated by such Contractor are registered in compliance with Chapter 320 of the Florida Statutes. Submit such proof of registration in the form of a notarized affidavit to the Department.

The Department will not make payment to the Contractor until the required proof of registration is on file with the Department.

If the Contractor fails to register any motor vehicle that he operates in Florida, pursuant to Chapter 320 of the Florida Statutes, the Department may disqualify the Contractor from bidding, or the Department may suspend and revoke the Contractor's certificates of qualification.

SECTION 8

PROSECUTION AND PROGRESS

8-1 Subletting or Assigning of Contracts.

8-1.1 General: Do not sublet, sell, transfer, assign or otherwise dispose of the Contract or Contracts or any portion thereof, or of the right, title, or interest therein, without written consent of the Department. With the Engineer's written consent, the Contractor may sublet a portion of the work, but shall perform with his own organization work amounting to not less than 50% of the total Contract amount less the total amount for those Contract items designated as "Specialty Work."

Include in the total Contract amount the cost of materials and manufactured component products, and their transportation to the project site. For the purpose of meeting this requirement the Department will not consider off-site commercial production of materials and manufactured component products that the Contractor purchases, or their transportation to the project, as subcontracted work.

If the Contractor sublets a part of a Contract item, the Department will use only the sublet proportional cost in determining the percentage of subcontracted normal work.

Execute all agreements to sublet work in writing and include all pertinent provisions and requirements of the Contract. Upon request, furnish the Department with a copy of the subcontract. The subletting of work does not relieve the Contractor or the surety of their respective liabilities under the Contract.

The Department recognizes a subcontractor only in the capacity of an employee or agent of the Contractor, and the Engineer may require the Contractor to remove the subcontractor as in the case of an employee.

8-1.2 Specialty Work: For normal road and bridge Contracts, Specialty Work is defined as work of a type not normally performed by road and bridge contractors with their own organizations.

The following work is specifically designated as Specialty Work for normal road and bridge construction.

Auxiliary Power Unit.
Buildings, including Control House.
Cleaning, Coating, Injection, Grouting, Grinding, Grooving, or Sealing Concrete Surfaces.
Deep Well Installation.
Electrical Work.
Fencing.
Highway Lighting.
Installing Pipe or Pipe Liner, by Jacking or Boring.
Installing Structural Plate Pipe Structures.
Landscaping.
Machinery and Castings for Movable Bridges.
Navigation Lights.
Painting.
Plugging Water Wells.
Pressure Grouting.
Pumping Equipment.
Roadway Signing and Pavement Marking.
Riprap.
Removal of Buildings.
Rumble Strips.
Scale Systems - Static and Weigh - In - Motion
Sealing Wells by Injection.
Septic Tank and Disposal System.
Signalization.
Utility Work.
Vehicular Impact Attenuator.
Water and Sewage Treatment Systems.

When the major work under the Contract is of a type not normally performed by road and bridge contractors, the above-listed work will be considered as Specialty Work only as so listed in the special provisions.

8-2 Work Performed by Equipment-Rental Agreement.

The limitations set forth in 8-1, concerning the amount of work that may be sublet, do not apply to work performed by equipment-rental agreement. However, for any work proposed to be performed by equipment-rental agreement, notify the Engineer in writing of such intention before using the rented equipment, and indicate whether the equipment will be rented on an operated or non-operated basis. Include with the written notice a listing and description of the equipment and a description of the particular work to be performed with such equipment. As an exception to the above requirements, the Department will not require written notice for equipment to be rented (without operators) from an equipment dealer or from a firm whose principal business is the renting or leasing of equipment.

The operators of all rented equipment, whether rented on an operated or a non-operated basis, are subject to all wage rate requirements applicable to the project. When renting equipment without operators, the Contractor shall carry the operators on his own payroll. For equipment that is rented on an operated basis, and when required by the Contract or requested by the Engineer, furnish payrolls from the lessor with the names of the operators shown thereon.

When a lessor provides rentals of equipment on an operated basis that exceed $10,000, such lessor is subject to any Equal Employment Opportunity requirements that are applicable to the project.

8-3 Prosecution of Work.

8-3.1 Compliance with Time Requirements: Commence work in accordance with the approved working schedule and provide sufficient labor, materials and equipment to complete the work within the time limit(s) set forth in the proposal. Should the Contractor fail to furnish sufficient and suitable equipment, forces, and materials, as necessary to prosecute the work in accordance with the required schedule, the Engineer may withhold all estimates that are, or may become due, or suspend the work until the Contractor corrects such deficiencies.

8-3.2 Submission of Working Schedule: Within 21 calendar days after Contract award or at the preconstruction conference, whichever is earlier, submit to the Engineer a work progress schedule for the project.

Provide a schedule that shows the various activities of work in sufficient detail to demonstrate a reasonable and workable plan to complete the project within the Contract Time. Show the order and interdependence of activities and the sequence for accomplishing the work. Describe all activities in sufficient detail so that the Engineer can readily identify the work and measure the progress on of each activity. Show each activity with a beginning work date, a duration, and a monetary value. Include activities for procurement fabrication, and deliver of materials, plant, and equipment, and review time for shop drawings and submittals. Include milestone activities when milestones are required by the Contract Documents. In a project with more than one phase, adequately identify each phase and its completion date, and do not allow activities to span more than one phase.

Conduct sufficient liaison and provide sufficient information to indicate coordination activities with utility owners that have facilities within the limits of construction have been resolved. Incorporate in the schedule any utility adjustment schedules included in the Contract Documents unless the utility company and the Department mutually agree to changes to the utility schedules shown in the Contract.

Submit a working plan with the schedule, consisting of a concise written description of the construction plan.

The Engineer will return inadequate schedules to the Contractor for corrections. Resubmit a corrected schedule within 15 calendar days from the date of the Engineer's return transmittal. When approved, the Engineer will use this original schedule as the baseline against which to measure the progress.

Submit an updated Work Progress Schedule only when the Engineer requests it. If the Engineer requires revisions to the working schedule, furnish revised charts and analyses within 21 calendar days after the Engineer provides such notification.

If the Contractor fails to finalize either the initial or a revised schedule in the time specified, the Engineer will withhold all Contract payments until the Engineer approves the schedule.

8-3.3 Beginning Work: Notify the Engineer not less than five days in advance of the planned start day of work. Upon the receipt of such notice, the Engineer may give the Contractor Notice to Proceed and may designate the point or points to start the work. In the Notice to Proceed, the Engineer may waive the five day advance notice and authorize the Contractor to begin immediately. Notify the Engineer in writing at least two days in advance of the starting date of important features of the work. Do not commence work under the Contract until after the Department has issued the Notice to Proceed. The Department will issue the Notice to Proceed within 30 days after execution of the Contract.

8-3.4 Provisions for Convenience of Public: Schedule construction operations so as to minimize any inconvenience to adjacent businesses or residences. Where necessary, the Engineer may require the Contractor to first construct the work in any areas along the project where inconveniences caused by construction operations would present a more serious handicap. In such critical locations, where there is no assurance of continuous effective prosecution of the work once the construction operations are begun, the Engineer may require the Contractor to delay removal of the existing (usable) facilities.

8-3.5 Preconstruction Conference: Immediately after awarding the Contract but before the Contractor begins work, the Engineer will call a preconstruction conference at a place the Engineer designates to go over the construction aspects of the project. Attend this meeting, along with the Department and the various utility companies that will be involved with the road construction.

8-4 Limitations of Operations.

8-4.1 Night Work: During active nighttime operations, furnish, place and maintain lighting sufficient to permit proper workmanship and inspection. Use lighting with 5 ft≅cd [54 lx] minimum intensity. Arrange the lighting to prevent interference with traffic or produce undue glare to property owners. Operate such lighting only during active nighttime construction activities. Provide a light meter to demonstrate that the minimum light intensity is being maintained.

Lighting may be accomplished by the use of portable floodlights, standard equipment lights, existing street lights, temporary street lights, or other lighting methods approved by the Engineer.

Submit a lighting plan at the Preconstruction Conference for review and approval by the Engineer. Submit the plan on standard size plan sheets (not larger than 24 by 36 inch [610 by 915 mm]), and on a scale of either 100 or 50 foot to 1 inch [30 or 15 m to 25 mm]. Do not start night work prior to the Engineer=s approval of the lighting plan.

During active nighttime operations, furnish, place and maintain variable message signs to alert approaching motorists of lighted construction zones ahead. Operate the variable message signs only during active construction activities.

Equip all pickups and automobiles used on the project with either amber flashing lights or flashing white lights. Equip all other equipment with a minimum of 4 ft^2 [0.37 m^2] of reflective sheeting, or flashing lights. To avoid distraction to motorists, do not operate the lights on the vehicles or equipment when the vehicles are outside the clear zone or behind traffic control devices.

Ensure that all personnel shall wear reflective vests at all times while in the work area.

Comply with all applicable regulations governing noise abatement.

Have an ATSSA Certified Worksite Supervisor on site during all nighttime operations to ensure proper Maintenance of Traffic.

Include compensation for lighting for night work in the Contract prices for the various items of the Contract. Take ownership of all lighting equipment for night work.

8-4.2 Sequence of Operations: Do not open up work to the prejudice of work already started. The Engineer may require the Contractor to finish a section on which work is in progress before starting work on any additional section.

8-4.3 Interference with Traffic: At all times conduct the work in such manner and in such sequence as to ensure the least practicable interference with traffic. Operate all vehicles and other equipment safely and without hindrance to the traveling public. Park all private vehicles outside the clear zone. Place materials stored along the roadway so as to cause no obstruction to the traveling public as possible.

Where existing pavement is to be widened and stabilizing is not required, prevent any open trench from remaining after working hours by scheduling operations to place the full thickness of widened base by the end of each day. Do not construct widening strips simultaneously on both sides of the road, except where separated by a distance of at least 3 mile [0.5 km] along the road and where either the work of excavation has not been started or the base has been completed.

8-4.4 Coordination with other Contractors: Sequence the work and dispose of materials so as not to interfere with the operations of other contractors engaged upon adjacent work; join the work to that of others in a proper manner, in accordance with the spirit of the Contract Documents; and perform the work in the proper sequence in relation to that of other contractors; all as may be directed by the Engineer.

Each contractor is responsible for any damage done by him or his agents to the work performed by another contractor.

8-4.5 Drainage: Conduct the operations and maintain the work in such condition to provide adequate drainage at all times. Do not obstruct existing functioning storm sewers, gutters, ditches, and other run-off facilities.

8-4.6 Fire Hydrants: Keep fire hydrants on or adjacent to the highway accessible to fire apparatus at all times, and do not place any material or obstruction within 15 feet [5 m] of any fire hydrant.

8-4.7 Protection of Structures: Do not operate heavy equipment close enough to pipe headwalls or other structures to cause their displacement.

8-4.8 Fencing: Erect permanent fence as a first order of business on all projects that include fencing where the Engineer determines that the fencing is necessary to maintain the security of livestock on adjacent property, or for protection of pedestrians who are likely to gain access to the project from adjacent property.

8-4.9 Hazardous or Toxic Waste: When the construction operations encounter or expose any abnormal condition that may indicate the presence of a hazardous or toxic waste, discontinue such operations in the vicinity of the abnormal condition and notify the Engineer immediately. Be alert for the presence of tanks or barrels; discolored earth, metal, wood, ground water, etc.; visible fumes; abnormal odors; excessively hot earth; smoke; or other conditions that appear abnormal as possible indicators of hazardous or toxic wastes and treat these conditions with extraordinary caution.

Make every effort to minimize the spread of any hazardous or toxic waste into uncontaminated areas.

Do not resume the construction operations until so directed by the Engineer.

Dispose of the hazardous or toxic waste in accordance with the requirements and regulations of any Local, State, or Federal agency having jurisdiction. Where the Contractor performs work necessary to dispose of hazardous or toxic waste, and the Contract does not include pay items for disposal, the Department will pay for this work as provided in 4-4.

The Department may agree to hold harmless and indemnify the Contractor for damages when the Contractor discovers or encounters hazardous materials or pollutants during the performance of services for the Department when the presence of such materials or pollutants were unknown or not reasonably discoverable. Such indemnification agreements are only effective if the Contractor immediately stops work and notifies the Department of the hazardous material or pollutant problem.

Such indemnification agreement are not valid for damages resulting from the Contractor's willful, wanton, or intentional conduct or the operations of Hazardous Material Contractors.

8-5 Qualifications of Contractor's Personnel.

Provide competent, careful, and reliable superintendents, foremen, and workmen. Provide workmen with sufficient skill and experience to properly perform the work assigned to them. Provide workmen engaged on special work, or skilled work, such as bituminous courses or mixtures, concrete bases, pavements, or structures, or in any trade, with sufficient experience in such work to perform it properly and satisfactorily and to operate the equipment involved. Provide workmen that shall make due and proper effort to execute the work in the manner prescribed in the Contract Documents, or the Engineer may take action as prescribed below.

Whenever the Engineer determines that any person employed by the Contractor is incompetent, unfaithful, intemperate, disorderly, or insubordinate, the Engineer will provide written notice and the Contractor shall discharge the person from the work. Do not employ any discharged person on the project without the written consent of the Engineer. If the Contractor fails to remove such person or persons, the Engineer may withhold all estimates that are or may become due, or suspend the work until the Contractor complies with such orders. Protect, defend, indemnify, and hold the Department, its agents, officials, and employees harmless from all claims, actions, or suits arising from such removal, discharge, or suspension of employees.

8-6 Temporary Suspension of Contractor=s Operations.

8-6.1 Authority to Suspend Contractor=s Operations: The Engineer has the authority to suspend the Contractor=s operations, wholly or in part, for such periods deemed necessary. The Engineer will order such suspension in writing, giving in detail the reasons for the suspension and stating whether Contract Time will be charged during the suspension. Unless the Engineer, at his sole discretion, determines that the suspension of the Contractor=s operations is for the convenience of the Department, Contract Time will be charged during all suspensions of Contractor=s operations. No additional compensation will be paid to the Contractor when the operations are suspended for the following reasons:

a. The Contractor fails to comply with the Contract Documents.

b. The Contractor fails to carry out orders given by the Engineer.

c. The Contractor causes conditions considered unfavorable for continuing the Work.

Immediately comply with any suspension order. Do not resume operations until authorized to do so by the Engineer in writing. Any operations performed by the Contractor and otherwise constructed in conformance with the provisions of the Contract after the issuance of the suspension order and prior to the Engineer=s authorization to resume operations will be at no cost to the Department. Further, failure to immediately comply with any suspension order will also constitute an act of default by the Contractor and is deemed sufficient basis in and of itself for the Department to declare the Contractor in default in accordance with 8-9, with the exception that the Contractor will not have ten calendar days to correct the conditions for which the suspension was ordered.

8-6.2 Prolonged Suspensions: If the Engineer suspends the Contractor=s operations for an indefinite period, store all materials in such manner that they will not obstruct or impede the traveling public unnecessarily or become damaged in any way. Take every reasonable precaution to prevent damage to or deterioration of the work performed. Provide suitable drainage of the roadway by opening ditches, shoulder drains, etc., and provide any temporary structures necessary for public travel through the project.

8-6.3 Permission to Suspend Contractor=s Operations: Do not suspend operations or remove equipment or materials necessary for completing the work without obtaining the Engineer's written permission. Submit all requests for suspension of operations in writing to the Engineer, and identify specific dates to begin and end the suspension. Contract Time will be charged during suspension periods requested by the Contractor and approved by the Engineer. The Contractor is not entitled to any additional compensation for suspension of operations during such periods.

8-6.4 Suspension of Contractor=s Operations - Holidays: Unless the Contractor submits a written request to work on a holiday at least ten days in advance of the requested date and receives written approval from the Engineer, the Contractor shall not work on the following days: Martin Luther King, Jr. Day; Memorial Day; the Saturday and Sunday immediately preceding Memorial Day; Independence Day; Labor Day; the Friday, Saturday, and Sunday immediately preceding Labor Day; Veterans Day; Thanksgiving Day; the Friday, Saturday and Sunday immediately following Thanksgiving Day; and December 24 through January 2, inclusive. Contract Time will be charged during these holiday periods regardless of whether or not the Contractor=s operations have been suspended. The Contractor is not entitled to any additional compensation for suspension of operations during such holiday periods.

During such suspensions, remove all equipment and materials from the clear zone, except those required for the safety of the traveling public and retain sufficient personnel at the job site to properly meet the requirements of Sections 102 and 104. The Contractor is not entitled to any additional compensation for removal of equipment from clear zones or for compliance with Section 102 and Section 104 during such holiday periods.

8-7 Computation of Contract Time.

8-7.1 General: Perform the contracted work fully, entirely, and in accordance with the Contract Documents within the Contract Time specified in the proposal, or as may be extended in accordance with the provisions herein below.

The Department considers in the computation of the allowable Contract Time the effect that utility relocation and adjustments have on job progress and the scheduling of construction operations required in order to adequately maintain traffic, as detailed in the plans or as scheduled in the Special Provisions.

8-7.2 Date of Beginning of Contract Time: The date on which Contract Time begins is either (1) the date on which the Contractor actually begins work, or (2) the date for beginning the charging of Contract Time as set forth in the proposal; whichever is earlier.

8-7.3 Adjusting Contract Time:

8-7.3.1 Increased Work: The Department may grant an extension of Contract Time when it increases the Contract amount due to overruns in original Contract items, adds new work items, or provides for unforeseen work. The Department will base the consideration for granting an extension of Contract Time on the extent that the time normally required to complete the additional designated work delays the Contract completion schedule.

8-7.3.2 Contract Time Extensions: The Department may grant an extension of Contract Time when a controlling item of work is delayed by factors not reasonably anticipated or foreseeable at the time of bid. The Department may allow such extension of time only for delays occurring during the Contract Time period or authorized extensions of the Contract Time period. When failure by the Department to fulfill an obligation under the Contract results in delays to the controlling construction operations, the Department will consider such delays as a basis for granting a time extension to the Contract. Whenever the Engineer suspends the Contractor=s operations, as provided in 8-6, for reasons other than the fault of the Contractor, the Engineer will grant a time extension for any delay to a controlling item of work due to such suspension. The Department will not grant time extensions to the Contract for delays due to the fault or negligence of the Contractor.

The Department does not include an allowance for delays caused by the effects of inclement weather in establishing Contract Time.

The Department will handle time extensions for delays caused by the effects of inclement weather differently from those resulting from other types of delays. The Department will consider these time extensions only when rains or other inclement weather conditions or related adverse soil conditions prevent the Contractor from productively performing controlling items of work resulting in:

(1) The Contractor being unable to work at least 50% of the normal work day on pre-determined controlling work items due to adverse weather conditions; or

(2) The Contractor must make major repairs to work damaged by weather, provided that the damage is not attributable to the Contractor's failure to perform or neglect; and provided that the Contractor was unable to work at least 50% of the normal workday on pre-determined controlling work items.

No additional compensation will be made for delays caused by the effects of inclement weather.

The Engineer will continually monitor the effects of weather and, when found justified, grant time extensions on either a bimonthly or monthly basis. The Engineer will not require the Contractor to submit a request for additional time due to the effects of weather. The Department will consider the delays in delivery of materials or component equipment that affect progress on a controlling item of work as a basis for granting a time extension if such delays are beyond the control of the Contractor or supplier. Such delays may include an area-wide shortage, an industry-wide strike, or a natural disaster that affects all feasible sources of supply. In such cases, the Contractor shall furnish substantiating letters from a representative number of manufacturers of such materials or equipment clearly confirming that the delays in delivery were the result of an area-wide shortage, an industry-wide strike, etc.

The Department will not consider requests for time extension due to delay in the delivery of custom manufactured equipment such as traffic signal equipment, highway lighting equipment, etc., unless the Contractor furnishes documentation that he placed the order for such equipment in a timely manner, the delay was caused by factors beyond the manufacturer's control, and the lack of such equipment caused a delay in progress on a controlling item of work.

The Department will consider the affect of utility relocation and adjustment work on job progress as the basis for granting a time extension only if all the following criteria are met:

(1) Delays are the result of either utility work that was not detailed in the plans, or utility work that was detailed in the plans but was not accomplished in reasonably close accordance with the schedule included in the Special Provisions.

(2) Utility work actually affected progress toward completion of controlling work items.

(3) The Contractor took all reasonable measures to minimize the effect of utility work on job progress, including cooperative scheduling of the Contractor's operations with the scheduled utility work at the preconstruction conference and providing adequate advance notification to utility companies as to the dates to coordinate their operations with the Contractor's operations to avoid delays.

Make a preliminary request for an extension of Contract Time in writing to the Engineer within ten calendar days after commencement of a delay to a controlling item of work. If the Contractor fails to provide this required notice, the Contractor waives any rights to an extension of the Contract Time for that delay. In the case of a continuing delay, the Engineer will require only one request. Include with each request for an extension of time a description of the dates and cause of the delay, a complete description of the magnitude of the delay, and a list of the controlling items of work affected by the delay. Within 30 days after the elimination of the delay or the receipt of a written request from the Engineer, submit all documentation of the delay and a request for the exact number of days justified to be added to the Contract Time. If claiming additional compensation in addition to a time extension, include with the documentation a detailed cost analysis of the claimed extra compensation. The Contractor's failure to deliver the required notice or documentation within the required period constitutes an irrevocable waiver of an extension to the Contract Time for that delay. The Contractor's failure to provide sufficient documentation, justification, records, etc., to support a request for additional Contract Time is a valid basis for the Department to deny the request either in part or entirely.

8-8 Failure of Contractor to Maintain Satisfactory Progress.

8-8.1 General: Pursue the work to completion.

Section 337.16 of the Florida Statutes establishes certain requirements pertaining to the suspension or revocation of a Contractor's Certificate of Qualification because of delinquency on a previously awarded Contract.

8-8.2 Regulations Governing Suspension for Delinquency:

(a) A Contractor is delinquent when the allowed Contract Time for performing the work has expired, and the Contractor has not completed the Contract work.

(b) Once the Department determines that the Contractor is delinquent, the Department will give the Contractor written notice of intent to suspend the Contractor's Certificate of Qualification. If the Contractor disagrees with the delinquency, the Contractor shall file a request for an administrative hearing with the Clerk of Agency Proceedings within ten days of receipt of the notice of intent to suspend. If the Contractor does not file a request, the Department will make the suspension conclusive and final. The request for hearing is filed when the Contractor delivers it to, and it is received by, the Clerk of Agency Proceedings, Mail Station 58, 562 Haydon Burns Building, 605 Suwannee Street, Tallahassee, Florida 32399-0450.

(c) If the Contractor files a request for a hearing, the Department will schedule the hearing within 30 days of the hearing officer's receipt of the request.

(d) The Department will continue the period of suspension of the Contractor's Certificate of Qualification until the Contractor is no longer delinquent. If the Contractor requests an administrative hearing, the Department's final order, depending on the outcome of the hearing, will set forth the time period of suspension for the number of days the Department determines that the Contractor was delinquent, even if the Contractor cures the delinquency during the pendency of the administrative proceedings.

(e) During the period of suspension of the Contractor's Certificate of Qualification, the Department will not allow the Contractor and its affiliates to bid on any Department Contract, regardless of dollar amount, and will not approve the Contractor as a subcontractor on any Department contract.

(f) The Department may grant extensions of time during the prosecution of the work as allowed under these Specifications regardless of the Contractor's delinquency status.

8-9 Default and Termination of Contract.

8-9.1 Determination of Default: The Department will give notice, in writing, to the Contractor and his surety for any delay, neglect, or default, if the Contractor:

(a) fails to begin the work under the Contract within the time specified in the Notice to Proceed;

(b) fails to perform the work with sufficient workmen and equipment or with sufficient materials to ensure prompt completion of the Contract;

(c) performs the work unsuitably, or neglects or refuses to remove materials or to perform anew such work that the Engineer rejects as unacceptable and unsuitable;

(d) discontinues the prosecution of the work, or fails to resume discontinued work within a reasonable time after the Engineer notifies the Contractor to do so;

(e) becomes insolvent or is declared bankrupt, or files for reorganization under the bankruptcy code, or commits any act of bankruptcy or insolvency, either voluntarily or involuntarily;

(f) allows any final judgment to stand against him unsatisfied for a period of ten calendar days;

(g) makes an assignment for the benefit of creditors;

(h) fails to comply with Contract requirements regarding minimum wage payments or EEO requirements; or

(i) for any other cause whatsoever, fails to carry on the work in an acceptable manner, or if the surety executing the bond, for any reasonable cause, becomes unsatisfactory in the opinion of the Department.

If the Contractor, within a period of ten calendar days after receiving the notice described above, fails to proceed to correct the conditions of which complaint is made, the Department will, upon written certificate from the Engineer of the fact of such delay, neglect, or default and the Contractor's failure to correct such conditions, have full power and authority, without violating the Contract, to take the prosecution of the work out of the hands of the Contractor and to declare the Contractor in default.

The Department has no liability for anticipated profits for unfinished work on a Contract that the Department has determined to be in default.

8-9.2 Termination of Contract for Convenience: The Department may, by written notice and with FHWA approval where applicable, terminate the Contract or a portion thereof after determining that, for reasons beyond either Department or Contractor control, the Contractor is prevented from proceeding with or completing the work as originally contracted for and that termination would therefore be in the public interest. Such reasons for termination include, but are not limited to:

(a) executive orders of the President relating to prosecution of war or national defense;

(b) national emergency that creates a serious shortage of materials;

(c) orders from duly constituted authorities relating to energy conservation;

(d) restraining orders or injunctions obtained by third-party citizen action resulting from national or local environmental protection laws or where the issuance of such order or injunction is primarily caused by acts; or

(e) omissions of persons or agencies other than the Contractor.

When the Department terminates a contract, or any portion thereof, before the Contractor completes all items of work in the Contract, the Department will make payment for the actual number of units or items of work that the Contractor has completed, at the Contract unit price, or as mutually agreed for items of work partially completed or not started. The Department will not consider any claim for loss of anticipated profits.

The Department will consider reimbursing the Contractor for mobilization expenses (when not otherwise included in the Contract) including moving equipment to the job where the volume of the work that the Contractor has completed is too small to compensate the Contractor for these expenses under the Contract unit prices. The Department's intent is to make an equitable settlement with the Contractor.

The Department may purchase at actual cost acceptable materials procured for the work, that the Department has inspected, tested, and approved and that the Contractor has not incorporated in the work. Submit the proof of actual cost, as shown by receipted bills and actual cost records, at such points of delivery as the Engineer may designate.

Termination of a contract or a portion thereof, under the provisions of this Subarticle, does not relieve the Contractor or the surety of its responsibilities for the completed portion of the Contract or its obligations for and concerning any just claims arising out of the work performed.

8-9.3 Completion of Work by Department: Upon declaration of default, the Department will have full power to appropriate or use any or all suitable and acceptable materials and equipment on the site and may enter into an agreement with others to complete the work under the Contract, or may use other methods to complete the work in an acceptable manner. The Department will charge all costs that the Department incurs because of the Contractor's default, including the costs of completing the work under the Contract, against the Contractor. If the Department incurs such costs in an amount that is less than the sum that would have been payable under the Contract had the defaulting Contractor completed the work then the Department will pay the difference to the defaulting Contractor. If the Department incurs such costs in an amount that exceeds the sum that would have been payable under the Contract, then the Contractor and the surety shall be liable and shall pay the State the amount of the excess.

If, after the ten day notice period and prior to any action by the Department to otherwise complete the work under the Contract, the Contractor establishes his intent to prosecute the work in accordance with the Department's requirements, then the Department may allow the Contractor to resume the work, in which case the Department will deduct from any monies due or that may become due under the Contract, any costs to the Department incurred by the delay, or from any reason attributable to the delay.

8-10 Liquidated Damages for Failure to Complete the Work.

8-10.1 Highway Code Requirements Pertaining to Liquidated Damages: Section 337.18, paragraph (2) of the Florida Statutes, requires that the Department adopt regulations for the determination of default and provides that the Contractor pay liquidated damages to the Department for any failure of the Contractor to complete the Contract work within the Contract Time. These Code requirements govern, and are herewith made a part of the Contract.

8-10.2 Amount of Liquidated Damages: Applicable liquidated damages are the amounts established in the following schedule:

Original Contract Amount	Daily Charge Per Calendar Day
$50,000 and under	$554
Over $50,000 but less than $250,000	$676
$250,000 but less than $500,000	$994
$500,000 but less than $2,500,000	$1,216
$2,500,000 but less than $5,000,000	$2,106
$5,000,000 but less than $10,000,000	$3,218
$10,000,000 but less than $15,000,000	$3,182
$15,000,000 but less than $20,000,000	$7,614
$20,000,000 and over	$7,614 plus 0.00027 of any amount over $20 million

8-10.3 Determination of Number of Days of Default: For all contracts, regardless of whether the Contract Time is stipulated in calendar days or working days, the Engineer will count default days in calendar days.

8-10.4 Conditions under which Liquidated Damages are Imposed: If the Contractor or, in case of his default, the surety fails to complete the work within the time stipulated in the Contract, or within such extra time that the Department may have granted then the Contractor or, in case of his default, the surety shall pay to the Department, not as a penalty, but as liquidated damages, the amount so due as determined by the Code requirements, as provided in 8-10.2.

8-10.5 Right of Collection: The Department has the right to apply, as payment on such liquidated damages, any money the Department owes the Contractor.

8-10.6 Allowing Contractor to Finish Work: The Department does not waive its right to liquidated damages due under the Contract by allowing the Contractor to continue and to finish the work, or any part of it, after the expiration of the Contract Time including granted time extensions.

8-10.7 Completion of Work by Department: In the case of a default of the Contract and the completion of the work by the Department, the Contractor and his surety are liable for the liquidated damages under the Contract, but the Department will not charge liquidated damages for any delay in the final completion of the Department's performance of the work due to any unreasonable action or delay on the part of the Department.

8-11 Release of Contractor's Responsibility.

The Department considers the Contract complete when the Contractor has completed all work and the Department has accepted the work. The Department will then release the Contractor from further obligation except as set forth in his bond, and except as provided in 5-13.

8-12 Recovery of Damages Suffered by Third Parties.

In addition to the damages provided for in 8-10.2 and pursuant to Section.337.18 of the Florida Statutes, when the Contractor fails to complete the work within the Contract Time or within such additional time that the Department may grant the Department may recover from the Contractor amounts that the Department pays for damages suffered by third parties unless the failure to timely complete the work was caused by the Department's act or omission.

SECTION 9
MEASUREMENT AND PAYMENT

9-1 Measurement of Quantities.

9-1.1 Measurement Standards: The Engineer will measure all work completed under the Contract in accordance with the United States Standard Measures [International System of Units (SI) Measures].

9-1.2 Method of Measurements: The Engineer will take all measurements horizontally or vertically.

9-1.3 Determination of Pay Areas:

9-1.3.1 Final Calculation: When measuring items paid for on the basis of area of finished work, where the pay quantity is designated to be determined by calculation, the Engineer will use lengths and widths in the calculations based on the station to station dimensions shown on the plans; the station to station dimensions actually constructed within the limits designated by the Engineer; or the final dimensions measured along the surface of the completed work within the neat lines shown on the plans or designated by the Engineer. The Engineer will use the method or combination of methods of measurement that reflect, with reasonable accuracy, the actual surface area of the finished work as the Engineer determines.

9-1.3.2 Plan Quantity: When measuring items paid for on the basis of area of finished work, where the pay quantity is designated to be the plan quantity, the Engineer will determine the final pay quantity based on the plan quantity subject to the provisions of 9-3.2. Generally, the Engineer will calculate the plan quantity using lengths based on station to station dimensions and widths based on neat lines shown in the plans.

9-1.4 Construction Outside Authorized Limits: The Engineer will not pay for surfaces constructed over a greater area than authorized, or for material that the Contractor has moved from outside of slope stakes and lines shown on the plans, except where the Engineer provides written instruction for the Contractor to perform such work.

9-1.5 Volume Measurement (Conversion from Truck Weights):

9-1.5.1 Eligible Materials: The Contractor may request that the following materials, when specified to be measured by volume, be weighed on truck scales, and the weights converted to equivalent volumes, in accordance with the provisions of this Subarticle:

(1) Borrow, where truck measurement is specified.

(2) Stabilizing materials.

(3) Limerock and shell, where truck measurement is specified.

(4) Cover materials for surface treatment and mineral seal coat.

9-1.5.2 Determination of Conversion Factor: The Department will establish the conversion factor as follows:

(a) Determination of Truck Volumes: The Engineer will measure the trucks that the Contractor will use in establishing the conversion factor and will calculate cubic content for each type and size.

When loading the trucks, heap the material in the truck bodies and then strike-off the material level with the sides of the trucks, leaving no voids along the perimeter of the truck body.

(b) Calculation of Conversion Factor: The Department will weigh the trucks loaded and empty, and divide the net weight of the material by the measured volume of the truck bodies to determine the conversion factor. The Department will calculate a factor from the average determined by weighing not less than three loaded and measured trucks each day, at various times during the day.

9-1.5.3 Weighing Operations after Establishment of Conversion Factor: After the Engineer establishes the conversion factor, weigh each load on truck scales and keep an accurate record of the total weight and the tare weight of each load. The Department will calculate a tare weight using the weight of the empty truck, weighed with the fuel tank full, less the calculated weight of α of a tank of fuel. The Department does not require the leveling of the material in the truck bodies after establishment of the conversion factor.

In the event that the material involved is wet by rain after the conversion factor has been established, the Department will establish a new conversion factor in the manner prescribed in 9-1.5.2.

Provide truck scales that meet the requirements of 320-2.2.1. Furnish the scales and the scale operator at a location near the project site.

9-1.6 Ladders and Instrument Stands for Bridge Projects: On bridge projects, in order to facilitate necessary measurements, provide substantial ladders to the tops of piers and bents, and place and move such ladders as the Engineer directs.

For bridge projects crossing water or marshy areas, supply fixed stands for instrument mounting and measurements, in accordance with the details stipulated in the Specifications for the project.

9-2 Scope of Payments.

9-2.1 Items Included in Payment: Accept the compensation as provided in the Contract as full payment for furnishing all materials and for performing all work contemplated and embraced under the Contract; also for all loss or damage arising out of the nature of the work or from the action of the elements, or from any unforeseen difficulties or obstructions which may arise or be encountered in the prosecution of the work until its final acceptance; also for all other costs incurred under the provisions of Division I.

For any item of work contained in the proposal, except as might be specifically provided otherwise in the basis of payment clause for the item, include in the Contract unit price (or lump sum price) for the pay item or items the cost of all labor, equipment, materials, tools and incidentals required for the complete item of work, including all requirements of the Section specifying such item of work, except as specifically excluded from such payments.

9-2.1.1 Bituminous Material: The Department will adjust the bid unit price for Bituminous Material to reflect changes, both increases and decreases, in the Asphalt Index price of bituminous material from that in effect during the month bids were received for this Contract. The Contractor will not be given the option to reject this cost adjustment. Adjustments will be made using the following criteria:

(a) Price adjustments will apply only to the price of bituminous material F.O.B. manufacturer's asphalt terminal and will not reflect variations in the cost of transportation from the terminal to the job site.

(b) Price adjustments will be made for all bituminous material incorporated into asphalt pavement whether paid for under a separate bid item such as Item No. 300-1 [Item No. 2300-1] or under other items that include the cost of bituminous material.

(c) Price adjustments will be paid on a monthly basis with payment being based on the increased quantities shown on the previous estimate.

(d) The adjusted unit price will be calculated for the month during which the material was incorporated into the project in accordance with the following formula:

$P_a = P_b + (I_d - 1.05\ I_b)$ during a period of increasing prices.

$P_a = P_b + (I_d - 0.95\ I_b)$ during a period of decreasing prices.

where: P_a = Adjusted unit price for Bituminous Material. (The Department will calculate it separately for each month bituminous material is used and will reflect an increased or decreased price.)

P_b = Bid unit price for Bituminous Material.

I_d = Asphalt Price Index during the month the material is incorporated into the project.

I_b = Asphalt Price Index during the month bids were received for this

Contract.

(e) The Department will determine the Asphalt Price Index for each month by averaging quotations in effect on the first day of the month at all terminals that could reasonably be expected to furnish bituminous material to projects in the State of Florida.

(f) A price adjustment will be made only when the current Asphalt Price Index varies more than 5% from the index that was applicable when bids were received.

(g) If the adjusted unit price for any Bituminous Material item exceeds the bid unit price in excess of 50% of the Asphalt Price Index for the month bids were received, the Department reserves the right to reduce the quantity of that item or delete from the Contract work where this material is to be used.

(h) When a reduced payment rate for bituminous material is applied due to material failing to meet the specified viscosity requirement, the reduction factor will be applied to the applicable adjusted unit price in lieu of the original Contract unit price.

(i) The dollar value paid for adjustments will not be included in the Contract amount from which normal retainage is withheld (as per 9-6.1).

(j) No adjustment will be allowed for the quantity of any item left in place at no pay.

(k) No adjustment will be allowed for the volume of water used to dilute emulsified asphalt in the proportions established by the Contract documents for use on the job.

The above provisions will apply to a recycling agent if used in a hot bituminous mixture in lieu of asphalt cement. In this case the Asphalt Price Index for Asphalt Cements (AC-20/AC-30) will apply to asphalt recycling agents and the Asphalt Price Index for Emulsified Asphalts (RS-2) will apply to emulsified recycling agents.

The Asphalt Price Index is available from the Department's Contracts Office after the 15th of each month.

9-2.1.2 Gasoline and Diesel Fuels: Contract price adjustments will be made to reflect increases or decreases in the prices of gasoline and diesel fuels from those in effect during the month in which bids were received for this Contract. The Contractor will not be given the option of accepting or rejecting this adjustment. This adjustment will be made in accordance with the following criteria:

(a) Price adjustments will be based on monthly average quoted bulk prices of gasoline and diesel fuel as derived by the Department. These prices shall be determined by averaging bulk fuel prices on the first day of the month as quoted by major oil companies that could reasonably be expected to furnish fuel to projects in the State of Florida.

(b) Price adjustments will be made for only the amounts of diesel and gasoline fuel estimated by the Department as required to complete the Contract. The requirements of each kind of fuel for each pay item is estimated by multiplying the Department's standard fuel factor for that pay item by the pay quantity of that item.

(c) Price adjustments will be paid on a monthly basis with the following conditions:

1. Payment will be based on the increased quantities shown on the

previous estimate on all items for which established standard fuel factors are on a file maintained by the Department.

2. Monthly calculations will be based partially on truck haul for commercial material deliveries to the job site and the use of diesel fuel for drying operations of asphaltic mixes.

3. Any fuel used for drying aggregate will be adjusted using the index for diesel fuel.

(d) A price adjustment for gasoline and diesel fuel respectively will be made only when the current fuel price varies by more than 5% from the price prevailing in the month when bids were received.

(e) The adjustment for each fuel will be calculated for each month during which the fuel was used on the project in accordance with the following formula:

$A_i = F_i (P_i - 1.05 P_b)$ during a period of increasing prices.

$A_i = F_i (P_i - 0.95 P_b)$ during a period of decreasing prices.

where: A_i = Total dollar amount - positive or negative - of the cost adjustment for each kind of fuel used by the Contractor during the month "I."

F_i = Total gallons calculated as being used during the month.

P_i = Average price for fuel prevailing during month "I."

P_b = Average price for fuel prevailing during the month "b" when bids were received on this Contract.

(f) Adjustments will be paid or charged to the Prime Contractor only. Any Contractor receiving an adjustment under this provision shall distribute the proper proportional part of such adjustment to subcontractors who perform applicable work.

(g) The dollar value paid for adjustments will not be included in the Contract amount from which normal retainage is withheld (as per 9-6.1).

(h) No adjustment will be allowed for the quantity of any item which is left in place at no pay.

Average quoted monthly bulk prices for diesel and gasoline will be available from the Department's Contracts Office after the 15th of each month.

9-2.2 Non-Duplication of Payment: In cases where the basis of payment clause in these Specifications relating to any unit price in the bid schedule requires that the unit price cover and be considered compensation for certain work or material essential to the item, the Department will not measure or pay for this same work or material under any other pay item that may appear elsewhere in these Specifications.

9-3 Compensation for Altered Quantities.

9-3.1 General: When alteration in plans or quantities of work not requiring a supplemental agreement as hereinbefore provided for are offered and performed, the Contractor shall accept payment in full at Contract unit bid prices for the actual quantities of work done, and no allowance will be made for increased expense, loss of expected reimbursement, or loss of anticipated profits suffered or claimed by the Contractor, resulting either directly from such alterations, or indirectly from unbalanced allocation among the Contract items of overhead expense on the part of the bidder and subsequent loss of expected reimbursement therefor, or from any other cause.

Compensation for alterations in plans or quantities of work requiring supplemental agreements shall be stipulated in such agreement, except when the Contractor proceeds with the work without change of price being agreed upon, the Contractor shall be paid for such increased or decreased quantities at the Contract unit prices bid in the Proposal for the items of work. If no Contract unit price is provided in the Contract, and the parties cannot agree as to a price for the work, the Contractor agrees to do the work in accordance with 4-3.2.

9-3.2 Payment Based on Plan Quantity:

9-3.2.1 Error in Plan Quantity: As used in this Article, the term Asubstantial error≅ is defined as the smaller of (a) or (b) below:

(a) a difference between the original plan quantity and final quantity of more than 5%,

(b) a change in quantity which causes a change in the amount payable of more than $5,000.

On multiple job Contracts, changes made to an individual pay item due to substantial errors will be based on the entire Contract quantity for that pay item.

Where the pay quantity for any item is designated to be the original plan quantity, the Department will revise such quantity only in the event that the Department determines it is in substantial error. In general, the Department will determine such revisions by final measurement, plan calculations, or both, as additions to or deductions from plan quantities.

In the event that either the Department or the Contractor contends that the plan quantity for any item is in error and additional or less compensation is thereby due, the claimant shall submit, at their own expense, evidence of such in the form of acceptable and verifiable measurements or calculations. The Department will not revise the plan quantity solely on the basis of a particular method of construction that the Contractor selects. For earthwork items, the claimant must note any differences in the original ground surfaces from that shown in the original plan cross-sections that would result in a substantial error to the plan quantity, and must be properly documented by appropriate verifiable level notes, acceptable to both the Contractor and the Department, prior to disturbance of the original ground surface by construction operations. The claimant shall support any claim based upon a substantial error for differences in the original ground surface by documentation as provided above.

9-3.2.2 Authorized Changes in Limits of Work: Where the Department designates the pay quantity for any item to be the original plan quantity and authorizes a plan change which results in an increase or decrease in the quantity of that item, the Department will revise the plan quantity accordingly. In general, the Department will determine such revisions by final measurement, plan calculations or both.

9-3.2.3 Specified Adjustments to Pay Quantities: Do not apply the limitations specified in 9-3.2.1 and 9-3.2.2 to the following:

(1) Where these Specifications or Special Provisions provide that the Department determines the pay quantity for an item on the basis of area of finished work adjusted in accordance with the ratio of measured thickness to nominal thickness.

(2) Where these Specifications provide for a deduction due to test

results falling outside of the allowable specified tolerances.

(3) To payment for extra length fence posts, as specified in 550-6.3.

9-3.3 Lump Sum Quantities:

9-3.3.1 Error in Lump Sum Quantity: Where the Department designates the pay quantity for an item to be a lump sum and the plans show an estimated quantity, the Department will adjust the lump sum compensation only in the event that either the Contractor submits satisfactory evidence or the Department determines and furnishes satisfactory evidence that the lump sum quantity shown is in substantial error as defined in 9-3.2.1.

9-3.3.2 Authorized Changes in Work: Where the Department designates the pay quantity for an item to be a lump sum and the plans show an estimated quantity, the Department will adjust compensation for that item proportionately when an authorized plan change is made which results in an increase or decrease in the quantity of that item. When the plans do not show an estimated plan quantity or the applicable specifications do not provide adjustments for contingencies, the Department will compensate for any authorized plan change resulting in an increase or decrease in the cost of acceptably completing the item by establishing a new unit price through a supplemental agreement as provided in 4-3.2.

9-3.4 Deviation from Plan Dimensions: If the Contractor fails to construct any item to plan or to authorized dimensions within the specified tolerances, the Engineer, at his discretion will: require the Contractor to reconstruct the work to acceptable tolerances at no additional cost to the Department; accept the work and provide the Contractor no pay; or accept the work and provide the Contractor a reduced final pay quantity or reduced unit price. The Department will not make reductions to final pay quantities for those items designated to be paid on the basis of original plan quantity or a lump sum quantity under the provisions of this Article unless such reduction results in an aggregate monetary change per item of more than $100, except that for earthwork items, the aggregate change must exceed $5,000 or 5% of the original plan quantity, whichever is smaller. If, in the opinion of the Engineer, the Contractor has made a deliberate attempt to take advantage of the construction tolerances as defined in 120-11.1 to increase borrow excavation in fill sections or to decrease the required volume of roadway or lateral ditch excavation or embankment, the Department will take appropriate measurements and will apply reductions in pay quantities. The Department will not use the construction tolerance, as defined in 120-11.1, as a pay tolerance. The construction tolerance is not to be construed as defining a revised authorized template.

9-4 Common Carrier Freight Rates.

9-4.1 General: Except as provided hereinafter for certain railroad freight rates, the Department will make no allowance or deduction for any increase or decrease in common carrier rates or transportation costs on materials.

9-4.2 Materials on which Adjustment is Allowable: The Department will make an allowance or deduction for any changes in railroad freight rates under the provisions of this Article, only for the construction materials described and limited below.

(1) Limerock used in bases and in Limerock Bearing Ratio (LBR) stabilizing.

(2) Limerock overburden used in LBR stabilizing.

(3) Shell used in bases and in LBR stabilizing.

(4) Stone screenings used in LBR stabilizing.

(5) Asphalt.

(6) Fine and coarse aggregates for asphaltic mixtures or bituminous surface treatments (mineral filler excluded).

(7) Fine and coarse aggregates and portland cement, used in portland cement concrete for which the Contract provides payment by area or by volume.

(8) Structural steel shapes and plates, and reinforcing steel, for which the Contract provides direct payment by lump sum or weight basis; as shipped from the final fabrication or jobbing point.

(9) Riprap (rubble).

(10) Cement used in optional base.

9-4.3 Explanation of Terms: The designation "applicable materials" as used hereinafter includes only the materials listed in 9-4.2 that are actually shipped by railroad and only within the limitations set forth in this Article. In addition, any such materials that the bidder, at his option, may himself exclude from such designation (as provided in 9-4.6) are not "applicable materials" for the particular contract for which they are thus excluded.

9-4.4 Basis for Adjustment: It is agreed that prices bid on items in the proposal that include the applicable materials are based on railroad freight rates, including multiple-car rates if applicable, and are shown on the Option and Affidavit Form in the proposal (as provided in 9-4.6 and 9-4.7). In case there is a difference between rates shown on the Option and Affidavit Form and rates quoted by the authorized freight agent for the same origin and destination, the Department will use the rates most favorable to the Department when making any adjustment. In the event that the freight rates on the applicable materials, including any multiple-car shipment reductions, are increased or decreased after the date the Department opened the bids and any of the applicable materials are shipped at the increased or decreased rates, the Department will adjust the final Contract amount in accordance with, and subject to, the provisions set forth hereinafter.

9-4.5 Method of Determining Adjustment: The Department will determine the amount of any contract adjustment to be made under the provisions of this Article as follows:

(a) For any applicable material, the Department will determine the base freight rate increase or decrease as the product of either the theoretical weight or the actual weight of the material shipped at the increased or decreased rate, whichever is less, by the change in rate. When the actual weight shipped, as determined from the freight bills, exceeds the theoretical weight as shown below, the Department will assume that the theoretical weight was shipped first when rates are increasing and last when rates are decreasing.

(b) The Department will not make any Contract adjustment for a net base freight cost increase or decrease of $1,000 or less on the Contract.

(c) The Department will further limit the amount of the Contract adjustment to 90% of the base freight cost increase or decrease over the $1,000 deductible amount.

(d) The Department will make adjustments for freight rate changes on the applicable materials entering into and forming a part of the completed work, whether or not they are supplied direct to the Contractor. (This applies to the applicable materials in structural concrete, concrete pavement, and plant-mixed asphalt mixtures, even though the Contractor purchases concrete or asphalt mixture from another firm.)

(e) The Department will base weights used in calculating the amount of any adjustment on the final Contract pay quantities whichever is less, the actual weight or the unit theoretical weights shown below.

(1) Limerock Base (square yard [square meter] pay unit) - 100 lbs/yd^2≅in [2 kg/(m^2≅mm)].

(2) Limerock and Limerock Overburden (cubic yard [cubic meter] pay unit, truck measurement) - 2,400 lbs/yd^3 [1,420 kg/m^3].

(3) Shell - 75 lbs/ft^3 [1,200 kg/m^3].

(4) Stone Screenings - 93 lbs/ft^3 [,1490 kg/m^3].

(5) Asphalt - 8.5 lbs/gal [1 kg/L].

(6) Fine and Coarse Aggregates for Asphaltic Mixtures - Weights specified in job-mix formula.

(7) Slag or Stone for Bituminous Surface treatments - 2,400 lbs/yd^3 [1,420 kg/m^3].

(8) Expanded aggregates for Bituminous Surface treatments - 1,100 lbs/yd^3 [650 kg/m^3].

(9) Portland Cement - Theoretical weight in the applicable concrete items, or for Optional Base - the amount actually applied and accepted.

(10) Fine and Coarse Aggregates for Portland Cement Concrete - Weights specified in job design mix.

(11) Structural Steel:

Lump sum pay basis - Shop bill weight.

Weight pay basis - Contract pay quantity.

(12) Reinforcing Steel - Contract pay quantity.

(13) Riprap (Rubble) - Contract pay quantity.

9-4.6 Contractor's Option for Excluding Materials: Exercise the option of including or of excluding any or all of the designated applicable materials from the provisions of this Article, and provide the required affidavit as described in 9-4.7, using a form that the Department will insert in the Contract forms at the time of award.

9-4.7 Affidavits Required: For those applicable materials that the Contractor desires covered by the provisions of this Article, the Contractor shall furnish within the time that the Department stipulates for returning the executed Contract and bond, affidavits showing the railroad freight rates and any multiple-car shipment reductions on which he has based his bid for the work. Indicate on these affidavits the rate for a single origin and destination for each of the applicable materials upon which the bid prices were determined. Support the affidavits with a signed quotation from an authorized freight agent. In case any rates or multiple-car shipment reductions are in litigation on the date that the Department opens the bids, do not base the bid on anticipation of a reduction. The Department will consider any change in railroad freight rates (including multiple-car shipment reductions ordered by the Court from the rates in effect on the date that the Department opened the bids as a rate revision under the provisions of this Article. Advise the Department if the use of railroad transportation is not intended.

9-4.8 Failure to Furnish Affidavits or Exercise Option: If the Contractor does not execute the option described in 9-4.6 or does not furnish the affidavits described in 9-4.7, all within the time allowed for his execution and return of the Contract and the furnishing of the bond, then the Department will exclude all materials from the freight rate adjustment clauses of this Article.

9-4.9 Change in Shipping Methods or Points; Errors in Rate Quotations: Notify the Department immediately of any changes in the proposed shipping methods, including change in origin or destination, and supply appropriate new affidavits and supporting quotations that cover the following, if applicable. Obtain these quotations from an authorized freight agent:

(a) Single-car and multiple-car rates, in effect on the date of the Contract letting, for all applicable materials to be shipped from the revised origin or to the revised destination.

(b) Rate increases or decreases, applicable to the original origin and destination, that became effective between the date of Contract letting and the completion of the railroad shipments.

(c) The effective dates of such rate changes.

The Department will not make any allowances for increased freight cost due to errors in the affidavit or quotations, or change in type of transportation, or any change in freight costs due to a change in origin or destination; whether made by the Contractor, his supplier, or his carrier. Whenever there is a change in origin or destination and also a change in freight rates for the applicable material, in making any adjustment under the provisions of this Article, the Department will use the difference between the rates shown on the Option and Affidavit Form or the quoted rates, at the time of bid, and the rates in effect on date of shipment for either (1) the shipping points listed in the original Option and Affidavit Form, or (2) the actual shipping points; whichever are most favorable to the Department.

The provisions of this Article are applicable to materials used to construct Optional Base Course in accordance with Section 285 subject to the following stipulations:

(1) Base the Option and Affidavit Form (as provided in 9-4.6 and 9-4.7) on the materials required to construct the option on which the bid is based as specified in 285-3.

(2) If the Department directs the Contractor to construct an option other than the one on which the Contractor bid, in making any adjustment under the provisions of this Article the Department will use the difference between the rates shown on the affidavit or the quoted rates at the time of bid and the rates in effect on the date of shipment for either (1) the shipping points and materials listed in the original affidavit, or (2) the actual shipping points and materials; whichever are most favorable to the Department.

9-4.10 Submission of Freight Bills: For all applicable materials not excluded from the adjustment provisions of this Article, submit to the Engineer, as soon as practicable after completing the material shipments, one of the following sets of records or an appropriate combination thereof:

(a) Original receipted freight bills (or copies thereof) covering the applicable material and a tabulation showing each bill, listed in chronological order; the material, quantity, and date shipped; and the freight rate paid.

(b) Shipping tickets (or copies thereof); the tabular billing from the railroad, covering the applicable shipping tickets showing the material, origin, and destination and listing each ticket or car number, date shipped, quantity, and freight rate charged; and copies of the vouchers or receipts from the railroad showing payment of appropriate billings.

(c) Affidavits from authorized freight agents to the effect that there was no rate increase or decrease during the period of material shipments for use under the appropriate contract, as compared to the quotations furnished for the rates in effect on the date of Contract letting. Furnish affidavits for all applicable material, origins, and destinations not covered by records submitted under the provisions of (a) or (b) above.

The Department requires these records, in addition to the required quotations, even if the Contractor does not file any claim for increased rates. The Department will withhold payment of the final estimate until receipt of the required bills, quotations, and tabulations, or affidavits.

9-4.11 Payment of Claim: The Department will withhold payment for any increased freight costs until final payment on the Contract.

9-4.12 Expiration of Contract Time: If the Contractor has not completed work under the Contract at the expiration of the Contract Time, including any extensions that the Department may grant, then the Department will make no allowance for freight rate increases effective after the date that the Contract Time expires.

9-5 Deleted Work.

The Department will have the right to cancel the portions of the Contract relating to the construction of any acceptable item therein, by the payment to the Contractor of a fair and equitable amount covering all items of cost incurred prior to the date that the Engineer cancels or suspends the work.

9-6 Partial Payments.

9-6.1 General: The Engineer will make partial payments on monthly estimates based on the amount of work that the Contractor completes during the month (including delivery of certain materials, as specified herein below). The Engineer will make approximate monthly payments, and the Department will correct all partial estimates and payments in the subsequent estimates and in the final estimate and payment.

The Department will base the amount of such payments on the total value of the work that the Contractor performs to the date of the estimate, based on the quantities and the Contract unit prices, less an amount retained and less payments previously made. The Department will determine the amount retained in accordance with the following schedule:

% of Contract Amount Completed	Amount Retained
0 to 50	None
50 to 100	10% of the earnings on the current monthly estimate and subsequent monthly estimates when the percentage of dollar value of the Contractor's completed work is less than the dollar value of work that should have been completed in accordance with the Contractor's approved working schedule. The Department will release retainage withheld for this reason on the next progress estimate when actual earnings equal or exceed earnings projected on the latest approved working schedule.
75 to 100	10% of the value of work completed exceeding 75% of the Contract Amount. The Department will withhold this amount in addition to any amount withheld due to differences between actual earnings and earnings projected in accordance with the Contractor's approved working schedule.

Contract Amount is defined as the original Contract amount as adjusted by approved supplemental agreements.

Where more than one project or job (separate job number) is included in the Contract, the Department will apply the above percentages separately to each job.

9-6.2 Unsatisfactory Payment Record: In accordance with Sections 255.05 and 337.16 of the Florida Statutes, and the rules of the Department, the Department may disqualify the Contractor from bidding on future Department contracts if the Contractor=s payment record in connection with contract work becomes unsatisfactory. The Department may also disqualify the surety from issuing bonds for future Department contracts if they similarly fail to perform under the terms of their bond.

9-6.3 Withholding Payment:

9-6.3.1 Withholding Payment for Defective Work: If the Department discovers any defective work or material prior to the final acceptance, or if the Department has a reasonable doubt as to the integrity of any part of the completed work prior to final acceptance, then the Department will not allow payment for such defective or questioned work until the Contractor has remedied the defect and removed any causes of doubt.

9-6.3.2 Withholding Payment for Failure to Comply: The Department will withhold progress payments from the Contractor if he fails to comply with any or all of the following within 60 days after beginning work:

(a) comply with and submit required paperwork relating to prevailing wage rate provisions, Equal Employment Opportunity, On-Job-Training, and Affirmative Action;

(b) comply with or make a good faith effort to meet Disadvantaged

Business Enterprise goals;

(c) comply with or make a good faith effort to meet minority and female hiring goals; and

(d) comply with or make a good faith effort to meet On-Job-Training goals.

The Department will withhold progress payments until the Contractor has satisfied the above conditions.

9-6.4 Release of Retainage After Acceptance: When the Contractor has furnished the Department with all submittals required by the Contract, such as invoices, freight bills, freight rate certifications, wage rate affidavits, Federal Highway Administration Form FHWA-47 (formerly known as PR-47), EEO reports, materials certifications, certification of materials procured, etc., (excluding Contractor's letter of acceptance of final amount due and Form 21-A release) and the Engineer has determined that the measurement and computation of pay quantities is correct, the Department may reduce the retainage to $1,000 plus any amount that the Department elects to deduct for defective work as provided in 9-6.3.

The Department will not allow a semifinal estimate under the provisions of the above
paragraphs unless the time elapsing between (1) acceptance of the project and receipt of all test reports, invoices, etc., and (2) submission of the final estimate to the Contractor for acceptance, exceeds or is expected to exceed ten days.

The Department may deduct from payment estimates any sums that the Contractor owes to the Department on any account. Where more than one project or job (separate job number) is included in the Contract, the Department will distribute the reduced retainage as provided in the first paragraph of this Subarticle to each separate project or job in the ratio that the Contract value of the work for the particular job bears to the total Contract amount.

9-6.5 Partial Payments for Delivery of Certain Materials:

9-6.5.1 General: The Department will allow partial payments for new materials that will be permanently incorporated into the project and are stockpiled in approved locations in the project vicinity. Stockpile materials so that they will not be damaged by the elements and in a manner that identifies the project on which they are to be used.

The following conditions apply to all payments for stockpiled materials:

(1) There must be reasonable assurance that the stockpiled material will be incorporated into the specific project on which partial payment is made.

(2) The stockpiled material must be approved as meeting applicable specifications.

(3) The total quantity for which partial payment is made shall not exceed the estimated total quantity required to complete the project.

(4) The Contractor shall furnish the Engineer with copies of certified invoices to document the value of the materials received. The amount of the partial payment will be determined from invoices for the material up to the unit price in the Contract.

(5) Delivery charges for materials delivered to the jobsite will be included in partial payments if properly documented.

(6) Partial payments will not be made for materials which were

stockpiled prior to award of the Contract for a project.

9-6.5.2 Partial Payment Amounts: The following partial payment restrictions apply:

(1) Partial payments less than $5,000 for any one month will not be processed.

(2) Partial payments for any individual pay item with an extended total less than $5,000 will not be processed.

(3) Partial payments for structural steel and precast prestressed items will not exceed 85% of the bid price for the item. Partial payments for all other items will not exceed 75% of the bid price of the item in which the material is to be used.

(4) Partial payment will not be made for aggregate and base course material received after paving or base construction operations begin except when a construction sequence designated by the Department requires suspension of paving and base construction after the initial paving operations, partial payments will be reinstated until the paving and base construction resumes.

9-6.5.3 Off Site Storage: If the conditions of 9-6.5.1 are satisfied, partial payments will be allowed for materials stockpiled in approved in-state locations. Additionally, partial payments for materials stockpiled in approved out-of-state locations will be allowed if the conditions of 9-6.5.1 and the following conditions are met:

(1) Furnish the Department a Materials Bond stating the supplier guarantees to furnish the material described in the Contract to the Contractor and Department. Under this bond, the Obligor shall be the material supplier and the Obligees shall be the Contractor and the Florida Department of Transportation. The bond shall be in the full dollar amount of the bid price for the materials described in the contract.

(2) The following clauses must be added to the construction Contract between the Contractor and the supplier of the stockpiled materials:

"Notwithstanding anything to the contrary, <supplier> will be liable to the Contractor and the Florida Department of Transportation should <supplier> default in the performance of this agreement."

"Notwithstanding anything to the contrary, this agreement, and the performance bond issued pursuant to this agreement, does not alter, modify, or otherwise change the Contractor's obligation to furnish the materials described in this agreement to the Florida Department of Transportation."

(3) The agreement between the Contractor and the supplier of the stockpiled materials must include provisions that the supplier will store the materials and that such materials are the property of the Contractor.

9-6.5.4 Retainage on Partial Payments: The standard retainage as provided 9-6.1, will be withheld from all of the partial payments herein above described.

9-6.6 Substitution of Securities for Retainage: In accordance with Section 337.175 of the Florida Statutes, the Department will accept substitution of securities, as provided by Section 255.052 of the Florida Statutes, or certificates of deposit or irrevocable letters of credit approved by the Department's Comptroller, in lieu of retainage. Obtain information concerning such substitutions from the Office of

Comptroller of the Department of Transportation, Haydon Burns Building, 605 Suwannee Street, Tallahassee, Florida, 32399-0450.

9-6.7 Certification of Payment to Subcontractors: Section 337.11(10)(a) of the Florida Statutes requires that, prior to receipt of any progress (partial) payment, the prime contractor shall certify that all subcontractors having an interest in the Contract have received their pro rata share of previous progress payments to the Contractor for all work completed and materials furnished in the previous period. Provide this certification be in the form designated by the Department. The term "subcontractor," as used herein, includes persons or firms furnishing materials or equipment incorporated into the work or stockpiled for which the Department has made partial payment and firms working under equipment-rental agreements.

The Department will not make any progress payments after the initial partial payment until the Contractor certifies that he has disbursed to all subcontractors and suppliers having an interest in the Contract their pro rata shares of the payment out of progress payments that he has previously received unless the Contractor demonstrates good cause for not making any required payment and furnishes written notification of any such good cause to both the Department and the affected subcontractors and suppliers.

Within ten days of making a payment to any DBE subcontractor, obtain from the DBE subcontractor an executed sworn DBE Payment Certification Form and submit the form with relevant invoices from the DBE subcontractor to the Engineer within 30 days.

The DBE subcontractor's failure to sign the DBE Payment Certification Form and forward the form to the Contractor immediately upon receipt of payment is sufficient grounds for the Department to suspend the DBE subcontractor's certification.

The Contractor's failure to submit to the Engineer DBE Payment Certification Forms covering all payments made to DBE subcontractors, within 30 days after receiving the final progress payment, is sufficient grounds for the Department to suspend a Contractor's Certificate of Qualification under the provisions of Florida Administrative Code 14-22.012.

Within 30 days of the Contractor's receipt of the final progress payment or any other payments thereafter, except the final payment, the Contractor shall pay all subcontractors and suppliers having an interest in the Contract their pro rata shares of the payment for all work completed and materials furnished. The Department will honor an exception to the above when the Contractor demonstrates good cause for not making any required payment and furnishes written notification of any such good cause to both the Department and the affected subcontractors or suppliers within said 30-day period.

9-7 Record of Construction Materials.

9-7.1 General: For all construction materials used in the construction of the project, (except materials exempted by 9-7.2), preserve for the Department's inspection the invoices and records of the materials for a period of three years from the date of completion of the project. Apply this requirement when subcontractors purchase materials, and obtain the invoices and other materials records from the subcontractors.

Not later than one month after completing the project, furnish the Engineer with a certification of construction materials procured for the project by the Contractor and all subcontractors. Provide this certification in the form of an affidavit completed on a Department-furnished form.

9-7.2 Non-Commercial Materials: Provisions 9-7 do not apply to materials generally classed as non-commercial, such as fill materials, local sand, sand-clay, or local materials used as stabilizer.

9-8 Disputed Amounts Due the Contractor.

The Department reserves the right to withhold from the final estimate any disputed amounts between the Contractor and the Department. The Department will release all other amounts due, as provided in 9-9.

9-9 Acceptance and Final Payment.

Whenever the Contractor has completely performed the work provided for under the Contract and the Engineer has performed a final inspection and made final acceptance(as provided in 5-10 and 5-11), and subject to the terms of 8-11, the Engineer will prepare a final estimate showing the value of the work as soon as the Engineer makes the necessary measurements and computations. The Engineer will correct all prior estimates and payments in the final estimate and payment. The Department will pay the amount of this estimate, less any sums that the Department may have deducted or retained under the provisions of the Contract, as soon as practicable after final acceptance of the work, provided that the Contractor has met the requirements of (a) through (g) below.

If the Contractor fails to furnish all required Contract Documents within 90 days of the Department's offer of final payment, the Department may suspend the Contractor's Certificate of Qualification under the provisions of Florida Administrative Code 14-22.012.

(a) The Contractor has agreed in writing to accept the balance due, as determined by the Department, as full settlement of his account under the Contract and of all claims in connection therewith, or the Contractor has through the use of the Qualified Acceptance Letter, accepted the balance due, as determined by the Department, with the stipulation that his acceptance of such payment does not constitute any bar, admission, or estoppel, or have any effect as to those payments in dispute or the subject of a pending claim between the Contractor and the Department. To receive payment based on a Qualified Acceptance Letter, define in writing the dispute or pending claim with full particular of all items of all issues in dispute, including itemized amounts claimed for all particulars of all items, and submit it as part of the Qualified Acceptance Letter. The Contractor further agrees, by submitting a Qualified Acceptance Letter that any pending or future arbitration claim or suit is limited to those particulars, including the itemized amounts, defined in the Qualified Acceptance Letter, and that he will commence with any such arbitration claim or suit within 820 calendar days from and after the time of final acceptance of the work and that his failure to file a formal claim within this period constitutes his full acceptance of the Engineer's final estimate and payment.

(b) The Contractor has properly maintained the project, as specified hereinbefore.

(c) The Contractor has furnished a sworn affidavit to the effect that the Contractor has paid all bills and no suits are pending (other than those exceptions listed, if any) in connection with work performed under the Contract and that the Contractor has not offered or made any gift or gratuity to, or made any financial transaction of any nature with, any employee of the Department in the performance of the Contract. Include with the listed tort liability exceptions, if any, evidence of adequate insurance coverage as required in 7-12.1.

(d) The surety on the Contract bond consents, by completion of their portion of the affidavit and surety release subsequent to the Contractor's completion of his portion, to final payment to the Contractor and agrees that the making of such payment does not relieve the surety of any of its obligations under the bond.

(e) The Contractor has complied with and settled all requirements pertaining to any wage-rate provisions.

(f) The Contractor has furnished all required mill tests and analysis reports to the Engineer.

(g) The Contractor has submitted the Form FHWA-47 (formerly known as PR-47) Record of Materials and Labor on Federal-aid projects, to the Engineer for transmittal to the FHWA. This submittal is required on all Federal-aid contracts on the National Highway System, except those which provide solely for the installation of protective devices at railroad grade crossings, those which are constructed on a force account or direct labor basis, highway beautification contracts, and contracts for which the total final construction cost for roadway and bridge is less than $1,000,000.

The rate of any prejudgment or post judgment interest assessed against either party to this Contract is 6% per annum.

9-10 Interest Due on Delayed Payments.

The Department will determine and pay any interest due the Contractor for delays in final payment in accordance with Section 337.141 of the Florida Statutes.

9-11 Offsetting Payments.

Section 337.145 of the Florida Statutes, providing for offsetting payments to the Contractor, is hereby made a part of this Contract:

(1) After settlement, arbitration, or final adjudication of any claim of the Department for work done pursuant to a construction contract with any party, the Department may offset such amount from payments due for work done on any construction contract, excluding amounts owed to subcontractors, suppliers, and laborers, which it has with the party owing such amount if, upon demand, payment of the amount is not made within 60 days to the Department.

(2) Offsetting any amount pursuant to (1) above shall not be considered a breach of Contract by the Department.

DIVISION II
Construction Details

GENERAL CONSTRUCTION OPERATIONS

SECTION 100

CONSTRUCTION EQUIPMENTX

GENERAL REQUIREMENTS

100-1 General.

Unless restricted to a specific type by the Contract Documents or the Engineer, the Contractor may perform the work using equipment, tools, machinery, etc., of his own choosing. Note that facilities to be constructed under the Contract are adequate to support only their design loads in their completed construction stage. If the Contractor's equipment or procedures during construction damage any part of the facility, the Contractor shall replace or repair it as directed by the Engineer at no expense to the Department.

100-2 Equipment Condition and Approval.

100-2.1 Approval: Provide all equipment to be used in construction of the project on the site in due time prior to its need, in working condition, subject to approval or disapproval by the Engineer. Use only factory recommended exhaust mufflers on internal combustion engines. Remove from the job, alter, or repair equipment which is disapproved by the Engineer. Ensure that the number of units, the sizes, etc., of the equipment on hand are adequate to complete the work within the Contract Time.

100-2.2 Maintenance: Consistent with public interest, safety, and good practice, maintain all equipment, tools, and machinery used in a satisfactory working condition throughout the period they are on the job site. Also, provide adequate equipment maintenance procedures to minimize noise pollution caused by construction equipment.

100-2.3 Stationary Equipment: Screen all stationary equipment such as pumps, compressors, generators, etc., from noise sensitive receivers if that equipment is to operate beyond normal working hours. If it is feasible, screen this equipment during normal working hours to reduce noise impacts.

100-3 Experimental Equipment.

100-3.1 General: To encourage the development and use of new or improved equipment, the Engineer may grant the Contractor permission to use equipment other than that normally used and currently accepted, upon approval of the Contractor's written request for permission to use such equipment in place of the normally used equipment. The Engineer, before considering or granting such request, may require that the Contractor establish, at his own expense, satisfactory evidence that the proposed equipment will produce work equal in quality to that produced by the specified equipment.

100-3.2 Conditions of Approval: When the Engineer grants permission for the use of new or improved equipment, understand that the Engineer gives such permission for the purpose of testing the quality of work this equipment actually produces. The Engineer will maintain the right to retract permission for use of the equipment at any time that, in his opinion, the Contractor does not obtain results that are at least equal to the results obtainable with currently accepted equipment. Upon the Engineer=s withdrawal of such permission for the use of the equipment, use the equipment currently accepted and normal for the work, and remove and dispose of, or otherwise remedy, at no expense to the Department, any work which the Engineer considers defective or unsatisfactory as a result of the use of such experimental equipment. If the Engineer approved the use of particular equipment on a particular project, the Engineer=s approval does not extend to the use of the particular equipment on any other project. Furthermore, the Contractor is fully responsible for producing finished work of the quality required by the Contract Documents.

SECTION 101

MOBILIZATION

101-1 Description.

Perform preparatory work and operations in mobilizing for beginning work on the project, including, but not limited to, those operations necessary for the movement of personnel, equipment, supplies, and incidentals to the project site and for the establishment of temporary offices, buildings, safety equipment and first aid supplies, and sanitary and other facilities.

Include the costs of bonds and any required insurance and any other preconstruction expense necessary for the start of the work, excluding the cost of construction materials.

101-2 Basis of Payment.

101-2.1 When a Separate Item is Included in the Proposal: When the proposal includes a separate item of payment for this work, the work and incidental costs specified as being covered under this Section will be paid for at the Contract lump sum price for the item of Mobilization.

Payment will be made under:

Item No. 101- 1- Mobilization -lump sum.

Item No. 2101- 1- Mobilization - lump sum.

101-2.2 Partial Payments: When the proposal includes a separate pay item for Mobilization, partial payments will be made therefor in accordance with the following:

Percent of Original Contract Amount Earned	Allowable Percent of the Lump Sum Price for the Item*
5	25
10	50
25	75
50	100

*Partial payments for any project will be limited to 10% of the original Contract amount for that project. Any remaining amount will be paid upon completion of all work on the project.

The standard retainage, as specified in 9-6, will be applied to these allowances. Partial payments made on this item will in no way act to preclude or limit any of the provisions for partial payments otherwise provided for by the Contract.

When more than one project or job (separate job number) is included in the Contract, the above percentages shall apply separately to each job which has a separate pay item for Mobilization.

As an exception to partial payments being made based on Percent of Original Contract Amount Earned, the Department will pay the Contractor the invoice price of the Contract Bond when the Engineer has been furnished with a certified copy of the invoice from the Bonding Company. No other work will be required to receive payment for the Contract Bond included in the bid price for Mobilization.

101-2.3 When No Separate Item is Included in the Proposal: When the proposal does not include a separate item for Mobilization, all work and incidental costs specified as being covered under this Section will be included for payment under the several scheduled items of the overall Contract, and no separate payment will be made therefor.

SECTION 102

MAINTENANCE OF TRAFFIC

102-1 General Provisions.

102-1.1 Description: Maintain traffic within the limits of the project for the duration of the construction period, including any temporary suspensions of the work. Construct and maintain any necessary detour facilities. Provide necessary facilities for access to residences, businesses, etc., along the project. Furnish, install, and maintain traffic control and safety devices during construction. Furnish and install work zone pavement markings for maintenance of traffic in construction areas. Furnish and apply calcium chloride on the subgrade, unsurfaced base, or other unsurfaced traveled ways in order to control dust during construction operations. Provide any other special requirements for safe and expeditious movement of traffic as may be specified on the plans. The term, Maintenance of Traffic, includes all of such facilities, devices, and operations required for the safety and convenience of the public as well as for minimizing public nuisance.

102-1.2 Sections Not Requiring Traffic Maintenance: In general, do not maintain traffic over those portions of the project where no work is to be accomplished or where construction operations will not affect existing roads. However, do not obstruct or create a hazard to any traffic during the performance of the work, and repair any damage to existing pavement or facilities caused during the work.

102-1.3 Detours Over Existing Roads and Streets: When the Department specifies that traffic be detoured over roads or streets outside the project area, do not maintain such roads or streets. However, maintain all signs and other devices placed for the purpose of the detour.

102-1.4 Contractor's Responsibility: Maintain traffic starting the day work begins on the project or on the first day Contract Time is charged, whichever is earlier.

Continually and adequately review traffic control devices to ensure proper installation and working order, including monitoring of lights. Provide an individual responsible for this review who is certified as an American Traffic Safety Services Association Certified Worksite Supervisor.

102-1.5 Operation of Existing Movable Bridges: The Department will maintain and operate existing moveable bridges which are to be removed by the Contractor until such time as they are closed to traffic. During this period, make immediate repairs of any damage to such structures caused by use or operations related to the work at no expense to the Department, but do not provide routine repairs or maintenance. In the event that use or operations result in damage to a bridge requiring repairs, give such repairs top priority to any equipment, material, or labor available.

102-2 Specific Requirements.

102-2.1 Maintenance of Roadway Surfaces: Maintain all lanes that are being used for the maintenance of traffic, including those on detours and temporary facilities, under all weather conditions. Keep the lanes reasonably free of dust, and, when necessary to accomplish this, sprinkle them with water, or apply some other dust palliative. Provide the lanes with the drainage facilities necessary to maintain a smooth riding surface under all weather conditions.

102-2.2 Number of Traffic Lanes: Maintain one lane of traffic in each direction. Maintain two lanes of traffic in each direction at existing four (or more) lane cross roads, where necessary to avoid undue traffic congestion. Construct each lane used for maintenance of traffic at least as wide as the traffic lanes existing in the area prior to commencement of construction. Do not allow traffic control and warning devices to encroach on lanes used for maintenance of traffic.

The Engineer may allow the Contractor to restrict traffic to one-way operation for short periods of time provided that the Contractor employs adequate means of traffic control and does not unreasonably delay traffic. When a construction activity requires restricting traffic to one-way operations, locate the flaggers within view of each other when possible. When visual contact between flaggers is not possible, equip them with 2-way radios, use flag-carrying, official, or pilot vehicle(s), or use traffic signals.

102-2.3 Crossings and Intersections: Provide and maintain adequate accommodations for intersecting and crossing traffic. Do not block or unduly restrict any road or street crossing the project unless approved by the Engineer.

102-2.4 Access for Residences and Businesses: Provide access to all residences and all places of business.

102-2.5 Protection of the Work from Injury by Traffic: Where traffic would be injurious to a base, surface course, or structure constructed as a part of the work, maintain all traffic outside the limits of such areas until the potential for injury no longer exists.

102-2.6 Alternative Traffic Control Plan: The Contractor may propose an alternative Traffic Control Plan (TCP) to the plan presented in the Contract Documents. Have a Specialty Engineer sign and seal the alternative plan. Prepare the TCP in conformance with and in the form outlined in the current version of the Roadway Plans Preparation Manual. Indicate in the plan a TCP for each phase of activities.

Obtain the Engineer's written approval before beginning work using an alternate TCP. The Engineer=s written approval is required for all modifications to the TCP. The Engineer will only allow changes to the TCP in an emergency.

Perform daily inspections, including weekends and holidays, with some inspections at nighttime, of the installations on the project. Replace all equipment and devices not meeting the approved standards during that inspection. Advise the project personnel of the schedule of these inspections and give them the opportunity to join in the inspection as is deemed necessary.

Regardless of the TCP used, maintain the work zone in a safe condition.

102-2.7 Law Enforcement Services: Where specified in the TCP, provide uniformed off-duty law enforcement officers, including marked law enforcement vehicles, to assist in controlling and directing traffic in the work zone. Refer to the TCP for those situations where the officers will be utilized.

102-3 Traffic Control.

102-3.1 Standards: FHWA's MUTCD Part VI is the minimum standard for Traffic Control for Highway Construction, Maintenance, and Utility Operations. Follow the basic principles and minimum standards contained in this manual for the design, application, installation, maintenance, and removal of all traffic control devices and all warning devices and barriers which are necessary to protect the public and workers from hazards within the project limits. Understand that the standards established in the aforementioned manual constitute the minimum requirements for normal conditions. The Engineer will require additional traffic control devices, warning devices, barriers, or other safety devices where unusual, complex, or particularly hazardous conditions exist.

Reflectorize traffic cones used at night with cone collars meeting the following requirements:

(a) Use collars designed to properly fit the taper of the cone when installed. Place the upper 6 inch [150 mm] collar a uniform 32 inch [90 mm] distance from the top of the cone and the lower 4 inch [100 mm] collar a uniform 2 inch [50 mm] distance below the bottom of the upper 6 inch [150 mm] collar. Ensure that the collars are capable of being removed for temporary use or attached permanently to the cone in accordance with the manufacturer's recommendations. Provide a white sheeting having a smooth outer surface and that essentially has the property of a retroreflector over its entire surface.

(b) For the retroreflective sheeting for the collars, meet the requirements of ASTM D 4956 Table 4, Type III and Table 9, Type VI; excluding 0.1 degree observation angle and -4 degree, ∀30 degree entrance angles.

Provide three certified copies of test reports and certification from the manufacturer that the material furnished meets all requirements of (b) above.

Use reflective collars for cones included on the Qualified Products List.

102-3.2 Traffic Control Devices, Warning Devices and Barriers:

102-3.2.1 Installation: Install and maintain adequate traffic control devices, warning devices and barriers to protect the traveling public and workers, and to safeguard the work area. Erect the required traffic control devices, warning devices and barriers to prevent any hazardous conditions and in conjunction with any necessary traffic re-routing. Use only those devices that are included on the Qualified Products List (QPL). Use construction signs meeting the requirements of 700-2.5 and 700-5.5. Specific requirements for Maintenance of Traffic devices, additional to the requirements of this Section, are contained in the 600 series of the Roadway and Traffic Design Standards. Immediately remove, turn or cover any devices or barriers which do not apply to existing conditions.

All QPL approved safety devices must meet the requirements of National Cooperative Highway Research Report 350 (NCHRP 350) and current FHWA directives. Manufacturers seeking evaluation must furnish certified test reports showing that their product meets all test requirements set forth by NCHRP 350.

Notify the Engineer of any scheduled operation which will affect traffic patterns or safety, sufficiently in advance of commencing such operation to permit his review of the plan for the proposed installation of traffic control devices, warning devices or barriers.

Assign an employee the responsibility of maintaining the position and condition of all traffic control devices, warning devices and barriers throughout the duration of the Contract. Keep the Engineer advised at all times of the identification and means of contacting this employee on a 24-hour basis.

102-3.2.2 Maintenance of Devices and Barriers: Keep traffic control devices, warning devices, and barriers in the correct position, properly directed, clearly visible and clean, at all times. Immediately repair, replace or clean damaged, defaced or dirty devices or barriers and have the Engineer approve them for use.

102-3.2.3 Temporary Impact Attenuators: Furnish, install, maintain and subsequently remove temporary vehicular impact attenuators in accordance with the details and notes shown in the plans, and the Roadway and Traffic Design Standards.

Maintain the attenuators until their authorized removal. Repair all attachment scars to permanent structures and pavements after attenuator removal.

102-3.2.4 Flagger: Provide trained flaggers to direct traffic where one-way operation in a single lane is in effect and in other situations as required in 102-3.1. The Worksite Traffic Supervisor or others as approved by the Department will provide training for flaggers using Department-approved training materials.

102-3.2.5 Existing Pavement Markings: Where a detour changes the lane use or where normal vehicle paths are altered during construction, remove all existing pavement markings that will conflict with the adjusted vehicle paths. Do not overpaint. Remove existing pavement markings using a method that will not damage the surface texture of the pavement and which will eliminate the previous marking pattern regardless of weather and light conditions.

Remove all pavement markings that will be in conflict with "next phase of operation" vehicle paths as described above, prior to opening to traffic.

102-3.2.6 No Waiver of Liability: Conduct operations in such a manner that no undue hazard results due to the requirements of this Article. The procedures and policies described herein in no way acts as a waiver of any terms of the liability of the Contractor or his surety.

102-3.3 Work Zone Pavement Markings:

102-3.3.1 General: Provide centerlines, lane lines, edgelines, stop bars, and turn arrows in work zones in accordance with Section 6D of the MUTCD with the following additions:

(a) Install edgelines when a paved shoulder 4 feet [1.2 m] or greater in width exists along the edge of a lane.

(b) Place edgelines on all detours, where vehicle paths are altered from normal operations, and where a lane narrows from its normal width for any reason.

(c) Apply work zone pavement markings, including arrows and messages determined by the Engineer to be required for safe operation of the facility, prior to the end of the day if the highway is open to traffic. The Contractor may use channelizing devices to direct traffic during the day prior to the placement of work zone pavement markings.

(d) The Engineer or the plans will designate work zone pavement markings as removable or non-removable. For removable work zone pavement markings, use materials which can be taken up by hand without the use of additional equipment such as burners, sand blasting, etc. An example of this category of markings is reinforced plastic film (Tape). For non-removable work zone pavement markings, use any markings that are not classified as removable. Use removable or non-removable work zone pavement markings as follows:

Application	Category
Finished Pavement*	
All stripes representing final pavement markings.	Non-Removable
All stripes in an area where the traffic pattern will be altered prior to project acceptance.	Removable

*Place all striping representing final markings in the final location unless excepted in writing by the Engineer.

Application	Category
Intermediate Pavement Course	
All stripes in areas of pavement which will be covered with a subsequent course of pavement prior to altering of the traffic pattern within such area.	Non-Removable
All stripes in an area where the traffic pattern will be altered prior to placing of the subsequent paving course within such area.	Removable
Existing Pavement	
All stripes in areas of pavement which will be removed or overlaid with new pavement prior to altering of the traffic pattern within such area.	Non-Removable

All stripes in areas of pavement where the traffic pattern will be altered prior to removal or overlaying of such area.	Removable

The Contractor may substitute Removable Pavement Markings for Non-Removable Pavement Markings.

If Removable Pavement Markings are substituted for Non-Removable Pavement Markings, the Department will make payment under Non-Removable Pavement Marking.

102-3.3.2 Materials:

102-3.3.2.1 Paint and Glass Beads: For white paint, meet the requirements of 971-12.2. For yellow paint, meet the requirements of 971-12.3.

102-3.3.2.2 Preformed Pavement Marking Film (Tape): For Preformed Pavement Marking Film (Tape), ensure the manufacturer's certification of conformance to the following requirements:

(1) Composition: Use preformed, retro-reflective pavement marking consisting of foil or plastic materials pigments and glass beads uniformly distributed throughout its cross-sectional area and with a retro-reflective layer of beads bonded on the top surface. Use preformed pavement marking precoated with a pressure sensitive adhesive compatible with asphaltic concrete and portland cement concrete road surfaces.

(2) Thickness: Ensure that the thickness of the preformed film without adhesive is not less than 25 mils [640 μm].

(3) Tensile Strength: Use film having a minimum tensile strength of 40 psi [275 kPa] of cross-section when tested in accordance with ASTM D 638.

(4) Pigmentation: Thoroughly blend color pigments to provide a plastic marking film that maintains uniform color under both daylight and night lighting conditions throughout the expected life of the film. Use white pavement marking film similar to Federal Standard Color No. 595-17886. Use yellow pavement marking film similar to Federal Standard Color No. 595-13538.

(5) Glass Beads: Use colorless glass beads with a minimum refraction index of 1.50 when tested using the liquid oil immersion method. Use beads of such size and quantity to maintain the retroreflectivity of the preformed pavement marking. Test bead adhesion such that beads are not easily removed when film surface is scratched firmly with a thumbnail.

102-3.3.2.3 Preformed Removable Pavement Marking Film (Tape): For Preformed Pavement Marking Film (Tape), meet the following requirements:

(1) Composition: Use removable preformed plastic pavement marking tape consisting of a mixture of polymeric materials, pigments, non-metallic reinforcing medium to facilitate removal, glass beads, and a retro-reflective layer of glass beads firmly bonded to the top surface.

(2) Adhesive: Precoat the removable preformed plastic pavement marking film with a pressure sensitive adhesive capable of being affixed to asphaltic concrete and portland cement concrete pavement surfaces without the use of heat, solvents, and other additional adhesives or activators. Use an adhesive that exhibits excellent sheer characteristics and minimal tensile characteristics. Ensure that the adhesive does not require a protective liner when the preformed plastic pavement marking film is in rolled form for shipment. Ensure that the adhesive is capable of

temporarily bonding to the roadway pavement at temperatures of 50EF [10EC] and above without pick-up distortion by vehicular traffic.

(3) Pigmentation: Thoroughly blend color pigments to provide a plastic marking film that maintains uniform color under both daylight and night lighting conditions throughout the expected life of the film. Use white pavement marking film similar to Federal Standard Color No. 595-17886. Use yellow pavement marking film similar to Federal Standard Color No. 595-13538.

(4) Thickness: Ensure that the thickness of the removable plastic marking film without adhesive is not less than 30 mils [760 μm].

(5) Glass Beads: Provide colorless glass beads having a minimum refraction index of 1.50 when tested using the liquid oil immersion method. Use beads of the size and quantity necessary to maintain the retro-reflectivity of the preformed plastic film as the film wears through the surface course. Firmly adhere approximately 2% by weight of glass beads to the top of the preformed plastic film. Test bead adhesion such that beads are not easily removed when film surface is scratched firmly with thumbnail.

(6) Removability: Provide preformed plastic pavement marking film capable of being removed from bituminous concrete and portland cement concrete pavement intact or in substantially large strips, either manually or by a mechanical roll-up device, at temperatures above 40EF [4EC], and without the use of heat, solvents, grinding, or blasting. Ensure that the manufacturer shows by documented reports that the retro-reflective preformed plastic pavement marking film has met this requirement after being in place for a minimum of 90 days and under an average daily traffic count per lane of at least 9,000 vehicles per day.

102-3.3.3 Construction Methods: Align Non-Removable Pavement Markings (Paint or Preformed Pavement Marking Film) placed on the finished pavement surface so as to ensure coverage by the permanent traffic stripes.

Removable Pavement Markings (Reinforced Plastic Film) placed on the finished pavement surface may vary from the alignment of permanent traffic stripes.

Install all work zone pavement markings in accordance with the manufacturer's recommendations, except apply paint in accordance with Section 710. Ensure that the pavement surface is dry at the time of work zone pavement marking application. Remove all dirt, debris, loose particles, and heavy oil residues from the road surface application areas immediately prior to the installation of pavement markers.

Apply Removable and Non-Removable pavement marking film with a mechanical applicator to provide pavement lines which are neat, accurate, and uniform. Equip the mechanical applicator with a film cut-off device and with measuring devices which automatically and cumulatively measure the length of each line actually placed within an accuracy tolerance of ∀2%. Roll or tamp pavement marking films (tape) to facilitate adhesion to the road surface. Tape may be placed by hand on short sections 500 feet [150 m] or less provided that it is done in a neat, accurate manner.

When removable pavement markings are no longer required, remove them just ahead of the permanent pavement markings.

102-4 Detours.

102-4.1 General: Construct and maintain detour facilities wherever it becomes necessary to divert traffic from any existing roadway or bridge, or wherever construction operations block the flow of traffic.

102-4.2 Standards of Construction: Plan, construct, and maintain detours for the safe passage of traffic in all conditions of weather. Provide the detour with all facilities necessary to meet this requirement.

Where the plans call for the Department to furnish detour bridge components, construct the pile bents in accordance with the Structures Design Office Standard Drawings, Index No. 300 and 301, unless otherwise authorized by the Engineer.

Submit a letter with the following: company name, phone number, office address, project contact person, project number, detour bridge type, bridge length, span length, location and usage time frames, to the Engineer at least 30 calendar days prior to the intended pick-up date, to obtain the storage facility location and list of components for the project. Upon receipt of letter, the Engineer will, within ten calendar days provide an approved material list to the Contractor and the appropriate Department storage yard.

Provide a letter with an original company seal, identifying the representative with authority to pick up components, to the Engineer at least ten calendar days prior to the proposed pick-up date. The yard supervisor is not obligated to load the bridge components without this notice. At the time of issuance the Contractor=s representative shall sign for each item loaded.

Provide timber dunnage, and transport the bridge components from the designated storage facility to the job site. Unload, erect, and maintain the bridge, then dismantle the bridge and load and return the components to the designated storage facility.

Notify the Engineer in writing at least ten calendar days prior to returning the components. Include in this notice the name of the Contractor's representative authorized to sign for return of the bridge components. The yard supervisor is not obligated to unload the bridge components without this notice.

The Department will provide a crane and an operator at the Department's storage facility to assist in loading and unloading the bridge components. Furnish all other labor and equipment required for loading and unloading the components.

The Department=s representative will record all bridge components issued or returned on the Detour Bridge Issue and Credit Ticket. The Tickets must be signed by a Department and Contractor representative, after loading or unloading each truck to document the quantity and type of bridging issued or returned.

Bind together all bridge components to be returned in accordance with the instructions given by the storage facility The yard supervisor will repack components that are not packed in compliance with these instructions. Upon request, written packing instructions will be made available to the Contractor, prior to dismantling of the bridge for return to the Department's storage facility.

Assume responsibility for any shortage or damage to the bridge components. Monies due the Contractor will be reduced at the rate of $35.00 per hour plus materials for repacking, repairs or replacement of bridge components.

The skid resistance of open steel grid decking on the detour bridge may decrease gradually after opening the bridge to traffic. The Department will furnish a pneumatic floor scabbler machine for roughening the roadway surface of the detour bridge decking. Provide an air compressor at the job site with 200 ft^3/minute [6 m;/minute] capacity, 90 psi [620 kPa] air pressure for the power supply of the machine, and an operator. Transport the scabbler machine to and from the Department's Structures Shop. Repair any damage to the scabbler machine caused by operations at no expense to the Department. Perform scabbling when determined necessary by the Engineer. The Department will pay for the cost of scabbling as Unforeseeable Work in accordance with 4-4.

Return the bridge components to the designated storage facility beginning no later than ten calendar days after the date the detour bridge is no longer needed, the date the new bridge is placed in service, or the date Contract Time expires, whichever is earliest. Return the detour bridging at an average of not less than 200 feet [61 m] per week. Upon failure to return the bridge components to the Department within the time specified, compensate the Department for the bridge components not returned at the rate of $5.00 per 10 feet [$1.65 per meter], per day, per bridge, for single lane; and $10.00 per 10 feet [$3.30 per meter], per day, per bridge, for dual lane until the bridge components are returned to the Department.

102-4.3 Materials: Provide all materials for the construction and maintenance of all detours, except that, where the plans call for the Department to provide borrow or other material pits, the Engineer will allow the Contractor to obtain material from these pits for the detour. The Department will make no separate payment for materials used from these pits to construct detours.

102-4.4 Construction Methods: Do not apply the requirements of the Standard Specifications pertaining to construction and material details to detour construction. Select and use construction methods and materials that shall provide a stable and safe detour facility. Construct the detour facility to have sufficient durability to remain in good condition, supplemented by maintenance, for the entire period that the detour is required.

102-4.5 Removal of Detours: Remove temporary detours when they are no longer needed and before the Contract is completed. Take ownership of all materials from the detour and dispose of them, except for materials which might be on loan from the Department with the stipulation that they be returned.

102-5 Calcium Chloride for Dust Control.

102-5.1 General: The Engineer will direct the locations and the time of using calcium chloride for dust control. Regardless of the quantities which may be shown in the proposal, consider this work as being entirely contingent.

102-5.2 Materials: Meet the following requirements:

Calcium Chloride 986-1
Water 986-2

102-5.3 Equipment: Apply the calcium chloride using any spreader capable of such adjustment and control that the quantity of calcium chloride applied in any 25 foot [10 m] length of road does not vary more than 10% from the quantity intended for that length. Do not use rotary-type spreaders, as they are not considered capable of proper control.

Use equipment to apply water that is capable of applying the water uniformly within the limitations of moisture required.

102-5.4 Application:

102-5.4.1 Weather Limitations: Even if previously ordered by the Engineer, do not treat surfaces when raining or when the moisture condition exceeds that for proper application of the calcium chloride as determined by the Engineer.

102-5.4.2 Preparation for Treatment: Level the subgrade, base materials, or other surface to be treated to a smooth grade and crown or shape the surface to effect adequate drainage. When so directed, moisten the surface prior to application of the material.

102-5.4.3 Rate of Application: The Engineer will specify the actual rate at which to uniformly spread the material. Apply the flakes at a rate between 1.0 and 1.25 lbs/yd^2 [0.5 and 0.7 kg/m^2] of surface, and pellets at a rate between 0.80 and 1.0 lb/yd^2 [0.4 and 0.5 kg/m^2].

102-5.4.4 Subsequent Applications: If subsequent applications are required over a previously treated area which has previously been treated, make such applications at a rate of approximately 0.75 lb/yd^2 [0.4 kg/m^2] for flakes and 0.6 lb/yd^2 [0.3 kg/m^2] for pellets.

102-5.4.5 Protection from Traffic: Do not allow traffic on the treated surface until two hours after application.

102-6 Materials for Driveway Maintenance.

102-6.1 General: Place material in driveways to residences and businesses to provide safe, stable, and reasonable access.

102-6.2 Materials: Provide material of the type typically used for base and having stability and drainage properties that will provide a firm surface under wet conditions.

102-6.3 Construction Methods: Place, level, manipulate, compact, and maintain the material, to the extent appropriate for the intended use.

As permanent driveway construction is accomplished at a particular location, the Contractor may salvage and reuse previously placed materials that are suitable for reuse on other driveways.

102-7 Method of Measurement.

102-7.1 Maintenance of Traffic (General Work): When an item for this work is included in the proposal, the quantity to be paid for will be at the Contract lump sum price for Maintenance of Traffic.

Where the plans require the use of trucks and truck mounted impact attenuators, these items will not be paid for separately but shall be included in the cost of Maintenance of Traffic. Only use those attenuators that have been tested by a facility approved by the Engineer and certified as meeting the requirements as specified in NCHRP 350 and that have been properly maintained.

102-7.2 Law Enforcement Services: The quantity to be paid for will be at the Contract unit price per hour for the actual number of officers on the project site. Payment will be made only for those off-duty law enforcement officers specified in the TCP and authorized by the Engineer.

102-7.3 Special Detours: When a detour facility is specifically detailed in the plans, or is otherwise described or detailed as a special item, and an item for separate payment is included in the proposal, the work of constructing, maintaining, and subsequently removing such detour facilities will be paid for separately. Traffic control devices, warning devices, barriers, signing, and pavement markings for Special Detours will also be paid for separately.

When the plans show more than one detour, each detour will be paid for separately, at the Contract lump sum price for each.

Where a separate item for a specific detour facility is included in the proposal, payment will be made under Special Detour

102-7.4 Materials for Driveway Maintenance: The quantity to be paid for will be the volume, in cubic yards [cubic meters], of all materials authorized by the Engineer, acceptably placed and maintained for driveway maintenance. The quantity will be determined by truck measurement, loose volume after loading and striking off the material to uniform depth. The quantity which is authorized to be reused and which is acceptably salvaged, placed, and maintained in other designated driveways will be measured in truck bodies and included again for payment.

102-7.5 Calcium Chloride for Dust Control: The quantity to be paid for will be the weight, in tons [metric tons], of calcium chloride authorized and acceptably spread on the road, within the limits specified by the Engineer. The quantity will be determined from scales, certified freight bills, or other sources, the accuracy of which can be authenticated.

102-8 Basis of Payment.

102-8.1 Maintenance of Traffic (General Work): When an item of Maintenance of Traffic is included in the proposal, price and payment will be full compensation for all work and costs specified under this Section except as may be specifically covered for payment under other items.

102-8.2 Law Enforcement Services: Price and payment will be considered full compensation for the services of the off-duty law enforcement officer, including a marked law enforcement vehicle and all other direct and indirect costs.

102-8.3 Special Detours: Price and payment will be full compensation for providing all detour facilities shown on the plans and all costs incurred in carrying out all requirements of this Section for general maintenance of traffic within the limits of the detour, as shown on the plans.

102-8.4 Calcium Chloride for Dust Control: Price and payment will be full compensation for all work and materials specified for this item, including specifically all required shaping and maintenance of the treated area and all water furnished and applied to the area.

102-8.5 Payment Items: Payment will be made under:

Item No. 102- 1-	Maintenance of Traffic - lump sum.
Item No. 2102- 1-	Maintenance of Traffic - lump sum.
Item No. 102-10-	Off-Duty Law Enforcement Officer - per hour.
Item No. 2102-10-	Off-Duty Law Enforcement Officer - per hour.
Item No. 102- 2-	Special Detour - lump sum.
Item No. 2102- 2-	Special Detour - lump sum.
Item No. 102- 3-	Commercial Materials for Driveway Maintenance - per cubic yard.
Item No. 2102- 3-	Commercial Materials for Driveway Maintenance - per cubic meter.

Item No. 102- 4- Calcium Chloride for Dust Control - per ton.
Item No. 2102- 4- Calcium Chloride for Dust Control - per metric ton.

SECTION 103

TEMPORARY WORK STRUCTURES

103-1 Description.

103-1.1 Scope of Work: Construct temporary work structures used solely to support construction equipment. Temporary structures include but are not limited to work bridges, elevated platforms and rail systems. Items such as barges, mats, or items such as falsework or scaffolding are not included in this Section. If a temporary structure type other than the structure type shown in the plans is chosen, assume responsibility for obtaining all necessary permit revisions and the Engineer=s approval. Conform to any limitations contained in the plans and permits. Do not place embankment outside the limits shown in the plans. The cost of the embankment, placing, compaction, and removal will be included in the lump sum price for Temporary Work Structure.

103-1.2 Materials: Construct the temporary work structure using materials sufficient to handle the anticipated loads. Assume responsibility for the design of the temporary structure.

103-1.3 Navigation Requirements: Submit drawings showing the location of the temporary work structures relative to the navigable waterway to the Coast Guard at least 60 days prior to beginning construction of the structure, or as required by conditions of the permit. Provide adequate lighting of the structure during the duration of construction as required by the Coast Guard or local authorities.

103-2 Basis of Payment.

103-2.1 General: The unit price for the temporary work structure will include all costs associated with the design, materials, labor, installation, removal and disposal of the structure.

103-2.2 Partial Payments: When the plans include a separate pay item for Temporary Work Structure, 75% of the lump sum price will be paid upon completion of the temporary work structure, and 25% will be paid upon complete removal of the temporary work structure from the project site. When the project requires numerous structures or multiple setups (leap frog type) of the same system, the 75% will be split evenly between the various structures or setups. Partial payments for any project will be limited to 5% of the original Contract amount for that project. Any remaining amount will be paid upon completion of all work on the project.

When more than one project is included in the Contract, the above percentages will apply separately to each project which has a separate pay item for Temporary Work Structures.

Payment will be made under:

Item No. 103- 1- Temporary Work Structures - lump sum.
Item No. 2103- 1- Temporary Work Structures - lump sum.

SECTION 104

PREVENTION, CONTROL, AND ABATEMENT OF

EROSION AND WATER POLLUTION

104-1 Description.

Provide erosion control measures on the project and in areas outside the right-of-way where work is accomplished in conjunction with the project, so as to prevent pollution of water, detrimental effects to public or private property adjacent to the project right-of-way and damage to work on the project. Construct and maintain temporary erosion control features or, where practical, construct and maintain permanent erosion control features as shown in the plans or as may be directed by the Engineer.

104-2 General.

Coordinate the installation of temporary erosion control features with the construction of the permanent erosion control features to the extent necessary to ensure economical, effective, and continuous control of erosion and water pollution throughout the life of the Contract.

Due to unanticipated conditions, the Engineer may direct the use of control features or methods other than those included in the original Contract. In such event, the Department will pay for this additional work as unforeseeable work.

104-3 Control of Contractor's Operations Which May Result in Water Pollution.

Prevent pollution of streams, canals, lakes, reservoirs, and other water impoundments with fuels, oils, bitumens, calcium chloride, or other harmful materials. Also, conduct and schedule operations to avoid or otherwise minimize pollution or siltation of such water impoundments, and to avoid interference with movement of migratory fish. Do not dump any residue from dust collectors or washers into any live stream.

Restrict construction operations in rivers, streams, lakes, tidal waters, reservoirs, canals, and other water impoundments to those areas where it is necessary to perform filling or excavation to accomplish the work shown in the plans and to those areas which must be entered to construct temporary or permanent structures. As soon as conditions permit, promptly clear rivers, streams, and impoundments of all obstructions placed therein or caused by construction operations.

Do not frequently ford live streams with construction equipment. Wherever an appreciable number of stream crossings are necessary at any one location, use a temporary bridge or other structure.

Except as necessary for construction, do not deposit excavated material in rivers, streams, canals, or impoundments, or in a position close enough thereto, to be washed away by high water or runoff.

Where pumps are used to remove highly turbid waters from enclosed construction areas such as cofferdams or forms, treat the water by one or more of the following methods prior to discharge into State waters: pumping into grassed swales or appropriate vegetated areas or sediment basins, or confined by an appropriate enclosure such as turbidity barriers when other methods are not considered appropriate.

Do not disturb lands or waters outside the limits of construction as staked, except as authorized by the Engineer.

Obtain the Engineer's approval for the location of, and method of operation in, borrow pits, material pits, and disposal areas furnished for waste material from the project (other than commercially operated sources) such that erosion during and after completion of the work will not result in probability of detrimental siltation or water pollution.

104-4 Materials for Temporary Erosion Control.

The Engineer will not require testing of materials used in construction of temporary erosion control features other than as provided for geotextile fabric in 985-3 unless such material is to be incorporated into the completed project. When no testing is required, the Engineer will base acceptance on visual inspection.

The Contractor may use new or used materials for the construction of temporary silt fence, staked turbidity barriers, and floating turbidity barrier not to be incorporated into the completed project, subject to the approval of the Engineer.

104-5 Preconstruction Conference.

At the Preconstruction Conference, provide to the Department a special plan to prevent, control, and reduce erosion and water pollution, meeting the requirements or special conditions of all permits authorizing project construction. If no permits are required or the approved permits do not contain special conditions or specifically address erosion and water pollution, the project erosion control plan will be governed by Subarticles 7-1.1, 7-2.2, 7-8.1, 7-8.2, and Articles 104-1 through 104-10.

When a National Pollutant Discharge Elimination System (NPDES) Permit is issued or approved by the U.S. Environmental Protection Agency (EPA) pursuant to 40 CFR Part 122.26, the Contractor's plan shall be prepared as a part of the Department's Stormwater Pollution Prevention Plan (SWPPP). The SWPPP will include this erosion control plan and all additional measures that will be employed to dispose of, control, or prevent the discharge of solid, hazardous, and sanitary wastes to waters of the U.S.. Include procedures to control off-site tracking of soil by vehicles and construction equipment and a procedure for cleanup and reporting of non-storm water discharges, such as contaminated groundwater or accidental spills. The Department will review and approve the Contractor's part of the SWPPP, including required signed certification statements, before soil disturbing activities begin.

Failure to sign any required documents or certification statements will be considered a default of the Contract. Any earth disturbing activities performed without the required signed documents or certification statements may be considered a violation of the Clean Water Act by the EPA.

When the SWPPP is required, prepare the erosion control plan in accordance with the sequence of operations and present in the NPDES Stormwater Pollution Prevention Plan required format provided by the Department. The erosion control plan shall describe, but not be limited to, the following items or activities:

(1) For each phase of construction operations or activities, supply the following information:

(A) Locations of all erosion control devices

(B) Types of all erosion control devices

(C) Estimated time erosion control devices will be in operation

(D) Monitoring schedules for maintenance of erosion control devices

(E) Methods of maintaining erosion control devices

(F) Containment or removal methods for pollutants or hazardous wastes

(2) The name and telephone number of the person responsible for monitoring and maintaining the erosion control devices.

(3) Submit for approval the erosion control plans meeting paragraphs 3A, 3B, or 3C below:

(A) Projects permitted by the Southwest Florida Water Management District, require the following:

Submit a copy of the erosion control plan to the Engineer for review and to the appropriate Southwest Florida Water Management District Office (SWFWMD) for review and approval. Include the SWFWMD permit number on all submitted data or correspondence.

The Contractor may schedule a meeting with the appropriate SWFWMD Office to discuss his erosion control plan in detail, to expedite the review and approval process. Advise the Engineer of the time and place of any meetings scheduled with SWFWMD.

Do not begin construction activities until the erosion control plan receives written approval from both SWFWMD and the Engineer.

(B) Projects permitted by the South Florida Water Management District or the St. Johns River Water Management District, require the following:

Obtain the Engineer=s approval of the erosion control plan.

Do not begin construction activities until the erosion control plan receives written approval from the Engineer.

(C) Projects authorized by permitting agencies other than the Water Management Districts or projects for which no permits are required require the following:

The Engineer will review and approve the Contractor=s erosion control plan.

Do not begin construction activities until the erosion control plan receives written approval from the Engineer.

Comply with the approved erosion control plan.

104-6 Construction Requirements.

104-6.1 Limitation of Exposure of Erodible Earth: The Engineer may limit the surface areas of unprotected erodible earth exposed by the construction operation and may direct the Contractor to provide erosion or pollution control measures to prevent contamination of any river, stream, lake, tidal waters, reservoir, canal, or other water impoundments or to prevent detrimental effects on property outside the project right-of-way or damage to the project. Limit the area in which excavation and filling operations are being performed so that it does not exceed the capacity to keep the finish grading, grassing, sodding, and other such permanent erosion control measures current in accordance with the accepted schedule.

Do not allow the surface area of erodible earth that clearing and grubbing operations or excavation and filling operations expose to exceed 750,000 ft^2 [70,000 m^2] without specific prior approval by the Engineer. This limitation applies separately to clearing and grubbing operations and excavation and filling operations.

The Engineer may increase or decrease the amount of surface area the Contractor may expose at any one time.

104-6.2 Incorporation of Erosion Control Features: Incorporate permanent erosion control features into the project at the earliest practical time. Use approved temporary erosion control features to correct conditions that develop during construction which were not foreseen at the time of design, to control erosion prior to the time it is practical to construct permanent control features, or to provide immediate temporary control of erosion that develops during normal construction operations, which are not associated with permanent erosion control features on the project.

The Engineer may authorize temporary erosion control features when Topsoil is specified in the Contract and the limited availability of that material from the grading operations will prevent scheduled progress of the work or damage the permanent erosion control features.

104-6.3 Scheduling of Successive Operations: Schedule operations such that the area of unprotected erodible earth exposed at any one time is not larger than the minimum area necessary for efficient construction operations, and the duration of exposure of uncompleted construction to the elements is as short as practicable.

Schedule and perform clearing and grubbing so that grading operations can follow immediately thereafter. Schedule and perform grading operations so that permanent erosion control features can follow immediately thereafter if conditions on the project permit.

104-6.4 Details for Temporary Erosion Control Features:

104-6.4.1 General: Use temporary erosion and water pollution control features that consist of, but are not limited to, temporary grassing, temporary sodding, temporary mulching, sandbagging, slope drains, sediment basins, sediment checks, berms, baled hay or straw, floating turbidity barrier, staked turbidity barrier and silt fence. For design details for some of these items, refer to the Water Quality Section of the Roadway and Traffic Design Standards.

104-6.4.2 Temporary Grassing: The Engineer may designate certain areas of grassing constructed in accordance with Section 570 as temporary erosion control features. The Engineer may direct the Contractor to omit permanent type grass seed from grassing and the reduce the specified rate of spread for fertilizer used in conjunction with grassing operations when such work is designated as a temporary erosion control feature.

104-6.4.3 Temporary Sod: Furnish and place sod in accordance with Section 575 within areas designated by the Engineer to temporarily control erosion. If the Engineer determines that the sod will be of a temporary nature, he may not require fertilizer and lime. Keep the sod in a moist condition in order to ensure growth. The Department will pay for all required watering under Item No. 570-9 [2570-9].

104-6.4.4 Temporary Mulching: Furnish and apply a 2 to 4 inch [50 to 100 mm] thick blanket of straw or hay mulch to designated areas, then mix or force the mulch into the top 2 inches [50 mm] of the soil in order to temporarily control erosion. Use only undecayed straw or hay which can readily be cut into the soil and which otherwise complies with 981-3.1. The Contractor may substitute other measures for temporary erosion control, such as hydromulching, chemical adhesive soil stabilizers, etc., for mulching with straw or hay, if approved by the Engineer. When beginning permanent grassing operations, plow under temporary mulch materials in conjunction with preparation of the ground.

104-6.4.5 Sandbagging: Furnish and place sandbags in configurations to control erosion and siltation.

104-6.4.6 Slope Drains: Construct slope drains in accordance with the details shown in the plans, the Roadway and Traffic Design Standards, or as may be approved as suitable to adequately perform the intended function.

104-6.4.7 Sediment Basins: Construct sediment basins in accordance with the details shown in the plans, the Roadway and Traffic Design Standards, or as may be approved as suitable to adequately perform the intended function. Clean out sediment basins as necessary in accordance with the plans or as directed.

104-6.4.8 Berms: Construct temporary earth berms to divert the flow of water from an erodible surface.

104-6.4.9 Baled Hay or Straw: Provide bales having minimum dimensions of 14 by 18 by 36 inches [350 by 450 by 900 mm], at the time of placement. Construct baled hay or straw dams to protect against downstream accumulations of silt. Construct the baled hay or straw dams in accordance with the details shown in the plans or the Roadway and Traffic Design Standards. Meet the provisions of 981-3.1 for all baled hay or straw.

Place the dam to effectively control silt dispersion under conditions present on this project. The Contractor may use alternate solutions and usage of materials if approved.

104-6.4.10 Temporary Silt Fences:

104-6.4.10.1 General: Furnish, install, maintain, and remove temporary silt fences, in accordance with the manufacturer's directions, these Specifications, the details as shown on the plans, and the Roadway and Traffic Design Standards.

104-6.4.10.2 Materials and Installation: Use a geotextile fabric made from woven or nonwoven fabric, meeting the physical requirements of Section 985 according to those applications for erosion control.

Choose the type and size of posts, wire mesh reinforcement (if required), and method of installation. Do not use products which have a separate layer of plastic mesh or netting. Provide a durable and effective temporary silt fence that controls sediment comparable to the Roadway and Traffic Design Standards, Index No. 102.

Install all sediment control devices in a timely manner to ensure the control of sediment and the protection of lakes, streams, gulf or ocean waters, or any wetlands associated therewith and to any adjacent property outside the right-of-way as required.

At sites where exposure to such sensitive areas is prevalent, complete the installation of any sediment control device prior to the commencement of any earthwork.

After installation of sediment control devices, repair portions of any devices damaged at no expense to the Department.

Erect temporary silt fence at upland locations across ditchlines and at temporary locations shown on the plans or approved by the Engineer where continuous construction activities change the natural contour and drainage runoff. Do not attach temporary silt fence to existing trees unless approved by the Engineer.

104-6.4.10.3 Inspection and Maintenance: Inspect all temporary silt fences immediately after each rainfall and at least daily during prolonged rainfall. Immediately correct any deficiencies. In addition, make a daily review of the location of silt fences in areas where construction activities have changed the natural contour and drainage runoff to ensure that the silt fences are properly located for effectiveness. Where deficiencies exist, install additional silt fences as directed by the Engineer.

Remove sediment deposits when the deposit reaches approximately 2 of the volume capacity of the temporary silt fence or as directed by the Engineer. Dress any sediment deposits remaining in place after the temporary silt fence is no longer required to conform with the finished grade, and prepare and seed them in accordance with Section 570.

104-6.4.11 Floating Turbidity Barriers and Staked Turbidity Barriers: Install, maintain, and remove turbidity barriers to contain turbidity that may occur as the result of dredging, filling, or other construction activities which may cause turbidity to occur in the waters of the State. The Contractor may need to deploy turbidity barriers around isolated areas of concern such as seagrass beds, coral communities, etc. both within as well as outside the right-of-way limits. The Engineer will identify such areas. Place the barriers prior to the commencement of any work that could impact the area of concern. Install the barriers in accordance with the details shown in the plans or as approved by the Engineer. Ensure that the type barrier used and the deployment and maintenance of the barrier will minimize dispersion of turbid waters from the construction site. The Engineer may approve alternate methods or materials.

Operate turbidity barriers in such a manner to avoid or minimize the degradation of the water quality of the surrounding waters.

104-6.4.12 Rock Bags: Furnish and place rock bags to control erosion and siltation. Place the bags as shown in the plans, the Roadway and Traffic Design Standards or as directed by the Engineer. Use a fabric material with openings that are clearly visible to minimize clogging yet small enough to prevent rock loss. Use material of sufficient strength to allow removing and relocating bags without breakage. The bag size when filled with rocks shall be approximately 12 by 12 by 4 inch [300 by 300 by 100 mm]. Use No. 4 or No. 5 coarse aggregate rock.

104-6.5 Removal of Temporary Erosion Control Features: In general, remove or incorporate into the soil any temporary erosion control features existing at the time of construction of the permanent erosion control features in an area of the project in such a manner that no detrimental effect will result. The Engineer may direct that temporary features be left in place.

104-7 Maintenance of Erosion Control Features.

104-7.1 General: Provide routine maintenance of permanent and temporary erosion control features, at no expense to the Department, until the project is complete and accepted. If reconstruction of such erosion control features is necessary due to the Contractor's negligence or carelessness or, in the case of temporary erosion control features, failure by the Contractor to install permanent erosion control features as scheduled, the Contractor shall replace such erosion control features at no expense to the Department. If reconstruction of permanent or temporary erosion control features is necessary due to factors beyond the control of the Contractor, the Department will pay for replacement under the appropriate Contract pay item or items.

104-7.2 Mowing: The Engineer may direct mowing of areas within the limits of the project. Mow these designated areas within seven days of receiving such order. Do not mow slopes that are steeper than three horizontal to one vertical.

104-8 Protection During Suspension of Contract Time.

If it is necessary to suspend the construction operations for any appreciable length of time, shape the top of the earthwork in such a manner to permit runoff of rainwater, and construct earth berms along the top edges of embankments to intercept runoff water. Provide temporary slope drains to carry runoff from cuts and embankments that are in the vicinity of rivers, streams, canals, lakes, and impoundments. Locate slope drains at intervals of approximately 500 feet [150 m], and stabilize them by paving or by covering with waterproof materials. Should such preventive measures fail, immediately take such other action as necessary to effectively prevent erosion and siltation. The Engineer may direct the Contractor to perform, during such suspensions of operations, any other erosion control work deemed necessary.

104-9 Method of Measurement.

When separate items for temporary erosion control features are included in the Contract, the quantities to be paid for will be: (1) the areas, in square yards [square meters], of Artificial Coverings; (2) the area, in acres [hectares], of Mowing; (3) the volume, in cubic yards [cubic meters], of Sandbagging, measured in accordance with 530-4.1; (4) the length, in feet [meters], of Slope Drains (Temporary), measured along the surface of the work constructed; (5) the number of Sediment Basins acceptably constructed; (6) the number of Sediment Basin Cleanouts acceptably accomplished; (7) the number of hay or straw bales; (8) the length, in feet [meters], of Floating Turbidity Barrier; (9) the length, in feet [meters], of Staked Turbidity Barrier; (10) the length, in feet [meters], of Staked Silt Fence; (11) seeding materials in accordance with Section 570 and (12) the number of Rock Bags acceptably placed.

The quantity of floating turbidity barrier, relocated turbidity barrier, staked turbidity barrier, and staked silt fence to be paid for will be the total length, in feet [meters], furnished, installed, and accepted at a new location, regardless of whether materials are new or used or relocated from a previous installation on the project.

104-10 Basis of Payment.

Prices and payments will be full compensation for all work specified in this Section, including construction and routine maintenance of temporary erosion control features and for mowing.

Any additional costs resulting from compliance with the requirements of this Section, other than construction, routine maintenance, and removal of temporary erosion control features and mowing, will be included in the Contract unit prices for the item or items to which such costs are related. The work of Grassing or Sodding designated as a temporary erosion control feature in accordance with 104-6.4.2 or 104-6.4.3 will be paid for under the appropriate pay items specified in Sections 570 and 575.

Separate payment will not be made for the cost of constructing temporary earth berms along the edges of the roadways to prevent erosion during grading and subsequent operations. The Contractor shall include these costs in the Contract prices for grading items.

Additional temporary erosion control features constructed as directed by the Engineer will be paid for as unforeseeable work.

In case of repeated failure on the part of the Contractor to control erosion, pollution, or siltation, the Engineer reserves the right to employ outside assistance or to use the Department's own forces to provide the necessary corrective measures. Any such costs incurred, including engineering costs, will be charged to the Contractor and appropriate deductions made from the monthly progress estimate.

Payment will be made under:

Item No. 104- 1- Artificial Coverings - per square yard.
Item No. 2104- 1- Artificial Coverings - per square meter.
Item No. 104- 4- Mowing - per acre.
Item No. 2104- 4- Mowing - per hectare.
Item No. 104- 5- Sandbagging - per cubic yard.
Item No. 2104- 5- Sandbagging - per cubic meter.
Item No. 104- 6- Slope Drains (Temporary) - per foot.
Item No. 2104- 6- Slope Drains (Temporary) - per meter.
Item No. 104- 7- Sediment Basins - each.
Item No. 2104- 7- Sediment Basins - each.
Item No. 104- 9- Sediment Basin Cleanouts - each.
Item No. 2104- 9- Sediment Basin Cleanouts - each.
Item No. 104- 10- Baled Hay or Straw - each.
Item No. 2104- 10- Baled Hay or Straw - each.
Item No. 104- 11- Floating Turbidity Barrier - per foot.
Item No. 2104- 11- Floating Turbidity Barrier - per meter.
Item No. 104- 12- Staked Turbidity Barrier - per foot.
Item No. 2104- 12- Staked Turbidity Barrier - per meter.
Item No. 104- 13- Staked Silt Fence - per foot.
Item No. 2104- 13- Staked Silt Fence - per meter.

Item No. 104- 16- Rock Bags - each.
Item No. 2104- 16- Rock Bags - each.
Item No. 104- 75- Relocate Floating Turbidity Barrier - per foot.
Item No. 2104- 75- Relocate Floating Turbidity Barrier - per meter.

CLEARING CONSTRUCTION SITE

SECTION 110

CLEARING AND GRUBBING

110-1 Description.

Clear and grub within the areas of the roadway right-of-way and of borrow pits, sand-clay base material pits, lateral ditches, and any other areas shown in the plans to be cleared and grubbed. Remove and dispose of all trees, stumps, roots and other such protruding objects, and buildings, structures, appurtenances, existing flexible asphalt pavement, and other facilities necessary to prepare the area for the proposed construction, and remove and dispose of all product and debris not required to be salvaged or not required to complete the construction.

Also, perform certain miscellaneous work the Engineer considers necessary for the complete preparation of the overall project site, as follows:

(a) Plug any water wells that are encountered within the right-of-way and that are to be abandoned.

(b) Level the terrain outside the limits of construction for purposes of facilitating maintenance and other post-construction operations.

(c) Trim trees and shrubs within the project right-of-way that are identified in the Contract Documents.

Meet the requirements for such miscellaneous work as specified in 110-10.

110-2 Standard Clearing and Grubbing.

110-2.1 Work Included: Completely remove and dispose of all buildings, timber, brush, stumps, roots, rubbish, debris, and all other obstructions resting on or protruding through the surface of the existing ground and the surface of excavated areas, and all other structures and obstructions necessary to be removed and for which other items of the Contract do not specify the removal thereof, including septic tanks, building foundations, and pipes.

Perform Standard Clearing and Grubbing within the following areas:

(a) All areas where excavation is to be done, including borrow pits, lateral ditches, right-of-way ditches, etc.

(b) All areas where roadway embankments will be constructed.

(c) All areas where structures will be constructed, including pipe culverts and other pipe lines.

110-2.2 Depths of Removal of Roots, Stumps, and Other Debris: In all areas where excavation is to be performed and the excavated material is to be used in the construction of roadway embankment or roadway base or pavement, and in all areas where roadway embankments are to be constructed, remove roots and other debris to a depth of at least 12 inches [300 mm] below the ground surface. Plow the surface to a depth of at least 6 inches [150 mm], and remove all roots thereby exposed to a depth of at least 12 inches [300 mm]. Completely remove and dispose of all stumps within the roadway right-of-way.

Where excavating within the roadway area and for structures, remove all roots, etc., protruding through or appearing on the surface of the completed excavation to a depth of at least 12 inches [300 mm] below the finished excavation surface.

In borrow pits, material pits, and lateral ditches, remove or cut off all stumps, roots, etc., protruding through or appearing on the surface of the completed excavation below the finished excavation surface.

In borrow and material pits, do not perform any clearing or grubbing within 3 feet [1.0 m] inside the right-of-way line.

Within all other areas where Standard Clearing and Grubbing is to be performed, remove roots and other debris projecting through or appearing on the surface of the original ground, to a depth of 12 inches [300 mm] below the surface, but do not plow or harrow these areas.

110-2.3 Trees to Remain: As an exception to the above provisions, where so directed by the Engineer, trim, protect, and leave standing desirable trees within the roadway area. Trim branches of trees extending over the area occupied by the roadway as directed, to give a clear height of 16 feet [5 m] above the roadway.

110-2.4 Boulders: Remove any boulders encountered in the roadway excavation (other than as permitted under the provisions of 120-7.2) or found on the surface of the ground, and place them in neat piles inside the right-of-way and adjacent to the right-of-way line. The Contractor may stockpile boulders encountered in Department-furnished borrow areas, which are not suitable for use in the embankment construction, within the borrow area.

110-3 Selective Clearing and Grubbing.

The Contractor shall remove and dispose of all vegetation, obstructions, etc., as provided above except that, where so elected, the Contractor may cut roots, etc., flush with the ground surface. Completely remove and dispose of stumps. Entirely remove undergrowth except in specific areas designated by the Engineer to remain for aesthetic purposes. Trim, protect, and leave standing desirable trees, with the exception of such trees as the Engineer may designate to be removed in order to facilitate right-of-way maintenance. Remove undesirable or damaged trees as so designated by the Engineer. Perform Selective Clearing and Grubbing only in areas so designated in the plans.

110-4 Protection of Property Remaining in Place.

Protect and do not displace property obstructions which are to remain in place, such as buildings, sewers, drains, water or gas pipes, conduits, poles, walls, posts, bridges, etc.

110-5 Removal of Buildings.

110-5.1 Parts to be Removed: Completely remove all parts of the buildings, including utilities, plumbing, foundations, floors, basements, steps, connecting concrete sidewalks or other pavement, septic tanks, and any other appurtenances, by any practical manner which is not detrimental to other property and improvements. Remove utilities to the point of connection to the utility authority's cut-in. After removing the sewer connections to the point of cut-in, construct a concrete plug at the cut-in point, as directed by the Engineer, except where the utility owners may elect to perform their own plugging. Contact the appropriate utility companies prior to removal of any part of the building to ensure disconnection of services.

110-5.2 Removal by Others: Where buildings within the area to be cleared and grubbed are so specified to be removed by others, remove and dispose of any foundations, curtain walls, concrete floors, basements or other foundation parts which might be left in place after such removal of buildings by others.

110-6 Removal of Existing Structures.

110-6.1 Structures to be Removed: Remove and dispose of the materials from existing structures. Remove the following: (1) those structures, or portions of structures, shown in the plans to be removed; (2) those structures, or portions of structures, found within the limits of the area to be cleared and grubbed, and directed by the Engineer to be removed; (3) those structures, or portion of structures, which are necessary to remove in order to construct new structures; and (4) other appurtenances or obstructions which may be designated in the Contract Documents as to be included in an item of payment for the work under this Article.

110-6.2 Method of Removal: Remove the structures in such a way as to leave no obstructions to any proposed new structures or to any waterways. Pull, cut off, or break off pilings to the requirements of the permit or other Contract Documents, whichever requires the deepest removal, but not less than 2 feet [0.6 m] below the finish ground line. In the event that the plans indicate channel excavation to be done by others, consider the finish ground line as the limits of such excavation. For materials which are to remain the property of the Department or are to be salvaged for use in temporary structures, avoid damage to such materials, and entirely remove all bolts, nails, etc., from timbers to be so salvaged. Mark structural steel members for identification as directed.

Remove existing steel members painted with a paint identified by the Resource Conservation Recovery Act (RECRA), as a hazardous material. The Contractor removing any material or waste identified as hazardous, must submit proof of QP2, Category AA≅ certification with the Society of Protective Coatings (SSPC) prior to removal activities. Paint identified as hazardous, that is disturbed or removed from the steel members, is considered hazardous waste.

110-6.3 Partial Removal of Bridges: On concrete bridges to be partially removed and widened, remove concrete by manually or mechanically operated pavement breakers, by concrete saws, or by chipping hammers. Do not use explosives. Where concrete is to be removed to neat lines, use concrete saws capable of providing a reasonably uniform cleavage face. If the equipment used will not provide a uniform cut without surface spalling, first score the outlines of the work with small trenches or grooves.

110-6.4 Authority of U.S. Coast Guard: For structures in navigable waters, when constructing the project under authority of a U.S. Coast Guard permit, the U.S. Coast Guard may inspect and approve the work to remove any existing structures involved therein, prior to acceptance by the Department.

110-7 Removal of Existing Pavement.

Remove and dispose of existing rigid portland cement concrete pavement, sidewalk, slope pavement, ditch pavement, curb, and curb and gutter, where shown in the plans or ordered by the Engineer to be removed or where required because of the construction operations. Retaining walls, drainage structures and flexible asphalt pavement are not included in the work under this Article.

110-8 Ownership of Materials.

Except as may be otherwise specified in the Contract Documents, the Contractor shall take ownership of all buildings, structures, appurtenances, and other materials removed by him and shall dispose of them in accordance with 110-9.

110-9 Disposal of Materials.

110-9.1 General Disposal: Provide disposal areas approved by the Engineer. Either stack any material designated to remain the property of the Department in neat piles within the right-of-way or load it onto the Department's vehicles.

Dispose of timber, stumps, brush, roots, rubbish, and other objectionable material resulting from clearing and grubbing in areas and by methods approved by the Engineer. Do not block waterways by the disposal of debris.

110-9.2 Burning Debris: Where burning of such materials is permitted, perform all such burning in accordance with the applicable laws, ordinances, and regulations. Perform all burning at locations where trees and shrubs adjacent to the cleared area will not be harmed.

110-9.3 Disposal in Areas Adjacent to Project: The Contractor may dispose of materials on private property, provided the Contractor furnishes the Engineer with a written Statement from the owner of the property giving permission for the disposal of the materials on his property. The Contractor shall locate all disposal areas for materials resulting from clearing and grubbing, both on private property and on property owned by him, (1) in areas out of sight of the project and (2) at least 300 feet [90 m] from the nearest roadway right-of-way line of the project. If burying materials, the Contractor may disregard requirement (2).

110-9.4 Timber and Crops: The Contractor may sell any merchantable timber, fruit trees, and crops that are cleared under the operations of clearing and grubbing for his own benefit, subject to the provisions of 7-1.2, which may require that the timber, fruit trees, or crops be burned at or near the site of their removal, as directed by the Engineer. The Contractor is liable for any claims which may arise pursuant to the provisions of this Subarticle.

110-9.5 Hazardous Materials/Waste: Ensure that all hazardous materials and waste are handled and disposed of in accordance with all Local, State and Federal requirements.

Use one of the following methods for the disposal of all hazardous materials and waste:

(a) Deliver the steel members and other hazardous waste to a licensed recycling center capable of processing steel members coated with paint identified by RECRA as hazardous.

(b) Remove all hazardous materials from the steel members and dispose of the hazardous waste, as required by EPA and other governing authorities.

(c) Deliver the steel members to an approved agency for use as an offshore artificial reef. Deliver any other hazardous materials or waste to a licensed hazardous materials/waste recycling center.

Submit the name, address and qualifications of the transporter, treatment facility, proposed treatment and disposal methods for the Engineers approval, prior to transport, treatment or disposal of any hazardous materials or waste.

Transport all hazardous waste and/or materials in accordance with applicable 40 CFR 263 Standards. Provide all hazardous materials or waste manifests, certificates of disposal, chain of custody forms and other applicable documents within 21 days of each shipment.

All compensation for the cost of removal and disposal of hazardous materials or waste will be included in the Cost of Removal of Existing Structures.

110-10 Miscellaneous Operations.

110-10.1 Plugging Abandoned Water Wells:

110-10.1.1 Water Wells Required to be Plugged: Fill or plug all water wells within the right-of-way, including areas of borrow pits and lateral ditches, that are not to remain in service, as specified herein.

Cut off the casing of cased wells at least 12 inches [300 mm] below the ground line or 12 inches [300 mm] below the elevation of the finished excavation surface, whichever is lower.

Water wells, as referred to herein, are defined either as artesian or non-artesian, as follows:

(a) An artesian well is an artificial hole in the ground from which water supplies may be obtained and which penetrates any water-bearing rock, the water in which is raised to the surface by natural flow or which rises to an elevation above the top of the water-bearing bed. Artesian wells are further defined to include all holes drilled as a source of water that penetrate any water-bearing beds that are a part of the artesian water system of Florida, as determined by representatives of the Division of Interior Resources of the State of Florida Department of Environmental Protection.

(b) A non-artesian (water-table) well is a well in which the source of water is an unconfined aquifer. The water in a non-artesian well does not rise above the source bed.

If the plans do not indicate whether a non-flowing well is artesian or non-artesian, the Engineer will contact the Florida Department of Environmental Protection to determine the type of the particular well and will furnish the information to the Contractor.

110-10.1.2 Plugging Artesian Wells: For plugging artesian wells, obtain advice from the Florida Bureau of Geology, and employ a competent well-driller.

Plug artesian wells, flowing or non-flowing, from bottom to surface with neat portland cement mortar (cement and water only). Substantially stop the well's flow before the introduction of the cement mixture by introducing "drilling mud", or by other methods approved by the Bureau of Geology.

Introduce the cement mixture into the well bore at the point at which it is to remain, by means of a dump-bailer or by a drop-pipe through which the mixture is pumped into place. Do not allow the cement mixture to fall freely through the water in the well.

For wells intercepting cavities or caverns, fill the cavernous sections with heavy mud, crushed limerock, or clean sand or gravel, in such manner as to form a base to hold the application of the cement mixture. Use other methods to fill wells which involve special or difficult problems, subject to approval by the Bureau of Geology.

Should leakage around the outside of the casing appear after plugging the well, neatly grout the casing with cement mortar to eliminate the leakage.

110-10.1.3 Plugging Non-Artesian Wells: Fill non-artesian wells with cement mortar, concrete, clay, or other material which prevents the flow of surface waters down the well. Perform the work in such a manner that it will not contaminate an underground water supply.

110-10.2 Landscape Areas: When certain areas of the right-of-way, outside of the limits of construction, are shown in the plans or designated by the Engineer to be landscaped, either under the construction Contract or at a later time, remove undesirable trees, stumps, undergrowth, and vegetation, as directed, and preserve and trim natural growth and trees as directed by the Engineer.

110-10.3 Leveling Terrain: Within the areas between the limits of construction and the outer limits of clearing and grubbing, fill all holes and other depressions, and cut down all mounds and ridges. Make the area of a sufficient uniform contour so that the Department's subsequent mowing and cutting operations are not hindered by irregularity of terrain. Perform this work regardless of whether the irregularities were the result of construction operations or existed originally.

110-10.4 Mailboxes: When the Contract Documents require furnishing and installing mailboxes, permit each owner to remove the existing mailbox. Work with the Local Postmaster to develop a method of temporary mail service for the period between removal and installation of the new mailboxes. Install the mailboxes in accordance with the AASHTO publication, AA Guide for Erecting Mailboxes on Highways≅.

110-11 Method of Measurement.

110-11.1 Clearing and Grubbing:

110-11.1.1 Lump Sum Payment: When direct payment is provided in the Contract, the quantity to paid for will be either the lump sum quantity or the number of acres [hectares], cleared and grubbed.

110-11.1.2 Areas Paid for Separately (by the acre [hectare]): For borrow pits and other areas of clearing and grubbing which are designated to be paid for separately by the acre [hectare], the quantity to be paid for will be determined by measurement of the areas authorized by the Engineer to be cleared and grubbed, and acceptably completed.

Payment by the acre [hectare] for the clearing and grubbing of borrow pits will be subject to the following provisions:

(a) When the Contractor exercises an option to furnish substitute borrow areas to be used in lieu of pits furnished by the Department, the quantity to be paid for in the substitute borrow areas will be either the area actually cleared and grubbed or the area shown on the plans for the corresponding borrow areas furnished by the Department, whichever is smaller.

(b) When the Contractor is required to furnish the borrow areas, no separate payment for clearing and grubbing of those areas will be made.

(c) Clearing and grubbing performed on haul roads, provided either by the Department or by the Contractor, will not be included in the areas to be paid for under Clearing and Grubbing. The costs of any clearing and grubbing work necessary to open haul roads for the Contractor's use will be included in the particular item (or items) of the Contract to which such work is pertinent.

(d) Areas where Selective Clearing and Grubbing is performed will be included in the measurement under the item of Clearing and Grubbing.

110-11.2 Removal of Existing Structures: When direct payment is provided in the Contract, the quantity to paid for will be the lump sum quantity or quantities for the specific structures removed, as designated.

110-11.3 Removal of Existing Pavement: Payment for removal of flexible asphalt pavement is included in the Lump Sum price for Clearing and Grubbing. When a separate item for Removal of Existing Pavement is provided, the quantity to be paid for will be the number of square yards [square meters] of existing pavement of the types listed in 110-7, acceptably removed and disposed of, as specified. The quantity will be determined by actual measurement along the surface of the pavement before its removal. Measurements for appurtenances which have irregular surface configurations, such as curb and gutter, steps, and ditch pavement, will be the area as projected to an approximate horizontal plane. Where the removal of pavement areas is necessary only for the construction of box culverts, pipe culverts, storm sewers, inlets, manholes, etc., these areas will not be included in the measurements.

110-11.4 Plugging Water Wells: When direct payment is provided in the Contract, the quantity to paid for will be the number of water wells plugged, for each type of well (artesian or non-artesian).

110-11.5 Mailboxes: When direct payment is provided in the Contract, the quantity to be paid for will be the number of mailboxes acceptably furnished and installed.

110-11.6 Delivery of Salvageable Material to the Department: When direct payment is provided in the Contract, the quantity to be paid for will be the Lump Sum quantity for delivery of salvageable materials to the Department as indicated in the plans.

110-11.7 General: In each case, except as provided below, where no item of separate payment for such work is included in the proposal, all costs of such work will be included in the various scheduled items in the Contract, or under specific items as specified herein below or elsewhere in the Contract.

110-12 Basis of Payment.

110-12.1 Clearing and Grubbing:

110-12.1.1 Lump Sum Payment: Price and payment will be full compensation for all clearing and grubbing required for the roadway right-of-way and for lateral ditches, channel changes, or other outfall areas, and any other clearing and grubbing indicated, or required for the construction of the entire project, except for any areas designated to be paid for separately or to be specifically included in the costs of other work under the Contract.

Where construction easements are specified in the plans and the limits of clearing and grubbing for such easements are dependent upon the final construction requirements, no adjustment will be made in the lump sum price and payment, either over or under, for variations from the limits of the easement defined on the plans.

110-12.1.2 General: Price and payment, either lump sum or by the acre [hectare], will be full compensation for all the work specified in this Section (other than as specified below, when separate payment is provided for removal of existing structures, removal of existing pavement, and plugging water wells), including all necessary hauling, furnishing equipment, equipment operation, furnishing any areas required for disposal of debris, leveling of terrain and the landscaping work of trimming, etc., as specified herein.

110-12.1.3 When No Direct Payment is Provided: When no item for clearing and grubbing is included in the proposal, the Contractor shall include the cost of any work of clearing and grubbing which is necessary for the proper construction of the project in the Contract price for the structure or other item of work for which such clearing and grubbing is required.

The Contractor shall include the cost of all clearing and grubbing which might be necessary in pits or areas from which base material is obtained in the Contract price for the base in which such material is used. The clearing and grubbing of areas for obtaining stabilizing materials, where required only for the purpose of obtaining materials for stabilizing, will not be paid for separately.

110-12.2 Removal of Existing Structures: Price and payment will be full compensation for all work of removal and disposal of the designated structures.

When direct payment for the removal of existing structures is not provided in the proposal, the Contractor shall include the cost of removing all structures in the Contract price for Clearing and Grubbing or, if no item of Clearing and Grubbing is included, in the compensation for the other items covering the new structure being constructed.

110-12.3 Removal of Existing Pavement: Price and payment will be full compensation for performing and completing all the work of removal and satisfactory disposal.

When no separate item for this work is provided and no applicable item of excavation or embankment covering such work (as provided in 120-13.1) is included, the Contractor shall include the costs of this work in the Contract price for the item of Clearing and Grubbing or for the pipe or other structure for which the pavement removal is required.

110-12.4 Plugging Water Wells: Price and payment will be full compensation for each type of well acceptably plugged.

If a water well requiring plugging is encountered and the Contract contains no price for plugging wells of that specific type, the plugging of such well will be paid for as unforeseeable work.

110-12.5 Mailboxes: Price and payment will be full compensation for all work and materials required, including supports and numbers.

110-12.6 Delivery of Salvageable Material to the Department: Price and payment will be full compensation for all work required for delivery of the materials to the Department.

110-12.7 Payment Items: Payment will be made under:

Item No. 110- 1- Clearing and Grubbing - lump sum.
Item No. 2110- 1- Clearing and Grubbing - lump sum.
Item No. 110- 2- Clearing and Grubbing - per acre.
Item No. 2110- 2- Clearing and Grubbing - per hectare.
Item No. 110- 3- Removal of Existing Structures - lump sum.
Item No. 2110- 3- Removal of Existing Structures - lump sum.
Item No. 110- 4- Removal of Existing Pavement - per square yard.
Item No. 2110- 4- Removal of Existing Pavement - per square meter.
Item No. 110- 5- Plugging Water Wells (Artesian) - each.
Item No. 2110- 5- Plugging Water Wells (Artesian) - each.
Item No. 110- 6- Plugging Water Wells (Non-Artesian) - each.
Item No. 2110- 6- Plugging Water Wells (Non-Artesian) - each.
Item No. 110- 7- Mailbox (Furnish and Install) - each.
Item No. 2110- 7- Mailbox (Furnish and Install) - each.
Item No. 110- 86- Delivery of Salvageable Material to FDOT - lump sum.
Item No. 2110- 86- Delivery of Salvageable Material to FDOT - lump sum.

EARTHWORK AND RELATED OPERATIONS

SECTION 120

EXCAVATION AND EMBANKMENT

120-1 Description.

Excavate and construct embankments as required for the roadway, ditches, channel changes and borrow material. Prepare subgrades and foundations, construct embankments, and otherwise use or dispose of the materials excavated. Use suitable excavated materials or authorized borrow. Also compact and dress excavated areas and embankments. For excavation and backfilling of structures, refer to Section 125.

Excavate materials for clearing and grubbing under Section 110. Unclassified material displaced by the storm sewer or drainage structure system is not included in the earthwork quantities shown on the plans.

120-2 Classifications of Excavation.

120-2.1 General: The Department may classify excavation specified under this Section for payment as any of the following: (1) Regular Excavation, (2) Subsoil

Excavation, (3) Lateral Ditch Excavation, and (4) Channel Excavation.

If the proposal does not show Subsoil Excavation or Lateral Ditch Excavation as separate items of payment, include such excavation under the item of Regular Excavation.

If the proposal shows Lateral Ditch Excavation as a separate item of payment, but does not show Channel Excavation as a separate item of payment, include such excavation under the item of Lateral Ditch Excavation. Otherwise, include Channel Excavation under the item of Regular Excavation.

120-2.2 Regular Excavation: Regular Excavation includes roadway excavation and borrow excavation, as defined below for each.

120-2.2.1 Roadway Excavation: Roadway Excavation consists of the excavation and the utilization or disposal of all materials necessary for the construction of the roadway, ditches, channel changes, etc., except as may be specifically shown to be paid for separately and that portion of the lateral ditches within the limits of the roadway right-of-way as shown in the plans.

120-2.2.2 Borrow Excavation: Borrow Excavation consists of the excavation and utilization of material from authorized borrow pits, including only material that is suitable for the construction of roadway embankments or of other embankments covered by the Contract, and unsuitable material in borrow areas furnished by the Department that must be excavated as determined by the Engineer in order to obtain the suitable material.

A Value Engineering Change Proposal (VECP) submittal based on using borrow material from within the project limits will not be considered.

120-2.3 Subsoil Excavation: Subsoil Excavation consists of the excavation and disposal of muck, clay, rock, or any other material that is unsuitable in its original position and that is excavated below the finished grading template. For stabilized bases and sand bituminous road mixes, consider the finished grading template as the top of the finished base, shoulders and slopes. For all other bases and rigid pavement, consider the finished grading template as the finished shoulder and slope lines and bottom of completed base or rigid pavement. Subsoil Excavation also consists of the excavation of all suitable material within the above limits as necessary to excavate the unsuitable material. Consider the limits of Subsoil Excavation indicated on the plans as being particularly variable, in accordance with the field conditions actually encountered.

The quantity of material required to replace the excavated material and to raise the elevation of the roadway to the bottom of the template will be paid for separately.

120-2.4 Lateral Ditch Excavation: Lateral Ditch Excavation consists of all excavation of inlet and outlet ditches to structures and roadway, changes in channels of streams, and ditches parallel to the roadway right-of-way. Dress lateral ditches to the grade and cross-section shown in the plans The Department will classify all excavation in that portion of lateral ditches beyond the limits of the roadway right-of-way, including the sections where dressing is required as provided above, as Lateral Ditch Excavation.

120-2.5 Channel Excavation: Channel Excavation consists of the excavation and satisfactory disposal of all materials from the limits of the channel as shown in the plans.

120-3 Preliminary Soils Investigations.

When the plans contain the results of a soil survey, do not assume such data is a guarantee of the depth, extent, or character of material present.

120-4 Removal of Unsuitable Materials and Existing Roads.

120-4.1 Subsoil Excavation: Where muck, rock, clay, or other material within the limits of the roadway is unsuitable in its original position, excavate such material to the cross-sections shown in the plans or indicated by the Engineer, and backfill with suitable material. Shape backfill material to the required cross-sections. Where the removal of plastic soils below the finished earthwork grade is required, meet a construction tolerance, from the lines shown in the plans as the removal limits, of ∀0.2 feet [∀60 mm] in depth and ∀6 inches [∀150 mm] (each side) in width.

120-4.2 Removal of Existing Old Road: Where a new roadway is to be constructed over an old one, plow or scarify the old road, and break it up full width, regardless of height of fill. If the plans provide that paving materials may be incorporated into the fill, distribute such material in a manner so as not to create voids.

120-4.3 Obliterating Old Road: Where the plans call for obliteration of portions of an old road outside of the proposed new roadway, obliterate such sections of the old road by grading to fill ditches and to restore approximately the original contour of the ground or a contour which produces a pleasing appearance.

120-5 Disposal of Surplus and Unsuitable Material.

120-5.1 Ownership of Excavated Materials: The Department will retain ownership of all suitable excavated materials until the final job requirements for fill or backfill materials have been fulfilled. Take ownership of remaining excavated materials not needed for job requirements, and dispose of them outside the right-of-way, to the satisfaction of the Engineer.

In urban or other areas where temporary storage of apparent excess suitable materials within the right-of-way may be impracticable, the Contractor may stockpile the materials outside the right-of-way in areas provided by him, until the Contractor needs such materials in the job or declares them as surplus. With the written approval of the Engineer, the Contractor may dispose of such apparent excess material with the stipulation that he shall replace any portion of the disposed material required to fulfill the actual job requirements, with equally suitable material, at his own expense.

120-5.2 General Requirements for Disposal: Dispose of excavated muck or other materials unsuitable for the roadway construction as shown in the plans or, if the plans do not indicate the disposal, take ownership of the materials and dispose of them outside the right-of-way.

120-5.3 Disposal of Muck on Side Slopes: As an exception to the provisions of 120-5.2, when approved by the Engineer, in rural undeveloped areas, the Contractor may place muck (A-8 material) on the slopes, or store it alongside the roadway, provided there is a clear distance of at least 6 feet [2 m] between the roadway grading limits and the muck, and the Contractor dresses the muck to present a reasonably neat appearance. In addition, the Contractor may also dispose of this material by placing it on the slopes in developed areas where, in the opinion of the Engineer, this will result in an aesthetically pleasing appearance and will have no detrimental effect on the adjacent developments. Where the Engineer allows the Contractor to dispose of muck or other unsuitable material inside the right-of-way limits, the Contractor shall not place such material in a manner which will impede the inflow or outfall of any channel or of side ditches. The Engineer will determine the limits adjacent to channels within which the Contractor may place such materials.

120-5.4 Disposal of Paving Materials: Unless otherwise noted, take ownership of paving materials, such as paving brick, asphalt block, concrete slab, sidewalk, curb and gutter, etc., excavated in the removal of existing pavements, and dispose of them outside the right-of-way. If the materials are to remain the property of the Department, place them in neat piles as directed. Existing limerock base that is removed may be incorporated in the stabilized portion of the subgrade. If the construction sequence will allow, incorporate all existing limerock base into the project as allowed by the Contract Documents.

120-5.5 Disposal Areas: Where the Contract Documents require disposal of excavated materials outside the right-of-way, and the disposal area is not indicated in the Contract documents, furnish the disposal area without additional compensation.

Provide areas for disposal of removed paving materials out of sight of the project and at least 300 feet [90 m] from the nearest roadway right-of-way line of any State-maintained road. If the materials are buried, disregard the 300 foot [90 m] limitation.

120-6 Borrow.

120-6.1 Authorization for Use of Borrow: Use borrow only when sufficient quantities of suitable material are not available, as herein prescribed, from roadway and drainage excavation, to properly construct the embankment, subgrade, and shoulders, and to complete the backfilling of structures. Do not use borrow material until so ordered by the Engineer, and then only use material from designated borrow pits. Do not open borrow pits until the Engineer has approved their location and, where measurement of payment quantities is to be in the original position, cross-sections have been taken of the original ground surface.

Do not provide borrow materials that are polluted as defined in Chapter 376 of the Florida Statutes (oil of any kind and in any form, gasoline, pesticides, ammonia, chlorine, and derivatives thereof, excluding liquefied petroleum gas) in concentrations above any local, State, or Federal standards.

Prior to placing any borrow material that is the product of soil incineration, provide the Engineer with a copy of the Certificate of Materials Recycling and Post Burn Analysis showing that the material is below all allowable pollutant concentrations.

120-6.2 Furnishing of Borrow Areas: Unless otherwise specified, furnish areas for borrow material. When the Department is to furnish upland borrow areas, it will secure the necessary rights, permits or waivers. When the Department is to furnish a dredging area, it will obtain any necessary property rights and will make the necessary application for the dredging permits, which permits will be subsequently issued to the Contractor in accordance with 7-2.

To obtain the Engineer's approval to use an off-site construction activity area that involves excavation such as a borrow pit or local aggregate pit, request in writing, a Cultural Resources Assessment. Send the request to the Division of Historical Resources, Department of State, State Historic Preservation Officer, Tallahassee, FL. As a minimum, include in the request the State Project Job Number, the County, a description of the property with Township, Range, Section, etc., the dimensions of the area to be affected, and a location map. Do not start any work at the off-site construction activity area until receiving a clearance letter from the Division of Archives and written clearance from the Engineer concerning compliance with the Federal Endangered Species Act as specified in 7-1.4.

For certain locations, the Division of Archives will require a Cultural Resources Field Survey before approval can be granted. When this is required, secure professional archaeological services to make the survey and prepare a report. Submit the report to the Division of Archives with a copy to the Department. The Engineer will base final approval or rejection of the use of the off-site construction activity area on the report.

The Department will adjust Contract Time in accordance with 8-7 for any suspension of operations required to comply with this Article. The Department will not accept any monetary claims due to delays or loss of off-site construction activity areas.

Except where the plans specifically call for the use of a particular borrow or dredging area, the Contractor may substitute borrow or dredging areas of his own choosing provided: (1) the Engineer determines the materials from such areas meet the Department's standards and other requirements for stability for use in the particular sections of the work in which it is to be placed, and (2) the Contractor absorbs any increase in hauling or other costs.

Before using any borrow material from any substitute areas, obtain the Engineer's approval, in writing, for the use of the particular areas, and, where applicable, ensure that the Engineer has cross-sectioned the surface. Upon such written approval by the Engineer, consider the substitute areas as designated borrow areas.

When furnishing the dredging or borrow areas, supply the Department with evidence that the necessary permits, rights, or waivers for the use of such areas have been secured.

Do not excavate any part of a Contractor furnished borrow area which is less than 300 feet [90 m] from the right-of-way of the project or any State Road until the Engineer has approved a plan for landscaping and restoring the disturbed area. Perform this landscaping and land restoration at no expense to the Department, prior to final acceptance of the project. Do not provide a borrow area closer than 25 feet [8 m] to the right-of-way of any state road. In Department furnished borrow pits, do not excavate material within 5 feet [1.5 m] of the adjacent property lines.

Upon completion of excavation, neatly shape, dress, grass, vegetate, landscape, and drain all exposed areas including haul roads, as necessary so as not to present an objectionable appearance.

Meet the requirements of Section 104 when furnishing borrow areas, regardless of location.

120-6.3 Use of Overburden from Material Pits: Use overburden from areas from which sand-clay or other selected material is to be obtained, which is suitable for use in the embankment as borrow, as directed by the Engineer.

120-6.4 Borrow Material for Shoulder Build-up: When so indicated in the plans, furnish borrow material with a specific minimum bearing value, for building up of existing shoulders. Blend materials as necessary to achieve this specified minimum bearing value prior to placing the materials on the shoulders. Take samples of this borrow material at the pit or blended stockpile. Include all costs of providing a material with the required bearing value in the Contract unit price for borrow material.

120-6.5 Requirements for Excavating in Borrow Areas: When borrow material is to be measured for payment, excavate the borrow pits neatly, and shape the bottoms and edges so that the Engineer can make accurate measurements of the excavated material. If the bottom of the pit is above the normal water table, shape it to a regular grade that will not permit the ponding of water. Do not maintain the bottom or edges after the final cross-sections have been taken, except for the correction of erosion along the pit perimeter. Where the plans show the depth and width of excavation, consider such depths and widths as approximations only and subject to variation.

120-6.6 Drainage of Borrow Pits: Where shown in the plans or ordered by the Engineer, construct ditches for draining the borrow pits. Classify the excavation of such pit drains as borrow, and use all suitable materials excavated from pit drains as borrow.

120-6.7 Haul Routes for Borrow Pits: Provide and maintain, at no expense to the Department, all necessary roads for hauling the borrow material. The Department will obtain any necessary property easements for haul roads from pits which it furnishes. Where borrow area haul roads or trails are used by others, do not cause such roads or trails to deteriorate in condition.

Arrange for the use of all non-public haul routes crossing the property of any railroad. Incur any expense for the use of such haul routes. Establish haul routes which will direct construction vehicles away from developed areas when feasible, and keep noise from hauling operations to a minimum. Advise the Engineer in writing of all proposed haul routes.

120-7 Materials for Embankment.

120-7.1 Use of Materials Excavated From the Roadway and Appurtenances: Use all suitable materials resulting from roadway excavation as far as practicable for completion of the work. Where so shown in the plans, use suitable material excavated from lateral ditches in the construction of the roadway and appurtenances. Use overburden stripped from material pits in the construction of embankments.

120-7.2 General Requirements for Embankment Materials: Construct embankments of acceptable material including broken portland cement concrete pavement and portland cement concrete rubble, but containing no muck, stumps, roots, brush, vegetable matter, rubbish, reinforcement bar or other material that does not compact into a suitable and enduring roadbed. Remove and waste material designated as undesirable. Use material in embankment construction in accordance with plan details or as the Engineer directs.

Complete the embankment using maximum particle sizes as follows:

In top 12 inches [300 mm]: 32 inches [90 mm] (in any dimension).

12 to 24 inches [300 to 600 mm]: 6 inches [150 mm] (in any dimension).

In the depth below 24 inches [600 mm]: not to exceed 12 inches [300 mm] (in any dimension) or the compacted thickness of the layer being placed, whichever is less.

Spread all material so that the larger particles are separated from each other to minimize voids between them during compaction. Compact around these rocks in accordance with 120-9.2.

When and where approved by the Engineer, the Contractor may place larger rocks (not to exceed 18 inches [450 mm] in any dimension) outside the two to one slope and at least 4 feet [1.2 m] or more below the bottom of the base. Compact around these rocks to a firmness equal to that of the supporting soil. Compact grassed embankment areas in accordance with 120-9.2.6.

Where constructing embankments adjacent to bridge end bents or abutments, do not place rock larger than 32 inches [90 mm] in diameter within 3 feet [1.0 m] of the location of any end-bent piling.

120-7.3 Selected Material for Plant Growth: When material suitable for plant growth, as designated by the Engineer, is available from the excavation within the limits of the project, use such material for at least the top 8 inches [200 mm] of earth material in areas designated for subsequent landscape planting. Do not place material which is unsuitable for plant growth in such areas.

120-7.4 Materials Used at Pipes, Culverts, etc.: Construct embankments over and around pipes, culverts, and bridge foundations with selected materials.

120-8 Embankment Construction.

120-8.1 General: Construct embankments in sections of not less than 300 feet [90 m] in length or for the full length of the embankment.

120-8.2 Dry Fill Method:

120-8.2.1 General: Except as provided below for material placed on unstable ground and for materials used for flattening slopes, construct embankments in successive layers of not more than 8 inches [200 mm] in thickness, measured loose, for the full width of the embankment. However, the Contractor may construct embankments in successive layers of not more than 12 inches [300 mm] compacted thickness, if he can demonstrate with field tests that he has compacting equipment sufficient to achieve density required by 120-9.2 for the full depth of a thicker lift, and if the compactive effort is approved by the Engineer. Construct all layers approximately parallel to the centerline profile of the road.

The Engineer will base his approval on the results of a test section the Contractor constructed using his specified compactive effort. Construct the test section with a minimum length of 300 feet [90 m], full width, and a maximum length of 1,000 feet [300 m].

Once approved, if there is a change in soil classification of the embankment materials, construct a new test section. Do not change the compactive effort once a test section is approved.

The Engineer reserves the right to terminate the Contractor's use of thick lift construction and have him revert to the 8 inch [200 mm] loose lifts whenever it is determined that satisfactory results are not being achieved.

As far as practicable, distribute traffic over the work during the construction of embankments so as to cover the maximum area of the surface of each layer.

Construct embankment in the dry whenever normal dewatering equipment and methods can accomplish the needed dewatering.

120-8.2.1.1 Equipment and Methods: Provide normal dewatering equipment including, but not limited to, surface pumps, sump pumps and trenching/digging machinery. Provide normal dewatering methods including, but not limited to, constructing shallow surface drainage trenches/ditches, using sand blankets, sumps and siphons.

When normal dewatering does not adequately remove the water, the Engineer may require the embankment material to be placed in the water or in low swampy ground in accordance with 120-8.2.2

120-8.2.2 Placing in Unstable Areas: Where depositing the material in water, or in low swampy ground that will not support the weight of hauling equipment, construct the embankment by dumping successive loads in a uniformly distributed layer of a thickness not greater than necessary to support the hauling equipment while placing subsequent layers. Once sufficient material has been placed so that the hauling equipment can be supported, construct the remaining portion of the embankment in layers in accordance with the applicable provisions of 120-8.2.1 and 120-8.2.3.

120-8.2.3 Placing on Steep Slopes: When constructing an embankment on a hillside sloping more than 20 degrees from the horizontal, before starting the fill, deeply plow or cut into steps the surface of the original ground on which the embankment is to be placed.

120-8.2.4 Placing Outside Standard Minimum Slope: Where material that is unsuitable for normal embankment construction is to be used in the embankment outside the standard minimum slope (approximately two to one), place such material in layers of not more than 18 inches [450 mm] in thickness, measured loose. The Contractor may also place material which is suitable for normal embankment, outside such standard minimum slope, in 18 inch [450 mm] layers.

120-8.3 Hydraulic Method:

120-8.3.1 Method of Placing: When the hydraulic method is used, as far as practicable, place all dredged material in its final position in the embankment by such method. Place and compact any dredged material that is rehandled, or moved and placed in its final position by any other method, as specified in 120-8.2. The Contractor may use baffles or any form of construction he may select provided the slopes of the embankments are not steeper than indicated in the plans. Remove all timber used for temporary bulkheads or baffles from the embankment, and fill and thoroughly compact the holes thus formed. When placing fill on submerged land, construct dikes prior to beginning of dredging, and maintain the dikes throughout the dredging operation.

120-8.3.2 Excess Material: Do not use excess material placed outside the prescribed slopes, below the normal high-water level, to raise the fill. Remove only the portion of this material required for dressing the slopes.

120-8.3.3 Protection of Openings in Embankment: Leave openings in the embankments at the bridge sites. Remove any material which invades these openings or existing channels without additional compensation to provide the same depth of channel as existed before the construction of the embankment. Do not excavate or dredge any material within 200 feet [60 m] of the toe of the proposed embankment.

120-9 Compaction Requirements.

120-9.1 Moisture Content: Compact the materials at a moisture content such that the specified density can be attained. If necessary to attain the specified density, add water to the material, or lower the moisture content by manipulating the material or allowing it to dry, as is appropriate.

120-9.2 Compaction of Embankments:

120-9.2.1 Density Requirements: Except for embankment constructed by the hydraulic method as specified in 120-8.3 and for the material placed outside the standard minimum slope as specified in 120-8.2.4, and for other areas specifically excluded herein, compact each layer of the material used in the formation of embankments to a density of at least 100% of the maximum density as determined by AASHTO T 99, Method C. Uniformly compact each layer, using equipment that will achieve the required density, and as compaction operations progress, shape and manipulate each layer as necessary to ensure uniform density throughout the embankment.

120-9.2.2 Compaction Over Unstable Foundations: Where the embankment material is deposited in water or on low swampy ground, and in a layer thicker than 12 inches [300 mm] (as provided in 120-8.2.2), compact the top 6 inches [150 mm] (compacted thickness) of such layer to the density as specified in 120-9.2.1.

120-9.2.3 Compaction Where Plastic Material Has Been Removed: Where unsuitable material is removed and the remaining surface is of the A-4, A-5, A-6, or A-7 Soil Groups (see Florida Sampling and Testing Methods, M145), as determined by the Engineer, compact the surface of the excavated area by rolling with a sheepsfoot roller exerting a compression of at least 250 psi [1.7 MPa] on the tamper feet, for the full width of the roadbed (subgrade and shoulders). Perform rolling before beginning any backfill, and continue until the roller feet do not penetrate the surface more than 1 inch [25 mm]. Do not perform such rolling where the remaining surface is below the normal water table and covered with water. Vary the procedure and equipment required for this operation at the discretion of the Engineer.

120-9.2.4 Compaction of Material To Be Used In Base, Pavement, or Stabilized Areas: Do not compact embankment material which will be incorporated into a pavement, base course, or stabilized subgrade, to be constructed as a part of the same Contract.

120-9.2.5 Compaction of Grassed Shoulder Areas: For the upper 6 inches [150 mm] layer of all shoulders which are to be grassed, since no specific density is required, compact only to the extent directed.

120-9.2.6 Compaction of Grassed Embankment Areas: For the outer layer of all embankments where plant growth will be established, do not compact. Leave this layer in a loose condition to a minimum depth of 6 inches [150 mm] for the subsequent seeding or planting operations.

120-9.3 Compaction for Pipes, Culverts, etc.: Compact the backfill of trenches to the densities specified for embankment or subgrade, as applicable, and in accordance with the requirements of 125-8.

Thoroughly compact embankments over and around pipes, culverts, and bridges in a manner which will not place undue stress on the structures, and in accordance with the requirements of 125-8.

120-9.4 Compaction of Subgrade: If the plans do not provide for stabilizing, compact the subgrade area (as defined in 1-3) in both cuts and fills to the density specified in 120-9.2.1. Do not apply density requirements where constructing narrow widening strips 4 feet [1.2 m] or less on undisturbed soil.

Where trenches for widening strips are not of sufficient width to permit the use of standard compaction equipment, perform compaction using vibratory rollers, trench rollers, or other type compaction equipment approved by the Engineer.

Maintain the required density until the base or pavement is placed on the subgrade.

120-10 Maintenance and Protection of Work.

While construction is in progress, maintain adequate drainage for the roadbed at all times. Maintain a shoulder at least 3 feet [1 m] wide adjacent to all pavement or base construction in order to provide support for the edges.

Maintain all earthwork construction throughout the life of the Contract, and take all reasonable precautions to prevent loss of material from the roadway due to the action of wind or water. Repair, at no expense to the Department, except as otherwise provided herein, any slides, washouts, settlement, subsidence, or other mishap which may occur prior to final acceptance of the work. Perform maintenance and protection of earthwork construction in accordance with Section 104.

Maintain all channels excavated as a part of the Contract work against natural shoaling or other encroachments to the lines, grades, and cross-sections shown in the plans, until final acceptance of the project.

120-11 Construction.

120-11.1 Construction Tolerances: Shape the surface of the earthwork to conform to the lines, grades, and cross-sections shown in the plans. In final shaping of the surface of earthwork, maintain a tolerance of 0.3 foot [90 mm] above or below the plan cross-section with the following exceptions:

1. Shape the surface of shoulders to within 0.1 foot [30 mm] of the plan cross-section.

2. Shape the earthwork to match adjacent pavement, curb, sidewalk, structures, etc.

3. Shape the bottom of ditches so that the ditch impounds no water.

4. When the work does not include construction of base or pavement, shape the entire roadbed (shoulder point to shoulder point) to within 0.1 foot [30 mm] above or below the plan cross-section.

Ensure that the shoulder lines do not vary horizontally more than 0.3 foot

[90 mm] from the true lines shown in the plans.

120-11.2 Operations Adjacent to Pavement: Carefully dress areas adjacent to pavement areas to avoid damage to such pavement. Complete grassing of shoulder areas prior to placing the final wearing course. Do not manipulate any embankment material on a pavement surface.

When shoulder dressing is underway adjacent to a pavement lane being used to maintain traffic, exercise extreme care to avoid interference with the safe movement of traffic.

120-12 Method of Measurement.

120-12.1 General: When payment for excavation is on a volumetric basis, the quantity to be paid for will be the volume, in cubic yards [cubic meters], calculated by the method of average end areas, unless the Engineer determines that another method of calculation will provide a more accurate result. The material will be measured in its original position by field survey or by photogrammetric means as designated by the Engineer, unless otherwise specified under the provisions for individual items.

Where Subsoil Excavation extends outside the lines shown in the plans or authorized by the Engineer including allowable tolerances, and the space is backfilled with material obtained in additional authorized roadway or borrow excavation, the net fill, plus shrinkage allowance, will be deducted from the quantity of Roadway Excavation or Borrow Excavation to be paid for, as applicable.

The quantity of all material washed, blown, or placed beyond the authorized roadway cross-section will be determined by the Engineer and will be deducted from the quantity of Roadway Excavation or Borrow Excavation to be paid for, as applicable.

Subsoil Excavation that extends outside the lines shown in the plans or authorized by the Engineer including allowable tolerances will be deducted from the quantity to be paid for as Subsoil Excavation.

120-12.2 Roadway Excavation: The measurement will include only the net volume of material excavated between the original ground surface and the surface of the completed earthwork, except that the measurement will also include all unavoidable slides which may occur in connection with excavation classified as Roadway Excavation.

The pay quantity will be the plan quantity provided that the excavation was accomplished in substantial compliance with the plan dimensions and subject to the provisions of 9-3.2 and 9-3.4.

120-12.3 Borrow Excavation: The measurement will be in accordance with 120-12.1 except that in special cases, when so shown in the Contract Documents, measurement will be made on a loose volume basis, as measured in trucks or other hauling equipment at the point of dumping on the road. If measurement is made in vehicles, level the material to facilitate accurate measurement.

Measurement of borrow excavation in borrow areas furnished by the Department will include unsuitable material that is necessary to excavate, as determined by the Engineer, in order to obtain suitable borrow material. Such unsuitable material excavated from borrow pits where truck measurement is provided for and from any borrow pits furnished by the Contractor, will not be included in the quantity of excavation to be paid for.

For suitable material excavated from a borrow pit and not used for roadway fill within specification tolerances, as limited by 9-3.4, either the Contractor shall return the material to the pit before final cross-sections are taken or the Engineer will measure the material in place and deduct the quantity, plus an allowance for shrinkage, from the pay quantity of borrow excavation. In case borrow paid by truck measure is returned to the pit, the Contractor shall keep tabulation records of the material returned, and the Engineer will deduct an equivalent volume of borrow from the measured pay quantity. This provision applies but is not limited to materials used in construction of haul roads, flushed fill slopes, pit rim berms, and backfill of unauthorized Subsoil Excavation.

Except when used as borrow material for construction of the roadway embankment, or when otherwise shown in the plans, overburden stripped from pits from which selected base material is to be obtained will not be measured for payment, but the costs thereof will be included in the Contract unit price for the base.

120-12.4 Lateral Ditch Excavation: The measurement will include only material excavated within the lines and grades indicated in the plans or as directed by the Engineer. The measurement will include the full station-to-station length shown in the plans or directed by the Engineer and acceptably completed. Excavation included for payment under Section 125 will not be included in this measurement.

The pay quantity will be the plan quantity provided that the excavation was accomplished in substantial compliance with the plan dimensions and subject to the provisions of 9-3.2 and 9-3.4.

120-12.5 Channel Excavation: The measurement will include only material excavated within the lines and grades indicated in the plans or in accordance with authorized plan changes. The measurement will include the full station-to-station length shown in the plans including any authorized changes thereto.

If shoaling occurs subsequent to excavation of a channel and the Engineer authorized the shoaled material to remain in place, the volume of any such material remaining within the limits of channel excavation shown in the plans will be deducted from the measured quantity of Channel Excavation.

120-12.6 Subsoil Excavation: The measurement will include only material excavated within the lines and grades indicated in the plans (including the tolerance permitted therefor) or as directed by the Engineer.

When no item for Subsoil Excavation is shown in the proposal but Subsoil Excavation is subsequently determined to be necessary, such unanticipated Subsoil Excavaton will be paid for as provided in 4-4. The cost of additional material required to replace the unanticipated Subsoil Excavation will be paid for as specified for the particular case shown below:

(a) No additional payment will be made for backfill material obtained from surplus material available from the normal excavation or grading operations.

(b) When the necessary material is not available from the normal excavation or grading operations and the Contract includes an item for borrow excavation, backfill material authorized to be obtained from designated borrow areas will be included in the volume of borrow excavation to be paid for.

(c) When the work of grading for the project is paid for under the item of regular excavation, any backfill material authorized to be obtained by increasing the volume of excavation within the roadway right-of-way will be measured and paid for as regular excavation subject to the provisions of 9-3.2.2.

(d) When authorization is given for obtaining the material from outside the Right-Of- Way and from other than designated borrow areas, such excavation will be paid for as provided in 4-4.

120-12.7 Embankment: The quantity will be at the plan quantity.

Where payment for embankment is not to be included in the payment for the excavation, and is to be paid for on a cubic yard [cubic meter] basis for the item of Embankment, the plan quantities to be paid for will be calculated by the method of average end areas unless the Engineer determines that another method of calculation will provide a more accurate result. The measurement will include only material actually placed above the original ground line, within the lines and grades indicated in the plans or directed by the Engineer. The length used in the computations will be the station-to-station length actually constructed. The original ground line used in the computations will be as determined prior to placing of embankment subject to the provisions of 9-3.2, and no allowance will be made for subsidence of material below the surface of the original ground.

If there are authorized changes in plan dimensions or if errors in plan quantities are detected, plan quantity will be adjusted as provided in 9-3.2.

Where the work includes excavation of unsuitable material below the finished grading template or original ground line, whichever is lower as defined in 120-2.3, the original ground line is defined as the surface prior to beginning excavation, except that this surface is not outside the permissible tolerance of lines and grades for Subsoil Excavation as indicated in the plans or as directed by the Engineer. Any overrun or underrun of plan quantity for Subsoil Excavation which results in a corresponding increase or decrease in embankment will be considered as an authorized plan change for adjustment purposes as defined in 9-3.2.2.

No payment will be made for embankment material used to replace unsuitable material excavated beyond the lines and grades shown in the plans or ordered by the Engineer.

In no case will payment be made for material allowed to run out of the embankment on a flatter slope than indicated on the cross-section. The Contractor shall make his own estimate on the volume of material actually required to obtain the pay section.

120-13 Basis of Payment.

120-13.1 General: Prices and payments for the various work items included in this Section will be full compensation for all work described herein, including excavating, dredging, hauling, placing, and compacting; dressing the surface of the earthwork; maintaining and protecting the complete earthwork; and hauling.

The Department will not allow extra compensation for any rehandling involved under the provisions of 120-5.1.

The Department will compensate for the cost of grassing or other permanent erosion control measures directed by the Engineer as provided in the Contract for similar items of roadway work.

120-13.2 Excavation:

120-13.2.1 Items of Payment: When no classification of material is indicated in the plans, and bids are taken only on Regular Excavation, the total quantity of all excavation specified under this Section will be paid for at the Contract unit price for Regular Excavation.

When separate classifications of excavation are shown in the proposal, the quantities of each of the various classes of materials so shown will be paid for at the Contract unit prices per cubic yard [cubic meter] for Regular Excavation, Lateral Ditch Excavation, Subsoil Excavation, and Channel Excavation, as applicable, and any of such classifications not so shown will be included under the item of Regular Excavation (except that if there is a classification for Lateral Ditch Excavation shown and there is no classification for Channel Excavation, any channel excavation will be included under the item of Lateral Ditch Excavation).

120-13.2.2 Basic Work Included in Payments: Prices and payments will be full compensation for all work described under this Section, except for any excavation, or embankment which is specified to be included for payment under other items. Such prices and payments will include hauling; any rehandling that may be necessary to accomplish final disposal as shown in the plans; the dressing of shoulders, ditches and slopes; removal of trash, vegetation, etc., from the previously graded roadway where no item for clearing and grubbing is shown in the plans; and compacting as required.

120-13.2.3 Additional Depth of Subsoil Excavation: Where Subsoil Excavation is made to a depth of 0 to 5 feet [0 to 1.5 m] below the depth shown on the Contract plans, such excavation will be paid for at the unit price bid.

Where Subsoil Excavation is made to a depth greater than 5 feet [1.5 m], and up to 15 feet [4.5 m], deeper than the depth shown on the Contract plans, such excavation will be paid for at the unit price bid plus 25% of such unit price. Additional extra depth, more than 15 feet [4.5 m] below such plan depth, will be considered as a change in the character of the work and will be paid for as Unforeseeable Work.

Where no subsoil excavation is shown in a particular location on the original plans, payment for extra depth of subsoil will begin 5 feet [1.5 m] below the lowest elevation on the grading template.

120-13.2.4 Borrow Excavation: When the item of Borrow Excavation is included in the Contract, and the plans, price and payment will also include the cost of furnishing the borrow areas and any necessary clearing and grubbing thereof, the removal of unsuitable material that it is necessary to excavate in order to obtain suitable borrow material, and also the costs incurred in complying with the provisions of 120-6.4.

120-13.2.5 Materials Excluded from Payment for the Excavation: No payment as excavation will be made for any excavation covered for payment under the item of Embankment.

No payment will be made for the excavation of any materials which are used for purposes other than those shown in the plans or designated by the Engineer. No payment will be made for materials excavated outside the lines and grades given by the Engineer, unless specifically authorized by the Engineer; except that, in the operations of roadway excavation, all slides and falls of insecure masses of material beyond the regular slopes and not due to lack of precaution on the part of the Contractor will be paid for at the Contract unit price for the material involved. The removal of slides and falls of material classified as Lateral Ditch Excavation or as Subsoil Excavation will not be paid for separately, but will be included in the Contract unit price for the pay quantity of these materials, measured as provided in 120-12.

120-13.3 Embankment:

120-13.3.1 General: Price and payment will be full compensation for all work specified in this Section, including all material for constructing the embankment; all excavating, dredging, pumping, placing and compacting of material for constructing the embankment complete; dressing of the surface of the roadway, maintenance and protection of the completed earthwork, and the removal of rubbish, vegetation, etc., from the roadway, where no clearing and grubbing of the area is specified in the plans. Also, such price and payment, in each case, will specifically include all costs of any roadway, lateral ditch, or channel excavation, unless such excavation is specifically shown to be paid for separately, regardless of whether the materials are utilized in the embankment.

120-13.3.2 Excluded Material: No payment will be made for the removal of muck or overburden from the dredging or borrow areas. No payment will be made for embankment material used to replace muck or other unsuitable material excavated beyond the lines and grades shown in the plans or ordered by the Engineer.

120-13.3.3 Clearing and Grubbing: No payment will be made for any clearing and grubbing of the borrow or dredging areas. Where no clearing and grubbing of such areas is specified in the plans, the cost of any necessary clearing and grubbing will be included in the Contract unit or lump sum price for Embankment.

120-13.3.4 Cost of Permits, Rights, and Waivers: Where the Contractor provides borrow or dredging areas of his own choosing, the cost of securing the necessary permits, rights or waivers will be included in the Contract price for Embankment.

120-13.4 Payment Items: Payment will be made under:

Item No. 120- 1- Regular Excavation - per cubic yard.
Item No. 2120- 1- Regular Excavation - per cubic meter.
Item No. 120- 2- Borrow Excavation - per cubic yard.
Item No. 2120- 2- Borrow Excavation - per cubic meter.
Item No. 120- 3- Lateral Ditch Excavation - per cubic yard.
Item No. 2120- 3- Lateral Ditch Excavation - per cubic meter.
Item No. 120- 4- Subsoil Excavation - per cubic yard.
Item No. 2120- 4- Subsoil Excavation - per cubic meter.
Item No. 120- 5- Channel Excavation - per cubic yard.
Item No. 2120- 5- Channel Excavation - per cubic meter.
Item No. 120- 6- Embankment - per cubic yard.

Item No. 2120- 6- Embankment - per cubic meter.

SECTION 121

FLOWABLE FILL

121-1 Description.

Furnish and place Flowable Fill as an alternative to compacted soil as approved by the Engineer. Applications for this material includes, beddings, encasements, closures for tanks, pipes, and general backfill for trenches.

121-2 Materials.

Meet the following requirements:

Fine Aggregate*..Section 902
Portland Cement (Types I, II, or III)..............................Section 921
Fly Ash, Slag and other Pozzolanic Materials...............Section 929
Air Entraining Admixtures** ....Section 924
Water...Section 923

*Any clean fine aggregate with 100% passing a δ inch [9.5 mm] mesh sieve and not more than 15% passing a No. 200 [75 μm] sieve may be used.
**High air generators or foaming agents may be used in lieu of conventional air entraining admixtures and may be added at jobsite and mixed in accordance with manufacturers recommendation.

121-3 Mix Design.

Flowable Fill is a mixture of portland cement, fly ash, fine aggregate, air entraining admixture and water. Flowable fill contains a low cementitious content for reduced strength development.

Submit mix designs to the Engineer for approval. The following are suggested mix guides for excavatable and non-excavatable flowable fill:

	Excavatable	Non-Excavatable
Cement Type 1	75-100 lb/yd^3 [45-60 kg/m^3]	75-150 lb/yd^3 [45-90 kg/m^3]
Fly Ash	None	150-600 lb/yd^3 [90-355 kg/m^3]
Water	*	*
Air**	5-35%	5-15%
28 Day Compressive Strength**	Maximum 100 psi [690 kPa]	Minimum 125 psi [860 kPa]
Unit Weight (Wet)**	90-110 lb/yd^3 [1,440-1,760 kg/m^3]	100-125 lb/yd^3 [1,600-2,000 kg/m^3]

*Mix designs shall produce a consistency that will result in a flowable self-leveling product at time of

placement.
**The requirements for percent air, compressive strength and unit weight are for laboratory designs only and are not intended for jobsite acceptance requirements.
Fine Aggregate shall be proportioned to yield 1 yd^3 [1 m^3].

121-4 Production and Placing.

Use flowable fill manufactured at plants that qualify as approved sources in accordance with the Standard Operating Procedure for Ready-Mix concrete. Revolution counter requirements are waived.

Deliver flowable fill using concrete construction equipment. Place flowable fill by chute, pumping or other methods approved by the Engineer. Tremie flowable fill through water.

121-5 Construction Requirements.

Use straps, soil anchors or other approved means of restraint to ensure correct alignment when flowable fill is used as backfill for pipe or where flotation or misalignment may occur.

Protect flowable fill from freezing for a period of 36 hours after placement.

Place flowable fill to the designated fill line without vibration or other means of compaction. Do not place flowable fill during inclement weather, e.g. rain or ambient temperatures below 40EF [4EC]. Take all necessary precautions to prevent any damages caused by the hydraulic pressure of the fill during placement prior to hardening. Provide the means to confine the material within the designated space.

121-6 Acceptance.

Acceptance of flowable fill will be based on the following documentation and a minimum temperature of flowable fill at the point of delivery of 50EF [10EC].

Furnish a delivery ticket to the Engineer for each load of flowable fill delivered to the worksite. Ensure that each ticket contains the following information:

(1) Project designation,
(2) Date,
(3) Time,
(4) Class and quantity of flowable fill,
(5) Actual batch proportions,
(6) Free moisture content of aggregates,
(7) Quantity of water withheld.

Leave the fill undisturbed until the material obtains sufficient strength. Sufficient strength is 35 psi [240 kPa] pentration resistance as measured using a hand held penetrometer in accordance with FM 1-T 197. Provide a hand held penetrometer to measure the penetration resistance of the hardened flowable fill.

121-7 Basis of Payment.

When the item of flowable fill is included in the Contract, payment will be made at the Contract unit price per cubic yard [cubic meter]. Such price and payment will include all cost of the mixture, in place and accepted, determined as specified above. No measurement and payment will be made for material placed outside the neat line limits or outside the adjusted limits, or for unused or wasted material.

Payment will be made under:

Item No. 121-70 - Flowable Fill - per cubic yard.
Item No. 2121-70 - Flowable Fill - per cubic meter.

SECTION 125

EXCAVATION FOR STRUCTURES

125-1 Description.

Excavate for bridge foundations, box culverts, pipe culverts, storm sewers and all other pipe lines, retaining walls, headwalls for pipe culverts and drains, catch basins, drop inlets, manholes, and similar structures. Also, (1) construct and remove cofferdams, sheeting, bracing, etc.; (2) pump or otherwise dewater foundations; (3) remove and dispose of any existing structures or portions of structures not covered by other items in the Contract, including foundations, abutments, piers, wings, and all other materials, obstructions, etc., found necessary to clear the site for the proposed work; (4) backfill, dispose of surplus material, and perform final cleaning, as may be necessary for the proper execution of the work. This Section does not include excavation for bases or pavements, curbs, curb and gutter, valley gutter, ditch pavement, or rubble gutter.

125-1.1 Trench Excavation Safety System and Shoring, Special (Trench Excavation): When performing trench excavation in excess of 5 feet [1.5 m] in depth, comply with the Occupational Safety and Health Administration=s (OSHA) trench safety standards, 29 C.F.R., s. 1926.650, Subpart P, and all subsequent revisions or updates adopted by the Department of Labor and Employment Security. Ensure that trench boxes are wide enough to accommodate compaction and density testing.

Submission of bid and subsequent execution of the Contract will serve as certification that all trench excavation in excess of 5 feet [1.5 m] in depth will be in compliance with Section 553.62, Florida Statutes.

Consider all available geotechnical information available when designing the trench excavation safety system.

Consider these and any more stringent trench safety standards as minimum Contract requirements.

125-2 Classification.

Consider all materials excavated as unclassified and as excavation regardless of the material encountered.

125-3 Cofferdams.

125-3.1 Construction:

125-3.1.1 Methods: Construct all foundations by open excavation, and shore, brace, or protect the foundation openings with cofferdams. Provide cofferdams or cribs for foundation construction below the bottom of the footings. Provide sufficient clearance in the cofferdam interiors to permit construction of forms and inspection of their exteriors, and for pumping equipment.

125-3.1.2 Protection of Concrete: Construct cofferdams to protect green concrete against damage from a sudden rising of the water and to prevent damage by erosion. Do not leave timber or bracing in cofferdams or cribs that extend into the substructure masonry except where permitted in writing by the Engineer.

125-3.1.3 Placing in the Dry: For placing footings in the dry, the Engineer may require cofferdam sheeting to be driven to an elevation 6 feet [1.8 m] below the elevation of the bottom of the footings and require sufficient pumping equipment to dewater and maintain the cofferdam in a comparatively dry condition.

125-3.1.4 Working Drawings: For substructure work, submit drawings showing the proposed method of cofferdam construction and other details left to choice or not fully shown on the plans. Obtain the Engineer's approval of the type and clearance of cofferdams, insofar as such details affect the character of the finished work. For other details of design that do not affect the character of the finished work, assume responsibility for the successful construction of the work. Retain a Professional Engineer, registered in the State of Florida, to prepare the above construction drawing, and keep a signed and sealed copy on hand at the site at all times. On completion of the work, furnish the Department with as-built drawings on permanent reproducible material as noted in 5-1.4.1.

125-3.2 Removal: Unless otherwise provided, remove cofferdams or cribs, with all sheeting and bracing, after completion of the substructure without disturbing or marring the finished masonry.

125-4 Excavation.

125-4.1 Requirements for all Excavation: Excavate foundation pits to permit the placing of the full widths and lengths of footings shown in the plans, with full horizontal beds. Do not round or undercut corners or edges of footings. Perform all excavation to foundation materials, satisfactory to the Engineer, regardless of the elevation shown on the plans. Perform all excavation in stream beds to a depth at least 4 feet [1.2 m] below the permanent bed of the stream, unless a firm footing can be established on solid rock before such depth is reached, and excavate to such additional depth as may be necessary to eliminate any danger of undermining. Wherever rock bottom is secured, excavate in such manner as to allow the solid rock to be exposed and prepared in horizontal beds for receiving the masonry. Remove all loose and disintegrated rock or thin strata. Have the Engineer inspect and approve all foundation excavations prior to placing masonry.

125-4.2 Earth Excavation:

125-4.2.1 Foundation Material other than Rock: When masonry is to rest on an excavated surface other than rock, take special care to avoid disturbing the bottom of the excavation, and do not remove the final foundation material to grade until just before placing the masonry. In case the foundation material is soft or mucky, the Engineer may require excavation to a greater depth and to backfill to grade with approved material.

125-4.2.2 Foundation Piles: Where foundation piles are used, complete the excavation of each pit before driving the piles. After the driving is completed, remove all loose and displaced material, leaving a smooth, solid, and level bed to receive the masonry.

125-4.2.3 Removal of Obstructions: Remove boulders, logs, or any unforeseen obstacles encountered in excavating. Compensation will be in accordance with the requirements of 4-3.4.

125-4.3 Rock Excavation: Clean all rock and other hard foundation material, remove all loose material, and cut all rock to a firm surface. Either level, step vertically and horizontally, or serrate the rock, as may be directed by the Engineer. Clean out all seams, and fill them with concrete or mortar.

125-4.4 Pipe Trench Excavation: Excavate trenches for pipe culverts and storm sewers to the elevation of the bottom of the pipe and to a width sufficient to provide adequate working room. Remove soil not meeting the classification specified as suitable backfill material in 125-8.3.2.2, to a depth of 4 inches [100 mm] below the bottom of the pipe elevation. Remove rock, boulders or other hard lumpy or unyielding material to a depth of 12 inches [300 mm] below the bottom of the pipe elevation. Remove muck or other soft material to a depth necessary to establish a firm foundation. Where the soils permit, ensure that the trench sides are vertical up to at least the mid-point of the pipe.

For pipe lines placed above the natural ground line, place and compact the embankment, prior to excavation of the trench, to an elevation at least 2 feet [0.6 m] above the top of the pipe and to a width equal to four pipe diameters, and then excavate the trench to the required grade.

125-5 Preservation of Channel.

125-5.1 General: unless shown on the plans, do not excavate outside of caissons, cribs, cofferdams, or sheet piling, and do not disturb the natural stream bed adjacent to the structure. If excavating or dredging at the site of the structure before sinking caissons, cribs, or cofferdams, complete the foundation and backfill all such excavations to the original ground surface or other required elevation, with material satisfactory to the Engineer.

125-5.2 Removal of Excavated Materials: Do not allow materials that are deposited adjacent to the stream area to infiltrate the water areas. Leave the stream in its original condition.

125-6 Disposal of Surplus.

Use suitable excavated materials for backfilling over or around the structure. Dispose of unsuitable materials. Meet the disposal requirements pertaining to water pollution contained in Section 104 and in 7-1.1.

125-7 Pumping.

Pump from the interior of any foundation enclosure in such manner as to preclude the possibility of any portion of the concrete materials being carried away. Do not pump while placing concrete, or for a period of at least 24 hours thereafter, unless using a suitable pump separated from the concrete work by a watertight wall.

125-8 Backfilling.

125-8.1 Requirements for all Structures:

125-8.1.1 General: Backfill in the Dry whenever normal dewatering equipment and methods can accomplish the needed dewatering.

125-8.1.2 Equipment and Methods: Provide normal dewatering equipment including, but not limited to, surface pumps, sump pumps, wellpoints and header pipe and trenching/digging machinery. Provide normal dewatering methods including, but not limited to, constructing shallow surface drainage trenches/ditches, using sand blankets, perforated pipe drains, sumps and siphons.

125-8.1.3 Backfill Materials: Backfill to the original ground surface or subgrade surface of openings made for structures, with a sufficient allowance for settlement. The Engineer may require that the material used for this backfill be obtained from a source entirely apart from the structure. Use only material accepted by the Engineer.

Do not allow heavy construction equipment to cross over culvert or storm sewer pipes until placing and compacting backfill material to the finished earthwork grade or to an elevation at least 4 feet [1.2 m] above the crown of the pipe.

125-8.1.4 Use of A-7 Material: In the backfilling of trenches, A-7 material may be used from a point 12 inches [300 mm] above the top of the pipe up to the elevation shown on the Roadway and Traffic Design Standards as the elevation for undercutting of A-7 material.

125-8.1.5 Time of Placing Backfill: Do not place backfill against any masonry or concrete abutment, wingwall, or culvert until permission has been given by the Engineer, and in no case until the masonry or concrete has been in place seven days or until the specified 28-day compressive strength occurs.

125-8.2 Requirements for Structures Other than Pipe Culverts and Storm Sewers:

125-8.2.1 Density: Place the material in horizontal layers not exceeding 8 inches [200 mm] in depth above water level, behind abutments, wingwalls and end bents or end rest piers, and around box culverts and structures other than pipe culverts, and compact it to a density of at least 100% of the maximum density as determined by AASHTO T 99. Where the backfill material is deposited in water, obtain a 12 inch [300 mm] layer of comparatively dry material, thoroughly compacted by tamping, before verifying the layer and density requirements.

125-8.2.2 Box Culverts: For box culverts over which pavement is to be constructed, compact around the structure to an elevation not less than 12 inches [300 mm] above the top of the structure, using rapid-striking mechanical tampers.

125-8.2.3 Other Limited Areas: Compact in other limited areas using mechanical tampers or approved hand tampers, until the cover over the structure is at least 12 inches [300 mm] thick. When hand tampers are used, deposit the materials in layers not more than 4 inches [100 mm] thick using hand tampers suitable for this purpose with a face area of not more than 100 in^2 [64,500 mm^2]. Take special precautions to prevent any wedging action against the masonry, and step or terrace the slope bounding the excavation for abutments and wingwalls if required by the Engineer.

125-8.2.4 Culverts and Piers: Backfill around culverts and piers on both sides simultaneously to approximately the same elevation.

125-8.2.5 Compaction Under Wet Conditions: Where wet conditions do not permit the use of mechanical tampers, compact using hand tampers. Use only

A-3 material for the hand tamped portions of the backfill. When the backfill has reached an elevation and condition such as to make the use of the mechanical tampers practical, perform mechanical tamping in such manner and to such extent as to transfer the compaction force into the sections previously tamped by hand.

125-8.3 Requirements for Pipe Culverts and Storm Sewers:

125-8.3.1 General: Trenches for pipe may have up to four zones that must be backfilled.

Lowest Zone: The lowest zone is backfilled for deep undercuts up to within 4 inches [100 mm] of the bottom of the pipe.

Bedding Zone: The zone above the Lowest Zone is the Bedding Zone. Usually it will be the backfill which is the 4 inches [100 mm] of soil below the bottom of the pipe. When rock or other hard material has been removed to place the pipe, the Bedding Zone will be the 12 inches [300 mm] of soil below the bottom of the pipe.

Cover Zone: The next zone is backfill that is placed after the pipe has been laid and will be called the Cover Zone. This zone extends to 12 inches [300 mm] above the top of the pipe. The Cover Zone and the Bedding Zone are considered the Soil Envelope for the pipe.

Top Zone: The Top Zone extends from 12 inches [300 mm] above the top of the pipe to the base or final grade.

125-8.3.2 Material:

125-8.3.2.1 Lowest Zone: Backfill areas undercut below the Bedding Zone of a pipe with coarse sand, or other suitable granular material, obtained from the grading operations on the project, or a commercial material if no suitable material is available.

125-8.3.2.2 Soil Envelope: In both the Bedding Zone and the Cover Zone of the pipe, backfill with materials classified as A-1, A-2, or A-3. Material classified as A-4 may be used if the pipe is concrete pipe.

125-8.3.2.3 Top Zone: Backfill the area of the trench above the soil envelope of the pipe with materials allowed on Roadway and Traffic Design Standard, Index No. 505.

125-8.3.3 Compaction:

125-8.3.3.1 Lowest Zone: Compact the soil in the Lowest Zone to approximately match the density of the soil in which the trench was cut.

125-8.3.3.2 Bedding Zone: If the trench was not undercut below the bottom of the pipe, loosen the soil in the bottom of the trench immediately below the approximate middle third of the outside diameter of the pipe.

If the trench was undercut, place the bedding material and leave it in a loose condition below the middle third of the outside diameter of the pipe. Compact the outer portions to a minimum of 100% of the maximum density as determined by AASHTO T 99. Place the material in lifts no greater than 6 inches [150 mm] (compacted thickness).

125-8.3.3.3 Cover Zone: Before placing the Cover Zone material, lay pipe according to Section 430. Excavate for pipe bells before laying pipe. Place the material in 6 inch [150 mm] layers (compacted thickness), evenly deposited on both sides of the pipe, and compact with mechanical tampers suitable for this purpose. Hand tamp material below the pipe haunch that cannot be reached by mechanical tampers. For concrete pipe, compact the backfill to a density of at least 100% of the maximum density as determined by AASHTO T 99, Method C. For metal and plastic pipe, compact the backfill to a density of at least 95% of the maximum density as determined by AASHTO T 99, Method C.

125-8.3.3.4 Top Zone: Place the material in layers not to exceed 12 inches [300 mm] in compacted thickness. Compact with appropriate equipment to a density of at least 100% of the maximum density as determined by AASHTO T 99, Method C, except as provided below.

In locations outside the plane described by a two (horizontal) to one (vertical) slope downward from the roadway shoulder line or the back of curb as applicable and along storm sewer outfall lines where no vehicular traffic will pass over the pipe, compact the backfill to a firmness approximately equal to that of the soil next to the pipe trench.

125-8.3.4 Backfill Under Wet Conditions: Where wet conditions are such that dewatering by normal pumping methods would not be effective, the procedure outlined below may be used when specifically authorized by the Engineer in writing. The Department will pay for any select material which is not available from the grading as Unforeseeable Work. The Department will not pay for select material that might be used by the Contractor for his own convenience instead of dewatering.

The Department will permit the use of granular material below the elevation at which mechanical tampers would be effective, but only material classified as A-3. Place and compact the material using timbers or hand tampers until the backfill reaches an elevation such that it=s moisture content will permit the use of mechanical tampers. When the backfill has reached such elevation, use normally acceptable backfill material. Compact the material using mechanical tampers in such manner and to such extent as to transfer the compacting force into the material previously tamped by hand.

The Department will permit the use of coarse aggregate below the elevation at which mechanical tampers would be effective. Use coarse aggregate as specified in Section 901 for Aggregate Size Number 89, 8, 78, 7, 68, 6, or 57. Place the coarse aggregate such that it will be stable and firm. Fully wrap the aggregate with a layer of Type D-4 filter fabric, as specified on Roadway and Traffic Design Standard, Index No. 199. Do not place coarse aggregate within 4 feet [1.2 m] of the ends of the trench or ditch. Use normally accepted backfill material at the ends.

125-8.4 Requirements for Thick Lift Compaction in Granular Materials: If it is demonstrated that the required density can be obtained in thicker lifts than permitted above, the Engineer may permit placement of granular material of soil groups A-1, A-2, or A-3 in lifts up to a maximum of 3 foot [0.9 m] compacted thickness. In such cases, furnish equipment and labor to excavate and backfill test pits to be dug for the performance of density tests.

Use of thick lift compaction procedures will not be allowed for backfilling the soil envelope of pipe culverts and storm sewers.

125-9 Replacing Pavement.

Where existing pavement, curb, curb and gutter, sidewalk or valley gutter is removed only for the purpose of constructing or removing box culverts, pipe culverts, storm sewers, inlets, manholes, etc., replace or restore those items to the

Engineer=s satisfaction, without direct compensation.

125-10 Cleaning Up.

Upon completion of the work, leave the structure and all adjacent areas in a neat and presentable condition, clear up all temporary structures, rubbish and surplus material and leave the space under the structure unobstructed and in such shape that drift will not collect nor scour be induced. Pile all material from existing structures that have been removed neatly on the bank, unless otherwise directed by the Engineer. Pull falsework piling unless the Engineer permits it to cut or broken off, in which case it will be cut or broken off at least 2 feet [0.6 m] below the ground line or stream bed.

125-11 Method of Measurement.

When direct payment for Excavation for Structures is provided in the proposal, and such payment is on a unit basis, such excavation will be measured in its original position by the cross-section method to determine the amount of material. The cubic yard [cubic meter] volume of excavation used as a basis of payment will then be that material actually removed below the original ground line or stream bed, but not including that shown on the plans to be paid for either as Regular Excavation, Subsoil Excavation, Lateral Ditch Excavation or Channel Excavation, or which is included in the item for Grading, and except that no payment will be made for material removed in excavating for footings or foundations outside of an area which is bounded by vertical planes 12 inches [300 mm] outside of the limits of the footing and parallel thereto. For pipe trenches the width used to be in the calculation shall be the diameter of the pipe, plus 24 inches [600 mm].

125-12 Basis of Payment.

125-12.1 When No Direct Payment Provided: When direct payment for Excavation for Structures is not provided for in the proposal, all work specified in this Section, other than as specified in 125-12.3 through 125-12.7, shall be included in the Contract price for the concrete or for other items covering the applicable structure.

125-12.2 Direct Payment: When direct payment for work under this Section is provided, the Contract price per cubic yard [cubic meter] (measured as provided in 125-11), as shown in the proposal, shall be full compensation for all the work specified in this Section, except such work as is specifically stipulated to be paid for separately, in 125-12.3 through 125-12.7.

125-12.3 Excavation Below Plan Grade: When excavation of material below plan grade is called for in the plans or authorized by the Engineer, and payment for Excavation for Structures is on a cubic yard [cubic meter] basis, the material excavated below plan grade will be included in the measurement for this item.

Payment for the material used for the backfill will be made as specified in 125-12.7.

125-12.4 Strengthening Foundations: The work of strengthening the foundations (as provided in 125-4.2) shall be paid for as provided in 4-4, unless such work is covered by a bid item.

125-12.5 Backfilling for Additional Support: The work of providing additional support by backfilling with sand or other satisfactory material, where called for by the Engineer (as specified in 125-8), shall be paid for as provided in 4-4.

125-12.6 Removal and Replacement of Existing Pavement: For pavement, curb, etc., which is removed only in order to construct pipe culverts or storm sewers, as specified in 125-9, all costs of such removal and replacement shall be included in the costs of the pipe or other structure for which it is removed, unless otherwise provided for in the contract.

125-12.7 Removal and Replacement of Material Unsuitable for Backfill: When it cannot reasonably be anticipated from information contained in the plans, that material excavated for the structure will be unsuitable for use as backfill, and such material proves to be unsuitable for this use, the work of disposing of such material away from the site will be paid for as unforeseeable work, and the work of bringing in substitute material for the backfill will be paid for as specified for the particular case shown below:

(a) No additional payment will be made for backfill materials obtained from surplus material available from the normal excavation or grading operations.

(b) When the necessary material is not available from the normal excavation or grading operations, and the Contract includes an item for Borrow Excavation, backfill material authorized to be obtained from designated borrow areas will be included in the volume of Borrow Excavation to be paid for.

(c) When the necessary material is not available from the normal excavation or grading operations and no separate item for Borrow Excavation is included in the Contract, any backfill material obtained by increasing the volume of excavation within the roadway right of way will be measured and paid for as regular excavation subject to the provisions of 9-3.2.2.

(d) When authorization is given for obtaining the material from outside the right of way and from other than designated borrow areas, such excavation will be paid for as unforeseeable work.

(e) Where pipe bedding is provided, as specified in 125-8, by the use of select granular material, the quantity of such select material obtained either as commercial material or from material from the grading operations other than in the immediate vicinity of the pipe to be bedded, as authorized by the Engineer, will be paid for at the Contract price per cubic yard [cubic meter] for Select Bedding Material. No payment for this material will be made for material available from the excavation for the pipe culvert or from other material available from the grading operations at a location not sufficiently remote as to require loading on trucks.

125-12.8 Pay Items: Payment for the work under this Section, when provided for directly, shall be made under:

Item No. 125- 1- Excavation for Structures - per cubic yard.
Item No. 2125- 1- Excavation for Structures - per cubic meter.
Item No. 125- 3- Select Bedding Material - per cubic yard.
Item No. 2125- 3- Select Bedding Material - per cubic meter.

SECTION 160

STABILIZING

160-1 Description.

Stabilize designated portions of the roadbed to provide a firm and unyielding subgrade, having the required bearing value specified in the plans. When specified in the plans, provide additional strengthening of the subbase by additional stabilizing of the upper portion of the previously stabilized subgrade, within the limits specified.

160-2 Stabilized Subgrade.

For stabilized subgrade, the Contractor may choose the type of material, Commercial or Local.

When the stabilizing is designated as Type B, the Engineer will determine compliance with the bearing value requirements by the Limerock Bearing Ratio (LBR) Method. If approved by the Engineer and only for materials requiring an LBR value of 40, the Engineer may omit Sections 6.0 and 6.1 of Florida Method of Test for Limerock Bearing Ratio (FM 5-515) and perform an Unsoaked LBR Test. The Engineer or the Contractor may request to use this method. If the Unsoaked LBR Test results in a failing test, then the Engineer will perform a standard Soaked LBR Test. When the stabilizing is designated as Type C, the Engineer will determine compliance by the Florida Soil Bearing Test.

The Contractor is responsible to make the finished roadbed section meet the bearing value requirements, regardless of the quantity of stabilizing materials necessary to be added. Also, the Department will make full payment for any areas where the existing subgrade materials meet the design bearing value requirements without the addition of stabilizing additives, as well as areas where the Contractor may elect to place select high-bearing materials from other sources within the limits of the stabilizing.

After substantially completing the roadbed grading operations, determine the type and quantity (if any) of stabilizing material necessary for compliance with the bearing value requirements. Notify the Engineer of the approximate quantity to be added. Obtain the Engineer's approval for spreading and mixing-in of such quantity of materials to achieve uniformity and effectiveness.

The Engineer may allow, at no additional cost to the Department, the substitution of 6 inches [150 mm] of Granular Subbase meeting the requirements of Section 290, when 12 inches [300 mm] of Type B Stabilization requiring an LBR value of 40 is specified.

160-3 Stabilized Subbase.

When Stabilized Subbase is required, after the mixing operations for the stabilization of the entire subgrade limits, strengthen the upper portion of the subgrade, within the limits shown, by adding and mixing-in a loose depth of commercial stabilizing material as designated in the plans or as may be otherwise designated by the Engineer. Provide a minimum depth of spread 3 inches [75 mm] (loose measurement).

160-4 Materials.

160-4.1 Commercial and Local Materials: Meet the requirements of Section 914 for the particular type of stabilizing material to be used.

160-4.2 Use of Materials from Existing Base: When the use of materials from an existing base is required as all, or a portion, of the stabilizing additives, the Engineer will direct the location, placement, and distribution of such materials. Perform this work prior to the spreading of any additional commercial or local materials. Do not remove any section of existing base until the need for it in maintaining traffic is fulfilled.

The Engineer may direct the Contractor to use materials from an existing base in combination with either of the designated types of stabilizing.

160-5 Construction Methods.

160-5.1 General: Prior to the beginning of stabilizing operations, construct the area to be stabilized to an elevation such that, upon completion of stabilizing operations, the completed stabilized subgrade will conform to the lines, grades, and cross-section shown in the plans. Prior to spreading any additive stabilizing material, bring the surface of the roadbed to a plane approximately parallel to the plane of the proposed finished surface.

The Contractor may process the subgrade to be stabilized in one course, unless the equipment and methods being used do not provide the required uniformity, particle size limitation, compaction, and other desired results, in which case, the Engineer will direct that the processing be done in more than one course.

160-5.2 Application of Stabilizing Material: When additive stabilizing materials are required, spread the designated quantity uniformly over the area to be stabilized.

When materials from an existing base are to be used in the stabilizing at a particular location, place and spread all of such materials prior to the addition of other stabilizing additives.

Spread commercial stabilizing material by the use of mechanical material spreaders, except that where use of such equipment is not practicable, use other means of spreading, but only upon written approval of the proposed alternate method.

160-5.3 Mixing: Perform mixing using rotary tillers or other equipment meeting the approval of the Engineer. The Contractor may mix the materials in a plant of an approved type suitable for this work. Thoroughly mix the area to be stabilized throughout the entire depth and width of the stabilizing limits.

Perform the mixing operations, as specified, (either in place or in a plant) regardless of whether the existing soil, or any select soils placed within the limits of the stabilized sections, have the required bearing value without the addition of stabilizing materials.

As an exception to the above mixing requirements, where the subgrade is of rock, the Engineer may waive the mixing operations (and the work of stabilizing), and the Department will not pay for stabilization for such sections of the roadway.

160-5.4 Maximum Particle Size of Mixed Materials: At the completion of the mixing, ensure that the gradation of the material within the limits of the area being stabilized is such that 97% will pass a 32 inch [90 mm] sieve and that the material does not have a plasticity index greater than eight or liquid limit greater than 30. Note that clay balls or lumps of clay size particles (2 microns or less) [(2 µm or less)] and therefore cannot be considered as individual particle sizes. Remove any materials not meeting the plasticity requirements from the stabilized area. The Contractor may break down or remove from the stabilized area materials not meeting the gradation requirements.

160-5.5 Compaction: Except where a stabilized subbase is also to be constructed (as specified in 160-6), after completing the mixing operations and satisfying the requirements for bearing value, uniformity, and particle size, compact the stabilized area in accordance with 160-8. Compact the materials at a moisture content permitting the specified compaction. If the moisture content of the material is improper for attaining the specified density, either add water or allow the material to dry until reaching the proper moisture content for the specified compaction.

160-5.6 Finish Grading: Shape the completed stabilized subgrade to conform with the finished lines, grades, and cross-section indicated in the plans. Check the subgrade using elevation stakes or other means approved by the Engineer.

160-5.7 Requirements for Condition of Completed Subgrade: After completing the stabilizing and compacting operations, ensure that the subgrade is firm and substantially unyielding to the extent that it will support construction equipment and will have the bearing value required by the plans.

Remove all soft and yielding material, and any other portions of the subgrade which will not compact readily, and replace it with suitable material so that the whole subgrade is brought to line and grade, with proper allowance for subsequent compaction.

160-5.8 Maintenance of Completed Subgrade: After completing the subgrade as specified above, maintain it free from ruts, depressions, and any damage resulting from the hauling or handling of materials, equipment, tools, etc. The Contractor is responsible for maintaining the required density until the subsequent base or pavement is in place including any repairs, replacement, etc., of curb and gutter, sidewalk, etc., which might become necessary in order to recompact the subgrade in the event of underwash or other damage occurring to the previously compacted subgrade. Perform any such recompaction at no expense to the Department. Construct and maintain ditches and drains along the completed subgrade section.

160-6 Stabilized Subbase (Additional Strengthening of Upper Portion).

When a stabilized subbase is to be constructed in conjunction with the stabilization operations, after the mixing of the stabilization area as specified in 160-5.3, and determination that the bearing value requirements specified in 160-7 have been met, shape the area over which the stabilized subbase is to be constructed as provided in 160-5.1, and compact it sufficiently to provide a firm surface for the operations to follow. Spread the amount of commercial stabilizing material specified in 160-3 for this operation, in accordance with 160-5.2, and mix it to the depth indicated in the plans, in accordance with 160-5.3. Allow a tolerance of 1 inch [25 mm] in excess of the plan depth in this mixing. The Engineer will not perform any additional tests for bearing value after the mixing of materials for the Stabilized

Subbase.

Compact and finish grading, as specified in 160-5.5 and 160-5.6, and meet the provisions of 160-5.4, 160-5.7, and 160-5.8 for this work.

When commercial materials are used as the stabilizing additives for the initial subgrade stabilization, the Engineer may eliminate the work of Stabilized Subbase, either entirely or in designated sections of the overall limits for this work as may be specified in the plans.

160-7 Bearing Value Requirements.

160-7.1 General: The Engineer will obtain and test bearing value samples at completion of satisfactory mixing of the stabilized area. For any area where the bearing value obtained is deficient from the value indicated in the plans, in excess of the tolerances established herein, spread and mix additional stabilizing material in accordance with 160-5.3. Perform this reprocessing for the full width of the roadway being stabilized and longitudinally for a distance of 50 feet [15 m] beyond the limits of the area in which the bearing value is deficient.

The Contractor shall make his own determination of the quantity of additional stabilizing material to be used in reprocessing.

160-7.2 Tolerances in Bearing Value Requirements: Use the following undertolerances from the specified bearing value, as based on tests performed on samples obtained after completing mixing operations:

Specified Bearing Value	Undertolerance
LBR 40	5.0
LBR 35	4.0
LBR 30 (and under)	2.5
All Florida Bearing Values	5.0

The following unsoaked bearing value requirement is based on tests performed on samples obtained after completing mixing operations:

Specified Bearing Value	Unsoaked Bearing Value Required	Undertolerance
LBR 40	LBR 43	0.0

160-8 Density Requirements.

160-8.1 General: Within the entire limits of the width and depth of the areas to be stabilized, other than as provided in 160-8.2, obtain a minimum density at any location of 98% of the maximum density as determined by AASHTO T 180. When bearing value determinations are made by the Florida Soil Bearing Test, the Engineer will use Test Method C of AASHTO T 180, and, when bearing value determinations are made by the Limerock Bearing Ratio Method, the Engineer will use Test Method D of AASHTO T 180 (as modified by the Department's Research Bulletin 22-B, Revised April, 1972).

160-8.2 Exceptions to Density Requirements: The Contractor need not obtain the minimum density specified in 160-8.1 if within the following limits:

(a) The width and depth of areas which are to be subsequently incorporated into a base course under the same contract.

(b) The upper 6 inches [150 mm] of areas to be grassed under the same contract.

Compact these areas to a reasonably firm condition as directed by the Engineer.

160-9 Method of Measurement.

160-9.1 Type B Stabilization and Type C Stabilization: The quantity to be paid for will be the plan quantity, in square yards [square meters], completed and accepted.

160-9.2 Stabilized Subbase: The quantity to be paid for will be the area, in square yards [square meters], completed and accepted.

160-9.3 Commercial Stabilizing Material: The quantity to be paid for separately will be determined by measurement, loose volumes, in truck bodies, at the point of unloading.

160-10 Basis of Payment.

160-10.1 Type B Stabilization and Type C Stabilization: Price and payment will constitute full compensation for all work specified in this Section applicable to these types of Stabilization, including furnishing and spreading of all stabilizing material required and any reprocessing of stabilization areas necessary to attain the specified bearing value.

160-10.2 Stabilized Subbase: Price and payment will constitute full compensation for the work of incorporating the additional commercial stabilizing material into the designated subbase area.

160-10.3 Commercial Stabilizing Material: Price and payment will be full compensation for furnishing and spreading commercial stabilizing material.

No separate payment will be made for any commercial stabilizing material which the Contractor may elect to use in Type B or Type C Stabilization.

No separate payment will be made for the work of using materials from an existing base, in the stabilizing section.

160-10.4 General: The above prices and payments will constitute full compensation for all work and materials specified in this Section, specifically including all costs of the processing and incorporation of existing base materials into the proposed stabilization area when such work is required by the plans.

If the item of Borrow Excavation is included in the Contract, any stabilizing materials obtained from designated borrow areas will be included in the pay quantity for Borrow Excavation.

160-10.5 Payment Items: Payment will be made under:

Item No. 160- 3- Commercial Stabilizing Material - per cubic yard.
Item No. 2160- 3- Commercial Stabilizing Material - per cubic meter.
Item No. 160- 4- Type B Stabilization - per square yard.
Item No. 2160- 4- Type B Stabilization - per square meter.
Item No. 160- 5- Type C Stabilization - per square yard.
Item No. 2160- 5- Type C Stabilization - per square meter.
Item No. 160- 6- Stabilized Subbase - per square yard.

Item No. 2160- 6- Stabilized Subbase - per square meter.

SECTION 161

PREDESIGNED STABILIZED SUBGRADE

161-1 Description.

Design and construct a stabilized subgrade composed of roadbed soil stabilized with commercial stabilizing material.

161-2 Stabilizing Material.

Use commercial material meeting the requirements of 914-3.1, and the plasticity requirements of 914-3.2.

Proportion the stabilizing material in accordance with FM 5-560, Section 9.2. Design the subgrade using the minimum required Limerock Bearing Ratio (LBR) shown in the plans.

161-3 Determination of Rate of Spread for Stabilizing Material.

Determine the spread rate for stabilizing material. Base the spread rate on tests performed by a testing laboratory approved by the Engineer.

Furnish copies of reports for all tests and calculations used in determining the spread rate to the Engineer at least 14 days prior to beginning stabilizing operations in the section of the project covered by that information. The Engineer may request samples of the subgrade soil and the stabilizing material for verification tests.

Make a separate determination of the spread rate for each source of stabilizing material and whenever significant variations occur in the characteristics of the soil in the subgrade portion of the roadbed.

The Engineer will approve the actual spread rate of stabilizing material used, based on test data and calculations submitted by the Contractor and any verification tests or independent calculations the Engineer deems necessary.

161-4 Trial Section.

Construct a trial section at the beginning of stabilizing operations, approximately 200 feet [60 m] long, using the designated stabilizing material and spread rate. The Engineer will evaluate this section by visual observation, LBR testing and other tests as appropriate. The Engineer may require a modification to the Contractor=s construction operations or an increase in the spread rate of stabilizing material, if this evaluation indicates the subgrade is not firm and unyielding or does not have the specified LBR value. After the Engineer approves the trial section, no further acceptance LBR testing is required.

The Engineer may waive construction of a trial section in areas to be stabilized where traffic conditions or the configuration would cause a hazardous or impractical situation.

161-5 Preparation of Roadbed.

Prior to the beginning of stabilizing operations, construct the area to be stabilized to an elevation such that, upon completion of stabilizing operations, the completed stabilized subgrade will conform to the lines, grades, and cross-section shown in the plans. Prior to spreading any additive stabilizing material, bring the surface of the roadbed to a plane approximately parallel to the plane of the proposed finished surface. Dispose of any surplus excavated materials resulting from this work as specified in 120-5.

As an exception to the above, if the typical section is new construction and does not include curb and gutter construction, the Engineer will authorize raising the finished elevation of the stabilized subgrade 1 inch [25 mm] to allow for excess bulking caused by incorporation of commercial material. Raise the overlaying base and pavement course a corresponding distance. The pay quantity for Embankment will not be adjusted when the finished elevation of the completed roadway is raised.

161-6 Incorporation of Stabilizing Material and Mixing-In.

161-6.1 Spreading Stabilizing Material: Place and spread the stabilizing material uniformly at the rate determined in 161-3. Use mechanical spreaders, except in those areas where the Engineer deems that it is not practical.

Take five measurements of the depth of the stabilizing material at random locations within each 200 foot [60 m] section of Stabilized Subgrade, if the average of these five measurements is less than the rate of spread as determined in accordance with 161-3. Spread additional stabilizing material over the entire limits of that section and remeasure the depth. The Engineer may verify the depth measurements of any 200 foot [60 m] section.

161-6.2 Mixing: After the Engineer has approved the spreading of the stabilizing material, thoroughly mix the material with the roadbed soil using rotary tillers or other approved equipment which is capable of achieving a satisfactory blend. Cross blading and rolling of the mixture using graders will not be considered satisfactory. Mix the material as soon as practical, but not later than two working days after the material is placed on the road. Thoroughly mix the area throughout the entire depth and width of the stabilized subgrade as shown in the plans.

161-6.3 Maximum Particle Size and Plasticity of Mixed Materials: At completion of the mixing, ensure that the gradation of the material within the limits of the area being stabilized is such that 97% will pass a 32 inch [90 mm] screen and does not have a plasticity index greater that eight or liquid limit greater than 30. Clay balls or lumps are aggregation of clay size particles (2 microns or less) [(2Φm or less)] and cannot be considered as individual particle sizes. Remove materials not meeting the plasticity requirements from the stabilized area. Materials not meeting the gradation requirements may be broken down or removed from the stabilized area.

161-6.4 Depth of Mixing Stabilizing Material: Immediately after mixing has been completed and prior to beginning of compaction, take nine measurements of the depth to which the subgrade has been mixed at random locations within each 200 foot [60 m] section of the stabilized subgrade. The Engineer may verify the depth of mixing for any 200 foot [60 m] section.

The following tolerances over or under the specified depth are allowed:

Plan Depth	Tolerance
8 inches [200 mm] or less	1 inch [25 mm]
over 8 inches [200 mm]	2 inches [50 mm]

When any measured depth of mixing within a 200 foot [60 m] section is less than the plan depth minus the tolerance specified above, remix the stabilized subgrade over the entire section and take a new set of depth measurements, randomly located, to verify that the mixing criteria has been accomplished.

When any measured depth of mixing within a 200 foot [60 m] section exceeds the plan depth plus the tolerance specified above, add 1 inch [25 mm], loose measure, of stabilizing material for each 1 inch [25 mm] of mixing depth in excess of the allowable depth (but in no case less than 1 inch [25 mm] of material) over the entire section and mix this additional stabilizing material into the top 6 inches [150 mm] of the subgrade. Compensation will not be made for any work or material required to correct the above deficiency.

161-7 Plant Mixing.

Proportioning of stabilizing materials with roadbed soil and mixing operations may be accomplished by the central plant-mixed method. Central plant mixing shall achieve a uniform blend of the materials meeting maximum particle size as specified in 161-6.3 and containing the proper amount of water for compaction.

Submit to the Engineer for approval prior to beginning this operation, a description of the equipment and technique to be used.

Spread the premixed subgrade material with a mechanical material spreader, except in areas where the Engineer deems that it is not practicable. Use other satisfactory means of achieving uniform spreading in such cases. Take thickness measurements within each 200 foot [60 m] section of the subgrade and take appropriate corrective action if the thickness of the subgrade fails to meet the plan depth within the tolerances set out in 161-6.4.

161-8 Compaction.

When mixing operations are completed and accepted, shape and compact the subgrade. The minimum density acceptable at any location within the limits of the subgrade will be 98% of the maximum density in accordance with FM 5-521. In areas to be grassed, density in the upper 6 inches [150 mm] as specified above is not required.

Compact the material at a moisture content permitting the specified density to be attained.

161-9 Finish Grading.

Shape the completed stabilized subgrade to conform with the finished lines, grades and cross-section indicated in the plans. Check the subgrade by use of elevation stakes, or other means approved by the Engineer.

Surplus excavated materials from stabilizing operations may be disposed of under shoulders that are to be grassed or sodded.

161-10 Requirements for Condition of Completed Subgrade.

Ensure that the subgrade is firm and substantially unyielding to the extent that it will support construction equipment.

161-11 Maintenance of Completed Subgrade.

Maintain the completed subgrade free from ruts, depressions and damage resulting from the hauling or handling of materials, equipment, tools, etc. Maintain the required density of the subgrade until subsequent base is in place. Work required for recompaction will be at no expense to the Department. The Engineer may confirm that the required density is being maintained at any time.

161-12 Method of Measurement.

The quantity to be paid for will be the plan quantity, in square yards [square meters] of Stabilized Subgrade, completed and accepted, and the volume, in cubic yards [cubic meters] of commercial stabilizing material, applied on the road and accepted.

The quantity of Commercial Stabilized Material will be determined by measurement in a loose condition in truck bodies at the point of proportioning with roadbed soil. Level the material in the truck bodies to facilitate measurement.

161-13 Basis of Payment.

Prices and payments will be full compensation for all the work specified in this Section, including laboratory testing, furnishing and hauling, placing and spreading all stabilizing material, mixing, compacting, finishing and maintaining the subgrade below the finished grade of the stabilizing material and the disposal of surplus excavation and all quality control measurements required.

No additional compensation will be made for work or material which may be required to correct over or under depth mixing as specified in 161-6.4.

Payment will be made under:

Item No. 161-70 - Predesigned Stabilized Subgrade - per square yard.
Item No. 2161-70 - Predesigned Stabilized Subgrade - per square meter.
Item No. 160- 3 - Commercial Stabilizing Material - per cubic yard.
Item No. 2160- 3 - Commercial Stabilizing Material - per cubic meter.

SECTION 162

FINISH SOIL LAYER

162-1 Description.

Prepare a 6 inch [150 mm] thick layer of mixed material favorable to grass growth over areas of the project which are to be seeded, seeded and mulched, or planted, by applying and mixing in a muck blanket, topsoil, compost or commercially available supplements.

162-2 Materials.

Meet the requirements of Section 987.

162-3 Ownership of Surplus Materials.

The Department will retain ownership of all materials suitable for construction of the finish soil layer until the final job requirements have been fulfilled. Unless otherwise provided by the Contract Documents, take ownership of any surplus materials then remaining and not needed for job requirements and dispose of, outside the right-of-way, to the Engineer=s satisfaction.

In urban or other areas where temporary storage of apparent surplus materials within the right-of-way may be impracticable, the materials may be stockpiled outside the right-of-way in areas provided by the Contractor until needed on the project or declared surplus. With the Engineer=s written approval, the Contractor may dispose of excess material with the stipulation that any portion required to fulfill job requirements will be replaced with equally suitable material at no cost to the Department.

No extra compensation is allowed for any rehandling involved under the provisions of this Subarticle.

162-4 Construction Methods.

162-4.1 Preparation of Areas: Prior to the beginning of the work, construct the surface of the earthwork to such lines and elevations that will provide a surface conforming to the plan lines and elevations upon completion of the finish soil operations. Leave the surface of the earthwork in a roughened and loose condition.

Prevent contamination of the finish soil layer material by other construction operations. Remove any contaminated material and replace at no cost to the Department.

162-4.2 Spreading and Mixing: Uniformly spread the necessary material over areas to receive treatment.

After spreading, mix the material with the underlying soil to a combined depth of 6 inches [150 mm]. Continue mixing to provide a uniform finish soil layer true to line and grade. Correct any slippage of this material at no cost to the Department.

Immediately after spreading and mixing, the top 6 inches [150 mm] of the mixed material will be sampled and tested for organic matter content in accordance with AASHTO T 267 by the Engineer. The samples will be taken at a minimum of three samples per mile [kilometer]. On projects or areas less than 3 mile [400 m] in length, one sample per 3 mile [400 m] is sufficient. When the source of added material changes, an additional sample will be required. Test results will be averaged for each shoulder mile [kilometer] or increment thereof to determine specification compliance. Out of tolerance individual tests to a minimum of 1% organic content will be allowed.

162-5 Method of Measurement.

The quantity to be paid for will be the area, in square yards [square meters], for the finish soil layer meeting the requirements of 162-2, completed and accepted.

162-6 Basis of Payment.

Prices and payments will be full compensation for completing all work specified in this Section, including hauling any material from the project right-of-way, designated borrow areas, other sources as may be provided by the Contractor, or any combination of the above; furnishing any materials required to meet the required organic levels; and mixing, grading, and/or leveling as required to provide a relatively uniform homogeneous mix throughout the 6 inches [150 mm] within the prescribed lines and grades.

Payment will be made under:

Item No. 162- 3- Finish Soil Layer - per square yard.
Item No. 2162- 3- Finish Soil Layer - per square meter.

SECTION 165

LIME-TREATED SUBGRADE

165-1 Description.

Construct a lime-treated subgrade composed of designated soils obtained from the roadway or borrow areas and hydrated lime.

165-2 Materials.

For hydrated lime meet the requirements of ASTM C 207, for Type N, except that the requirements for popping, pitting, and water retention will not apply. The Contractor may use hydrated lime produced as a byproduct when tested and approved, provided the calcium oxide content is at least 80% and provided the lime meets the other requirements for ASTM C 207, Type N, as amended above. Ensure that the residue retained on a No. 30 [600 μm] sieve is not more than 1%, and ensure that the residue retained on a No. 200 [75 μm] sieve is not more than 15%. If using bulk hydrated lime, provide equipment for handling, weighing, and spreading, as approved by the Engineer.

Apply lime at the rate designated by the Engineer after sampling and testing of the soil. In general, the Engineer will require a period of approximately two weeks, subsequent to the time that the Contractor has substantially constructed a particular section of subgrade to grade, for such testing.

Make hydrated lime slurry by blending water and lime in proportions of 2 to 3 pounds [2 to 3 kilograms] or more of water per pound [kilogram] of hydrated lime. Blend the materials using a pugmill or compressed air or circulating pumps as stirring devices. Blend during or prior to loading the truck tank.

165-3 Construction Methods.

165-3.1 Preparation: Prior to beginning lime treatment, construct the subgrade to an elevation which will provide a subgrade surface conforming to the Contract Documents upon completion of the lime treatment.

Remove all roots, sticks, or other deleterious material from the subgrade.

Prior to adding lime, scarify the surface of the subgrade as directed. Apply water as required when soil conditions are such that prewetting will be beneficial to pulverization and mixing. Construct windrows along each side of the area to be treated to prevent loss of lime. Cut drain openings through the windrows at sufficient intervals to prevent ponding of water on the subgrade, and move the windrowed material, when necessary, to permit the subgrade to dry.

The Contractor may also treat some of the areas to receive lime treatment with cement, in accordance with Section 170. Complete the lime treatment operations a minimum of seven days prior to spreading the cement.

165-3.2 Application of Lime: Uniformly spread the lime either dry or as a slurry.

If adding the lime as a slurry, blade thin layers of the lime and soil to the side as each increment of slurry is added by sprinkling, until windrows are formed. After applying the total quantity of lime and blading the windrows back across the road, the Contractor may begin mixing and compaction.

If using dry hydrated lime, apply it through the use of mechanical spreaders which are able to provide a uniform distribution of lime across the full width of the subgrade being treated or by other methods approved by the Engineer.

Whether applying the lime in the dry or slurry condition, take proper precautions to protect the workers' eyes and bodies while working with lime.

Do not allow the quantity of lime spread on any section to vary more than ∀5% from the quantity ordered. The Engineer will not include lime in excess of the allowable plus tolerance in the measurement for payment. When the quantity spread is deficient by more than the allowable minus tolerance, the Engineer will require an additional application to correct such deficiency.

165-3.3 Mixing: Immediately after spreading the lime over a section to be processed, scarify the soil over the full width and to the depth required. Then, apply water in liberal amounts as necessary, and incorporate the lime and water uniformly into the soil to be treated by means of a rotary type mixer or other equipment which may be approved by the Engineer. Control the addition of water prior to and in conjunction with mixing such that the moisture content does not exceed the optimum moisture content of the mixture by more than 5%. The Contractor may supplement a rotary mixer with disk harrows or other approved equipment.

Except as provided hereinafter, continue mixing and applying water until all material will pass a 1 inch [25.0 mm] screen and at least 60% will pass the 3 inch [6.3 mm] sieve. Control scarifying and mixing to provide uniform depth within 0.1 foot [30 mm] of the depth specified, and maintain the required elevation and cross-section.

With certain types of soils, if so directed by the Engineer, continue mixing and applying water until all material will pass a 2 inch [50 mm] sieve, then cease operations for a period of seven days to allow the lime and soil to react. Roll the surface of the subgrade to prevent the entrance of air and water to the treatment area. After the seven day period has elapsed, continue mixing and applying water as necessary until all material will pass a 1 inch [25.0 mm] sieve and at least 60% will pass a 3 inch [6.3 mm] sieve.

In the event that the operations must be suspended prior to completion, continue mixing and applying water at least until all material will pass a 3 inch [75 mm] screen. After completing this preliminary mixing, compact these sections lightly, and shape them to provide for runoff of surface water until final mixing can be completed.

165-3.4 Compaction: Immediately after mixing the full depth and width receiving lime treatment, begin compacting to not less than 100% of the maximum density as determined by AASHTO T 99. Prior to and during compaction operations, the Contractor may have to perform shaping to obtain uniform compaction and required cross-section and elevation. Do not compact areas which are to subsequently receive cement treatment as part of the work under this Section.

165-3.5 Finishing: After compaction, shape the surface to the required lines, grades, and cross-sections. In order to prevent the formation of surface laminations, lightly scarify the surface with a spring tooth harrow, spike drag, or other approved device, to uniformly loosen the surface. Then, seal the surface by rolling with a traffic roller. Do not finish areas which are to subsequently receive cement treatment as a part of the work under this Section. Seal the surface of such areas by rolling in order to minimize entrance of air and water into the lime-treated material.

165-3.6 Protection and Curing: Protect the finished treated subgrade from rapid drying, for seven days, by sprinkling with water as often as is necessary to prevent drying of the surface of the lime-treated subgrade, by priming at no expense to the Department, or by application of the overlying base course. Do not allow any vehicles or operations which will distort the surface to the extent that proper curing will be affected on the treated subgrade during the curing period.

165-4 Thickness.

During various stages of construction, dig test holes in the mixture to determine the thickness.

Where the deficiency in treatment thickness is (1) in excess of 2 inch [13 mm] for plan thickness up to 6 inches [150 mm]; or (2) in excess of 1 inch [25 mm] for plan thicknesses over 6 inches [150 mm], reprocess the treatment in the area of deficiency at no expense to the Department.

165-5 Method of Measurement.

165-5.1 Lime-Treated Subgrade: The quantity to be paid for will be the area, in square yards [square meters], of lime-treated subgrade, completed and accepted.

165-5.2 Hydrated Lime: The quantity to be paid for will be the weight, in tons [metric tons], of the hydrated lime authorized and used in the operation. The weight will be the actual quantity incorporated into the work except that lime spread on any section greater than 5% in excess of the authorized quantity will not be included in the measurement. If using sacked lime, the measurement for unbroken sacks will be taken as the net weight as packed as specified by the manufacturer.

165-6 Basis of Payment.

165-6.1 Lime-Treated Subgrade: Price and payment will be full compensation for all work specified in this Section, including all preparation of the subgrade; furnishing and applying water; scarifying; mixing and remixing the soil (including 2-stage mixing as specified in the third paragraph of 165-3.3), lime, and water; shaping and compacting the mixture; reprocessing of deficient sections; all protection and curing of the completed subgrade; and all equipment, tools, labor, and incidentals necessary to complete the work, but not including the costs of furnishing the hydrated lime.

165-6.2 Hydrated Lime: Price and payment will be full compensation for furnishing, hauling, and spreading the lime.

165-6.3 Payment Items: Payment will be made under:

Item No. 165- 70- Lime-Treated Subgrade - per square yard.
Item No. 2165- 70- Lime-Treated Subgrade - per square meter.
Item No. 165- 71- Hydrated Lime - per ton.
Item No. 2165- 71- Hydrated Lime - per metric ton.

SECTION 170

CEMENT-TREATED SUBGRADE

170-1 Description.

Construct a cement-treated subgrade, composed of a combination of soil and portland cement, uniformly mixed, moistened, shaped, compacted, finished, and cured.

170-2 Materials.

Meet the following requirements:

Cut-Back Asphalt, Grade RC-70 (Alternate for curing).................... 916-2
Emulsified Asphalt, Grade SS-1 (Alternate for curing) 916-4
Portland Cement, Type I ....Section 921
Water ....Section 923

Use soil for this cement-treated subgrade consisting of the natural material in the roadway or select soil placed in the roadbed, as shown in the plans, or a combination of these materials proportioned as directed. Do not use soil containing gravel or stone retained on a 2 inch [50 mm] sieve or more than 45% retained on a No. 4 [4.75 mm] sieve.

170-3 Composition and Proportioning.

Apply portland cement at the rate determined by the Engineer for the particular soil used. Do not start any processing of the soil-cement mixture until all tests of the soil to be used to construct the subgrade are complete and the specified rate of application of portland cement for the particular soil has been determined. The Engineer will require a period of approximately three weeks, subsequent to the time that the Contractor substantially completes a particular section of roadbed to grade, for such testing. The Engineer will specify the rate of application in terms of either pounds [kilograms] of portland cement per square yard [square meter] of the area to be mixed, or pounds [kilograms] of cement per cubic yard [cubic meter] of soil-cement mixture.

170-4 Preparation.

Prior to beginning subgrade treatment, construct the roadbed to an elevation which will provide a subgrade conforming to the Contract Documents upon completion of the cement treatment. Ensure that the roadbed is firm enough to support the equipment used in the cement treatment without appreciable distortion or displacement. Correct soft or yielding areas prior to mixing.

When the cement-treated subgrade is constructed of central-plant-mixed material, ensure that the underlying roadbed is moist to a depth of at least 1 inch [25 mm] at the time the material is spread.

170-5 Construction Methods.

170-5.1 General: If cement treatment of the subgrade is to be accomplished in conjunction with lime treatment, do not start spreading cement in an area until a minimum of seven days has elapsed from completion of the lime treatment operation for that area.

Mix the soil, cement, and water either by the mixed-in-place or the central-plant-mix method.

Ensure that the percentage of moisture in the soil at the time of cement application does not exceed the quantity that will permit a uniform and intimate mixture of soil and cement during mixing operations. For clay soils, ensure that the moisture content does not exceed the optimum moisture content for the soil-cement mixture. For sandy soils, ensure that the moisture content is within 2% above or below the optimum moisture content.

With certain types of soils, the Engineer may designate a moisture range other than those specified above.

During seasons of probability of freezing temperatures, do not make or place any cement or soil-cement mixture when conditions indicate that the temperature may fall below 35EF [2EC] within 24 hours. Also, do not spread any material unless the temperature is at least 40EF [4EC] in the shade and rising.

At completion of moist-mixing, pulverize the soil so that 100% passes a 1 inch [25.0 mm] sieve and a minimum of 80% passes a No. 4 [4.75 mm] sieve, exclusive of gravel and stone retained on the No. 4 [4.75 mm] sieve.

Perform the operations as specified in this Article and in 170-6 and 170-7, continuously, and complete them within a period of four hours, starting from the time mixing commences.

170-5.2 Mixed-in-Place: Where feasible, process the entire width of the subgrade as a single operation. Spread the specified quantity of cement uniformly on the subgrade at the required rate of application, by means of an approved method. If spread cement becomes displaced, replace it before mixing begins.

After applying the cement, begin mixing within 30 minutes. Initially mix the soil and cement until the cement has sufficiently blended with the soil to prevent formation of cement balls. Then, add water as necessary, and remix the soil-cement mixture.

The Contractor may process the soil-cement mixture to full depth in one course, provided that he can satisfactorily distribute the cement and water and obtain the specified density of the subgrade. If not, the Contractor shall perform construction in courses of such thickness to obtain satisfactory results. Make provisions to achieve adequate bonding between courses.

Immediately after mixing the soil and cement, add any necessary additional water. If the moisture content exceeds that specified, manipulate the soil-cement mixture by remixing or blading, as required to reduce the moisture content to within the specified range. Avoid excessive concentrations of water. During the time of application of water and after applying all mixing water, continue mixing until a uniform and intimate mixture of soil, cement, and water has been obtained.

As an alternative to the above described procedure, the Contractor may use an approved machine that will blend the cement and the soil, and then add and mix-in any necessary additional water.

170-5.3 Central Plant Mix: Mix the soil, cement, and water in a pugmill of either the batch or continuous-flow type. Use a plant equipped with feeding and metering devices which will accurately proportion the soil, cement, and water in the quantities specified. Mix soil and cement sufficiently to prevent cement balls from forming when adding water. Continue mixing until an intimate and uniform mixture of soil, cement and water is obtained.

Haul the mixture to the roadway in trucks equipped with protective covers. Place the mixture on the moistened subgrade in a uniform layer with an approved spreader. Do not allow more than 30 minutes to elapse between the placement of soil-cement in adjacent passes of the spreader at any location. When portland cement concrete pavement is to be constructed on the cement-treated subgrade, plan operations such that the joint between adjacent passes of the spreader will be offset a minimum of 12 inches [300 mm] from any proposed longitudinal joint in the concrete pavement. Provide a layer of soil-cement uniform in thickness and surface contour, and in such quantity that the completed subgrade will conform to the required grade and cross-section. Do not dump the mixture in piles or windrows upon the grade.

170-6 Compaction.

Begin compaction of the soil-cement immediately after completing mixing. Do not allow more than 60 minutes to elapse between the last pass of moist-mixing and the start of compaction of the soil-cement mixture at a particular location.

At the start of the final compaction operation, ensure that the percentage of moisture in the mixture and in unpulverized soil lumps, based on dry weights, is not more than 2% above or below the optimum moisture content.

The Engineer will determine the optimum moisture content and maximum density in the field by the methods prescribed in AASHTO T 134 on representative samples of the soil-cement mixture he obtains from the area being processed.

Uniformly compact the loose mixture to not less than 95% of the maximum density as determined by AASHTO T 180.

170-7 Finishing.

After compaction, shape the surface of the soil-cement to the required lines, grades, and cross-section. Check the subgrade by the use of elevation stakes or other means approved by the Engineer. In all cases where soil-cement mixture is added to any portion of the surface, lightly scarify the surface with a spring tooth harrow, spike drag, or other approved device, such that the surface is uniformly loosened prior to the addition of material and prior to initial set of the soil-cement mixture. Then, compact the resulting surface to the specified density. Continue rolling until all rutting ceases and until the entire subgrade meets the density requirements as provided in 170-6. With certain granular soils, the Engineer may determine that minor tire marks are acceptable.

Maintain the moisture content of the surface material at not less than 2% below its specified optimum moisture content during finishing operations. Perform surface compaction and finishing in such a manner as to produce a smooth, dense surface, free of compaction planes, cracks, ridges, or loose material.

If the subgrade is to be trimmed to final elevation with an automatically controlled grading machine, ensure that the surface of the subgrade immediately prior to such trimming operation is parallel to, and not in excess of 2 inch [13 mm] above, the finished elevation of the subgrade.

170-8 Construction Joints.

At the end of each day's construction, make a straight transverse construction joint by cutting back into the completed work to form a true vertical face. Locate the construction joint so as to exclude all of that part of the subgrade at the end of the run which does not meet the requirements of this Section or the typical section.

170-9 Curing.

During the period when finishing and surface correction operations are being accomplished, keep the surface of the cement-treated subgrade continuously moist by sprinkling as necessary. Subsequent to this period, protect the finished treated subgrade from drying, for seven days, by application of either (1) cut-back asphalt, Grade RC-70, applied at the rate of 0.15 to 0.20 gal/yd^2 [0.68 to 0.91 L/m^2]; or (2) a mixture containing equal parts of emulsified asphalt, Grade SS-1, and water, applied at the rate of 0.2 to 0.25 gal/yd^2 [0.91 to 1.13 L/m^2]. The Engineer will specify the actual rate of application that provides complete coverage without excessive run-off. At the time of applying the bituminous material, ensure that the soil-cement surface is dense and free of loose and extraneous material, and contains sufficient moisture to prevent excessive penetration of the bituminous material.

Should it be necessary to allow construction equipment or other traffic to use the completed subgrade before the bituminous material has cured sufficiently to prevent pickup or displacement, apply clean sand to the bituminous material at a rate of approximately 10 lb/yd^2 [5.5 kg/m^2].

170-10 Opening to Traffic.

Do not place traffic on the cement-treated subgrade subsequent to completion of the finishing operations as specified in 170-7 for a period of seven days. As an exception to this requirement, the Engineer will allow the equipment necessary for correction of surface irregularities and application of water and curing materials on the subgrade, provided that the tire contact pressures of such equipment do not exceed 45 psi [310 kPa]. After the seven day curing period, the Contractor may open the subgrade to traffic, provided that the soil-cement either is protected or has hardened sufficiently to prevent marring or distorting of the surface by equipment or traffic.

170-11 Maintenance.

Maintain the completed subgrade to a true and satisfactory surface until placing the overlying course of materials. If repairs or patching is necessary, extend them to the full depth of the subgrade and perform them in a manner that will ensure restoration of a uniform subgrade meeting the requirements of this Section. Do not make repairs by adding a thin layer of soil-cement to the completed work. The Contractor may make full depth repairs to small or minor areas, such as to manholes, or inlets with Class I Concrete.

170-12 Thickness.

During various stages of construction, dig test holes in the mixture to determine the thickness. After completing the subgrade, dig or drill test holes, and determine the thickness of the subgrade from measurements made in these test holes.

Where the deficiency in subgrade thickness is (1) in excess of 2 inch [13 mm] for a subgrade up to 6 inches [150 mm] specified thickness, or (2) in excess of 1 inch [25 mm] for subgrade thicknesses over 6 inches [150 mm] specified thickness, remove the subgrade in the area of deficiency, and replace it with subgrade of the specified thickness, at no expense to the Department.

As an exception to the above, if the deficiency does not impair the required strength of the subgrade, in the opinion of the Engineer, the Contractor may leave the deficient area in place.

170-13 Method of Measurement.

170-13.1 Cement-Treated Subgrade: The quantity to be paid for will be the area, in square yards [square meters], completed and accepted.

170-13.2 Cement: The quantity to be paid for will be the weight, in tons [metric tons], of cement authorized and used in the operation.

170-14 Basis of Payment.

170-14.1 Cement-Treated Subgrade: Price and payment will be full compensation for all work specified in this Section, including pulverizing and mixing the soil and cement; furnishing, hauling, and applying the water and mixing the water with the soil-cement mixture; compacting the mixture; surface finishing; furnishing and placing curing materials; and removing and replacing materials deficient in density or thickness, as provided for in 170-7, 170-11, and 170-12.

170-14.2 Cement: Price and payment will be full compensation for furnishing, hauling, placing, and spreading the cement.

170-14.3 General: No separate payment will be made for bituminous material applied as a curing membrane. No additional compensation will be allowed for the labor and materials used in reconstructing defective and deficient thickness base as provided in 170-7, 170-11, and 170-12.

No payment will be made for the treatment of the subgrade or the theoretical amount of cement used in areas of deficient thickness left in place without correction.

170-14.4 Payment Items: Payment will be made under:

Item No. 170- 1- Cement-Treated Subgrade - per square yard.
Item No. 2170- 1- Cement-Treated Subgrade - per square meter.
Item No. 170- 2- Cement - per ton.
Item No. 2170- 2- Cement - per metric ton.

SECTION 175

CRACKING AND RESEATING EXISTING CONCRETE PAVEMENT

175-1 Description.

Perform controlled cracking of concrete pavement and reseating of the cracked slabs, by rolling, tamping, etc., on the underlying subgrade to provide a firm base for asphaltic concrete surfacing.

175-2 Equipment.

175-2.1 For Cracking: Provide pneumatic or gravity-type breakers, or other specifically approved equipment that ensures controlled cracking to the size and extent of uniformity, etc., specified. Control the fall of gravity-type breakers by leads so that the fall will be straight and vertical. Use hammers for both pneumatic and gravity-type breakers of a type that will crack the concrete cleanly and not punch or unnecessarily shatter the concrete.

175-2.2 For Reseating: Provide vibratory compacting equipment or traffic rollers. Use traffic rollers that weigh at least 15 tons [14 metric tons].

175-3 Construction Requirements.

175-3.1 Protection of New Construction and Adjacent Structures: Perform cracking and reseating work prior to beginning all new construction which this work might endanger or disturb. Perform cracking and reseating in a manner that will not damage any existing structures which are to remain, and repair any damage to such structures that this work causes by this work at no expense to the Department.

175-3.2 Cracking and Seating: For the cracked slabs, make clean fractures, as near vertical as practicable. Do not punch the pieces into the subgrade, but firmly seat them thereon, to as uniform a contour as is practicable.

175-3.3 Special Requirements for Asphaltic-Surfaced Pavement: Where the existing concrete pavement is covered with an asphaltic surface, remove the asphaltic surfacing (after the cracking operation) on test areas approximately 10 by 10 feet [3 by 3 m], at locations selected by the Engineer, in order to determine if the required results are being obtained in the cracking operations. Prepare at least one such test area for each day's operation, and prepare additional areas if deemed necessary by the Engineer.

175-3.4 Dimensions of Slabs: Ensure that the cracked slabs have no dimension greater than 3 feet [1 m]. In the event that the required results in the cracking are not being obtained, adjust the spacing of blows or the height of drop of the blows as necessary to obtain the required results with the equipment being used.

175-4 Method of Measurement.

The quantity to be paid for will be the plan quantity, in square yards [square meters], of existing concrete pavement acceptably cracked and reseated on the subgrade.

175-5 Basis of Payment.

Price and payment will be full compensation for performing and completing all work specified in this Section.

Payment will be made under:

Item No. 175-1 - Reseating Concrete Pavement - per square yard.
Item No. 2175-1 - Reseating Concrete Pavement - per square meter.

BASE COURSES

SECTION 200

LIMEROCK BASE

200-1 Description.

Construct a base composed of limerock.

200-2 Materials.

Meet the requirements of Section 911. The Contractor may use more than one source of limerock on a single Contract provided that a single source is used throughout the entire width and depth of a section of base. Obtain approval from the Engineer before placing material from more than one source. Place material to ensure total thickness single source integrity at any station location of the base. Intermittent placement or ABlending≅ of sources is not permitted. Limerock may be referred to hereinafter as "rock".

Do not use any of the existing limerock base that is removed to construct the new limerock base.

200-3 Equipment.

Use mechanical rock spreaders, equipped with a device that strikes off the rock uniformly to laying thickness, capable of producing even distribution. For crossovers, intersections and ramp areas; roadway widths of 20 feet [6 m] or less; the main roadway area when forms are used and any other areas where the use of a mechanical spreader is not practicable; the Contractor may spread the rock using bulldozers or blade graders.

200-4 Transporting Limerock.

Transport the limerock to its point of use, over rock previously placed, if practicable, and dump it on the end of the preceding spread. Hauling and dumping on the subgrade will be permitted only when, in the Engineer's opinion, these operations will not be detrimental to the subgrade.

200-5 Spreading Limerock.

200-5.1 Method of Spreading: Spread the rock uniformly. Remove all segregated areas of fine or coarse rock and replace them with properly graded rock.

200-5.2 Number of Courses: When the specified compacted thickness of the base is greater than 6 inches [150 mm], construct the base in multiple courses of equal thickness. Individual courses shall not be less than 3 inches [75 mm]. The thickness of the first course may be increased to bear the weight of the construction equipment without disturbing the subgrade.

If, through field tests, the Contractor can demonstrate that the compaction equipment can achieve density for the full depth of a thicker lift, and if approved by the Engineer, the base may be constructed in successive courses of not more than 8 inches [200 mm] compacted thickness.

The Engineer=s approval will be based on results of a test section constructed using the Contractor=s specified compactive effort. Approval requires the compactive effort pass a minimum of five density tests with no failing tests. Construct a test section between 300 feet [90 m] and 1,000 feet [300 m] in length, full width. At each test site, the bottom 6 inches [150 mm] must be tested and pass. Remove the materials above the bottom 6 inches [150 mm], at no expense to the Department. The minimum density required on the thicker lift will be the average of the five results obtained on the thick lift in the passing test section. Maintain the exposed surface as close to Aundisturbed≅ as possible; no further compaction will be permitted during the test preparation. If unable to achieve the required density, remove and replace or repair the test section to comply with the specifications at no additional expense to the Department.

Once approved, a change in the source of base material will require the construction of a new test section. The compactive effort will not be allowed to change once the test section is approved. The Engineer will periodically verify the density of the bottom 6 inches [150 mm] during thick lift operations.

The Department may terminate the use of thick lift construction and have the Contractor revert to the 6 inch [150 mm] maximum lift thickness if satisfactory results are not being achieved.

200-5.3 Limerock Base for Shoulder Pavement: Unless otherwise permitted, complete all limerock base shoulder construction at any particular location before placing the final course of pavement on the traveled roadway. When dumping material for the construction of a limerock base on the shoulders, do not allow material capable of scarring or contaminating the pavement surface on the adjacent pavement. Immediately sweep off any limerock material that is deposited on the surface course.

200-6 Compacting and Finishing Base.

200-6.1 General:

200-6.1.1 Single Course Base: After spreading, scarify the entire surface, then shape the base to produce the required grade and cross-section after compaction.

200-6.1.2 Multiple Course Base: Clean the first course of foreign material, then blade and bring it to a surface cross-section approximately parallel to the finished base. Before spreading any material for the upper courses, allow the Engineer to make density tests for the lower courses to determine that the required compaction has been obtained. After spreading the material for the top course, finish and shape its surface to produce the required grade and cross-section, free of scabs and laminations, after compaction.

200-6.2 Moisture Content: When the material does not have the proper moisture content to ensure the required density, wet or dry it as required. When adding water, uniformly mix it in by disking to the full depth of the course that is being compacted. During wetting or drying operations, manipulate, as a unit, the entire width and depth of the course that is being compacted.

200-6.3 Density Requirements: When proper moisture conditions are attained, compact the material to not less than 98% of maximum density determined by AASHTO T 180.

Compact the limerock base for shoulder pavement to not less than 95% of the maximum density determined under AASHTO T 180.

200-6.4 Density Tests: The Engineer will perform at least three density determinations on each day's final compaction operations on each course, and at more frequent intervals, if deemed necessary.

During final compacting operations, blade any areas necessary to obtain the true grade and cross-section before making the Engineer the density tests on the finished base.

200-6.5 Correction of Defects:

200-6.5.1 Contamination of Base Material: If, at any time, the subgrade material becomes mixed with the base course material, dig out and remove the mixture, and reshape and compact the subgrade. Then replace the materials removed with clean base material, and shape and compact as specified above. Perform this work at no expense to the Department.

200-6.5.2 Cracks and Checks: If cracks or checks appear in the base, either before or after priming, which, in the opinion of the Engineer, would impair the structural efficiency of the base, remove the cracks or checks by rescarifying, reshaping, adding base material where necessary, and recompacting.

200-6.6 Compaction of Widening Strips: Where base construction consists of widening strips and the trench width is not sufficient to permit use of standard base compaction equipment, compact the base using vibratory compactors, trench rollers or other special equipment which will achieve the density requirements specified herein.

When multiple course base construction is required, compact each course prior to spreading material for the overlaying course.

200-7 Testing Surface.

Check the finished surface of the base course with a template cut to the required crown and with a 15 foot [4.572 m] straightedge laid parallel to the centerline of the road. Correct all irregularities greater than 3 inch [6 mm] to the satisfaction of the Engineer by scarifying and removing or adding rock as required, and recompact the entire area as specified hereinbefore.

200-8 Priming and Maintaining.

200-8.1 Priming: Apply the prime coat only when the base meets the specified density requirements and when the moisture content in the top half of the base does not exceed 90% of the optimum moisture of the base material. At the time of priming, ensure that the base is firm, unyielding and in such condition that no undue distortion will occur.

200-8.2 Maintaining: Maintain the true crown and template, with no rutting or other distortion, while applying the surface course.

200-9 Thickness Requirements.

Meet the requirements of 285-6.

200-10 Calculations for Average Thickness of Base.

Calculations for determining the average thickness of base will be made in accordance with 285-7.

200-11 Method of Measurement.

200-11.1 General: The quantity to be paid for will be the plan quantity, adjusted as specified below.

200-11.2 Authorized Normal Thickness Base: The surface area of authorized normal thickness base to be adjusted will be the plan quantity as specified above, omitting any areas not allowed for payment under the provisions of 200-9 and omitting areas which are to be included for payment under 200-11.3. The adjustment shall be made by adding or deducting, as appropriate, the area of base represented by the difference between the calculated average thickness, determined as provided in 200-10, and the specified normal thickness, converted to equivalent square yards [square meters] of normal thickness base.

200-11.3 Authorized Variable Thickness Base: Where the base is constructed to a compacted thickness other than the normal thickness as shown on the typical section in the plans, as specified on the plans or ordered by the Engineer for providing additional depths at culverts or bridges, or for providing transitions to connecting pavements, the volume of such authorized variable thickness compacted base will be calculated from authorized lines and grades, or by other methods selected by the Engineer, converted to equivalent square yards [square meters] of normal thickness base for payment.

200-12 Basis of Payment.

Price and payment will be full compensation for all the work specified in this Section, including correcting all defective surface and deficient thickness, removing cracks and checks as provided in 200-6.5.2, and the additional limerock required for crack elimination.

Prime coat will be paid for under Section 300.

Payment shall be made under:

Item No. 285-7- Optional Base - per square yard.
Item No. 2285-7- Optional Base - per square meter.

SECTION 204

GRADED AGGREGATE BASE

204-1 Description.

Construct a base course composed of graded aggregate.

204-2 Materials.

Use graded aggregate material, produced from Department approved sources, which yields a satisfactory mixture meeting all the requirements of these Specifications after it has been crushed and processed as a part of the mining operations.

The Contractor may furnish the material in two sizes of such gradation that, when combined in a central mix plant pugmill, the resultant mixture meets the required specifications.

Use graded aggregate base material of uniform quality throughout, substantially free from vegetable matter, shale, lumps and clay balls, and having a Limerock Bearing Ratio value of not less than 100. Use material retained on the No. 10 [2.00 mm] sieve composed of aggregate meeting the following requirements:

Soundness Loss, Sodium, Sulfate: AASHTO T 104 .... 15%
Percent Wear: AASHTO T 96 (Grading A)
Group 1 Aggregates 45%
Group 2 Aggregates 65%

Group 1: This group of aggregates is composed of limestone, marble, or dolomite.

Group 2: This group of aggregates is composed of granite, gneiss, or quartzite.

Use graded aggregate base material meeting the following gradation:

Sieve Size	Percent by Weight Passing
2 inch [50 mm]	100
12 inch [37.5 mm]	95 to 100
: inch [19.0 mm]	65 to 90
δ inch [9.5 mm]	45 to 75
No. 4 [4.75 mm]	35 to 60
No. 10 [2.00 mm]	25 to 45
No. 50 [300 µm]	5 to 25
No. 200 [75 µm]	0 to 10

For Group 1 aggregates, ensure that the fraction passing the No. 40 [425 µm] sieve has a Plasticity Index (AASHTO T 90) of not more than 4.0 and a Liquid Limit (AASHTO T 89) of not more than 25, and contains not more than 67% of the weight passing the No. 200 [75 µm] sieve.

For Group 2 aggregates, ensure that the material passing the No. 10 [2.00 mm] sieve has a sand equivalent (AASHTO T 176) value of not less than 28.

The Contractor may use graded aggregate of either Group 1 or Group 2, but only use one group on any Contract. (Graded aggregate may be referred to hereinafter as "aggregate".)

204-3 Equipment.

Provide equipment meeting the requirements of 200-3.

204-4 Transporting Aggregate.

Transport aggregate as specified in 200-4.

204-5 Spreading Aggregate.

Spread aggregate as specified in 200-5.

204-6 Compacting and Finishing Base.

204-6.1 General:

204-6.1.1 Single-Course Base: Construct as specified 200-6.1.1.

204-6.1.2 Multiple-Course Base: Construct as specified 200-6.1.2.

204-6.2 Moisture Content: Meet the requirements of 200-6.2.

204-6.3 Density Requirements: After attaining the proper moisture conditions, uniformly compact the material to a density of not less than 100% of the maximum density as determined by AASHTO T 180. Ensure that the minimum density that will be acceptable at any location outside the traveled roadway (such as intersections, crossovers, turnouts, etc.) is 98% of the maximum density.

204-6.4 Density Tests: Meet the requirements of 200-6.4.

204-6.5 Correction of Defects: Meet the requirements of 200-6.5.

204-6.6 Dust Abatement: Minimize the dispersion of dust from the base material during construction and maintenance operations by applying water or other dust control materials.

204-7 Testing Surface.

Test the surface in accordance with the requirements of 200-7.

204-8 Priming and Maintaining.

Meet the requirements of 200-8.

204-9 Thickness Requirements.

Meet the requirements of 285-6.

204-10 Calculations for Average Thickness of Base.

Calculations for determining the average thickness of base will be made in accordance with 285-7.

204-11 Method of Measurement.

204-11.1 General: The quantity to be paid for will be the area, in square yards [square meters], completed and accepted.

204-11.2 Authorized Normal Thickness Base: The surface area of authorized normal thickness base will be calculated as specified in 9-1.3, omitting any areas not allowed for payment under the provisions of 204-9 and omitting areas which are to be included for payment under 204-11.3. The area for payment, of authorized normal thickness base, will be the surface area determined as provided above, adjusted by adding or deducting, as appropriate, the area of base represented by the difference between the calculated average thickness, determined as provided in 204-10, and the specified normal thickness, converted to equivalent square yards [square meters] of normal thickness base.

204-11.3 Authorized Variable Thickness Base: As specified in 200-11.3.

204-12 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section, including dust abatement, correcting all defective surface and deficient thickness, removing cracks and checks and the additional aggregate required for such crack elimination.

Prime coat will be paid for under Section 300.

Payment will be made under:

Item No. 285- 7-	Optional Base - per square yard.
Item No. 2285- 7-	Optional Base - per square meter.

SECTION 210

REWORKING LIMEROCK BASE

210-1 Description.

Rework (or rework and widen) the existing rock base, by adding new limerock material as required by the plans. Construct adjacent turnouts, entirely with new limerock.

210-2 Materials.

Meet the limerock material requirements as specified in Section 911 if new limerock is needed. The Contractor may use limerock of either Miami Oolite or Ocala Formation but only use limerock of one formation on any Contract.

210-3 Equipment and Forms.

Provide equipment meeting the requirements of 200-3. The Engineer will not require forms unless specifically specified in the plans.

210-4 Existing Bituminous Surfaces.

210-4.1 Asphaltic Concrete: Remove asphaltic concrete surfaces from the base prior to excavating trenches or scarifying the rock. Dispose of removed materials as specified in 120-5.

210-4.2 Bituminous Surface Treatment: Remove and dispose of existing bituminous surface treatment only when specifically specified in the plans. Otherwise, the Contractor may mix the existing bituminous surfacing in with the existing limerock material.

210-5 Trenches and Subgrade.

Where widening the existing base, excavate trenches along the edges of the existing pavement to the width and depth indicated in the plans. Excavate the trenches before scarifying the existing base. Shape, compact, and maintain the subgrade of the trenches and turnouts as specified in 120-9, except that when stabilization of the subgrade is not included in the plans, do not compact the trenches unless the native underlying material has been disturbed. Dispose of all excavated materials as specified in 120-5.

210-6 Spreading, Shaping, and Compacting Rock.

210-6.1 General: Scarify and disk, or otherwise loosen the existing base to such extent that no pieces larger than 32 inches [90 mm] in greatest dimension remain bonded together. Then, spread the material to the full width of the proposed new base course and to a grade and cross-section roughly parallel to the finished grade. Compact the existing base material to the density specified in 200-6.3.

210-6.2 Widening Strips: Where the widening strips are not of sufficient width to permit the use of standard compaction equipment, compact the rock in accordance with 200-6.6.

210-6.3 Construction Sequence: Do not spread any material for the upper course until the Engineer has made the density tests on the lower course and has determined that the specified compaction requirements have been met. Then, construct the second course of new limerock in accordance with the requirements of 200-5 through 200-7.

210-7 Priming and Maintaining.

Meet the requirements of 200-8.

210-8 Method of Measurement.

210-8.1 Base: The quantity to be paid for will be the plan quantity, in square yards [square meters], completed and accepted, including the areas of widened base and of turnouts constructed of new limerock material.

210-8.2 Limerock Material: The quantity to be paid for will be the number of cubic yards [cubic meters] of only the new limerock material actually placed in the road and accepted. The quantity will be determined by measurement in loose volume, in truck bodies, at the point of dumping on the road, with proper deduction for all materials wasted, left in trucks or otherwise not actually used in the road. For this purpose, level the material in the truck bodies to facilitate accurate measurement.

210-9 Basis of Payment.

Prices and payments will be full compensation for performing all work specified in this Section, except all earthwork required for this work, and the work of removal and disposal of the existing bituminous surfaces, if required, as indicated in the plans.

When the plans do not provide for direct payment for such work, the cost will be included in the Contract unit price for Reworking Limerock Base.

Prime coat will be paid for under Section 300.

Payment will be made under:

Item No. 210- 1- Reworking Limerock Base - per square yard.
Item No. 2210- 1- Reworking Limerock Base - per square meter.
Item No. 210- 2- Limerock, New Material - per cubic yard.
Item No. 2210- 2- Limerock, New Material - per cubic meter.

SECTION 220

SHAPING AND COMPACTING LOCAL ROCK BASE

220-1 Description.

Scarify, shape, and compact portions of embankment that have been constructed of local rock to form a base course.

220-2 Equipment.

Provide equipment meeting the requirements of 200-3.

220-3 Construction Methods.

Scarify the embankment to a depth of not less than 6 inches [150 mm], for the full width of the proposed base, and then shape it to produce the required cross-section. Compact and finish the embankment in accordance with all of the applicable requirements of 200-6.

220-4 Testing Surface.

Test the surface in accordance with the requirements of 200-7.

220-5 Priming and Maintaining.

Meet the requirements of 200-8.

220-6 Method of Measurement.

The quantity to be paid for will be the plan quantity, in square yards [square meters], completed and accepted.

220-7 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section, including correcting all defective surface.

Prime coat will be paid for under Section 300.

Payment will be made under:

Item No. 220- 1- Shaping and Compacting Base - per square yard.
Item No. 2220- 1- Shaping and Compacting Base - per square meter.

SECTION 230

LIMEROCK STABILIZED BASE

230-1 Description.

Construct a base course composed of roadbed soil stabilized with limerock.

230-2 Materials.

Meet the limerock material requirements as specified in Section 911.

230-3 Equipment.

230-3.1 For Mixing: For mixing in the roadway, provide a heavy-duty rotary tiller or other equipment approved by the Engineer as equally effective for this work.

230-3.2 For Compaction: Select the equipment for compacting the stabilized material, except that for the final finish use a steel-wheeled roller.

230-4 Preparation of Roadbed.

Complete the area to be stabilized to the lines shown in the plans and to a grade parallel to the finished elevation of the stabilized base, before adding the stabilizing material. Ensure that the elevation of the roadbed is such that the base will conform to the typical cross-section upon completing the work. Dispose of any surplus excavated materials resulting from this work, as specified in 120-5.

230-5 Incorporation of Stabilizing Material and Mixing-In.

230-5.1 Spreading and Mixing: Place the limerock on the areas to be stabilized, and spread it uniformly to the loose depth shown in the plans or ordered by the Engineer. Then, thoroughly mix the limerock with the soil. Perform mixing as soon as practicable but not later than one week after placing the limerock on the road. Do not spread more limerock in advance of the mixing operations than can be mixed-in with the soil within one week.

230-5.2 Further Mixing Operations: Repeat the mixing operations as often as may be necessary to distribute the limerock uniformly throughout the soil, as determined by the Engineer. Further manipulate the material to uniformly distribute the limerock throughout the width and depth of the base course.

230-5.3 Plant Mixing: The Contractor may mix the soil, limerock, and water using the central plant-mix method in lieu of mixing in place, provided he obtains a uniform mixture with the proper amount of water.

230-5.4 Shaping Surface: After mixing, shape the surface so it conforms to the grade and typical cross-section shown in the plans after compacting.

230-5.5 Depth of Mixing Stabilizing Material: Ensure that the depth of mixing of the stabilizing material is in accordance with the following table:

NON SI UNITS

Specified Base Thickness (inches)	Required Mixing Depth (inches)	
	Minimum	Maximum
6	52	72
8	73	9:
10	9	12

SI UNITS

Specified Base Thickness (mm)	Required Mixing Depth (mm)	
	Minimum	Maximum
150	140	190
200	185	245
250	225	300

In the event that the measured depth of mixing is less than the minimum specified above, remix the base course, as directed by the Engineer, until the stabilizing material is distributed to the required depth throughout the base course.

Where the measured depth of mixing exceeds the maximum limits specified in the table, add 1 inch [25 mm], loose measure, of stabilizing material for each 1 inch [25 mm] of mixing depth in excess of the allowable depth (but in no case less than 1 inch [25 mm] of material, for any excess depth), and mix the added material in the top 6 inches [150 mm] of the base as specified in 230-5.1 and 230-5.2, at no expense to the Department. The Department will not include the volume of stabilizing material, which is added to compensate for excess mixing depth, in the pay quantity, and will not allow any additional compensation for the extra mixing required.

230-6 Compacting and Finishing Base.

Meet the requirements of 200-6.

230-7 Testing Surface.

Test the surface in accordance with the requirements of 200-7.

230-8 Priming and Maintaining.

Meet the requirements of 200-8.

230-9 Method of Measurement.

230-9.1 General: The quantities to be paid for will be the plan quantity, in square yards [square meters], completed and accepted.

230-9.2 Quantity of Limerock: The quantity to be paid for will be as specified in 210-8.2.

230-10 Basis of Payment.

Prices and payments will be full compensation for all work specified in this Section, including furnishing, hauling, placing, spreading, mixing, compacting, and finishing all limerock stabilizing material; any necessary excavating below the finished grade of the base to provide for placing the stabilizing material; and disposing of all surplus excavation resulting from this work.

Where extra limerock material is placed at locations of culverts, etc., as detailed in the plans, the volume of such material, determined as provided above, will be included in the quantity of Limerock Material to be paid for, but no adjustment will be made in the area of base to be paid for.

Prime coat will be paid for under Section 300.

Payment will be made under:

Item No. 230- 1- Limerock Stabilized Base - per square yard.
Item No. 2230- 1- Limerock Stabilized Base - per square meter.
Item No. 230- 2- Limerock Material - per cubic yard.
Item No. 2230- 2- Limerock Material - per cubic meter.

SECTION 240

SAND-CLAY BASE

240-1 Description.

Construct a base course composed of naturally or artificially mixed sand and clay.

240-2 Materials.

240-2.1 General: Meet the sand-clay material requirements as specified in Section 912. Before using any base course material, first have it tested by the Department's laboratory, then obtain the Engineer's approval.

240-2.2 Source of Materials:

240-2.2.1 Contractor's Option: The Department will generally furnish the areas for obtaining the sand-clay base material. The Contractor may either use such areas or provide other areas of his own choosing. The Contractor must absorb any increase in hauling or other costs for Contractor furnished material. If the Contractor elects to use the sand-clay base option, the Contractor shall furnish material from areas he provides.

240-2.2.2 Use of Department-Furnished Areas: The Department will not charge the Contractor for using Department-furnished pits. However, the Contractor shall provide and maintain all necessary roads for hauling material over the shortest practical route, as determined by the Engineer, to the points where the Contractor is using it. The Department will obtain any necessary property easements for haul roads from pits that it furnishes.

240-2.3 Excavation of Material Pits: Neatly excavate the material from the pits in accordance with the stakes set by the Engineer, and do not remove any material until the Engineer has set the stakes. Where the bottom is above the normal water table, shape it to a regular grade to prevent ponding of water.

240-2.4 Materials from Separate Sources: The Contractor may furnish areas consisting of a single source, containing material meeting the specified requirements (with proper manipulation of the various strata), or consisting of separate sources, requiring the mixing of the separate materials be mixed as directed by the Engineer or as shown in the plans.

240-2.5 Blending Materials: To obtain the required sand-clay blend when using material obtained from stratified pits for which blending in the pit is necessary, use a power shovel or front-end loader capable of raking the entire face of the cut with the dipper in the open position. Do not use draglines for such blending.

240-3 Equipment.

240-3.1 Graders: Provide blade graders of the rubber-tired, self-propelled type, of sufficient size and weight to accomplish the desired results.

240-3.2 Rollers: Provide pneumatic-tired rollers which have a double row of wheels equipped with rubber tires so spaced that the tires on the front and rear rows together will cover the entire area over which the roller travels.

240-3.3 Forms: The Engineer will not require forms for this work.

240-4 Placing and Mixing Materials.

240-4.1 Number of Courses: When the specified compacted thickness of the base is greater than 8 inches [200 mm], construct the base in two or more courses.

When the specified compacted thickness of the base is 8 inches [200 mm] or less, the Contractor may construct the base in one course if demonstrated that satisfactory mixture of materials, proper moisture content, and required density can be achieved. Otherwise, construct the base in two or more courses.

240-4.2 Single-Course Base:

240-4.2.1 General: For one course construction, place and mix the base course materials as provided hereinafter for either Case 1 or Case 2.

240-4.2.2 Case 1: This case covers the use of base course material consisting of natural sand-clay with which the mixing-in of additional sand or clay is not necessary. The Contractor may dump the material directly on the subgrade, and uniformly distribute it by approved methods. The Engineer will designate the loose thickness. Continuously check the thickness to ensure that the finished base will have the thickness and shape required by the typical section. Thoroughly mix the base course for its full width and depth as shown in the plans. After mixing, shape the material to the required grade and cross-section.

240-4.2.3 Case 2: This case covers the use of base course material consisting of a mixture of two materials, both of which are to be hauled in. Spread the material in successive layers on the road, and mix it in place. The Engineer will determine the order in which to spread the two materials, as well as the depth of layers of each material. Dump and spread each material, mix the two materials, and shape the base as specified for Case 1.

240-4.3 Multiple-Course Base: Where constructing the base in two or more courses, make the component courses approximately equal in thickness. Place and mix each course as provided above for either Case 1 or Case 2, except that in the operation of mixing a second or third course, operate the equipment so as to penetrate and break up the top 1 inch [25 mm] of the underlying course.

240-5 Compacting and Finishing Base.

240-5.1 General:

240-5.1.1 Single-Course Base: Construct as specified in 200-6.1.1.

240-5.1.2 Multiple-Course Base: Construct as specified in 200-6.1.2.

240-5.2 Moisture Content: Meet the requirements of 200-6.2.

240-5.3 Density Requirement: Meet the requirements of 200-6.3.

240-5.4 Density Tests: Meet the requirements of 200-6.4.

240-6 Testing Surface.

Test the surface in accordance with the requirements of 200-7.

240-7 Thickness of Base.

Meet the requirements of 285-6 and 285-7.

240-8 Priming, Maintaining, and Opening to Traffic.

240-8.1 Priming: Meet the requirements of 200-8.1.

240-8.2 Maintaining: Meet the requirements of 200-8.2.

240-8.3 Opening to Traffic: Distribute traffic so as to properly cure the entire area of base. After applying the prime coat, allow the base to further cure for a period of at least seven days before laying the wearing surface, unless otherwise directed in writing by the Engineer.

240-9 Method of Measurement.

The quantity to be paid for will be the plan quantity, in square yards [square meters], completed and accepted.

240-10 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section, including all materials; all clearing and grubbing of material pits; all stripping of overburden from the pits, if required; all hauling of material, except that if the location of a proposed pit is changed by the Engineer and such change entails an increase in haul distance; and all incidentals necessary to complete the work.

If there is an increase in the haul distance, it will be considered as Unforeseeable Work.

Prime coat will be paid under Section 300.

Payment will be made under:

Item No. 285- 7- Optional Base - per square yard.
Item No. 2285- 7- Optional Base - per square meter.

SECTION 250

SHELL BASE

250-1 Description.

Construct a base course composed of shell.

250-2 Materials.

Meet the shell material requirements as specified in Section 913. Where specifically specified in the plans, use coquina shell meeting the requirements of Section 915. Otherwise, the Contractor may use coquina shell at his request, if so approved by the Engineer.

Meet the shell-rock material requirements as specified in Section 913A.

250-3 Equipment.

Provide equipment meeting the requirements of 200-3.

250-4 Transporting Shell.

Transport shell as specified in 200-4.

250-5 Spreading Shell.

250-5.1 Method of Spreading: Spread shell as specified in 200-5.1. During the dumping and spreading operations, thoroughly saturate the shell with water, as required by the Engineer.

250-5.2 Number of Courses: Meet the requirements of 200-5.2.

250-6 Compacting and Finishing Base.

250-6.1 General:

250-6.1.1 Single-Course Base: Construct as specified in 200-6.1.1.

250-6.1.2 Multiple-Course Base: Construct as specified in 200-6.1.2, and the following.

Do not spread more than one day's work of the first course ahead of the spreading of the second course, unless specifically authorized by the Engineer.

250-6.2 Density Requirements: Meet compaction and density requirements as specified in 200-6 for limerock base. The Engineer will revise the method of making density determinations, both laboratory and field, so that the Engineer determines the density on the base material, sampled after the initial compacting, with no elimination of any screened material.

250-6.3 Density Tests: Meet the requirements of 200-6.4.

250-6.4 Correction of Defects: Meet the requirements of 200-6.5.

250-6.5 Widening Strips: Meet the requirements of 200-6.6.

250-7 Testing Surface.

Test the surface in accordance with the requirements of 200-7.

250-8 Priming and Maintaining.

Meet the requirements of 200-8.

250-9 Thickness Requirements.

Meet the requirements of 285-6 and 285-7.

250-10 Method of Measurement.

The quantity to be paid for will be measured as specified for limerock base in 200-11.

250-11 Basis of Payment.

Prices and payments will be full compensation for all work specified in this Section, including furnishing, hauling and placing all materials, except the prime coat, and for correcting all defective surface and deficient thickness.

Prime coat will be paid for under Section 300.

Payment will be made under:

Item No. 285- 7- Optional Base - per square yard.
Item No. 2285- 7- Optional Base - per square meter.

SECTION 260

SHELL STABILIZED BASE

260-1 Description.

Construct a base course composed of roadbed soil stabilized with shell.

260-2 Materials.

Meet the shell material requirements as specified in Section 913. Ensure that all roadbed material to be incorporated with the shell has at least the bearing value required by the plans for the subgrade.

260-3 Equipment.

Meet the requirements as specified in 230-3, and the following.

For compacting, provide either sheepsfoot or grid-type rollers, properly weighted, supplemented by traffic rollers and such other compaction equipment as is required to obtain the specified density.

260-4 Preparation of Roadbed.

Meet the requirements of 230-4.

260-5 Incorporation of Stabilizing Material and Mixing-In.

Meet the requirements of 230-5.

Where widening strips are not of sufficient width to permit the use of standard equipment and methods, the Contractor may (subject to the approval of the Engineer, and provided that he uses proper proportions of the shell base material and soil, as directed by the Engineer) mix the shell and soil at the side of the road and place the shell stabilized base material directly into the previously prepared trench.

260-6 Compacting and Finishing Base.

260-6.1 Rolling: After spreading and mixing, compact the shell using either the grid-type roller or the sheepsfoot roller, properly weighted, adding water as required, until the required density has been obtained. Perform final rolling with traffic rollers and any other compaction equipment which will obtain the specified density.

260-6.2 Compacting: Meet the requirements of 200-6.1 through 200-6.4, except as follows. The Engineer will revise the method of making the density determinations, both the laboratory and the field, so that the Engineer determines the density on the completely mixed material, sampled after the final mixing on the project, with no elimination of any screened material.

260-6.3 Widening Strips: Meet the requirements of 200-6.6.

260-7 Testing Surface.

Test the surface in accordance with the requirements of 200-7.

260-8 Protection, Priming, and Maintaining.

Meet the requirements of 230-8, except for the requirements for moisture content at time of priming.

260-9 Method of Measurement.

260-9.1 General: The quantities to be paid for will be (1) the plan quantity, in square yards [square meters], and (2) the volume, in cubic yards [cubic meters], of shell material, completed and accepted.

260-9.2 Quantity of Shell: The quantity will be determined by measurement in loose volume, in truck bodies, at the point where it is placed on the road with proper deduction for all materials wasted, left in trucks or otherwise not actually used in the road. For this purpose, level the material in the truck bodies to facilitate accurate measurement.

260-10 Basis of Payment.

Prices and payments will be full compensation for all work specified in this Section, including furnishing, hauling, placing, spreading, mixing, compacting, and finishing all shell stabilized material; any necessary excavating below the finished grade of the base to provide for placing the stabilized material; and disposing of all surplus excavation resulting from this work.

Where extra shell material is placed at locations of culverts, etc., as detailed in the plans, the volume of such material will be included in the quantity of Shell Base Material to be paid for, but no adjustment will be made in the area of base to be paid for.

Prime coat will be paid for under Section 300.

Payment will be made under:

Item No. 260- 1- Shell Stabilized Base - per square yard.

Item No. 2260- 1- Shell Stabilized Base - per square meter.
Item No. 260- 2- Shell Base Material - per cubic yard.
Item No. 2260- 2- Shell Base Material - per cubic meter.

SECTION 270

SOIL-CEMENT BASE

270-1 Description.

Construct a base course composed of a combination of soil, portland cement, and water.

270-2 Materials.

Meet the following requirements:

Cement: Portland Cement, Type I, II, III, or Type IP or Type IS ....Section 921

Water: Use water that is free from substances deleterious to hardening of the soil-cement mixture.

Curing Material: 916-4

Use Emulsified Asphalt Grade SS, RS, or MS as approved by the Engineer. Dilute these as recommended by the manufacturer.

Soil: For base course construction, use either the material existing in the location to be occupied by the base, a suitably friable material furnished by the Contractor, or a combination of these. If the material existing in the location to be occupied by the base does not meet the requirements specified below, remove and replace it with suitable soil.

Obtain approval of the material pits prior to use. Excavate material pits to achieve a uniformly mixed material with reasonably consistent characteristics. Blend strata or differing materials in accordance with a procedure approved by the Engineer. The Department will consider proposed recycled materials on a case by case basis.

Specific Requirements For Soil:

Organic Material (As per FM 1-T267) ....Maximum 5%
Total Clay and Silt Content (minus No. 200 [75Φm sieve) (As per FM 1-T088, no hydrometer test) ....Maximum 25%
Plastic Index (As per FM 1-T090)..............................Maximum 10%
Liquid Limit (As per FM 1-T089) ....Maximum 25%
Gradation: (As per FM 1-T088)
Passing 2 inch [50 mm] sieve............................. Minimum 100%
Passing No. 4 [4.75 mm] sieve............................. Minimum 55%
Passing No. 10 [2.00 mm] sieve........................... Minimum 37%

As an exception to the above requirements, the Contractor may use any material meeting the requirements for Limerock in Section 911.

270-3 Proportioning of Mix.

270-3.1 General: Proportion the soil-cement mixture in accordance with Strength Design or Brush Loss Criteria as specified below.

Submit for approval a design mix for the soil proposed for use in soil-cement construction prepared by a testing laboratory approved by the Engineer. With the design mix submittal, include the results of tests run to verify that the soil meets the requirements specified in 270-2, results of tests used to establish the cement content, and a final design laboratory sample. Submit the design mix to the Engineer for approval a minimum of 60 calendar days prior to beginning of soil-cement construction for Brush Loss Design Method or 15 calendar days prior to beginning of soil-cement construction for Strength Design Method.

The Engineer will perform laboratory testing for design mix evaluation using water from the same source proposed for use during construction.

Express the cement as a percentage of the dry unit weight of the soil. For mixed-in-place construction, the Engineer will use a rate of application of cement based on the maximum density of the soil, determined in accordance with AASHTO T 99 and rounded up to the nearest pound per cubic yard [kilogram per cubic meter].

270-3.2 Strength Design: When proportioning the soil-cement mixture in accordance with strength design, the Engineer will determine the minimum cement content using FM 5-520. Achieve the design compressive strength specified in the plans in seven days. Ensure that the cement content is not less than 5% by weight, except as noted in 270-3.4.

270-3.3 Brush Loss Design Criteria: When proportioning the soil-cement mixture in accordance with this criteria, the Engineer will determine the minimum cement content in accordance with AASHTO T 135. Ensure that the soil-cement loss at the completion of 12 cycles of testing conforms to the following limits:

AASHTO Soils Groups A-1, A-2-4, A-2-5, and A-3 ..... not over 14%
AASHTO Soils Groups A-2-6, A-2-7, A-4, and A-5 ..... not over 10%
AASHTO Soils Groups A-6 and A-7 .... not over 7%

Ensure that the cement content is not less than 5% by weight, except as noted in 270-3.4.

When proportioning of soil-cement mixture by the Brush Loss Design Criteria Method and processing by Central-Plant-Mixing where the requirements of 270-3.4 are met, the Engineer will not require strength testing of field specimens. The Engineer will verify the properties of the parent material during the processing, on a random frequency, to ensure that the final mix has not changed from the original design. Ensure that the producer furnishes a printout to the Engineer of each day's production that shows proportioning of the mixture meets the approved Brush Loss Design, including cement.

270-3.4 Exception for Central Mixed Materials: Do not apply the minimum 5% cement content specified in 270-3.2 and 270-3.3 if obtaining the soil material used in producing a soil-cement mixture from a commercial source (not to exclude recycled materials) where soil properties are consistently uniform, and if processing the mixture in a central mix plant that automatically weighs components and automatically records the weight of each component on a printed ticket, tape, or other digital record.

270-4 Construction Methods.

270-4.1 Equipment: For performing the work specified in this Section, use any machine, combination of machines, or equipment that is in good, safe working condition and that will produce results meeting the requirements for cement application, soil pulverization, mixing water application, compaction, finishing, and curing, as required herein. The Department directs special attention to the necessity for utilizing compaction equipment which will produce the required density in a particular soil-cement blend.

270-4.2 Preparation:

270-4.2.1 Subgrade: Before beginning base construction operations, complete the subgrade. Ensure that the subgrade is firm enough to support the equipment used in the soil-cement base operations without appreciable distortion or displacement. Remove any unsuitable material, and replace it with suitable material.

When constructing the base with central-plant-mixed soil-cement, grade and shape the subgrade to the lines, grades, and typical cross-section shown in the plans. Ensure that the subgrade is moist but not ponded at the time of placing the mixed base course material.

270-4.2.2 Base Soil for Mixed-in-Place Processing: Grade and shape the area over which the base is to be constructed to an elevation which will provide a base in conformance with the grades, lines, thickness, and typical cross-sections shown on the plans. Remove all roots, sticks, and other deleterious matter during processing.

270-4.3 Processing of Soil-Cement Mixture:

270-4.3.1 General: Mix the soil, cement, and water either by mixed-in-place or central-plant-mix methods.

Do not allow the percentage of moisture in the soil at the time of cement application to exceed the quantity that will permit a uniform and intimate mixture of soil and cement during mixing operations. With certain types of soils, the Engineer will designate a moisture range.

During seasons of freezing temperature, do not spread any cement or soil-cement mixture unless the ambient temperature is at least 40EF [4EC] in the shade and rising.

At the completion of moist-mixing, pulverize the soil so that 100% passes a 12 inch [37.5 mm] sieve, 95 to 100% passes the 1 inch [25.0 mm] sieve and a minimum of 80% passes a No. 4 [4.75 mm] sieve, exclusive of gravel, shell, or stone.

Continue the operations specified in 270-4.3, 270-4.4, 270-4.5, and 270-4.6 and complete them within a period of four hours starting from the time mixing commences.

270-4.3.2 Mixed-in-Place Method: Where feasible, process the entire width of the base in a single operation. Uniformly spread the design quantity of cement on the soil at the required rate of application, by means of an approved method. Replace spread cement that becomes displaced before starting mixing. The Engineer will check the uniformity of spread rate by (a) weight of cement spread/square yards [spread/square meters] covered for a short trial section that is between 100 and 300 feet [30 and 90 m] in length or (b) use of a square yard [square meter] cloth/box.

After applying the cement, begin mixing within 60 minutes. Initially mix the soil and cement until the cement has sufficiently blended with the soil to prevent formation of cement balls when applying additional water; then add water if necessary, and re-mix the soil-cement mixture. Do not perform windrow mixing.

The Contractor may process the full depth in one course, provided the Contractor obtains a satisfactory distribution of cement and water and the specified density. If not, construct courses of such thickness to obtain satisfactory results. Make provisions to achieve adequate bonding between courses.

Immediately after mixing of the soil and cement, add any additional water that is necessary. If the moisture content exceeds that specified, manipulate the soil-cement mixture by re-mixing or blading as required to reduce the moisture content to within the specified range. Avoid excessive concentrations of water. Continue mixing during and after applying water until obtaining a uniform and intimate mixture of soil, cement, and water.

As an alternative to the above described procedure, the Contractor may use an approved machine that will blend the cement and the soil and then add and mix-in any additional water that is necessary.

270-4.3.3 Central-Plant-Mixed Method: Mix the soil, cement, and water in a pugmill of either the batch or continuous-flow type. Equip the plant with feeding and metering devices which will accurately proportion the soil, cement, and water in the quantities specified. Mix soil and cement sufficiently to prevent cement balls from forming when adding additional water. Continue mixing until obtaining a uniform and intimate mixture of soil, cement, and water.

Haul the mixture to the roadway in trucks equipped with protective covers. Place the mixture on the moistened subgrade in a uniform layer with suitable equipment. Do not allow more than 60 minutes to elapse between placing of soil-cement in adjacent passes of the spreader at any location, except at construction joints. Ensure that the layer of soil-cement is uniform in thickness and surface contour, and in such quantity that the completed base will conform to the required grade and cross-section. Do not perform windrow mixing.

270-4.4 Construction Joints: Prior to joining any previously constructed section of base, form a vertical construction joint by cutting back into the completed work to form a true vertical face of acceptable soil-cement to the full depth of the base course. Moisten the vertical face, if directed, prior to placing new material against it.

270-4.5 Shaping and Finishing: Prior to final compaction, shape the surface of the soil-cement to the required lines, grades, and cross-section. In all cases where adding soil-cement mixture to any portion of the surface, lightly scarify the surface with a spring tooth harrow, spike drag, or other approved device to uniformly loosen the surface prior to adding material and prior to the initial set of the soil-cement mixture. Compact the resulting surface to the specified density. Continue rolling until all rutting ceases and until the base conforms to the density requirements.

Ensure that the surface material is moist but not ponded, and maintained at not less than 2% below its specified optimum moisture content, during finishing operations. Perform surface compaction and finishing in such a manner as to produce a smooth dense surface, free of compaction planes, construction cracks, ridges, and loose material. With certain soils, the Engineer may determine that minor tire marks are acceptable.

If the time limits specified in 270-4.3.1 are exceeded, leave the base undisturbed for a period of seven days, after which, the Engineer will examine it to determine its suitability. If the Engineer determines that it is suitable, the Department will fully compensate the Contractor, providing the base meets all other requirements specified herein. If found unsuitable, remove and replace the base without additional compensation. The Contractor may remove and replace the deficient base rather than wait seven days.

270-4.6 Compaction: Begin compacting the soil-cement mixture immediately after mixing or placing. Do not allow more than 30 minutes to elapse between the last pass of moist-mixing or spreading and the start of compaction of the soil-cement mixture at a particular location.

The Engineer will determine the optimum moisture content and the maximum density in the field by the methods prescribed in AASHTO T 134 on representative samples of the soil-cement mixture obtained immediately after the initial mixing. The Engineer will determine the density for each day's run or change of material.

Uniformly compact the loose material to meet the density requirements specified in 270-5.1. During compaction operations, the Contractor may reshape the material to obtain required grade and cross-section.

270-4.7 Protection Against Drying: While finishing and correcting the surface, keep the surface of the base continuously moist by sprinkling it as necessary until applying the emulsified asphalt curing material. As soon as practicable, protect the base from drying for seven days by applying the emulsified asphalt at the rate of 0.20 to 0.25 gallon [0.9 to 1.1 L] of the diluted mixture per square yard [square meter]. The Engineer will direct the actual rate of application that will provide complete coverage without excessive runoff. While applying the bituminous material, ensure that the soil-cement surface is dense, free of all loose and extraneous material, and contains sufficient moisture to prevent excessive penetration of the bituminous materials.

If it is necessary to allow construction equipment or other traffic to use the completed base before the bituminous material has cured sufficiently to prevent pickup or displacement, sand the bituminous material, using approximately 10 lbs [5 kg] of clean sand per square yard [square meter]. Do not use cover material containing organic acids or other compounds detrimental to the soil-cement base.

Maintain the curing material during the seven day protection period.

270-4.8 Opening to Traffic: Do not allow traffic on the base subsequent to completion of the finishing operations specified in 270-4.5 for a minimum period of 72 hours. As an exception to this requirement, allow equipment necessary for correction of surface irregularities, application of water, and application of curing materials on the base, provided that the tire contact pressures of such equipment do not exceed 45 psi [300 kPa]. Under special conditions (i.e. low speed limit, low traffic volume, urban conditions), the Engineer may waive the 72-hour period.

270-4.9 Maintenance: Maintain the base to a true and satisfactory surface until the wearing surface is constructed. If the Engineer requires any repairing or patching, extend the repair or patch to the full depth of the base, and make them in a manner that will ensure restoration of a uniform base course in accordance with the requirements of these Specifications. Do not repair the base by adding a thin layer of soil-cement or concrete to the completed work. The Contractor may make full depth repairs to small or minor areas, such as at manholes, inlets, or the like, with Class I concrete.

For patching of deficient areas less than 100 ft^2 [9 m^2] and less than 1 inch [25 mm] in depth, correct the areas using Type S-III Asphaltic Concrete. For patching of deficient areas less than 100 ft^2 [9 m^2] and greater than 1 inch [25 mm] in depth, remove the areas to full depth, and replace them using Asphalt Base Course Type 3, Type S Asphaltic Concrete, or soil-cement.

270-4.10 Control of Quality: Produce all Soil-Cement Base in accordance with an approved quality control plan in accordance with the Department's Standard Operating Procedure attached to this Specifications Package. In general, the procedure requires a written quality control plan stating how the Contractor will establish, maintain, and implement an individualized process control system to provide a product meeting the requirements of the applicable specifications.

270-5 Acceptance Requirements.

270-5.1 Density: As soon as possible after completing compaction, the Engineer will perform field density testing to ensure that the required density is 97% of the maximum density as determined by methods prescribed in AASHTO T 134.

For density determination, a LOT is defined as 2,500 yd^2 [2,000 m^2] of base. The Engineer may include any small section of base at the end of a day's operation in the preceding LOT (no LOT shall include more than 3,500 yd^2 [3,000 m^2]) or consider it as a separate LOT.

The Engineer will perform five density tests at locations randomly selected within each LOT and will ensure that a LOT value is the average of the five density tests performed within the LOT.

If a LOT value is less than 97% of the maximum density, the Department will reduce payment for the LOT in accordance with the requirements of 270-7.

If an individual test value within a LOT is less than 94% of the maximum density, the Engineer will determine the extent of this deficiency by performing density tests using a 5 foot [1.5 m] grid pattern until a test value of 95% or greater is located in all directions. Remove the delineated area of base, and replace it with base meeting all requirements of this Section, at no expense to the Department.

As an exception to the foregoing, if three or more of the original five individual test values within a LOT are less than 94% of the maximum density, the Engineer will reject the entire LOT, and the Contractor shall remove all base within the LOT and replace it with base meeting all requirements of this Section, at no expense to the Department.

270-5.2 Surface Finish: After compacting and finishing, and not later than the beginning of the next calendar day after constructing of any section of base, measure the surface with a template cut to the required cross-section and with a 15 foot [4.572 m] straightedge laid parallel to the centerline of the road. Correct all irregularities greater than 3 inch [6 mm] to the satisfaction of the Engineer with a blade adjusted to the lightest cut which will ensure a surface that does not contain depressions greater than 3 inch [6 mm] under the template or the straightedge. The

Engineer may approve other suitable methods for measurement. In the testing of the surface, do not take the measurements in small holes caused by the blades pulling out individual rocks. Waste the material removed.

270-5.3 Thickness: After completing the base, including hard planing if necessary, dig or drill 3 inch [75 mm] minimum diameter test holes. The Engineer will determine the thickness from measurements made in these test holes.

For thickness evaluation, a LOT is defined as 2,500 yd^2 [2,000 m^2] of base. The Engineer may include any small section of base at the end of a day's operation or small irregular areas as part of the preceding LOT. The Engineer will consider an area such as an intersection, crossover, ramp, etc., as a separate LOT. The Engineer may include small irregular areas as part of another LOT. No LOT shall include more than 3,500 yd^2 [3,000 m^2] of base.

The Engineer will perform five thickness measurements at locations randomly selected within each LOT.

The Engineer will determine construction tolerances for thickness as follows:

	Deviation From Plan Thickness
Central-Plant-Mixed Processing	-1 inch [-25 mm]
Mixed-in-Place Processing	∀1 inch [∀25 mm]

When any thickness measurement is outside the construction tolerance, the Engineer will take additional thickness measurements at 10 foot [3 m] intervals parallel to the centerline in each direction from the measurement which is outside the construction tolerance until a measurement in each direction is within the construction tolerance.

The Engineer will evaluate an area of base found to have a thickness outside the construction tolerance and, if he determines that the service life of the base will be significantly reduced, he will require the Contractor to remove and replace it with acceptable base of the thickness shown in the plans, at no expense to the Department. The Department will pay for areas of deficient thickness that are within the construction tolerance in accordance with 270-7.

270-5.4 Strength Testing of Field Specimens: Meet the following requirements for soil-cement when proportioning the mix by the Strength Design Method.

The Engineer is responsible for the following:

1. Checking the adequacy of cement content and uniformity of distribution of cement within the base by sampling and testing the completed mix.

2. Taking samples at the project site just prior to final compaction and determining a minimum of two Strength Test Values (STV) each day, with at least one STV per each 2,500 yd^2 [2,000 m^2] mixed.

3. Ensuring that each STV is the average strength value of a minimum of three individual specimens, and for discarding any obvious outliers.

4. Taking representative samples of the mixed soil-cement material for determining an STV just prior to final compaction, recording the sample location, and ensuring that the samples are large enough to mold three or more compressive strength test specimens as prescribed in FM 5-520.

5. Molding these test specimens at the field moisture content and casting the individual test specimens as close to identical as possible.

6. Resting the molds, during compaction of strength test specimens, on a 200 pound [90 kg] concrete block, or the equivalent thereto, that the Contractor provides.

7. Gently extruding these test specimens from the compaction mold, and carefully placing them in a moist curing environment (not in direct contact with ponded or moving water) such as a tightly closed container under wet cloth or burlap at locations where they will not be disturbed.

Continue the initial field cure for at least 24 hours, and if after 24 hours the Engineer determines that the specimens have not gained sufficient strength to be moved without probable damage, continue field curing until the Engineer determines that each specimen can be safely moved without probable damage occurring. When the Engineer determines that the specimens can be safely moved, the Engineer will transport them to the laboratory where they will be cured, as described in the design procedure (FM 5-520), to seven days of age. At seven days of age, the Engineer will test the individual specimen for determination of compressive stress and ensure that the loading procedure and rates are the same, as described in FM 5-520.

If an STV is less than 60% of the Laboratory Design Strength, remove and replace the material represented by the STV, at no expense to the Department.

270-6 Method of Measurement.

The quantity to be paid for will be plan quantity, in square yards [square meters], completed and accepted. The Contractor shall provide the Engineer with written documentation so he can perform calculations to confirm that the design quantity of cement for the project was incorporated into the project.

270-7 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section, including preparing the soil; preliminary grading; furnishing and adding cement; furnishing and adding water; mixing of soil, cement, and water; compacting the mixture; finishing the surface; furnishing and applying curing material; protecting the completed base from traffic; maintaining the completed base; and removing and replacing base which is deficient in thickness as provided in 270-5.3.

No separate payment will be made for cement or for bituminous material applied as a curing seal.

The completed base will be accepted on a LOT to LOT basis. LOTs that have a density less than 97%, or a thickness less than the plan thickness in excess of 0.5 inch [10 mm], will be paid for at reduced rates in accordance with the following schedules.

Density

Percent Of Maximum Density, LOT Average	Percent Payment
97 and above	100

95.0 to 96.9	90
94.0 to 94.9	50, or remove and replace at the option of the Engineer

Thickness
(Applicable only when processing is by the central-plant-mixed method)

Deficiency From Plan Thickness LOT Average*	Percent Payment
0.00 - 0.50 inch [0.00 - 13 mm]	100
0.51 - 0.75 inch [13.1 - 19 mm]	90
0.76 - 1.00 inch [19.1 - 25 mm]	80

*When processing is by the central-plant-mixed method, the average of the five thickness measurements will be determined. In calculating the average, thickness measurements which exceed the plan thickness by more than 0.5 inch [10 mm] will be considered to be the plan thickness plus 0.5 inch [10 mm] and measurements which are deficient from the plan thickness by more than 1 inch [25 mm] will not be included in the average. Exploratory measurements for determining the extent of an area in which the thickness is outside the construction tolerance will not be included in the average.

When the LOT average thickness of soil-cement base is deficient by more than 1 inch [25 mm] and the judgement of the Engineer is that the area of such deficiency should not be removed and replaced, payment for the area retained will be at 50%.

When multiple deficiencies occur, the applicable percent payment schedule will be applied to the LOT of base that is identified with each deficiency. The penalty for each deficiency will be applied separately to the unit price.

Payment will be made under:

Item No. 270- 1- Soil-Cement Base - per square yard.
Item No. 2270- 1- Soil-Cement Base - per square meter.

SECTION 280

ASPHALT BASE COURSES

280-1 Description.

Construct asphalt base courses, and meet the specific requirements for base widening construction.

The Engineer will accept work on a LOT to LOT basis in accordance with the applicable requirements of Sections 5 and 6. The Engineer will determine the size of the LOT as specified in 331-5 for the bituminous mixture accepted at the plant and as specified in 330-11 for the material accepted on the roadway.

Use mixes designated as Asphalt Base Course Type 1 (ABC-1), Asphalt Base Course Type 2 (ABC-2) and Asphalt Base Course Type 3 (ABC-3).

280-2 Materials.

280-2.1 Bituminous Material: Use Asphalt Cement, Viscosity Grade AC-20 or AC-30, meeting the requirements of 916-1.

280-2.2 Course Aggregates: Meet the requirements of Section 901.

280-2.3 Fine Aggregates: Meet the requirements of 335-2.2.

280-3 General Composition of the Mixes.

280-3.1 General: Meet the requirements of 332-3.1.

280-3.2 Grading Requirements: The mix design, as established by the Contractor and approved by the Department, shall be within the design ranges as specified in Table 331-1, for ABC-1, ABC-2, and ABC-3.

280-3.3 Stability: Meet the requirements of 332-3.3.2.

280-4 Job Mix Formula.

Meet the requirements of 332-3.3.1.

280-5 Contractor's Quality Control.

Meet the requirements of 332-3.4.

280-6 Acceptance of Mixture.

280-6.1 Acceptance at the Plant: The Engineer will accept the bituminous mixture at the plant with respect to gradation and asphalt content in accordance with the requirements of 331-4.

280-6.2 Acceptance on the Roadway: The Engineer will accept the bituminous mixture on the roadway with respect to compacted density in accordance with the applicable provisions of 330-11. Use the permissible variations from longitudinal and transverse grades as specified in 200-7.

280-6.3 Additional Tests: Meet the requirements of 331-4.5 for ABC-1, ABC-2, and ABC-3.

280-7 Plant, Methods, and Equipment.

Meet the plant, methods, and equipment requirements for asphalt base course construction as specified in Section 320, with the following modifications:

(a) Paving Equipment: The Engineer will not require mechanical spreading and finishing equipment for the construction of base widening strips less than 6 feet [1.8 m] in width.

(b) Compacting Equipment: For compaction in areas too restricted to accommodate the standard rollers, the Contractor may use vibratory rollers supplemented with trucks, motor graders, or other compaction equipment approved by the Engineer.

280-8 Construction Requirements.

280-8.1 General: Meet the construction requirements for asphalt base course construction as specified in Section 330, with the following modifications and specific requirements.

280-8.2 Limitations for Spreading: The Contractor may place the base mix on the subgrade when the air temperature is at least 40EF [4EC] and rising, provided the subgrade upon which the base mix is to be placed is not frozen or noticeably affected by frost. The Contractor may place the base mix where he removed all such frozen or frost-affected material during excavation for the subgrade.

280-8.3 Preparation of Subgrade: Before placing the initial layer of base material, prepare and compact the subgrade as specified in 160-8. Do not apply this requirement to base widening strips that are not to be stabilized and where the underlying native material has not been disturbed.

280-8.4 Tacking Between Layers: Place a tack coat between each successive layer of base material. As an exception, the Engineer may authorize the elimination of the tack coat between successive layers when the Contractor has laid them on the same day and the initial layer has not become contaminated by sand, dust, etc.

280-8.5 Placing the Mixture:

280-8.5.1 Spreading and Finishing: Place the base course material with a mechanical spreading and finishing machine meeting the requirements as specified in 320-6. Prior to the placing of the surface course, the Engineer may require motor grader leveling to bring the base into conformance with the plan grades and cross-section. The Contractor may spread the first course of multiple course bases with a motor grader where the subgrade will not support the use of a mechanical spreader.

280-8.5.2 Automatic Screed Control: For all machine-laid courses, use a paver that is equipped with automatic screed control of the ski or traveling string line type. Use the automatic joint matcher on the top course of the base after the first pass with the paving machine.

280-8.5.3 Thickness of Layers: Ensure that the maximum compacted thickness of any layer of asphalt base course is 3 inches [75 mm].

280-8.6 Compacting the Mixture: Apply the requirements for compaction as specified in 330-11 to the compaction of asphalt base courses with these two exceptions:

1. For widening strips 3 feet [1 m] or less in width, the Engineer will require specified target densities but will not require nuclear determinations. The Contractor may apply the compactive efforts using a trench roller, motor grader tires, or any other heavy equipment that will effectively exert a compactive effort. Specify what equipment will be used and what compactive effort (coverage) will be furnished. Obtain the Engineer's approval before starting the operation.

2. For the initial layer of an asphalt base course placed on a soil subgrade, the Engineer will not perform any density determinations. Propose a rolling train and pattern for the approval of the Engineer. The Engineer will perform density determinations on all subsequent layers, and apply the provisions of 330-11.

280-9 Thickness Requirements.

Meet the requirements of 330-15.

280-10 Calculations for Average Thickness of Base.

Meet the requirements of 330-16.

280-11 Method of Measurement.

The quantity to be paid for will be the area, in square yards [square meters], of asphalt base course after adjustment to the equivalent area of specified thickness.

280-12 Basis of Payment.

Prices and payments will be full compensation for all work specified in this Section, including the applicable requirements of Sections 320 and 330.

Payment will be made under:

Item No. 285- 7- Optional Base - per square yard.
Item No. 2285- 7- Optional Base - per square meter.

SECTION 283

RECLAIMED ASPHALT PAVEMENT BASE

283-1 Description.

Construct a base course composed of reclaimed asphalt pavement (RAP) material. Use RAP material as a base course only on paved shoulders, bike paths, or other non-traffic applications.

283-2 Materials.

Obtain the RAP material by either milling or crushing an existing asphalt pavement. Use material so that at least 97% (by weight) pass a 32 inch [90 mm] sieve and is graded uniformly down to dust.

When the RAP material is from a Department project and the composition of existing pavement is known, the Engineer may approve material on the basis of the composition. When the composition of obtained RAP is not known, the following procedure will be used for approval:

(1) Conduct a minimum of six extraction gradation analyses of the RAP material. Take samples at random locations in the stockpile. The average asphalt cement content of the six stockpile samples must be 4% or greater with no individual result below 32%.

(2) Request the Engineer to make a visual inspection of the stockpile of RAP material. Based on this visual inspection of the stockpiled material and the results of the Contractor's extraction gradation analyses, the Engineer will determine the suitability of the materials.

(3) The Engineer may require crushing of stockpiled material to meet the gradation criterion. Perform all crushing before the material is placed.

283-3 Spreading RAP Material.

283-3.1 Method of Spreading: Spread the RAP with a blade or device which strikes off the material uniformly to laying thickness and produces an even distribution of the RAP. The Contractor may also place the RAP material directly from the milling machine into the trench by a conveyor. When placing the RAP material by conveyor directly from the milling machine, obtain the Engineer's approval of the milling process.

283-3.2 Number of Courses: When the specified compacted thickness of the base is greater than 6 inches [150 mm], construct the base in two courses. Place the first course to a thickness of approximately 2 the total thickness of the finished base, or sufficient additional thickness to bear the weight of construction equipment without disturbing the subgrade.

Except as might be permitted by the Engineer for special cases, conduct all RAP base construction operations for shoulders before placing the final pavement on the adjacent traveled roadway.

283-4 Compacting and Finishing Base.

283-4.1 General.

283-4.1.1 Single-Course Base: Construct as specified in 200-6.1.1.

283-4.1.2 Multiple-Course Base: Construct as specified in 200-6.1.2.

283-4.2 Moisture Content: Meet the requirements of 200-6.2. Ensure that the moisture content at the time of compaction is within 2% of optimum.

283-4.3 Density Requirements: After attaining the proper moisture content, compact the material to a density of not less than 95% of maximum density as determined by FM 5-521. Where the width of the base construction is not sufficient to permit use of standard base compaction equipment, perform compaction using vibratory compactors, trench rollers, or other special equipment which will provide the density requirements specified herein.

283-4.4 Density Tests: Meet the requirements of 200-6.4.

283-5 Testing Surface.

Test the surface in accordance with the requirements of 200-7.

283-6 Priming and Maintaining.

283-6.1 Priming: Apply the prime coat only when the base meets the specified density requirements and the moisture content in the top half of the base is within 2% of optimum. At the time of priming, ensure that the base is firm, unyielding, and in such condition that no undue distortion will occur. The Engineer will not allow priming if the surface is dry, dusty, or sloughing.

283-6.2 Maintaining: Meet the requirements of 200-8.2.

SECTION 285

OPTIONAL BASE COURSE

285-1 Description.

Construct a base course composed of one of the optional materials shown on the typical cross-sections.

285-2 Materials.

Meet the material requirements as specified in the Section covering the particular type of base to be constructed.

Limerock ....Section 911
Graded Aggregate...Section 204

Sand-Clay Base ....Section 912
Shell Base ....Section 913
Shell-Rock ....Section 913A
Coquina Shell ....Section 915
Soil-Cement..Section 270
Asphalt ....Section 280

285-3 Selection of Base Option.

The plans will include typical cross-sections indicating the various types of base construction (material and thickness) allowable.

Select one base option as allowed for each typical cross-section shown in the plans. Only one base option is permitted for each typical cross-section.

Notify the Engineer in writing of the base option selected for each typical cross-section at least 45 calendar days prior to beginning placement of base material.

285-4 Construction Requirements.

Construct the base in accordance with the Section covering the particular type of base to be constructed.

Limerock ....Section 200
Graded Aggregate..Section 204
Sand-Clay Base ....Section 240
Shell Base ....Section 250
Shell-Rock ....Section 250
Soil-Cement..Section 270
Asphalt ....Section 280

285-5 Variation in Earthwork Quantities.

The plans will identify the optional materials used by the Department for determining the earthwork quantities (Roadway Excavation, Borrow Excavation, Subsoil Excavation, Subsoil Earthwork, or Embankment). The Department will not revise the quantities, for those items having final pay based on plan quantity, to reflect any volumetric change caused by the Contractor=s selection of a different optional material.

285-6 Thickness Requirements.

285-6.1 Measurements: When the Department is ready to check the finished base or granular subbase component of a composite base for thickness, provide traffic control, coring/boring equipment, and an operator for the coring/boring equipment. Provide traffic control in accordance with the standard maintenance of traffic requirements of the Contract. The Department will make no additional payment for traffic control or coring/boring. The Engineer will select the coring/boring locations and make the acceptance measurements.

Have a Contractor representative present during the entire coring/boring operations for acceptance purposes.

Except for asphalt base courses, the Engineer will measure the thickness of the base or subbase through holes, at least 3 inches [75 mm] in diameter, bored at random points on the cross-section and along the roadway. The Engineer will locate each hole to represent a section of main roadway no longer than 200 feet [60 m], regardless of the number of lanes. The Engineer will determine the thickness of the base or subbase on shoulders and widening separate from the main roadway and will locate each hole to represent a section no longer than 400 feet [120 m] for each shoulder or widening.

For subbases, meet the thickness requirements of 290-4.

The Engineer will determine the thickness of asphalt base courses in accordance with 330-16.

285-6.2 Correction of Deficient Areas: For non-asphalt bases, correct all areas of the completed base having a deficiency in thickness in excess of 2 inch [13 mm] by scarifying and adding additional base material. As an exception, if authorized by the Engineer, such areas may be left in place without correction and with no payment.

For asphalt bases, correct all areas of deficient thickness in accordance with 330-14.

285-7 Calculation of Average Thickness of Base.

For bases that are not mixed in place, the Department will determine the average thickness from the measurements specified in 285-6.1, calculated as follows;

(a) When the measured thickness is more than 2 inch [13 mm] greater than the design thickness shown on the typical cross-section in the plans, it will be considered as the design thickness plus 2 inch [13 mm].

(b) Average thickness will be calculated per typical cross-section for the entire job as a unit.

(c) Any areas of base left in place with no payment will not be included in the calculations.

(d) Where it is not possible through borings to distinguish the base materials from the underlying materials, the thickness of the base used in the measurement will be the design thickness.

285-8 Method of Measurement.

The quantity to be paid for will be the plan quantity area in square yards [square meters], omitting any areas where under-thickness is in excess of the allowable tolerance as specified in 285-6. The pay area will be the surface area, determined as provided above, adjusted in accordance with the following formula:

$$Pay\ Area = Surface\ Area\left(\frac{Calculated\ Average\ Thickness\ per\ 285\text{-}7}{Plan\ Thickness}\right)$$

The pay area shall not exceed 105% of the surface area.

There will be no adjustment of the pay area on the basis of thickness for base courses constructed utilizing mixed-in-place operations.

285-9 Basis of Payment.

Price and payment will be full compensation for all work specified in this

Section, including tack coat between base layers, prime coat, cover material for prime coat, bituminous material used in bituminous plant mix, and cement used in soil-cement.

Where the plans include a typical cross-section which requires the construction of an asphalt base only, price adjustments for bituminous material provided for in 9-2.1.1 will apply to that typical cross-section. For typical cross-sections which permit the use of asphalt or other materials for construction of an optional base, price adjustments for bituminous material provided for in 9-2.1.1 will not apply.

Payment will be made under:

Item No. 285-7 - Optional Base - per square yard.
Item No. 2285-7 - Optional Base - per square meter.

SECTION 286

TURNOUT CONSTRUCTION

286-1 Description.

Construct turnouts or extend existing turnouts on resurfacing and widening-resurfacing projects.

The Department does not include placing of asphaltic concrete surface course over turnouts in this Section.

286-2 Materials.

For base material for turnouts, use any material currently specified by the Department for base or surface construction, except do not use hot bituminous mixtures intended for use as open-graded friction course. Proportion bituminous mixtures in accordance with a job-mix formula approved by the Department.

In general, the Engineer will accept the material on the basis of visual inspection, with no testing required.

286-3 Excavation.

Excavate the area over which turnout construction is to be accomplished to the dimensions shown in the plans or the Roadway and Traffic Design Standards. If the surface of the underlying soil is disturbed during the excavation operation, compact it to the approximate density of the surrounding undisturbed soil.

If an existing paved turnout lies within the specified limits for turnout construction, leave the existing base and surface in place, as directed by the Engineer.

286-4 Spreading, Compacting, and Finishing Base.

Uniformly spread base material over the prepared area to a depth which will, upon completion of compaction and finishing, result in turnout base conforming with the specified lines and elevations. Then, strike off the base material to a plane paralleling the finished surface, and compact it in a manner similar to that used in the construction of roadway base. The Engineer will not require any specific density.

Finish the surface to the specified grade and cross-section.

286-5 Method of Measurement.

The quantity to be paid for will be the area, in square yards [square meters], except, when turnout construction is specified to be paid for by weight of mixture, the weight will be measured as specified in 320-2.

286-6 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section, including excavating; compacting excavated areas; furnishing material; placing, compacting, and finishing of base; and incidental work.

The cost of any bituminous material used in hot bituminous mix, or for prime coat or tack coat between base layers, will not be paid for separately.

Payment will be made under:

Item No. 286- 1- Turnout Construction - per square yard.
Item No. 2286- 1- Turnout Construction - per square meter.
Item No. 286- 2- Turnout Construction (Asphalt) - per ton.
Item No. 2286- 2- Turnout Construction (Asphalt) - per metric ton.

SECTION 290

GRANULAR SUBBASE

290-1 Description.

Construct a granular subbase as a component of an Optional Base.

290-2 Materials.

Select one of the materials listed below and conform to the following requirements:

Limerock ....Section 911
Cemented Coquina ....Section 915
Bank Run Shell..Section 913
Shell Rock ....Section 913A
Graded Aggregate... 204-2

290-3 Construction Methods.

For the subbase material selected, construct the subbase in conformance with the following:

Limerock ....Section 200
Cemented Coquina ....Section 204
Bank Run Shell..Section 250
Shell Rock ....Section 250
Graded Aggregate...Section 204

Straightedge and hard-planing provisions will not apply. Compact the subbase to an average of not less than 98% of the maximum density as determined under

FM 5-521. The minimum acceptable density at any location within the subbase is 95% of maximum. The highest density used in calculating the average density will be 100% of the maximum.

Priming is not required.

290-4 Thickness Requirements.

290-4.1 General: Do not substitute granular subbase materials in excess of the tolerance specified for the asphalt portion of the Optional Base.

290-4.2 Measurements: When the Department is ready to measure the finished subbase, provide the coring equipment and the operator and include this in the unit price for Optional Base. The Engineer will select the coring locations and make the acceptance measurements. Thickness measurements will be taken through 3 inch [75 mm] diameter holes. For subbase areas greater than 1,000 yd^2 [840 m^2], the minimum frequency of measurement will be one per 200 feet [60 meters] of roadway. For smaller subbase areas, the minimum frequency of measurement will be one per 500 yd^2 [420 m^2] of subbase.

290-4.3 Maximum Allowable Thickness: The maximum allowable thickness of the subbase is 43 inches [105 mm]. Remove and replace areas of subbase exceeding the maximum allowable thickness.

290-4.4 Minimum Allowable Thickness: The minimum allowable thickness of the subbase is 32 inches [90 mm]. Remove and replace areas not meeting the minimum allowable thickness. If authorized by the Engineer, additional asphalt may be substituted to achieve the full combined Optional Base thickness.

BITUMINOUS TREATMENTS,
SURFACE COURSES AND CONCRETE PAVEMENT

SECTION 300

PRIME AND TACK COATS FOR BASE COURSES

300-1 Description.

Apply bituminous prime coats on previously prepared bases, and apply bituminous tack coats on previously prepared bases and on existing pavement surfaces.

300-2 Materials.

300-2.1 Prime Coat: For prime coat, use Cut-back Asphalt Grade RC-70 or RC-250 meeting the requirements of 916-3; Emulsified Asphalt Grades SS-1 or CSS-1, SS-1H, or CSS-1H diluted in equal proportion with water; Emulsified Asphalt Grade AE-60, AE-90, AE-150, or AE-200 diluted at the ratio of six parts emulsified asphalt to four parts water; Special MS-Emulsion diluted at the ratio of six parts emulsified asphalt to four parts water; Asphalt Emulsion Prime (AEP), Emulsion Prime (RS Type), or EPR-1 Prime meeting the requirements of 916-4, or other types and grades of bituminous material which may be specified in the Contract Documents.

Where the above materials for use as a prime coat are to be diluted, certify that the dilution was done in accordance with this Section for each load of material used.

The Contractor may select any of the specified bituminous materials unless the Contract Documents indicate the use of a specific material. The Engineer may allow types and grades of bituminous material other than those specified above if the Contractor can show that the alternate material will properly perform the function of prime coat material.

300-2.2 Cover Material for Prime Coat: Uniformly cover the primed base by a light application of cover material. However, if using EPR-1 prime material, the Engineer may waive the cover material requirement if the primed base is not exposed to general traffic and construction traffic does not mar the prime coat so as to expose the base. The Contractor may use either sand or screenings for the cover material. For the sand, meet the requirements as specified in 902-2 or 902-6, and for the screenings, meet the requirements as specified in 902-5. If exposing the primed base course to general traffic, apply a cover material that has been coated with 2 to 4% asphalt cement. Apply the asphalt coated material at approximately 10 lb/yd^2 [5.5 kg/m^2]. Roll the entire surface of asphalt coated prime material with a traffic roller as required to produce a reasonably dense mat.

300-2.3 Tack Coat: Unless the Contract Documents call for a specific type or grade of tack coat, use undiluted Emulsified Asphalt Grades RS-1 or RS-2 meeting the requirements of 916-4. Heat RS-1 or RS-2 to a temperature of 140 to 180EF [60 to 82EC]. The Contractor may use RS-1 modified to include up to 3% naphtha to improve handling of the material during the winter months.

For night paving, use AC-5 tack coat meeting the requirements of 916-1 heated to a temperature of 250 to 300EF [120 to 150EC].

The Engineer may approve RS-1 or RS-2 for night paving if the Contractor demonstrates, at the time of use, that the emulsion will break to allow paving in a timely manner.

300-3 Equipment.

300-3.1 Pressure Distributor: Provide a pressure distributor that is equipped with pneumatic tires having a sufficient width of rubber in contact with the road surface to avoid breaking the bond or forming a rut in the surface. Ensure that the distance between the centers of openings of the outside nozzles of the spray bar is equal to the width of the application required, within an allowable variation of 2 inches [50 mm]. Ensure that the outside nozzle at each end of the spray bar has an area of opening not less than 25% or more than 75% in excess of the other nozzles. Ensure that all other nozzles have uniform openings. When the application covers less than the full width, the Contractor may allow the normal opening of the end nozzle at the junction line to remain the same as those of the interior nozzles.

300-3.2 Sampling Device: Equip all pressure distributors and transport tanks with an approved spigot-type sampling device.

300-3.3 Temperature Sensing Device: Equip all pressure distributors and transport tanks with an approved dial type thermometer.

Use a thermometer with a temperature range from 50 to 500EF [10 to 260EC] with maximum 25EF [10EC] increments with a minimum dial diameter of 2 inches [50 mm].

Locate the thermometer near the midpoint in length and within the middle third of the height of the tank, or as specified by the manufacturer (if in a safe and easily accessible location). Enclose the thermometer in a well with a protective window or by other means as necessary to keep the instrument clean and in the proper working condition.

300-4 Cleaning Base and Protection of Adjacent Work.

Before applying any bituminous material, remove all loose material, dust, dirt, caked clay and other foreign material which might prevent proper bond with the existing surface for the full width of the application. Take particular care in cleaning the outer edges of the strip to be treated, to ensure that the prime or tack coat will adhere.

When applying the prime or tack coat adjacent to curb and gutter, valley gutter, or any other concrete surfaces, cover such concrete surfaces, except where they are to be covered with a bituminous wearing course, with heavy paper or otherwise protect them as approved by the Engineer, while applying the prime or tack coat. Remove any bituminous material deposited on such concrete surfaces.

300-5 Weather Limitations.

Do not apply prime and tack coats when the air temperature in the shade and away from artificial heat is less than 40EF [5EC] at the location where the application is to be made or when weather conditions or the surface conditions are otherwise unfavorable.

300-6 Application of Prime Coat.

300-6.1 General: Clean the surface to be primed and ensure that the moisture content of the base does not exceed 90% of the optimum moisture. Ensure that the temperature of the prime material is between 100 and 150EF [40 and 65EC]. The Engineer will designate the actual temperature to ensure uniform distribution. Apply the material with a pressure distributor. Determine the application amount based on the character of the surface. Use an amount sufficient to coat the surface thoroughly and uniformly with no excess.

300-6.2 Rate of Application:

300-6.2.1 Limerock, Limerock Stabilized, and Local Rock Bases: For these bases, use a rate of application that is not less than 0.10 gal/yd^2 [0.50 L/m^2], unless a lower rate is directed by the Engineer.

300-6.2.2 Sand-Clay, Shell and Shell Stabilized Bases: For these bases, use a rate of application that is not less than 0.15 gal/yd^2 [0.7 L/m^2], unless a lower rate is directed by the Engineer.

300-6.3 Sprinkling: If so required by the Engineer, lightly sprinkle the base with water and roll it with a traffic roller in advance of the application of the prime coat.

300-6.4 Partial Width of Application: If traffic conditions warrant, the Engineer may require that the application be made on only 2 the width of the base at one time, in which case use positive means to secure the correct amount of bituminous material at the joint.

300-7 Application of Tack Coat.

300-7.1 General: Where the Engineer requires a tack coat prior to laying a bituminous surface, apply the tack coat as specified herein below.

300-7.2 Where Required: In general, the Engineer will not require a tack coat on primed bases except in areas that have become excessively dirty and cannot be cleaned, or in areas where the prime has cured to the extent that it has lost all bonding effect. Generally, the Engineer will require a tack coat on hot bituminous base courses before placing the surface course.

300-7.3 Method of Application: Apply the tack coat with a pressure distributor except that on small jobs, if approved by the Engineer, apply it by other mechanical devices or by hand methods. Heat the bituminous material to a suitable temperature as designated by the Engineer, and apply it in a thin, uniform layer.

300-7.4 Rate of Application: Use a rate of application between 0.02 and 0.08 gal/yd^2 [0.09 and 0.36 L/m^2]. For tack coat applied on concrete pavement which is to be surfaced, use a rate of application that exceeds the upper limit when directed by the Engineer. For open-graded friction course, set the target rate of application at 0.045 gal/yd^2 [0.20 L/m^2].

300-7.5 Curing and Time of Application: The Engineer will designate the curing period for the tack coat. Apply the tack coat sufficiently in advance of the laying of the bituminous mix to permit drying, but do not apply the tack coat so far in advance that it might lose its adhesiveness as a result of being covered with dust or other foreign material.

300-7.6 Protection: Keep the tack coat surface free from traffic until the subsequent layer of bituminous hot mix has been laid.

300-8 Method of Measurement.

300-8.1 General: The quantity to be paid for will be the volume, in gallons [liters], of bituminous material actually applied and accepted. This quantity will be determined from measurements made by the Engineer based on tank calibrations, as specified in 300-8.2. Where it is specified that prime coat material or tack coat material is to be diluted with water, the quantity to be paid for will be the volume after dilution.

300-8.2 Calibration of Tanks: Ensure that all distributors used for applying tack or prime coats are calibrated prior to use by the Engineer or by a reliable and recognized firm engaged in calibrating tanks. The Engineer will review and approve of all calibrations.

300-8.3 Temperature Correction: The Engineer will measure the volume and increase or decrease the volume actually measured to a corrected volume at a temperature of 60EF [15EC].

The Engineer will make the correction for temperature by applying the applicable conversion factor (K), as shown below.

For petroleum oils having a specific gravity (60EF/60EF) [(15EC/15EC)] above 0.966, K = 0.00035 [0.00063] per degree.

For petroleum oils having a specific gravity (60EF/60EF) [(15EC/15EC)] of between 0.850 and 0.966, K = 0.00040 [0.00072] per degree.

For emulsified asphalt, K = 0.00025 [0.00045] per degree.

When volume-correction tables based on the above conversion factors are not available, the Engineer will use the following formula in computing the corrections for volumetric change:

$$V = \frac{V^1}{K\,(T - 60)[(T15)] + 1}$$

Where:

V= Volume of the bituminous material at 60EF [15EC](pay volume).

V^1= Volume of bituminous material as measured.

K= Correction factor (Coefficient of Expansion).

T= Temperature (in EF [EC]), of the bituminous material when measured.

300-9 Basis of Payment.

Price and payment will be full compensation for all the work specified in this Section, including heating, hauling, and applying.

Prime and tack materials for Optional Base and Turnout Construction will be paid for under 285-9 and 286-6, respectively.

No separate payment will be made for prime coat cover material (including hot-asphalt coated cover material and the bituminous material therein), but the Contractor shall include the costs for furnishing and applying such material in the Contract unit price for Bituminous Material (Prime Coat).

Payment will be made under:

Item No. 300- 1- Bituminous Material - per gallon.
Item No. 2300- 1- Bituminous Material - per liter.

SECTION 310

BITUMINOUS SURFACE TREATMENT

(Including Mineral Seal Coat)

310-1 Description.

Construct a wearing surface composed of separate applications of bituminous material covered with aggregate, either in single applications, double (alternate) applications, or triple (alternate) applications.

310-2 Composition and Proportioning.

The tables below show the composition and proportioning for the various types of bituminous surface treatment and for mineral seal coat. Consider the limiting ranges of bituminous material and of cover material, as specified in the tables, and the proportions shown for Type 1-B, as general only. The Engineer may extend the ranges up or down if considered appropriate.

NON SI UNITS

Proportions for Bituminous Surface Treatment

			Cover Material		Bituminous Material	
Type	Application	Aggregate Size No.	Cubic Feet of Stone per Square Yard	Cubic Feet of Slag per Square Yard	Gallons of Asphalt Cement per Square Yard	Gallons of Emulsified Asphalt per Square Yard
1-A		56	0.42-0.46	0.45-0.52	0.30-0.45	0.36-0.54
1-B		6	0.32-0.38	0.35-0.42	0.20-0.30	0.24-0.36
*1-B		6	0.34	0.38	0.30	0.33
2	1st	56	0.42-0.46	0.46-0.52	0.18-0.22	0.22-0.26
	2nd	7	0.18-0.24	0.22-0.26	0.26-0.31	0.31-0.37
3	1st	56	0.42-0.46	0.46-0.52	0.18-0.22	0.22-0.26
	2nd	7	0.18-0.24	0.22-0.26	0.25-0.29	0.30-0.35
	3rd	89	0.10-0.16	0.10-0.16	0.18-0.22	0.22-0.26

*For use in conjunction with Asphaltic Concrete.

SI UNITS

Proportions for Bituminous Surface Treatment

			Cover Material		Bituminous Material	
Type	Application	Aggregate Size No.	Cubic Meter of Stone per Square Meter	Cubic Meter of Slag per Square Meter	Liters of Asphalt Cement per Square Meter	Liters of Emulsified Asphalt per Square Meter
1-A		56	0.014-0.016	0.015-0.018	1.4 - 2.0	1.6 - 2.4
1-B		6	0.011-0.013	0.012-0.014	0.9 - 1.4	1.1 - 1.6
*1-B		6	0.012	0.013	1.4	1.5
2	1st	56	0.014-0.016	0.016-0.018	0.8 - 1.0	1.0 - 1.2
	2nd	7	0.006-0.008	0.008-0.009	1.2 - 1.4	1.4 - 1.7
3	1st	56	0.014-0.016	0.016-0.018	0.8 - 1.0	1.0 - 1.2
	2nd	7	0.006-0.008	0.008-0.009	1.1 - 1.3	1.4 - 1.6
	3rd	89	0.003-0.005	0.003-.005	0.8 - 1.0	1.0 - 1.2

*For use in conjunction with Asphaltic Concrete.

(The Engineer will also allow cut-back asphalt, in the same proportions as shown for Asphalt Cement.)

NON SI UNITS

Proportions for Mineral Seal Coat

Cover Material		Bituminous Material	
Aggregate Size No.	Cubic Feet per Square Yard	Gallons of AC or RC per Square Yard	Gallons of Emulsified Asphalt per Square Yard
6	0.32 - 0.38	0.22 - 0.35	0.25 - 0.40
7	0.18 - 0.26	0.15 - 0.22	0.17 - 0.25
**89	0.13 - 0.18	0.12 - 0.18	0.14 - 0.23

** Use Size No. 89 unless other grade is specifically specified.

SI UNITS

Proportions for Mineral Seal Coat

Cover Material		Bituminous Material	
Aggregate Size No.	Cubic Meters per Square Meter	Liters of AC or RC per Square Meter	Liters of Emulsified Asphalt per Square Meter
6	0.011 - 0.013	1.0 - 1.6	1.1 - 1.8
7	0.006 - 0.009	0.7 - 1.0	0.8 - 1.1
**89	0.004 - 0.006	0.5 - 0.8	0.6 - 1.0

**Use Size No. 89 unless other grade is specifically specified.

310-3 Materials.

310-3.1 General Materials: Meet the following requirements:

(1) Bituminous Material:

Asphalt Cement, Viscosity Grade AC-5 916-1
Asphalt Cement, Viscosity Grade AC-10 916-1
Cut-back Asphalt, Grade RC-3000 916-3
Emulsified Asphalt, Grade CRS-2 and CRS-2H 916-4
Emulsified Asphalt, Grade RS-2.. 916-4

(2) Cover Material, limestone, slag or granite..........................Section 901

310-3.2 Alternate Bituminous Materials Shown in Proposal: Except for surface treatment used in conjunction with asphaltic concrete, the proposal will call for the use of either asphalt cement or emulsified asphalt as the bituminous material. If asphalt cement is stipulated in the Contractor's bid, the Engineer will restrict its actual use by seasonal requirements as provided in 310-3.4.

310-3.3 Optional Bituminous Materials for Surface Treatment Used in Conjunction with Asphaltic Concrete: For surface treatment used in conjunction with asphaltic concrete, the alternate items will not be shown, and the Contractor may choose the type to use, except as limited below for seasonal requirements.

310-3.4 Seasonal Requirements: For the asphalt cement alternate or option, in the event that the surface treatment or mineral seal coat is to be applied during the months of November through April, use cut-back asphalt or emulsified asphalt, Grade RS-2 or CRS-2, instead. During the remaining months of the year, the Contractor may use cut-back asphalt or emulsified asphalt in lieu of asphalt cement. When the Contractor uses emulsified asphalt and the Contractor based his bid on the use of asphalt cement, the Department will reduce the Contract unit price for bituminous material used in bituminous surface treatment or mineral seal coat by 10%.

310-3.5 Alternate Use of Aggregates: Unless first obtaining written permission from the Engineer, do not use coarse aggregates of different color in sections less than 1 mile [1.5 km] in length.

310-4 Equipment.

310-4.1 Pressure Distributor: Provide a pressure distributor that meets the requirements of 300-3.1.

310-4.2 Spreading Equipment: Provide sufficient trucks and aggregate spreaders at the site of the work to ensure continuous spreading of the aggregate on the uncovered bituminous material. Use a spreader of the mechanical type that is self-supported (towed) or self-propelled and is capable of producing a smooth, uniform distribution of the cover material. Do not use spreaders of the type attached directly to the rear of the truck body (tail gate spreaders).

310-4.3 Rollers: Provide rollers that are 3 to 5 ton [2.7 to 4.5 metric ton] steel-tired, or combination steel and rubber-tired, rollers and self-propelled, pneumatic-tired traffic type rollers equipped with at least seven smooth-tread, low-pressure tires and capable of carrying a gross load of at least 8 tons [7 metric tons]. Maintain the inflation of the tires such that in no two tires the air pressure varies more than 5 psi [35 kPa]. Load the traffic roller as directed by the Engineer.

310-5 Limitations to Width of Application.

Apply bituminous and cover materials over the entire width to be treated unless, in the opinion of the Engineer, traffic conditions are not suitable for full-width application. If traffic conditions are not suitable for full-width application, confine the application to one side of the road at one time over such area as the economical distribution of material from one delivery point will permit, leaving the other side open for traffic.

310-6 Preparation of Road Surface.

310-6.1 Cleaning: Sweep the surface to be covered clean and free of sand, dirt, dust, and other deleterious material by means of mechanical rotary sweepers, hand brooms, or other approved methods, and keep the surface free from moisture.

310-6.2 Condition of Underlying Surface: Where a prime coat has previously been applied to the surface, do not apply bituminous material until the prime coat has become thoroughly cured, as determined by the Engineer. Do not apply surface treatment over any pavement mixture when, due to heat from the sun or insufficient length of the curing period, the stability of the existing pavement is such as to allow penetration or displacement of the existing surface by the cover material during the rolling operations.

310-7 Protection of Adjacent Surfaces.

Where applying these surface courses adjacent to curb and gutter, valley gutter, or any other concrete surface, cover the concrete surfaces with heavy paper or other protection as approved by the Engineer during application of the bituminous material. Immediately remove any bituminous material deposited on such concrete surfaces.

310-8 Weather Limitations.

Do not apply bituminous material when the air temperature in the shade and away from artificial heat is less than 60 EF [15EC] at the location where application is to be made, or when weather conditions or the surface conditions are otherwise unfavorable.

310-9 Application of Bituminous Material.

310-9.1 Distributor Pressure: After cleaning the surface to be treated to the satisfaction of the Engineer, uniformly spray the bituminous material over the surface by means of a pressure distributor. When a surface constructed under this Section is on a paved shoulder, use a stringline or other approved method to produce a uniform line along the edge of the applied bituminous material adjacent to the traffic lanes. Use a distributor that maintains a pressure of at least 20 psi [140 kPa], but not more than 75 psi [520 kPa].

310-9.2 Application Temperatures: For asphalt cement, maintain an application temperature between 300 and 350EF [150 and 175EC]. For emulsified asphalt, maintain an application temperature between 100 and 170EF [38 and 75EC]. For cut-back asphalt, maintain an application temperature between 175 and 275EF [80 and 135EC].

310-9.3 Uniformity of Distribution: Take special precautions to obtain an even and uniform distribution of bituminous material, and adjust and operate the distributor so as to maintain uniform, even distribution of the type of material being applied. Immediately remove excessive deposits of bituminous material upon the road surface caused by stopping or starting the distributor, by leakage, or otherwise.

310-9.4 Limitations to Application: Ensure that the area to be covered by any one application of bituminous material is not greater than the aggregate can cover without interruption due to limitations of hauling and spreading equipment or to any other cause.

For double and triple application surface treatments, apply the second and third applications of bituminous and cover materials the same day as the first application, as far as is practicable and consistent with the curing requirements as specified in 310-11.

310-10 Spreading Cover Material.

310-10.1 Spreading: Spread the cover material immediately following each application of bituminous material. Uniformly distribute the cover material over the bituminous surface in one, two, or three courses, as specified. Perform spreading using approved mechanical spreaders. Use only drivers experienced in this type of work for driving the spreaders (or trucks when using towed spreaders). Do not drive trucks or spreaders on the uncovered bituminous material.

310-10.2 Double Application: For double application, distribute the cover material alternately over the bituminous surface in two separate courses. Apply the coarse size immediately after the first application of bituminous material, and uniformly distribute an amount that will cover the surface completely with a single layer of material. Broom the first application as needed to obtain a uniform surface, ensuring that no piece of cover material rests on top of another, and then roll it. After rolling and curing the first application as specified in 310-11, apply the second application of bituminous material, and immediately thereafter distribute the fine size cover material uniformly over the surface in the quantity specified or in an amount that completely fills the voids of the first application. Then, broom the fine size cover material as needed to secure a smooth and uniform surface, and roll it as specified in 310-11.

310-10.3 Triple Application: For triple application surface treatment, apply the cover material in three applications in the proportions specified. Spread, broom, and roll the first and second applications of bituminous and cover materials as provided in this Subarticle for double application surface treatment. Then, spread, broom, and roll the third application of bituminous and cover material as provided for the second application.

310-10.4 Brooming and Dressing: Immediately after each application of cover material, broom the surface in order to secure a uniform distribution of cover material and a smooth surface. Place additional aggregate by hand on any areas not properly covered. If deemed necessary by the Engineer, drag the surface with a light drag broom or other dragging equipment approved by the Engineer, of a type that will not disturb the embedded aggregate. Supplement this operation by additional hand brooming until obtaining a smooth and even surface. Repeat the dragging and brooming in conjunction with the rolling for as long as required to ensure a uniform surface. Apply these dragging requirements for each application of cover material.

310-11 Rolling and Curing.

310-11.1 General Requirements: Immediately after the spreading and dragging of each application of cover material, roll the entire surface. Begin the rolling within 30 minutes after the spreading of cover material. Begin rolling at the edges and progress to the center of the surface, uniformly lapping each preceding pass and thoroughly covering the entire surface. During rolling, perform additional dragging and hand brooming as specified in 310-10.5.

First, roll the entire surface with a traffic roller, followed immediately with a steel-wheeled roller. Cover the entire surface one time with the steel-wheeled roller. Then, roll the cover material again with the traffic roller.

Continue the rolling as long as is necessary to ensure thorough keying of the cover material into the bituminous material and to secure a uniformly closed surface.

310-11.2 Omission of Steel-Tired Roller: On stabilized bases or where the surface to be covered is irregular, the Contractor may omit rolling with the steel-tired roller, if so directed by the Engineer.

310-11.3 Shoulder Pavement: For bituminous surface treated shoulder pavement, the Engineer may require additional rolling as he deems necessary in order to compensate for the lack of subsequent rolling by highway traffic.

310-11.4 Curing Surface Treatment Used in Conjunction with Asphaltic Concrete: When covering the surface treatment with an asphaltic concrete course, thoroughly cure the surface treatment for a period of at least 30 days prior to applying the overlying course. When constructing the roadway under traffic, or otherwise wherever feasible to route traffic over the section, place traffic on the surface treatment for this 30-day curing period. In the event the Engineer considers that such traffic is sufficient to effect the required curing of the surface treatment in less than 30 days, he may shorten this 30-day period and notify the Contractor, in writing, that the surface treatment is cured sufficiently for placing the asphaltic concrete.

310-12 Surface Requirements.

Provide a finished surface that is uniform and conforms to the lines, grades, and typical cross-section shown in the plans. Remove all portions of the completed surface that are defective, are not properly finished, have fat joints, or are not in reasonably close conformance with these Specifications, and replace them with a satisfactory surface. The Department will not pay for the defective work and its removal.

When placing an asphaltic concrete course over the surface treatment, remove, or otherwise correct, any joint showing an excess of bituminous material before placing the overlying surface course.

310-13 Protection.

After applying the bituminous material, do not allow traffic to use the road until placing and thoroughly rolling the cover material. If practicable, keep traffic off the finished surface for the first 48 hours after completing finishing. Where it is impracticable to keep traffic off the finished surface for such period, restrict traffic to a maximum speed of 15 mph [25 km/h] during this time. For this purpose, furnish and maintain suitable barricades and lights, and provide watchmen and vehicles to lead traffic through the sections of the roadway being protected. Keep at least two such watchmen on duty continuously during this 48-hour restricted period, and provide a sufficient number to ensure enforcement of the 15 mph [25 km/h] maximum speed.

310-14 Method of Measurement.

310-14.1 Bituminous Material: The quantity to be paid for will be the volume, in gallons [liters], applied on the road and accepted, determined as provided in 300-8.

310-14.2 Cover Material: The quantity to be paid for will be the volume, in cubic yards [cubic meters], applied on the road and accepted, determined by measurement, in loose volume, in truck bodies for the particular type of surface treatment or for mineral seal coat.

310-14.3 Surface Treatment Placed with Asphaltic Concrete: As an exception to the above, when the Contractor places the surface treatment in conjunction with asphaltic concrete, compensation for surface treatment will be included in the payment for the asphaltic concrete course.

310-15 Basis of Payment.

310-15.1 Bituminous Material: Price and payment will be full compensation for furnishing all the materials and for heating, hauling, and applying.

310-15.2 Deduction for Deficiency in Viscosity or Deficiency from Minimum Percent Residue Required: The Contract unit price for Bituminous Material will be subject to the pay reduction tables contained in Section 916.

310-15.3 Cover Material: Price and payment will be full compensation for all the work described in this Section, except for the work paid for under the item of Bituminous Material.

310-15.4 Payment Items: Payment will be made under:

Item No. 300- 1-	Bituminous Material - per gallon.
Item No. 2300- 1-	Bituminous Material - per liter.
Item No. 310- 1-	Cover Material for Single Surface Treatment - per cubic yard.
Item No. 2310- 1-	Cover Material for Single Surface Treatment - per cubic meter.
Item No. 310- 2-	Cover Material for Type 2 Surface Treatment - per cubic yard.
Item No. 2310- 2-	Cover Material for Type 2 Surface Treatment - per cubic meter.
Item No. 310- 3-	Cover Material for Type 3 Surface Treatment - per cubic yard.
Item No. 2310- 3-	Cover Material for Type 3 Surface Treatment - per cubic meter.
Item No. 310- 4-	Cover Material for Mineral Seal Coat - per cubic yard.
Item No. 2310- 4-	Cover Material for Mineral Seal Coat - per cubic meter.

SECTION 311

SAND SEAL COAT

311-1 Description.

Provide a sand seal coat composed of bituminous material applied in one application and covered with sand cover material applied in a single application. Construct this work on cement-treated subgrade.

311-2 Proportioning.

Use the approximate proportions for the sand seal coat as follows:

Bituminous Material......................... 0.15 - 0.25 gal/yd^2 [0.7 to 1.1 L/m^2]

Cover Material..........................0.10 - 0.20 ft^3/yd^2 [0.003 to 0.007 m^3/m^2]

The Engineer will designate the actual spread for each material.

311-3 Materials.

311-3.1 Bituminous Material: Meet the following requirements:

Asphalt Cement, Viscosity Grade AC-5 916-1
Emulsified Asphalt, Grade RS-2.. 916-4

During the months of November through April, use emulsified asphalt. During the remaining months of the year, use asphalt cement or emulsified asphalt, unless asphalt cement is specified

311-3.2 Cover Material: Use clean and nonplastic sand composed of hard durable grains and free from loam, roots, clay balls, and other deleterious substances. The Contractor may use local sand if it meets the above requirements. Obtain the Engineer's approval of the sand.

311-4 Weather Limitations.

Do not apply bituminous material when the air temperature in the shade and away from artificial heat is less than 60EF [15EC] at the location where the application is to be made, or when weather conditions or the surface conditions are otherwise unfavorable.

311-5 Construction Methods.

311-5.1 Application of Bituminous Material: Meet the requirements as specified for bituminous surface treatments in 310-9.

311-5.2 Application of Cover Material: Apply sand uniformly at the rate designated by the Engineer. If the Engineer considers it necessary for the proper distribution of the spread, lightly drag the sand with a drag broom. Roll the entire area of the sand with at least ten passes of a traffic roller. Prior to the placing of concrete pavement over the sand seal coat, remove any excess sand from the surface of the cement-treated subgrade.

311-6 Method of Measurement.

311-6.1 Bituminous Material: The quantity to be paid for will be the volume, in gallons [liters], applied on the road and accepted, determined as provided in 300-8.

311-6.2 Cover Material: The quantity to be paid for will be the volume, in cubic yards [cubic meters], applied on the road and accepted, determined by measurement, in loose volume, in truck bodies.

311-7 Basis of Payment.

Prices and payments will be as specified for bituminous surface treatment in 310-15, except that the cover material will be paid for under Sand Cover Material.

Payment will be made under:

Item No. 300- 1- Bituminous Material - per gallon.
Item No. 2300- 1- Bituminous Material - per liter.
Item No. 311- 1- Sand Cover Material - per cubic yard.

Item No. 2311- 1- Sand Cover Material - per cubic meter.

SECTION 312

BITUMINOUS CRACK RELIEF LAYER

312-1 Description.

Construct a crack relief layer composed of a separate application of bituminous material covered with a single application of aggregate.

312-2 Composition and Proportioning.

Use the composition and proportioning for the crack relief layer as shown in the table below. The range of bituminous material and cover material are approximate. The Engineer may increase or decrease the range.

NON SI UNITS

Proportions For Crack Relief Layer

Aggregate Grade	Cover Material ft^3/yd^2	Bituminous Material gal/yd^2	
		Asphalt Cement	Emulsified Asphalt
67	0.32 - 0.38	0.20 - 0.30	0.29 - 0.43

SI UNITS

Proportions For Crack Relief Layer

Aggregate Grade	Cover Material m^3/m^2	Bituminous Material L/m^2	
		Asphalt Cement	Emulsified Asphalt
67	0.011 - 0.013	0.9 - 1.4	1.3 - 1.9

312-3 Materials.

Meet the following requirements:

(1) Bituminous Material:

Asphalt Cement, Viscosity Grade AC-5 916-1
Asphalt Cement, Viscosity Grade AC-10 916-1
Emulsified Asphalt, Grade RS-2.. 916-4

(2) Cover Material:

Stone, Slag, or Crushed Gravel...Section 901

312-4 Equipment.

312-4.1 Pressure Distributor: Provide a pressure distributor that meets the requirements of 300-3.1.

312-4.2 Spreading Equipment: Provide spreading equipment that meets the requirements of 310-4.2.

312-4.3 Rollers: Provide pneumatic-tired traffic type rollers equipped with at least seven smooth-tread, low-pressure tires and capable of carrying a gross load of at least 8 tons [7 metric tons]. Maintain the inflation of the tires such that in no two tires the air pressure varies more than 5 psi [35 kPa]. Load the traffic roller as directed by the Engineer.

312-5 Limitations to Width of Application.

Confine the application of bituminous and cover material to one lane at a time, leaving all additional lanes open to traffic.

312-6 Preparation of Road Surface.

312-6.1 Cleaning: Sweep the surface to be covered clean and free of sand, dirt, dust, and other deleterious material by means of mechanical rotary sweepers or other approved methods, and keep the surface free from moisture.

312-6.2 Condition of Underlying Surface: Do not construct the crack relief layer over any loose or unstable pavement that results in excessive penetration of the cover material during the rolling operations.

312-7 Protection of Adjacent Surface.

Where constructing a crack relief layer adjacent to curb and gutter, valley gutter, or any other concrete surface, cover the concrete surfaces with heavy paper or other protection approved by the Engineer during application of bituminous material. Immediately remove any bituminous material deposited on such concrete surfaces.

312-8 Weather Limitations.

Do not apply bituminous material when the air temperature in the shade and away from artificial heat is less than 45EF [4EC] or when weather conditions or the surface conditions are otherwise unfavorable.

312-9 Application of Bituminous Material.

312-9.1 Distributor Pressure: After cleaning the surface to be treated to the satisfaction of the Engineer, uniformly spray the bituminous material over the surface by means of a pressure distributor. Use a distributor that maintains a consistent pressure of at least 20 psi [135 kPa], but not more than 75 psi [520 kPa].

312-9.2 Application Temperatures: For asphalt cement, maintain an application temperature between 300 and 325EF [149 and 163EC]. For emulsified asphalt, maintain an application temperature between 140 and 180EF [60 and 82EC].

312-9.3 Uniformity of Distribution: Adjust and operate the distributor to maintain an even and uniform distribution of the bituminous material. Immediately remove excessive deposits of bituminous material upon the road surface caused by stopping or starting the distributor, by leakage, or otherwise.

312-9.4 Limitations to Application: Ensure that the area to be covered by any one application of bituminous material is no greater than the aggregate can cover without interruption due to limitations of hauling and spreading equipment or to any other cause.

312-10 Spreading Cover Material.

312-10.1 Spreading: Spread the cover material immediately following the application of bituminous material. Uniformly distribute the cover material over the bituminous surface in one course. Do not drive trucks, spreaders, or other vehicles on the uncovered bituminous material.

312-10.2 Brooming and Dressing: Immediately after applying the cover material, broom the surface in order to secure a uniform distribution of cover material and a smooth surface. Place additional aggregate by hand on any areas not properly covered. If deemed necessary by the Engineer, drag the surface with a light drag broom or other dragging equipment approved by the Engineer, of a type that will not disturb the embedded aggregate. Supplement this operation by additional hand brooming until obtaining a smooth and even surface. Repeat the dragging and brooming, in conjunction with the rolling, for as long as required to ensure a uniform surface.

312-11 Rolling.

Immediately after the spreading and dragging of cover material, roll the entire surface. Begin rolling at the edge of pavement, and progress toward the centerline, uniformly lapping each preceding pass and thoroughly covering the entire surface. During rolling, perform additional dragging and hand brooming as specified in 312-10.2.

312-12 Surface Requirements.

Remove all joints or portions of the completed surface that are defective, not properly finished, or not in conformance with these Specifications, and replace them with a satisfactory surface. The Department will not pay for the defective work and its removal.

312-13 Covering Crack Relief Layer.

Cover the crack relief layer with an asphaltic concrete layer prior to opening it to traffic.

312-14 Method of Measurement.

312-14.1 Bituminous Material: The quantity to be paid for will be the volume, in gallons [liters], applied on the road and accepted, determined as provided in 300-8.

311-14.2 Cover Material: The quantity to be paid for will be the area, in square yards [square meters], applied on the road and accepted, determined by surface area.

312-15 Basis of Payment.

312-15.1 Bituminous Material: Price and payment will be full compensation for furnishing all the materials and for heating, hauling, and applying.

312-15.2 Cover Material: Price and payment will be full compensation for all the work described in this Section, except for the work paid for under the item of Bituminous Material.

312-15.3 Payment Items: Payment will be made under:

Item No. 300- 1- Bituminous Material - per gallon.
Item No 2300- 1- Bituminous Material - per liter.
Item No. 312- 70- Cover Material for Crack Relief Layer - per square yard.
Item No. 2312- 70- Cover Material for Crack Relief Layer - per square meter.

SECTION 320

HOT BITUMINOUS MIXTURESX

PLANT, METHODS, AND EQUIPMENT

320-1 General.

This Section specifies the plant and methods of operation for preparing all plant-mixed hot bituminous mixtures for surface courses and bases, and the requirements for the equipment to be used in the construction of the pavements and bases.

320-2 Requirements for All Plants.

320-2.1 The Overall Plant:

320-2.1.1 General: Design, manufacture, coordinate, and operate the asphalt plant in a manner that will consistently produce a mixture within the job mix tolerances and temperatures specified.

320-2.1.2 Electronic Weigh Systems with Automatic Ticket Printout: Equip the asphalt plant with of the following three electronic weigh systems capable of automatically printing a delivery ticket:

1. Automatic batch plant with printout (in accordance with 320-2.3).
2. Electronic weigh system on hopper beneath a surge or storage bin.
3. Electronic weigh system on the truck scales. Include, as a minimum, the following information on the printed delivery ticket:

(a) Sequential load number.
(b) Project number.
(c) Date.
(d) Name and location of plant.
(e) Type of mix.
(f) Place for hand-recording mix temperature.
(g) Truck number.
(h) Gross, tare, and net weights (as applicable).
(i) Accumulated total of mix.

(j) Tons [metric tons].

Print the delivery ticket with an original and at least one copy. Furnish the original to the Engineer at the plant and one copy to the Engineer at the paving site.

320-2.2 Truck Scales:

320-2.2.1 Scale Requirements: Weigh plant-mixed hot bituminous mixture, whether from batch, continuous mix, or drum mixer plants, on certified truck scales furnished by the Contractor, regardless of the method of measurement for payment. However, when the Contractor provides a fully automatic batch plant equipped with an automatic recordation system approved by the Engineer, the Contractor may use the automatic recordation system to determine the net weight of each truck load.

The Engineer may approve other electronic weight systems to determine the weight of asphalt mix being loaded into a truck. Use a system that has an automatic printout, is certified every six months by an approved certified scale technician, and meets weekly comparison checks with certified truck scales as specified in 320-2.3. The Engineer will allow a maximum permissible deviation of 8 pounds per ton [4 kg per metric ton] of load.

Use scales of the type which directly indicate the total weight of the loaded truck. Use scales meeting the requirements for accuracy, condition, etc., of the Bureau of Weights and Measures of the Florida Department of Agriculture, and recertify such fact every six months, either by the Bureau of Weights and Measures or by a registered scale technician.

320-2.2.2 Checking Truck Scales: Check the accuracy of the truck scales at the commencement of production and thereafter at least once a week during production by the following:

(a) The Engineer will randomly select a loaded truck of asphalt mix and record the truck number and gross weight from the Contractor=s delivery ticket.

(b) Weigh the selected truck on a certified truck scale which is not owned by the Contractor and the gross weight will be recorded by the Engineer for the comparison checks. If another certified truck scale is not available, the Engineer may permit another set of certified truck scales owned by the Contractor to be used.

(c) The gross weight of the loaded truck as shown on the Contractor=s delivery ticket will be compared to the gross weight of the loaded truck from the other certified truck scale. The maximum permissible deviation is 8 pounds per ton [4 kg per metric ton] of load.

(d) If the distance from the asphalt plant to the nearest certified truck scale is enough for fuel consumption to affect the accuracy of the comparison checks, a fuel adjustment may be calculated by using the truck odometer readings for the distance measurement, and 6.1 miles per gallon [2.6 kilometers per liter] for the fuel consumption rate, and 115 ounces per gallon [860 grams per liter] for fuel weight.

(e) During production, when an additional certified truck scale is not available for comparison checks, the Engineer may permit the Contractor to weigh the truck on his certified scales used during production and then weigh it on another certified truck scale, as soon the other scale is available for the comparison checks.

In addition to the periodic checks as specified above, check the scales at any time the accuracy of the scales becomes questionable. When such inaccuracy does not appear to be sufficient to seriously affect the weighing operations, the Engineer will allow a period of two calendar days for the Contractor to effect the required scales check. However, in the event, the indicated inaccuracy is sufficient to seriously affect the mixture, the Engineer may require immediate shut-down until the accuracy of the scales has been checked and necessary corrections have been made. Include the cost of all scale checks in the bid price for asphaltic concrete, at no additional cost to the Department.

320-2.3 Automatic Printer System: In lieu of truck scales, the Contractor may provide an approved automatic printer system which will print the individual or cumulative weights of aggregate and liquid asphalt delivered to the pugmill and the total net weight of the asphalt mix measured by hopper scales or load cell type scales. Use the automatic printer system only in conjunction with automatic batching and mixing control systems that have been approved by the Engineer.

For the purpose of project recordation, the Department will take ownership of the original weight printed delivery tickets, tapes, or digital records, including the records of off-project mixes furnished during production runs for the Department.

Certify the batch scales and the accuracy of the automatic printer at least once every six months. Ensure that an approved certified scale technician furnishes such certification. Check the accuracy of the batch scales and printer system at the commencement of production and thereafter at least once a week during production for the Department by the following:

(a) The Engineer will randomly select a loaded truck of asphalt mix and record the truck number, tare and gross weights of the truck and the net weight of the asphalt mix from the Contractor=s delivery ticket.

(b) Weigh the selected truck on a certified truck scale which is not owned by the Contractor. The Engineer will record the gross weight of the loaded truck. If another certified truck scale is not available within a reasonable distance, the Engineer may permit a set of certified truck scales owned by the Contractor to be used.

(c) Deliver the asphalt mix to the project, then weigh the selected empty truck on the same certified truck scales. The Engineer will record the tare weight of the truck.

(d) Compare the net weight of the asphalt mix from the Contractor=s delivery ticket to the net weight of the asphalt mix as determined by the certified truck scale weights. The maximum permissible deviation is 8 pounds per ton [4 kg per metric ton] of load.

(e) Use the fuel adjustment as specified in 320-2.2.3 (d), when the distance from the asphalt plant to the nearest certified truck scale is enough for fuel consumption to affect the accuracy of the comparison checks.

(f) During production, when an additional certified truck scale is not available for comparison checks, the Engineer may permit the Contractor to load a truck with aggregate from the pugmill and follow the above procedures to conduct the comparison checks as soon as certified truck scale is available.

If the check shows a greater difference, then recheck on a second set of certified scales. If the check and recheck indicate that the printed weight is out of tolerance, have a certified scale technician check the batch scales and certify the accuracy of the printer. While the printer system is out of tolerance and before its adjustment, the Contractor may continue production only if he makes provisions to use a set of certified truck scales to determine the truck weights.

In the event of a malfunction of the automatic printer and if the plant is equipped with an electronic display, the Engineer may complete the blank automatic delivery ticket from the electronic display until the printer can be repaired but for a period not to exceed 48 hours.

320-2.4 Equipment for Preparation of Bituminous Material: Equip bituminous material storage tanks to heat liquid asphalt under effective and positive control to the temperatures required for the various mixtures. Heat using hot-oil, steam, electricity, or other means whereby no flame comes in contact with the tank. Use a circulating system of adequate size to ensure proper and continuous circulation during the entire operating period. Use steam or hot-oil jacketed pipe lines and fittings to prevent heat loss. Locate a thermometer, reading from 200 to 400EF [90 to 200EC], either in the storage tank or in the bituminous feed line.

320-2.5 Cold Feed: Provide a separate cold bin for each component of the fine and coarse aggregates required by the design mix. Equip the cold bins with accurate mechanical means for feeding the aggregates uniformly into the dryer in the proportions required for the finished mix to maintain uniform production and temperature.

320-2.6 Dryer: Provide a dryer of any satisfactory design for heating and drying the mineral aggregates. Use a dryer capable of heating the aggregates to within the specified temperature range for any mix, and equip the dryer with an electric pyrometer placed at the discharge chute to automatically register the temperature of the heated aggregates.

320-2.7 Gradation Unit: Provide plant screens capable of separating the fine and coarse aggregates and of further separating the coarse aggregate into specific sizes. (The coarse aggregate is defined as the aggregate retained on the No. 10 [2.00 mm] screen.) In addition, equip the gradation unit with a scalping screen to restrict the maximum size of the aggregates.

320-2.8 Hot Bins: Provide storage bins of sufficient capacity to supply the mixer when it is operating at full capacity. Provide hot bins with divided compartments to ensure separate and adequate storage of the appropriate fractions of the aggregate. Equip each compartment with an overflow chute of suitable size and location to prevent any backing up of material into other bins.

320-2.9 Bituminous Control Unit: Provide a satisfactory means, either by weighing, metering, or volumetric measuring, to obtain the proper amount of bituminous material in the mix, within the tolerance specified for the job mix. Provide either steam or hot-oil jacketing for maintaining the bituminous material at the specified temperature in the pipe lines, meters, weigh buckets, spray bars, and other containers of flow lines.

320-2.10 Pugmills: For all pugmills, do not exceed a clearance of 1 inch [25 mm] between the paddle tips and the lining of the pugmill. For pugmills with both long and short paddle arms, apply this requirement to the long arms only. When any paddle is worn more than : inch [20 mm] from its original dimensions, replace or restore it to its original dimensions. Operate the pugmills in the manner recommended by the manufacturer.

320-2.11 Sampling of Hot Aggregates: Provide a convenient and accurate means for obtaining samples of hot aggregates from each bin before the material enters the pugmill.

320-2.12 Hot Storage or Surge Bins: Use hot storage or surge bins with the Engineer's approval.

320-2.13 Contractor=s Responsibilities: Acceptance of any automatic delivery ticket printout, electronic weight delivery ticket, other evidence of weight of the materials or approval of any particular type of materials or production methods will not constitute agreement by the Department that such matters are in accordance with the Contract Documents and it shall be the Contractor=s responsibility to ensure that the materials delivered to the project are in accordance with the Contract Documents.

320-3 Special Requirements for Batch Plants.

320-3.1 Batch Scales: For scales for any weigh box or hopper, use either the beam type or the springless-dial type of a standard make and design, sensitive to 0.5% of the maximum load that may be required. Have a registered scale technician certify the accuracy of the scales every six months, or as often as the Engineer may deem necessary to ensure their continued accuracy. When the batch scales of a fully automatic plant are equipped with an automatic recordation system approved by the Engineer, the Contractor may use the automatic recordation system to record the individual batch weights and the net weight per truck load in lieu of the use of trucks scales.

320-3.2 Weigh Box or Hopper: Equip the batch plant with a means for accurately weighing each bin size of aggregate and the mineral filler into the weigh box or hopper. Suspend the weigh box or hopper on scales. Use a weigh box or hopper of ample size to hold a full batch without running over. Support it on fulcrums and knife edges, so constructed that they will not be thrown out of alignment or adjustment during batching operations. Use gates both on the hot bins and on the weigh box or hopper that are constructed to prevent leakage.

320-3.3 Volumetric Meter:

320-3.3.1 Design: When measuring the bituminous material volumetrically, equip the plant with an automatic volumetric meter. Use a volumetric meter designed and constructed to automatically measure the required amount of liquid asphalt into each batch, within a tolerance of 0.4%. Use a dial, which indicates the amount of bituminous material, with a sensitivity of at least 1 $^{1}/_{5}$ inches [8 mm] movement of the pointer per gallon [liter], or 0.2 in/lb [11 mm/kg]. Use a meter with a capacity at least 10% in excess of the volume of bituminous material used in any batch, constructed so that any dial setting may be locked and will automatically reset after the addition of bituminous material to each batch. Place the dial in full view of the mixer operator.

320-3.3.2 Arrangement: Hot-oil or steam jacket any part of the meter that is a part of the bituminous feed line. Use one or more jacketed spray bars whose individual lengths are not less than 75% of the length of the pugmill to deliver the liquid asphalt to the mixer. Use spray bar openings of a size and spacing which will provide a uniform application of the bituminous material for the full length of the spray bar.

320-3.3.3 Checking the Meter: Provide a valve and outlet in the section of the feed line between the charging valve and the spray bar. Provide platform scales with a capacity of 150 pounds [70 kg] to check the delivery of the volumetric meter.

320-3.4 Mixer Unit: Use a plant with a batch mixer of the twin-shaft pugmill type, hot-oil or steam jacketed, and capable of producing a uniform mixture within the job mix tolerance specified. Set paddles to produce a circular or "runaround" action in the pugmill. Ensure that the depth of the material in the pugmill does not extend above the tips of the paddles. Use a pugmill with a capacity of at least 1 ton [1 metric ton] unless permission for lesser capacity is approved by the Engineer.

320-3.5 Control of Mixing Time: Use a plant that is equipped with a positive means to control the time of mixing and to ensure the completion of the mixing cycle designated by the Engineer. Provide all timing devices and bypass switches with a means for being locked into the desired position as directed by the Engineer.

320-4 Special Requirements for Continuous-Mix Plants.

320-4.1 Gradation Control Unit:

320-4.1.1 Aggregate: Use a plant that includes a means for accurately proportioning each bin size of aggregate by volumetric measurement, and a feeder mounted under the bin compartments. Provide each bin with an accurately controlled individual gate which forms an orifice for volumetrically measuring the material drawn from each respective bin compartment. The orifice shall be rectangular, with one dimension adjustable by positive mechanical action, and shall be provided with a lock. Provide indicators on each gate to show the gate opening in inches and decimals of an inch [millimeters]. Equip the aggregate proportioning feeder with a revolution counter.

320-4.1.2 Mineral Filler: Proportion mineral filler (if needed) separately from a suitable hopper equipped with an adjustable positive feed which is accurately and conveniently calibrated. Use feeder equipment for the mineral filler that is approved by the Engineer.

320-4.1.3 Interlocking: Interlock, or calibrate, the mineral filler feed, the asphalt feed, and all aggregate feeds so that they give the specified proportions uniformly.

320-4.1.4 Sampling Devices: Equip gradation units with sampling devices mounted as an integral part of the unit for use in calibration and for obtaining hot bin samples.

320-4.1.5 Indicator Lights: Equip the bins with lights which indicate when the material in any of the bins falls below the required level for accurate proportioning. Use the burning light as the signal that adequate material is in the bin. Whenever the material in any of the bins falls below the required level, suspend mixing operations and refill the bins to the required level.

320-4.2 Weight Calibration of Aggregate Feed: Use a plant that includes a means for calibration of gate openings by the use of weight test samples. For the materials fed out of the bins through individual orifices, provide a bypass to a suitable test box, and confine each compartmented material in a separate section or box. Equip the plant to handle test samples weighing up to 300 pounds [135 kg] and to weigh them on accurate platform scales.

320-4.3 Synchronization of Aggregate and Bitumen Feed: Provide a satisfactory means to afford positive interlocking control between the flow of aggregate from the bins and the flow of bitumen from the meter or other proportioning source. Accomplish this control by interlocking mechanical means or any positive method approved by the Engineer.

320-4.4 Mixer Unit:

320-4.4.1 General: Use a plant that includes a continuous mixer of the twin-shaft pugmill type, either hot-oil or steam jacketed, and is capable of producing a uniform mix within the job mix tolerances specified. Equip the pugmill with an adjustable dam or gate at the discharge end to control the mixing time and the level of material passing through the pugmill. Provide the drive mechanism of the shafts with a clutch that stops the action of the pugmill when the flow of material is stopped.

320-4.4.2 Paddles: Use adjustable and reversible paddles to retard the flow of mix through the pugmill. Use the paddle settings as recommended by the manufacturer. Advance paddles in the discharge end of the pugmill by 90 degree intervals, for a distance of at least 75% of the length of the shaft.

320-4.4.3 Discharge Hopper: Use a mixer unit with a discharge hopper equipped with bottom-dump gates. Do not dump the mix until after filling the discharge hopper.

320-5 Special Requirements for Drum Mixer Plants.

320-5.1 General: Use drum mixer plants specially designed and constructed for the process. Obtain the Engineer's approval for the drum mixer and auxiliary equipment prior to the start of production.

320-5.2 Calibrated Cold Feed Proportioning: Use a cold feed capable of being calibrated to ensure full control of the mix gradation.

320-5.3 Weight Measurements of Aggregate: Maintain positive weight measurement of the combined cold feed to allow regulation of the cold feed gates and to permit automatic correction for variations in load.

320-5.4 Synchronization of Aggregate Feed and Bituminous Material Feed: Couple the bituminous feed control with the total aggregate weight device, including the RAP feed, in such a manner as to automatically vary the bitumen feed rate as necessary to maintain the required proportions.

320-6 Paving Equipment.

320-6.1 Mechanical Spreading and Screeding Equipment:

320-6.1.1 General: Provide mechanical spreading and screeding equipment of an approved type that is self-propelled and can be steered. Equip it with a receiving and distribution hopper and a mechanical screed. Use a mechanical screed capable of adjustment to regulate the depth of material spread and to produce the desired cross-section.

320-6.1.2 Automatic Screed Control: For all asphalt courses, with the exception of open-graded friction mixes, placed with mechanical spreading and finishing equipment in pavement widths of 20 feet [6 m]or greater, equip the paving machine with automatic longitudinal screed controls of either the skid type or the traveling stringline type. Ensure that the length of the skid or traveling stringline is at least 25 feet [7.5 m]. On the final layer of base, overbuild, and structural courses, and for friction courses, use the joint matcher in lieu of the skid or traveling stringline on all passes after the initial pass. Furnish a paving machine equipped with electronic transverse screed controls when required by the Contract Documents.

320-6.1.3 Inflation of Tires: When using paving machines equipped with pneumatic tires, the Engineer may require that the tires be ballasted.

320-6.1.4 Screed Width: Provide paving machines on full width lanes that have a screed width greater than 8 feet [2.5 m]. Do not use extendable screed strike-off devices that do not provide preliminary compaction of the mat in place of fixed screed extensions. The Contractor may use a strike-off device on irregular areas that would normally be done by hand and on shoulders 4 feet [1.2 m] or less in width. When using the strike-off device on shoulders in lieu of an adjustable screed extension, the Contractor must demonstrate the ability to obtain an acceptable texture, density, and thickness.

When using an extendable screed device to extend the screed's width on the full width lane or shoulder by 24 inches [600 mm] or greater, the Engineer will require an auger extension, paddle, or kicker device unless the Contractor provides written documentation from the manufacturer that these are not necessary.

320-6.2 Motor Graders: Provide two motor graders for spreading leveling courses. Equip them with a blade that is at least 2 feet [0.6 m] longer than the width of the lane being leveled. Use motor graders that are rated at not less than 6 tons [5.5 metric tons] and are self-propelled and power-controlled. Mount them on smooth tread or rib-type tires (no lug types allowed) with a wheel base of at least 15 feet [4.5 m]. Equip the front motor grader with a spreader box capable of spreading the mix at the required rate.

320-6.3 Rollers:

320-6.3.1 Steel-Wheeled Rollers: Provide tandem steel-wheeled rollers. For the seal rolling, use rollers that weigh between 5 and 12 tons [4.5 and 11 metric tons], and for the final rolling, use rollers that weigh between 8 and 12 tons [7 and 11 metric tons].

320-6.3.2 Traffic Rollers: Provide self-propelled, pneumatic-tired traffic rollers equipped with at least seven smooth-tread, low pressure tires. Maintain the tire pressure between 50 and 55 pounds [345 and 380 kPa]. Use rollers that weigh between 6 and 10 tons [5.5 and 9 metric tons]. Do not use wobble-wheeled rollers.

320-6.3.3 Prevention of Adhesion: Do not allow the mixture to adhere to the wheels of any rollers. Do not use fuel oil or other petroleum distillates to prevent adhesion. Do not use any method which results in water being sprinkled directly onto the mixture.

320-6.4 Trucks: Transport the mix in trucks of tight construction, which prevents the loss of material and the excessive loss of heat. Provide each truck with a tarpaulin or other waterproof cover mounted in such a manner that it can cover the entire load when required. When in place, overlap the waterproof cover on all sides so that it can be tied down. Equip the trucks with chains on the tail gates to limit the size of the opening while unloading into the paver.

320-6.5 Coring Equipment: Furnish a suitable saw or drill for obtaining the required density cores.

320-6.6 Hand Tools: Provide the necessary hand tools such as rakes, shovels, etc., and a suitable means for keeping them clean.

SECTION 327

MILLING OF EXISTING ASPHALT PAVEMENT

327-1 Description.

Remove existing asphaltic concrete pavement by milling to improve the rideability of the finished pavement, to lower the finished grade adjacent to existing curb prior to resurfacing, or to completely remove existing pavement.

When milling to improve rideability, the plans will specify an average depth of cut.

Take ownership of milled material.

327-2 Equipment.

Provide a milling machine capable of maintaining a depth of cut and cross slope that will achieve the results specified in the Contract Documents. Use a machine with a minimum overall length (out to out measurement excluding the conveyor) of 18 feet [5.5 m] and a minimum cutting width of 6 feet [1.8 m].

Equip the milling machine with a built-in automatic grade control system that can control the transverse slope and the longitudinal profile to produce the specified results.

To start the project, the Engineer will approve any commercially manufactured milling machine that meets the above requirements. If it becomes evident after starting milling that the milling machine cannot consistently produce the specified results, the Engineer will reject the milling machine for further use.

The Contractor may use a smaller milling machine when milling to lower the grade adjacent to existing curb or other areas where it is impractical to use the above described equipment.

Equip the milling machine with means to effectively limit the amount of dust escaping during the removal operation.

For complete pavement removal, the Engineer may approve the use of alternate removal and crushing equipment in lieu of the equipment specified above.

327-3 Construction.

Remove the existing raised reflective pavement markers prior to milling. Include the cost of removing existing pavement markers in the price for milling.

When milling to improve rideability or cross slope, remove the existing pavement to the average depth specified in the plans, in a manner that will restore the pavement surface to a uniform cross-section and longitudinal profile. The Engineer may require the use of a stringline to ensure maintaining the proper alignment.

Establish the longitudinal profile of the milled surface on the side of the cut nearest the centerline of the road. Ensure that the final cross slope of the milled surface parallels the surface cross slope shown on the typical section or as directed by the Engineer. Establish the cross slope of the milled surface by a second sensing device near the outside edge of the cut or by an automatic cross slope control mechanism. The plans may waive the requirement of automatic grade or cross slope controls where the situation warrants such action.

Multiple cuts may be made to achieve the required pavement configuration or depth of cut.

Operate the milling machine to minimize the amount of dust being emitted. The Engineer may require prewetting of the pavement.

Provide positive drainage of the milled surface and the adjacent pavement. Perform this operation on the same day as milling. Repave all milled surfaces no later than the day after the surface was milled.

If traffic is to be maintained on the milled surface prior to the placement of the new asphaltic concrete, provide suitable transitions between areas of varying thickness to create a smooth longitudinal riding surface. Produce a pattern of striations that will provide an acceptable riding surface. The Engineer will control the traveling speed of the milling machine to produce a texture that will provide an acceptable riding surface.

Prior to opening an area which has been milled to traffic, sweep the pavement with a power broom or other approved equipment to remove, to the greatest extent practicable, fine material which will create dust under traffic. Sweep in a manner that will minimize the potential for creation of a traffic hazard and to minimize air pollution.

Sweep the milled surface with a power broom prior to placing asphalt concrete.

In urban and other sensitive areas, use a street sweeper or other equipment capable of removing excess milled materials and controlling dust. Obtain the Engineer=s approval of such equipment, contingent upon its demonstrated ability to do the work.

Perform the sweeping operation immediately after the milling operations or as directed by the Engineer.

327-4 Milled Surface.

Provide a milled surface with a reasonably uniform texture, within 3 inch [6 mm] of a true profile grade, and with no deviation in excess of 3 inch [6 mm] from a straightedge applied to the pavement perpendicular to the centerline. Ensure that the variation of the longitudinal joint between multiple cut areas does not exceed 3 inch [6 mm]. The Engineer may accept areas varying from a true surface in excess of the above stated tolerance without correction if the Engineer determines that they were caused by a pre-existing condition which could not have reasonably been corrected by the milling operations. Correct any unsuitable texture or profile, as determined by the Engineer, at no additional expense to the Department.

The Engineer may require remilling of any area where a surface lamination causes a non-uniform texture to occur.

327-5 Method of Measurement.

The quantity to be paid for will be the area, in square yards [square meters], over which milling is completed and accepted.

327-6 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section, including hauling off and stockpiling or otherwise disposing of the milled material.

Payment will be made under:

Item No. 327- 70- Milling Existing Asphalt Pavement - per square yard.
Item No. 2327- 70- Milling Existing Asphalt Pavement - per square meter.

SECTION 330

HOT BITUMINOUS MIXTURES - QUALITY ASSURANCE,

GENERAL CONSTRUCTION REQUIREMENTS AND ACCEPTANCE PROCEDURES

330-1 Description.

Construct plant-mixed hot bituminous pavements and bases. Establish and maintain a quality control system that provides assurance that all materials, products and completed construction submitted for acceptance meet Contract requirements. This Section establishes Acceptance Procedures for materials and work performed under Sections 280, 290, 331, 332, 333, 334, 335, and 337. More specific requirements pertaining to hot bituminous base and base widening construction are contained in Section 280.

This Section also includes the method of determining the thickness of pavement the Department will pay for when payment is on a square yard [square meter] basis.

330-2 Acceptance Procedures.

The Department will approve all materials for acceptance through the Department's Acceptance Procedures specified herein. The Engineer is responsible for determining the acceptability of the construction and materials incorporated therein. The Contractor is responsible for the quality of construction and materials incorporated therein. Accomplish all quality control sampling and testing on a random basis in accordance with the approved Quality Control Plan. The Department will perform all necessary sampling and testing for acceptance purposes on a random basis as specified herein, in addition to monitoring and observing the Contractor's quality control test procedures and results. Maintain effective quality control until final project acceptance.

A LOT is defined as an isolated quantity of a specified material produced from a single source or operation, or it is a measured amount of specified construction produced by the same process. In order to change the process, thereby necessitating the termination of the current LOT and starting a new LOT, submit a written request, with justification, to the Engineer for approval. Obtain the Engineer's approval prior to making the process change.

Perform all quality control sampling and testing of materials in strict conformance with the Florida Method of Sampling and Testing as found in the Field Sampling and Testing Manual. The Department will perform all acceptance sampling and testing of materials in strict conformance with the Florida Method of Sampling and Testing as found in the Field Sampling and Testing Manual. This manual, developed and distributed by the FDOT Materials Office, contains the detailed sampling and testing procedures from AASHTO and ASTM as modified by the Department.

330-2.1 Acceptance Plans:

330-2.1.1 Payment Based on Acceptance Results: The Department will adjust the payment for each LOT of material, product, item of construction or completed construction on the basis of acceptance test results in accordance with the requirements specified hereinafter in the applicable Sections.

330-2.1.2 Resampling of LOTs: The Department requires that LOTs of materials, products, items of construction or completed construction meet the requirements of these Specifications at the time of submission. The Department will not take check samples for acceptance purposes.

330-2.1.3 Referee System: The Department has established a referee system to verify the validity of the acceptance test results on LOTs at the asphalt plant. The Department will evaluate the acceptance test results with data from split samples run by the District and Central Labs. The Engineer will make a final determination and disposition of the acceptance test results. When the referee analysis indicates that one or more test results are not representative, the Engineer will discard the non-representative test value(s) and base payment calculations for the LOT (including the sublot with the non-representative test values) on the remaining sublot(s) test data as defined in 331-5.

330-2.2 Quality Control by the Contractor: Provide and maintain a quality control system that provides reasonable assurance that all materials, products and completed construction submitted for acceptance meet Contract requirements. Develop and maintain a quality control system in conformance with the following requirements:

CONTRACTOR QUALITY CONTROL SYSTEM

I. SCOPE:

These Specifications establish minimum requirements and activities for a Contractor quality control system. These requirements pertain to the inspections and tests necessary to substantiate material and product conformance to Contract requirements and to all inspections and tests required by the Contract.

II. FUNCTIONS AND RESPONSIBILITIES:

1. The Department. The Department will verify the Contractor's design mixes, inspect plants and monitor control of the operations to ensure conformance with these Specifications. The Department will design all open-graded friction mixes (FC-2 and FC-5).

At no time will the Engineer issue instructions to the Contractor or producer as to the setting of dials, gauges, scales and meters. However, the Department's representatives may question and warn the Contractor against the continuance of any operations or sequence of operations that obviously do not result in satisfactory compliance with the requirements of these Specifications.

2. The Contractor. Submit in writing the proposed Quality Control Plan for each asphalt plant for the Engineer's approval. Maintain the approved Quality Control Plan in effect for the plant to which it is assigned until the Engineer rejects it in writing. Include in the plan the sampling, testing, inspection and the anticipated frequencies of each to maintain process control. A recommended series of sampling, testing and inspecting activities are shown in Table 330-1.

Table 330-1

RECOMMENDATIONS FOR A CONTRACTOR
QUALITY CONTROL PLAN

A. All Types of Plants

1. Stockpiles
    a. Place materials in the correct stockpile.
    b. Use good stockpiling techniques.
    c. Inspect stockpiles for separation, contamination, segregation, etc.
2. Incoming Aggregate
    a. Obtain gradations and bulk specific gravity (BSG) values from the aggregate supplier.
    b. Determine gradation of all component materials.
    c. Compare gradations and BSG to mix design.
3. Cold Bins
    a. Calibrate the cold gate/feeder belt settings.
    b. Observe operation of cold feed for uniformity.
4. Dryer
    a. Observe pyrometer for aggregate temperature control.
    b. Observe efficiency of the burner.
5. Hot Bins
    a. Determine gradation of aggregates in each bin.
    b. Determine theoretical combined grading.
6. Bituminous Mixture
    a. Determine asphalt content.
    b. Determine mix gradation.
    c. Check mix temperature.
    d. Verify modifier addition.

B. Batch Plants

1. For batch weights, determine percent used and weight to be pulled from each bin to ensure compliance with the mix design.
2. Check mixing time.
3. Check operations of weigh bucket and scales.

C. Continuous Mix Plant

1. Determine gate calibration chart for each bin.

2. Determine gate settings for each bin to ensure compliance with the mix design.

3. Determine gallons [cubic meters] per revolution or gallons [cubic meters] per minute to ensure compliance with the mix design.

D. Drum Mixer Plant

1. Calibrate the cold feed and prepare a calibration chart for each cold gate.

2. Develop information for the synchronization of the aggregate feed, reclaimed asphalt pavement (RAP) feed and the bituminous material feed.

3. Calibrate the weigh bridge on the changing conveyor.

The activities shown in Table 330-1 are the normal activities necessary to control the production of bituminous concrete at an acceptable quality level. The Department recognizes, however, that depending on the type of process or materials, some of the activities listed may not be necessary and, in other cases, additional activities may be required. The frequency of these activities will also vary with the process and the materials. When the process varies from the defined process average and variability targets, increase the frequency of these activities until the proper conditions are restored. Take one sample and test for every 1,000 tons [900 metric tons] of incoming aggregate (including RAP) as it is stockpiled. Test RAP material for extracted gradation and asphalt content.

Plot and keep up-to-date control charts for all quality control sampling and testing. Provide control charts for the following:

a. gradation of incoming aggregates
b. gradation and asphalt content of RAP
c. combined gradations of hot bins
d. extracted asphalt content
e. mix gradation
f. gradation of cold feed (drum mixers)

Post all current control charts in the asphalt lab where they can be seen.

Formulate all design mixes with the exception of open-graded friction mixes (FC-2 and FC-5). Submit design mixes to the Engineer for verification prior to their use. Provide process control of all materials during handling, blending, mixing and placing operations.

III. QUALITY CONTROL SYSTEM:

1. General Requirements. Furnish and maintain a quality control system that provides reasonable assurance that all materials and products submitted to the Engineer for acceptance meet the Contract requirements. Perform, or have performed, the inspection and tests required to substantiate product conformance to Contract requirements, and also perform, or have performed, all inspections and tests otherwise required by the Contract. Keep a quality control technician, who has been certified by the Department as a Certified Asphalt Plant Technician, available at the asphalt plant at all times when producing asphalt mix for the Department. Place a person in responsible charge of the paving operations who is certified by the Department as an Asphalt Paving Technician and who possesses a valid certificate of qualification. Document the quality control procedures, inspection and tests, and make that information available for review by the Engineer throughout the life of the Contract.

2. Documentation. Maintain adequate records of all inspections and tests. Record the nature and number of tests made, the number and type of deficiencies found, the quantities approved and rejected, and the nature of corrective action taken, as appropriate. The Department may review and approve all documentation procedures prior to the start of the work. The Department will take ownership of all charts and records documenting the Contractor's quality control tests and inspections upon completion of the work.

3. Charts and Forms. Record all conforming and nonconforming inspections and test results on approved forms and charts, and keep them up to date and complete and make them available at all times to the Engineer during the performance of the work. Prepare charts of test properties for the various materials and mixtures on forms that are in accordance with the applicable requirements of the Department. The Engineer will furnish a copy of each applicable chart and form. Provide a supply of the charts and forms from the copy furnished. Obtain the Engineer's approval of non-standard forms and charts prior to using them.

4. Corrective Actions. Take prompt action to correct any errors, equipment malfunctions, process changes or other problems that result or could result in the submission of materials, products or completed construction that do not meet the requirements of these Specifications. When it becomes evident to the Department that the Contractor is not controlling his process and is making no effort to take corrective actions, the Department will require the Contractor to cease plant operations until such time as the Contractor can demonstrate that he can and is willing to control the process.

5. Laboratories with Measuring and Testing Equipment. Furnish a fully equipped asphalt laboratory (permanent or portable) at the production site, and meeting the following requirements:

a. Area - Provide an effective working area for the laboratory that is a minimum of 180 ft^2 [17 m^2]. This area does not include the space for desks, chairs and file cabinets.

b. Lighting - Provide lighting in the lab adequate to illuminate all areas of work.

c. Temperature Control - Equip the lab with heating and air conditioning units that provide a satisfactory working environment.

d. Ventilation - Equip the lab with fume hoods and exhaust fans that will remove all hazardous fumes from within the laboratory in accordance with OSHA requirements.

e. Equipment and Supplies - Furnish the lab with the necessary sampling and testing equipment, and supplies, for performing Contractor quality control and Department acceptance sampling and testing. A detailed list of equipment and supplies required for each test is included in the Field Sampling and Testing Manual.

When running plants at a high production rate, furnish additional testing equipment as necessary to allow the completion of the Contractor's quality control tests and the Department's Acceptance tests within the specified time frame.

6. Sampling and Testing. Use the sampling and testing methods and procedures that the Department provides to determine quality conformance of the materials and products. The Department will use these same methods and procedures for its acceptance tests. Include the sampling for other material characteristics on a random

basis and the plotting of the test results on control charts in the Quality Control Plan.

7. Alternative Procedures. The Contractor may use alternative sampling methods, procedures and inspection equipment when such procedures and equipment provide, as a minimum, the quality assurance required by the Contract Documents. Prior to applying such alternative procedures, describe them in a written proposal and demonstrate for the Engineer's approval that their effectiveness is equal to or better than the Contract requirements. In case of dispute as to whether certain proposed procedures provide equal assurance, use the procedures stipulated by the Contract Documents.

8. Nonconforming Materials. Establish and maintain an effective and positive system for controlling nonconforming materials, including procedures for identification, isolation and disposition. Reclaim or rework nonconforming materials in accordance with procedures acceptable to the Engineer. Discuss the details of this system at the preconstruction conference, and make these details a part of the record of the conference.

9. Department Inspection at Subcontractor or Supplier Facilities. The Department reserves the right to inspect materials not manufactured within the Contractor's facility. The Department's inspection does not constitute acceptance and does not, in any way, replace the Contractor's inspection or otherwise relieve the Contractor of his responsibility to furnish an acceptable material or product. When the Department inspects the subcontractor's or supplier's product, such inspection does not replace the Contractor's responsibility to inspect such subcontractor's or supplier's product.

Inspect subcontracted or purchased materials when received, as necessary, to ensure conformance to Contract requirements. Report to the Engineer any nonconformance found on Department source-inspected material, and require the supplier to take necessary corrective action.

330-2.3 Defective Materials:

330-2.3.1 Acceptance or Rejection: Following the application of the appropriate acceptance plan, the Engineer will make the final decision as to the acceptance, rejection or acceptance at an adjusted payment of the LOTs.

330-2.3.2 Disposition of LOTs: For nonconforming LOTs of materials, products, items of construction or complete construction that are not adaptable to correction by reworking, either remove and replace the nonconforming work, or accept no payment or an adjusted payment as stated in these Specifications, or, if not stated, as directed by the Engineer.

330-2.4 General Basis of Adjusted Payment For Deficiencies: When the Engineer determines that a deficiency exists, the Engineer will apply the applicable payment factor as shown in these Specifications to the entire LOT. When the Engineer determines that multiple deficiencies exist, the Engineer will apply an adjustment to the LOT of material that is identified by each deficiency. The Engineer will apply the adjustment for each deficiency separately as it occurs. The Engineer will not allow an adjustment to be affected by any other adjustment occurring for the same LOT. As an exception to the foregoing requirements, when there are two or more deficiencies in the gradation acceptance tests (% pass No. 4 [4.75 mm] sieve, % pass No. 10 [2.0 mm] sieve, % pass No. 40 [425 Φm sieve], % pass No. 200 [75 Φm] sieve) the Engineer will only apply the greater adjustment.

The Engineer will express all reductions in payment in terms of equivalent pay items at no pay. When the item is measured by the ton [metric ton], the Engineer will convert the LOT in the field, which is measured in feet [meters], to equivalent tons [metric tons] and by using the average calculated spread for that LOT. When the pay item is measured by the square yard [square meter], the Engineer will convert the LOT at the production point, which is measured in tons [metric tons], to equivalent square yards [square meters] at the design thickness and by using the laboratory density as a conversion factor.

330-3 Substitution of Types of Hot Bituminous Mixtures.

Except for asphaltic concrete friction courses and other wearing surfaces, the Contractor may substitute certain types of hot bituminous mixtures as follows:

1. Substitute Type S Asphaltic Concrete mixtures for other Type S mixtures, as specified in the Roadway and Traffic Design Standards, Index No. 513.

2. Substitute Type S Asphaltic Concrete mixtures for other non-structural mixtures provided the gradation criteria as shown in Table 331-1 are met for the specified mixture.

3. Substitute Type III Asphaltic Concrete for Type II Asphaltic Concrete or Sand-Asphalt Hot Mix. Substitute Type II Asphaltic Concrete for Sand-Asphalt Hot Mix.

In each case, meet the Marshall and volumetric properties for the higher quality mix. Make all substitutions at no additional expense to the Department over that which would have accrued had the specified mixture been used.

330-4 Limitations of Operations.

330-4.1 Weather Limitations: Do not begin plant operations unless all weather conditions are suitable for the laying operations.

330-4.2 Limitations of Laying Operations:

330-4.2.1 General: Spread the mixture only when the surface upon which it is to be laid has been previously prepared, is intact, firm, and properly cured, and is dry. Do not spread mixture that cannot be finished and compacted during daylight hours. Do not place friction course until the adjacent shoulder area has been dressed and grassed.

330-4.2.2 Temperature: Spread the mixture only when the air temperature in the shade and away from artificial heat is at least 40EF [4EC] for layers greater than 1 inch (100 lb/yd^2) [25 mm (55 kg/m^2)] in thickness and at least 45EF [7EC] for layers 1 inch (100 lb/yd^2) [25 mm (55 kg/m^2)] or less in thickness (this includes leveling courses). The minimum temperature requirement for leveling courses with a spread rate of 50 lb/yd^2 [25 kg/m^2] or less is 50EF [10EC].

330-4.2.3 Wind: Do not spread the mixture when the wind is blowing to such an extent that proper and adequate compaction cannot be maintained or when sand, dust, etc., are being deposited on the surface being paved to the extent that the bond between layers will be diminished.

330-5 Preparation of Asphalt Cement.

Deliver the asphalt cement to the asphalt plant at a temperature not to exceed

350EF [175EC], and equip the transport tanks with sampling and temperature sensing devices meeting the requirements of 300-3.2. Maintain the asphalt cement in storage within a range of 230 to 350EF [110 to 175EC] in advance of mixing operations. Maintain constant heating within these limits, and do not allow wide fluctuations of temperature during a day's production.

330-6 Preparation of Aggregates.

330-6.1 Stockpiles: Place each aggregate component in an individual stockpile, and separate each from the adjacent stockpiles, either by space or by a system of bulkheads. Prevent the intermingling of different materials in stockpiles at all times. Identify each stockpile, including RAP, as shown on the approved mix design.

330-6.2 Prevention of Segregation: Form and maintain stockpiles in a manner that will prevent segregation. If a stockpile is determined to have excessive segregation, the Engineer will disapprove the material for use on the project until the appropriate actions have been taken to correct the problem.

330-6.3 Blending of Aggregates: The Engineer will not allow blending or proportioning from railroad cars. Stockpile all aggregates prior to blending or placing in the cold hoppers. Place all aggregates to be blended or proportioned in separate bins at the cold hopper. Proportion by means of securely positioned calibrated gates or other approved devices.

330-6.4 Cold Bins:

330-6.4.1 Adequacy of Bins: Use separate bin compartments in the cold aggregate feeder that are constructed to prevent any spilling or leakage of aggregate from one bin to another. Ensure that each bin compartment has the capacity and design to permit a uniform flow of aggregates. Mount all of the bin compartments over a feeder of uniform speed, which will deliver the specified proportions of the separate aggregates to the drier at all times. If necessary, equip the bins with vibrators to ensure a uniform flow of the aggregates at all times.

330-6.4.2 Gates: Provide each bin compartment with a gate which is adjustable in a vertical direction. Provide gates that can be held securely at any specified vertical opening. Equip the gates with a measuring device for measuring the vertical opening of the gates from a horizontal plane level with the bottom of the feeder.

330-6.5 Mineral Filler: If mineral filler is required in the mix, feed or weigh it in separately from the other aggregates.

330-6.6 Heating and Drying: Heat and dry the aggregates before screening. Control the temperature of the aggregates so that the temperature of the completed mixture at the plant falls within the permissible range allowed by this Section.

330-6.7 Screening Unit:

330-6.7.1 Oversize Aggregate: Remove any oversized pieces of aggregate by the use of a scalping screen. Do not return this oversized material to the stockpile for reuse unless it has been crushed and reprocessed into sizes that will pass the scalping screen.

330-6.7.2 Screening: Ensure that the quantity of aggregates being discharged onto the screens does not exceed the capacity of the screens to actually separate the aggregates into the required sizes. Allow up to a maximum of 10% plus-10 material in the minus-10 bin. The Engineer will determine the maximum amount of minus-10 material allowed in the plus-10 bins, in accordance with its effect on the uniformity of the mix.

330-6.8 Mixing Different Materials: Unless written permission is obtained, do not mix coarse aggregates of different types, and do not use coarse aggregates of different types alternately in sections less than 1 mile [1.5 km] in length.

330-7 Preparation of the Mixture.

330-7.1 Batch Mixing:

330-7.1.1 Aggregates: Once the dried aggregates and mineral filler (if required) are prepared in the manner previously described and combined in batches to meet the verified mix design by weighing each separate bin size, convey them to the empty mixer.

330-7.1.2 Bitumen: Introduce the accurately measured hot asphalt cement into the mixer simultaneously with, or after, the hot aggregates. Continue mixing until the mixture is thoroughly uniform with all particles fully coated.

330-7.1.3 Mixing Time: The mixing time begins when the measuring devices for both the asphalt and the aggregates indicate that all the material is in the mixer, and continues until the material begins to leave the mixing unit. Since the mixing time varies in relation to the nature of the aggregates and the capacity of the mixer, the Engineer will designate the mixing time. In no case will the Engineer allow the mixing time to be less than 35 seconds.

330-7.2 Continuous Mixing: Introduce the dried aggregates and mineral filler (if required), prepared as specified and proportioned to meet the verified mix design by volumetric measurements, into the mixer in synchronization with the accurate feeding of the hot asphalt cement. Ensure that the rate of flow of material to the pugmill is such that the maintained depth of the mix does not exceed the tips of the paddles when in the upright position. Mix sufficiently to produce a thoroughly and uniformly coated mixture.

330-7.3 Mixing Temperature: Heat and combine the ingredients of the mix in such a manner as to produce a mixture at a temperature, when discharged from the pugmill or surge bin, within the range of 230 to 310EF [110 to 155EC] and within the tolerance shown in Table 330-2.

Table 330-2

Temperature Tolerance From Verified Mix Design

Any Single Measurement	∀25EF [∀14EC]
Average of Any Five Consecutive Measurements	∀15EF [∀8EC]

Reject any load or portion of a load of asphalt mix at the plant or on the road with a mix temperature exceeding 335EF [170EC].

Determine the temperature of the completed mixture using a quick-reading thermometer through a hole in the side of the loaded truck immediately after loading. Locate the hole within the middle third of the length of the body, and at a distance of from 6 to 10 inches [150 to 250 mm] above the surface supporting the mixture. If a truck body already has a hole located in the general vicinity of the above specified location, use this hole. At the Engineer's discretion, the Contractor may take the temperature of the load over the top of the truck in lieu of using the hole in the side of the truck.

Take the mix temperature at the plant and allow the Engineer to take the mix temperature at the roadway for each day for each design mix on the first five loads and an average of once every five loads thereafter. Take and record the temperature measurements at the plant for review by the Engineer. The Engineer will take the temperature measurements at the roadway and record them on the backside of the delivery ticket. If the temperature exceeds the specified tolerance, take immediate corrective action.

330-7.4 Maximum Period of Storage: Allow the maximum time that any mix may be kept in a hot storage or surge bin to be 72 hours.

330-7.5 Contractor's Responsibility for Mixture Requirements: Produce a homogeneous mixture, free from moisture and with no segregated materials, that meets all specification requirements for the mixture, including compliance with the Marshall Properties. Also apply these requirements to all mixes produced by the drum mixer process and all mixes processed through a hot storage or surge bin, both before and after storage.

330-8 Transportation of the Mixture.

Transport the mixture in tight vehicles previously cleaned of all foreign material. After cleaning, thinly coat the inside surface of the truck bodies with soapy water or an approved emulsion containing not more than 5% oil. Apply the coating prior to the first loading each day and repeat as necessary throughout the day's operations. After the truck bodies are coated and before any mixture is placed therein, raise them to drain out all excess liquids. Cover each load during cool and cloudy weather and at any time there is a probability of rain.

330-9 Preparation of Application Surfaces.

330-9.1 Cleaning: Prior to the laying of the mixture, clean the surface of the base or pavement to be covered of all loose and deleterious material by the use of power brooms or blowers, supplemented by hand brooming where necessary.

330-9.2 Patching and Leveling Courses: Where an asphalt mix is to be placed on an existing pavement or old base which is irregular, and wherever the plans indicate, bring the existing surface to proper grade and cross-section by the application of patching or leveling courses.

330-9.3 Application Over Surface Treatment: Where an asphalt mix is to be placed over a newly constructed surface treatment, sweep and dispose of all loose material from the paving area.

330-9.4 Coating Surfaces of Contacting Structures: Paint all structures which will be in actual contact with the asphalt mixture, with the exception of the vertical faces of existing pavements and curbs or curb and gutter, with a uniform coating of asphalt cement to provide a closely bonded, watertight joint.

330-9.5 Tack Coat:

330-9.5.1 Tack Coat Required: Apply a tack coat, as specified in Section 300, on existing pavement structures that are to be overlaid with an asphalt mix and between successive layers of all asphalt mixes.

330-9.5.2 Tack Coat at Engineer's Option: Apply a tack coat on the following surfaces only when so directed by the Engineer:

1. Freshly primed bases.
2. Surface treatment.

330-10 Placing Mixture.

330-10.1 Requirements Applicable to All Types:

330-10.1.1 Alignment of Edges: Lay all asphaltic concrete mixtures, including leveling courses, other than adjacent to curb and gutter or other true edges, by the stringline method to obtain an accurate, uniform alignment of the pavement edge.

330-10.1.2 Temperature of Spreading: The Contractor shall maintain the temperature of the mix at the time of spreading within ∀25EF [∀14EC] of the established mix temperature selected by the Contractor. As a minimum, the Engineer will take mix temperatures of the mix on the road in an average frequency of one per five trucks. If the temperature fails to fall within the specified tolerance range, take corrective action.

330-10.1.3 Rain and Surface Conditions: Immediately cease transportation of asphalt mixtures from the plant when rain begins at the roadway. Do not place asphalt mixtures while rain is falling, or when there is water on the surface to be covered. As an exception, the Contractor may place mixture caught in transit at the Contractor's risk if the only option is to waste this mixture and provided the surface has been tacked as required prior to the rain and the surface is broomed in front of the spreading operation. The Engineer will evaluate such placed mixture separately, and if the mixture is unsatisfactory in any way, remove and replace it with satisfactory mixture at no expense to the Department.

330-10.1.4 Speed of Spreader: The Engineer will establish the forward speed of the asphalt spreader.

330-10.1.5 Number of Crews Required: For each paving machine operated, use a separate crew, each crew operating as a full unit. The Contractor's Certified Paving Technician in charge of the paving operations may be responsible for more than one crew but must be physically accessible to the Engineer at all times when placing mix.

330-10.1.6 Checking Depth of Layer: Check the depth of each layer at frequent intervals, and make adjustments when the thickness exceeds the allowable tolerance. When making an adjustment, allow the paving machine to travel a minimum distance of 32 feet [10 m] to stabilize before the second check is made to determine the effects of the adjustment.

330-10.1.7 Hand Spreading: In limited areas where the use of the spreader is impossible or impracticable, the Contractor may spread and finish the mixture by hand.

330-10.1.8 Straightedging and Back-patching: Straightedge and back-patch after obtaining initial compaction and while the material is still hot.

330-10.2 Requirements Applicable to Courses Other Than Leveling:

330-10.2.1 Spreading and Finishing: Upon arrival, dump the mixture in the approved mechanical spreader, and immediately spread and strike-off the mixture to the full width required, and to such loose depth for each course that, when the work is completed, the required weight of mixture per square yard [square meter], or the specified thickness, is secured. Carry an excess amount of mixture ahead of the screed at all times. Hand rake behind the machine as required.

330-10.2.2 Thickness of Layers: Construct each course in layers of the thickness shown on Roadway and Traffic Design Standards, Index No. 513.

330-10.2.3 Laying Width: If necessary due to the traffic requirements, lay the mixture in strips in such a manner as to provide for the passage of traffic. As an option, where the road is closed to traffic, lay the mixture to the full width with machines traveling in echelon.

330-10.2.4 Correcting Defects: Before starting any rolling, check the surface; correct any irregularities; remove all drippings, fat sandy accumulations from the screed, and fat spots from any source; and replace them with satisfactory material. Do not skin patch. When correcting a depression while the mixture is hot, scarify the surface and add fresh mixture.

330-10.3 Requirements Applicable Only to Leveling Courses:

330-10.3.1 Patching Depressions: Before spreading any leveling course, fill all depressions in the existing surface more than 1 inch [25 mm] deep by spot patching with leveling course mixture, and then compact them thoroughly.

330-10.3.2 Spreading Leveling Courses: Place all courses of leveling by the use of two motor graders, equip one with a spreader box. Use other types of leveling devices after they have been approved by the Engineer.

330-10.3.3 Rate of Application: When the total asphalt mix provided for leveling exceeds 50 lb/yd^2 [27 kg/m^2], place the mix in two or more layers, with the average spread of any layer not to exceed 50 lb/yd^2 [27 kg/m^2]. When using Type S-III Asphaltic Concrete for leveling, do not allow the average spread of a layer to be less than 50 lb/yd^2 [27 kg/m^2] or more than 75 lb/yd^2 [40 kg/m^2]. The quantity of mix for leveling shown in the plans represents the average for the entire project; however, the Contractor may vary the rate of application throughout the project as directed by the Engineer. When leveling in connection with base widening, the Engineer may require placing all the leveling mix prior to the widening operation.

330-10.3.4 Placing Leveling Course Over Existing Pavement: When the Contract Documents specify a leveling course to be placed over cracked concrete pavement, including existing concrete pavement covered with an asphaltic surface, place the first layer of leveling course as soon as possible but no later than 48 hours after cracking the concrete.

330-10.3.5 Removal of Excess Joint Material: Where placing a leveling course over existing concrete pavement or bridge decks, trim the excess joint filler in the cracks and joints flush with the surface prior to placing the first layer of the leveling course.

330-11 Compacting Mixture.

330-11.1 Provisions Applicable to All Types:

330-11.1.1 Equipment and Sequence: For each paving or leveling train in operation, furnish a separate set of rollers, with their operators.

When density testing is required, select equipment, sequence, and coverage of rolling to meet the minimum density requirement in accordance with Table 330-3. The coverage is the number of times the roller passes over a given area of pavement. Regardless of the rolling procedure used, complete the final rolling before the surface temperature of the pavement drops below 160EF [70EC].

Once the Contractor selects the equipment and establishes the rolling procedures and has used these for an acceptable control strip density, then the Contractor shall continue to use the same equipment and rolling procedures for all asphalt mix represented by the control strip. If the Contractor changes the mix design, lift thickness, underlying pavement structure, equipment, or rolling procedures, the Department will require a new control strip density determination. Notify the Engineer prior to changing the rolling process.

330-11.1.2 Standard Rolling Procedure: Meet the following equipment, sequence, and coverage requirements:

1. Seal Rolling: Provide two coverages with a tandem steel-wheeled roller (either vibratory or static), weighing 5 to 12 tons [4.5 to 11 metric tons], following as close behind the spreader as possible without pick-up, undue displacement, or blistering of the material. Use vibratory rollers in the static mode for layers of 1 inch [25 mm] or less in thickness.

2. Intermediate rolling: Provide five coverages with a self-propelled pneumatic-tired roller, following as close behind the seal rolling operation as the mix will permit.

3. Final rolling: Provide one coverage with a tandum steel-wheeled roller (static mode only), weighing 5 to 12 tons [4.5 to 11 metric tons], after completing the seal rolling and intermediate rolling, but before the surface pavement temperature drops below 160EF [70EC].

The Contractor may use equipment, sequences, or coverages other than those specified in the standard rolling procedure if so authorized in writing by the Engineer.

330-11.1.3 Compaction at Crossovers, Intersections, etc.: When using a separate paving machine to pave the crossovers, compact the crossovers with one, 8 to 10 ton [7 to 9 metric ton] tandem steel roller. If placing crossovers, intersections, and acceleration and deceleration lanes with the main run of paving, also use a traffic roller to compact these areas.

330-11.1.4 Rolling Procedures: Ensure that the initial rolling is longitudinal. Where the lane being placed is adjacent to a previously placed lane, pinch or roll the center joint prior to the rolling of the rest of the lane.

Roll across the mat, overlapping the adjacent pass by at least 6 inches [150 mm]. Roll slowly enough to avoid displacement of the mixture, and correct any displacement at once by the use of rakes and the addition of fresh mixture if required. Continue final rolling to eliminate all roller marks.

330-11.1.5 Speed of Rolling: Operate the self-propelled, pneumatic-tired roller at a speed of 6 to 10 mph [10 to 16 km/h]. For each roller, do not exceed an area of coverage of 4,000 yd^2/h [3,300 m^2/h] if rolling Type S Asphaltic Concrete, do not exceed an area of coverage of 3,000 yd^2/h [2,500 m^2/h].

330-11.1.6 Number of Pneumatic-tired Rollers Required: Use a sufficient number of self-propelled pneumatic-tired rollers to ensure that the rolling of the surface for the required number of passes does not delay any other phase of the laying operation and does not result in excessive cooling of the mixture before completing the rolling. In the event that the rolling falls behind, discontinue the laying operation until the rolling operations are sufficiently caught up.

330-11.1.7 Compaction of Areas Inaccessible to Rollers: Use hand tamps or other satisfactory means to compact areas which are inaccessible to a roller, such as areas adjacent to curbs, headers, gutters, bridges, manholes, etc..

330-11.1.8 Rolling Patching and Leveling Courses: Use self-propelled pneumatic-tired rollers to roll all patching and leveling courses. Where placing the initial leveling course over broken concrete pavement, use a pneumatic-tired roller that weighs at least 15 tons [14 metric tons]. For Type S-III Asphaltic Concrete leveling courses, use a steel-wheeled roller to supplement the traffic rollers. On other leveling courses, use a steel-wheeled roller to supplement the traffic rollers on all passes after the first pass.

330-11.1.9 Correcting Defects: Do not allow the rollers to deposit gasoline, oil, or grease onto the pavement. Remove and replace any areas damaged by such deposits as directed by the Engineer. While rolling is in progress, test the surface continuously, and correct all discrepancies to comply with the surface requirements. Remove and replace all drippings, fat or lean areas, and defective construction of any description. Remedy depressions that develop before completing the rolling by loosening the mixture and adding new mixture to bring the depressions to a true surface. Should any depression remain after obtaining the final compaction, remove the full depth of the mixture, and replace it with sufficient new mixture to form a true and even surface. Correct all high spots, high joints, and honeycombing as directed by the Engineer. Remove and replace any mixture remaining unbonded after rolling. Correct all defects prior to laying the subsequent course.

330-11.1.10 Use of Traffic Roller on First Overbuild Course: Use a self-propelled pneumatic-tired roller on the first overbuild course. Compact with a minimum of five passes.

330-11.1.11 Use of Traffic Roller on First Structural Layer Placed on a Milled Surface: Use a self-propelled pneumatic-tired roller on the first structural layer placed on a milled surface. Compact with a minimum of three passes.

330-11.1.12 Use of Traffic Roller on First Structural Layer Placed on an Asphalt Rubber Membrane Interlayer (ARMI): Use a self-propelled pneumatic-tired roller on the first structural layer placed on an ARMI. Cover with a minimum of three passes.

330-11.2 Provisions Applicable to Shoulder Pavement Only: Compact shoulder pavements wider than 3 feet [1 m] with equipment as required for other asphaltic concrete pavements. Determine the density on shoulder pavements wider than 3 feet [1 m] when the thickness is 1 inch [25 mm] or greater. Determine these densities, including the control strip, separately from the pavement lane densities even when placing the pavement lane and shoulder in the same pass.

Do not determine the density on asphaltic concrete or sand-asphalt hot mix shoulders that are 3 feet [1 m] or less in width. Use tandem steel rollers not exceeding 12 tons [11 metric tons] in weight to compact these shoulder areas. In restricted areas, the Engineer may approve of other equipment that will effectively exert a compactive effort. Submit to the Engineer what equipment and compactive effort (coverage) is proposed to be used, and obtain the Engineer's approval before starting the operation. Where constructing sand-asphalt hot mix shoulders within the limits of curb and gutter, compact the shoulders using light weight rolling equipment approved by the Engineer that does not displace the previously constructed curb and gutter.

Place friction courses such that longitudinal joints do not extend into the final travel lane shown on the plans by more than 4 inches [100 mm].

330-11.3 Density Control:

330-11.3.1 Density Control Nuclear Method: Determine the in-place density of each course of asphalt mix construction using the Nuclear Density Backscatter Method as specified by FM 1-T238 (Method B). For a completed course, obtain an average in-place LOT density of at least 98% of the valid control strip density.

Do not perform density testing on patching courses, leveling and intermediate courses less than 1 inch [25 mm] thick (or a specified spread rate less than 100 lb/yd^2 [55 kg/m^2]), overbuild courses where the minimum thickness is less than 1 inch [25 mm], projects less than 1,000 feet [300 m], sections with variable width, or open-graded friction courses. Compact these courses, with the exception of open-graded friction courses in accordance with 330-11.1.1.

330-11.3.2 Control Strips: In order to determine the density of compacted asphalt mixtures for the purpose of acceptance, first establish a control strip. Construct one or more control strips for the purpose of determining the control strip density. Construct a control strip at the beginning of asphalt construction and one thereafter for each successive course. Construct a new control strip for any change in the composition of the mix design, underlying pavement structure, compaction equipment, or procedures. The Engineer may require an additional control strip when the Engineer deems it necessary to establish a new control strip density or confirm the validity of the control strip density being used at that time. The Contractor may also request a confirmation of the control strip density. Construct the control strip as a part of a normal day's run.

Construct a control strip 300 feet [100 m] in length and of an adequately uniform width to maintain a consistent compactive effort throughout the section. When constructing the control strip, start it between 300 and 1,000 feet [100 and 300 m] from the beginning of the paving operation. Construct a control strip of a thickness that is the same as that specified for the course of which it is a part. Construct the control strip using the same mix, the same paving and rolling equipment, and the same procedures as those used in laying the asphalt course of which the control strip is to become a part. Leave every control strip in place to become a portion of the completed roadway.

In order to determine the acceptability of the control strip, make ten nuclear density determinations at random locations within the control strip after completing the compaction of the control strip. Do not make any determinations within 12 inches [300 mm] of any unsupported edge. Use the average of these ten determinations for the Control Strip Density. For purposes of determining the percent of laboratory density, as required in Table 330-3, the Engineer will develop a correction factor at four nuclear density locations from 6 inch [150 mm] diameter cores or by direct transmission nuclear determination where applicable. Cut the cores prior to opening the roadway to traffic. The Engineer will calculate the percent of lab density to the nearest 0.01% and round it to the nearest 0.1%. Should the percent of lab density in a control strip exceed 99.0%, notify the Engineer immediately.

In the event that a control strip does not meet the minimum density requirements specified in Table 330-3, take appropriate corrective actions and construct a new control strip. If three consecutive control strips fail to meet specification requirements, the Engineer will limit production and placement of the mix to 800 to 1,000 feet [250 to 300 m], regardless of the thickness and width the Contractor is placing, until the Contractor obtains a passing control strip.

Once the Contractor has obtained a passing control strip after a failing control strip (for the same mix, layer, and project), the Department will use the passing control strip to accept all previously laid mix. In the event the Contractor does not obtain a passing control strip, and this particular mix, layer, etc., is completed on the project, the Engineer will evaluate density in accordance with FM 5-543.

Table 330-3

Roadway Requirements for Bituminous Concrete Mixes

Mix Type	Density	Minimum Control Strip Density* (% of Lab Density)	Surface Tolerance
S-I, S-II, S-III, Type II, Type III, SAHM	per 330-11.3	96	per 330-13
ABC-1, ABC-2, ABC-3	per 280-8.6	96	per 200-7
FC-2	No density required	N/A	per 330-13
FC-3	per 330-11.3	96	per 330-13

* The minimum control strip density requirement for shoulders is 95% of lab density.

330-11.3.3 LOTs: For the purpose of acceptance and partial payment, the Engineer will divide each day's production into LOTs. The Engineer will close out all LOTs at the end of the day. The standard size of a LOT is 5,000 feet [1,500 m] of any pass made by the paving train regardless of the width of the pass or the thickness of the course. A sublot will be 1,000 feet [300 m] or less. The Engineer will consider pavers traveling in echelon as two separate passes. When at the end of a production day, the completion of a given course, layer, or mix, or at the completion of the project, and a LOT size is determined to be less than 5,000 feet [1,500 m], it will be considered a partial LOT. Handle partial LOTs as follows:

If the length of the partial LOT is 2,000 feet [600 m] or less, and a previous full-size LOT from the same day, mix, layer, and project is available, then the previous full-size LOT will be redefined to include this partial LOT and the number of tests required for the combined LOT will be as shown in Table 330-4.

If the partial LOT is 2,000 feet [600 m] or less, and a previous full-size LOT from the same day, mix, layer, and project is not available, the Engineer will evaluate the partial LOT separately and perform the number of tests required for the partial LOT as shown in Table 330-4.

If the partial LOT is greater than 2,000 feet [600 m] long, the Engineer will evaluate the partial LOT separately and perform the number of tests required for the partial LOT as shown in Table 330-4.

Table 330-4

Testing Requirements for Partial LOTs

LOT Size	Number of Tests
Less than 3,000 feet [900 m]	3
3,001 to 4,000 feet [901 to 1,200 m]	4
4,001 to 5,000 feet [1,201 to 1,500 m]	5
5,001 to 6,000 feet [1,501 to 1,800 m]	6
6,001 to 7,000 feet [1,801 to 2,100 m]	7
Greater than 7,000 feet [2,100 m]	2 LOTs

For each LOT and partial LOT, the Engineer will make density determinations at a frequency shown in Table 330-4 at random locations within the LOT, but will not take them within 12 inches [300 mm] of any unsupported edge. The Engineer will determine the random locations by the use of statistically derived stratified random number tables. For the Contractor to receive full payment for density, the average density of a LOT shall be a minimum of 98.0% of the control strip density. Once the Engineer determines the average density of a LOT, do not provide additional compaction to raise the average. Notify the Engineer should the average density for two consecutive LOTs be greater than 102% of control strip density.

330-11.3.4 Acceptance: The Engineer will accept the completed pavement with respect to density on a LOT basis. The Department will make partial payment for those LOTs that have an average density less than 98.0% of the Control Strip Density based on the following schedule:

Table 330-5

Payment Schedule For Density

Percent of Control Strip Density*	Percent of Payment
98.0 and above	100
97.0 to less than 98.0	95
96.0 to less than 97.0	90
Less than 96.0**	75

* In calculating the percent of control strip density, do not round off the final percentage.

** If approved by the Engineer, based on an engineering determination that the material is acceptable to remain in place, the Contractor may accept the indicated partial pay; otherwise, remove and replace the material at no expense to the Department. The Contractor may remove and replace the material at no expense to the Department at any time.

330-11.3.5 Density Requirements for Small Projects and Other Non-mainline Roadway Areas: For projects less than 1,000 feet [300 m] in length and bridge projects with approaches less than 1,000 feet [300 m] each side, do not apply the requirements for control strips and nuclear density determination. Use the standard rolling procedures as specified in 330-11.1.2. Do not apply the provisions for partial payment to these small projects.

In other non-mainline roadway areas where it is not practical to establish a control strip, such as parking areas, toll plazas, turn lanes, and acceleration/deceleration lanes, the Contractor may use the standard rolling procedure to determine density requirements if so authorized in writing by the Engineer.

330-12 Joints.

330-12.1 Transverse Joints: Place the mixture as continuously as possible. Do not pass the roller over the unprotected end of the freshly laid mixture except when discontinuing the laying operation long enough to permit the mixture to become chilled. When thus interrupting the laying operation, construct a transverse joint by cutting back on the previous run to expose the full depth of the mat.

330-12.2 Longitudinal Joints: For all layers of pavement except the leveling course, place each layer so that longitudinal construction joints are offset 6 to 12 inches [150 to 300 mm] laterally between successive layers. The Engineer may waive this requirement where offsetting is not feasible due to the sequence of construction.

330-12.3 General: When laying fresh mixture against the exposed edges of joints (trimmed or formed as provided above), place it in close contact with the exposed edge to produce an even, well-compacted joint after rolling.

330-13 Surface Requirements.

330-13.1 Contractor's Responsibility: Obtain a smooth surface on all pavement courses placed, and then straightedge all intermediate and final courses with a 15 foot [4.572 m] rolling straightedge. Furnish a 15 foot [4.572 m] manual straightedge, and make it available at the job site at all times during the paving operation for checking joints and surface irregularities.

330-13.2 Texture of the Finished Surface of Paving Layers: Produce a finished surface of uniform texture and compaction with no pulled, torn, or loosened portions and free of segregation, sand streaks, sand spots, or ripples. Correct any area of the surface that does not meet the foregoing requirements in accordance with 330-13.4.

Do not use asphalt concrete mixtures containing aggregates that cause a different color appearance in the final wearing surface in sections less than 1 mile [1.5 km] in length without written permission.

330-13.3 Acceptance Testing for Surface Tolerance:

330-13.3.1 General: The Engineer will perform acceptance testing for surface tolerance on all pavement lanes and ramps where the width is constant, including all construction joints.

The Engineer will not test intersections, tapers, crossovers, transitions at beginning and end of project, and similar areas for surface tolerance with the rolling straightedge as provided below. However, correct any individual surface irregularity in these areas in excess of δ inch [10 mm] as determined by a 15 foot [4.572 m] straightedge, and that the Engineer deems to be objectionable, in accordance with 330-13.4.

When the Engineer is ready to perform acceptance testing for surface tolerance, provide the required traffic control in accordance with standard maintenance of traffic requirements as specified in the Contract. Include the cost of this traffic control in the Contract bid prices for the asphalt items.

Also provide a representative to be present during the entire operation of straightedging for acceptance purposes.

330-13.3.2 Test Method: The Engineer will perform acceptance testing with one pass of a standard 15 foot [4.572 m] rolling straightedge operated along the centerline of each lane tested. This does not preclude the Engineer from performing additional acceptance testing at other locations within the lane being tested.

330-13.3.3 Acceptance Criteria for Last Layer Prior to Friction Course: Furnish and operate an acceptable 15 foot [4.572 m] rolling straightedge for testing of the last layer prior to the friction course as directed and supervised by the Engineer. Correct all deficiencies in excess of 3/16 inch [5 mm] in accordance with 330-13.4, and retest the last layer prior to placement of the friction course. Where the final surface is not a friction course, meet acceptance criteria in accordance with 330-13.3.4.

330-13.3.4 Acceptance Criteria for Final Surface or Friction Course: Upon completion of the final surface or friction course, the Engineer will test the finished surface with a 15 foot [4.572 m] rolling straightedge. Correct all deficiencies in excess of 3/16 inch [5 mm] in accordance with 330-13.4, except do not correct by overlaying when the final surface is a friction course.

The Engineer may waive corrections specified above if an engineering determination indicates that the deficiencies are sufficiently separated so as not to significantly affect the ride quality of the pavement and corrective action would unnecessarily mar the appearance of the finished pavement.

Where the Engineer elects to waive correction and the finished pavement surface is a friction course, the Department will reduce the pay quantity for Asphaltic Concrete Friction Course by the amount of friction course that the Contractor would have removed and replaced if the Contractor had made the correction.

Where the Engineer elects to waive a correction and the finished pavement surface is other than a friction course, the Department will reduce the appropriate pay quantity for Asphaltic Concrete by the equivalent quantity of materials that the Contractor would have removed and replaced if the Contractor had made the correction.

a. Where the pay quantity is in square yards [square meters], the Department will base the reduction on the area that the Contractor would have removed (100 feet by lane width) [(30 m by lane width)] multiplied by the ratio of the layer thickness to the total thickness of the type of mix specified.

b. Where the pay quantity is in tons [metric tons], the Department will base the reduction on the volume that the Contractor would have removed 100 feet by lane width by layer thickness) [(30 m by lane width by layer thickness)] multiplied by the laboratory density for the mix.

330-13.4 Correcting Unacceptable Pavement: The Contractor may select one of the following methods, unless 330-13.3.4 prohibits overlaying:

a. Removing and Replacing: If correction is made by removing and replacing the pavement, remove the full depth of the course and extend at least 50 feet [15 m] on either side of the defective area for the full width of the paving lane.

b. Overlaying: If correction is made by overlaying, cover the length of the defective area and taper uniformly to a featheredge thickness at a minimum distance of 50 feet [15 m] on either side of the defective area. Extend the overlay the full width of the roadway. Maintain the specified cross slope. The Engineer may adjust, as necessary, the mix used for the overlay for this purpose.

c. Other Methods: For courses which will not be the final pavement surface, correct minor straightedge deficiencies by methods other than specified above as approved by the Engineer.

Perform all corrective work, at no expense to the Department.

330-14 Protection of Finished Surface.

Keep sections of newly compacted asphaltic concrete, which are to be covered by additional courses, clean until the successive course is laid.

Do not dump embankment or base material directly on the pavement. Dress shoulders before placing the friction course on adjacent pavement.

Equip blade graders operating adjacent to the pavement during shoulder construction with a 2 by 8 inch [50 by 200 mm] or larger board, or other attachment providing essentially the same results, attached to their blades in such manner that it extends below the blade edge in order to protect the pavement surface from damage by the grader blade.

To prevent rutting or other distortion, protect sections of newly finished dense-graded friction course and the last structural layer prior to the friction course from traffic until the surface temperature has cooled below 160EF [70EC].

The Contractor may use artificial methods to cool the pavement to expedite paving operations. The Department may direct the Contractor to use artificial cooling methods when maintenance of traffic requires opening the pavement to traffic at the earliest possible time.

330-15 Correcting Deficient Thickness.

330-15.1 Allowable Deficiencies: When the Department pays for the pavement on a square yard [square meter] basis, the Engineer will determine the thickness from the length of the core borings as specified in 330-16.1. The Engineer will allow a maximum deficiency from the specified thickness as follows:

1. For pavement of a specified thickness of 22 inches [60 mm] or more: 2 inch [13 mm].

2. For pavement of a specified thickness of less than 22 inches [60 mm]: 3 inch [6 mm].

330-15.2 Pavement Exceeding Allowable Deficiency in Thickness:

330-15.2.1 When Deficiency is Seriously in Excess: Where the deficiency in thickness is: (1) in excess of δ inch [10 mm] for pavement of less than 22 inches [60 mm] in specified thickness, or (2) in excess of : inch [20 mm] for pavement of specified thickness of 22 inches [60 mm] or more, correct the deficiency either by replacing the full thickness for a length extending at least 50 feet [15 m] from each end of the deficient area, or, when the Engineer allows, by overlaying as specified in 330-15.2.3.

As an exception to the above, the Contractor may leave pavement outside the main roadway in place without compensation when the Engineer allows, even though the deficiency exceeds the tolerance as specified above.

The Department will not compensate the Contractor for any pavement removed or for the work of removing such pavement.

330-15.2.2 When Deficiency is Not Seriously in Excess: When the deficiency in the thickness of the pavement is over 3 inch [6 mm] but not more than δ inch [10 mm] for pavement of specified thickness less than 22 inches [60 mm], or when the deficiency in thickness is over 2 inch [13 mm] but not more than : inch [20 mm] for pavement of specified thickness of 22 inches [60 mm] or greater, the Engineer will allow the Contractor to leave such pavement in place, but without compensation. The Department will determine the square yard [square meter] area, for which it will make no payment, by multiplying the product of the total distance between acceptable cores by the lane width which the Contractor laid at the particular pass in which deficient thickness was indicated. Perform all overlaying and compacting at no expense to the Department.

330-15.2.3 Correcting Deficiency by Adding New Surface Material*:* For any case of excess deficiency of the pavement, if approved by the Engineer for each particular location, correct the deficient thickness by adding new surface material, and compact it to the same density as the adjacent surface. The Engineer will determine the area to be corrected and the thickness of new material added as specified in 330-13.3. Perform all overlaying and compacting at no expense to the Department.

330-16 Calculations for Thickness of Pavement to be Paid for (Applicable Only Where the Pavement Is to be Paid for by the Square Yard [Square Meter]).

330-16.1 Core Borings: When the Department is ready to core the finished asphalt construction for thickness, provide traffic control, coring equipment, and an operator to obtain the cores. Provide traffic control in accordance with the standard maintenance of traffic requirements as specified in this Contract. The Department will make no additional payment for traffic control or coring. The Engineer will select the coring locations and make the acceptance measurements.

Provide a representative to be present during the entire coring operations for acceptance purposes.

The Engineer will determine the thickness of the pavement from the length of cores, at least 2 inches [50 mm] in diameter, taken at random points on the cross-section and along the roadway. The Engineer will locate each core to represent a section of roadway no longer than 200 feet [60 m], regardless of the number of lanes. The Engineer will determine the thickness for paved shoulders and widening separate from the mainline roadway and will locate each core to represent a section no longer than 400 feet [120 m] for each shoulder or widening. The Engineer will determine the average thickness from the measured thicknesses, in accordance with the procedure and criteria as specified herein.

If, during coring operations the Engineer cannot determine the line of demarcation between pay items, the Engineer will direct that cores extend to the full combined depth of the pay items to determine total thickness. In such cases, the Engineer will prorate all adjustments based on the plan thickness of the pay items.

The Engineer will make thickness adjustments in accordance with the following:

$$S_{adj} = \left(\frac{T_c}{T_p} - 1\right) S_p$$

$$B_{adj} = \left(\frac{T_c}{T_p} - 1\right) B_p$$

where: S_{adj}= Thickness adjustment of structural course

B_{adj}= Thickness adjustment of base course

T_c= Total combined specification average thickness

T_p= Total combined plan thickness

S_p= Plan thickness of structural course

B_p= Plan thickness of base course

If the Contractor believes that the number of cores taken is insufficient to properly indicate the thickness of the pavement, he may request that the Engineer select additional boring locations. The Department will deduct the cost of selecting additional boring locations and measuring the cores from any sums due the Contractor unless such borings indicate that the pavement within the questioned area is of specified thickness.

330-16.2 Criteria for Calculations:

a. The Engineer will calculate average thickness for the total length of project.

b. When the thickness as measured by the cores is more than 2 inch [13 mm] greater than the specified thickness, the Engineer will consider it as the specified thickness plus 2 inch [13 mm] in the calculation.

c. The Engineer will not take into account in the calculations areas of deficient-thickness pavement that the Contractor left in place for no compensation as specified in 330-15.2.

d. Where the Contractor corrects areas of defective surface or deficient thickness by overlaying with additional material, the Engineer will use the specified thickness for such areas in the calculations.

SECTION 331

TYPE S ASPHALT CONCRETE

331-1 Description.

Construct a Type S-I, Type S-II or Type S-III Asphalt Concrete as specified by the Contract. When offered as alternates, either Type may be constructed. The composition and physical test properties for all mixes including Type S Asphaltic

Concrete (S-I, S-II and S-III) are shown in Tables 331-1 and 331-2.

Where Type S Asphalt Concrete is specified in the Contract, if approved by the Engineer, Type S-III Asphalt Concrete may be selected as an alternate for the final surface when no friction course is specified, and as the final layer of structural course prior to the friction course. The Engineer will not permit Type S-II Asphaltic Concrete as the final layer prior to the friction course.

Meet the requirements for plant and equipment specified in Section 320. Meet the general construction requirements specified in Section 330.

Table 331-1
Bituminous Concrete Mixtures
(Gradation Design Range)

Type	Total Aggregate Passing Sieves[1]							
	: inch [19.0 mm]	2 inch [12.5 mm]	δ inch [9.5 mm]	No. 4 [4.75 mm]	No. 10 [2.0 mm]	No. 40 [425 Φm]	No. 80 [180 Φm]	No. 200 [75 Φm]
S-I[5]	100	88-98	75-93	47-75	31-53	19-35	7-21	2-6
S-II[2]	83-98	71-87	62-78	47-63	33-49	19-35	9-18	2-6
S-III[5]		100	88-98	60-90	40-70	20-45	10-30	2-6
Type II		100	90-100	80-100	55-90			2-12
Type III		100	80-100	65-100	40-75	20-45	10-30	2-10
SAHM		100						0-12
ABC-1		100						0-12
ABC-2		100			55-90			0-12
ABC-3[3]	70-100			30-70	20-60	10-40		2-10
FC-2[4]		100	85-100	10-40	4-12			2-5
FC-3[5]		100	88-98	60-90	40-70	20-45	10-30	2-6

[1] In inches [mm] or sieves [Φm].
[2] 100% passing 13 inch [31.5 mm] sieve and 94 to 100% passing 1 inch [25.0 mm] sieve.
[3] 100% passing 12 inch [37.5 mm] sieve.
[4] The Engineer may increase the design range for the No. 10 [2.00 mm] sieve for lightweight aggregates.
[5] The Engineer may retain up to 1% on the maximum sieve size.

Table 331-2 Non SI Units
Marshall Design Properties For Bituminous Concrete Mixes

Mix Type	Minimum Marshall Stability (lbs.)	Flow** (0.01 in.)	Minimum VMA (%)	Air Voids (%)	Minimum Effective Asphalt Content (%)	VFA Voids Filled with Asphalt (%)
S-I	1,500*	8-13	14.5	4-5	***	65-75
S-II	1,500*	8-13	13.5	4-5	***	65-75
S-III	1,500*	8-13	15.5	4-6	***	65-75

Type II	500-750	7-15	18	5-16	6.0	-
Type III	750-1,000	7-15	15	5-12	5.5	-
SAHM	300-500	7-15	15	5-16	6.0	-
ABC-1	500	7-15	15	5-16	6.0	-
ABC-2	750	7-15	15	5-14	5.5	-
ABC-3	1,000	8-13	14	4-7	***	65-78
FC-2	-	-	-	-	-	-
FC-3	1,500	8-13	15.5	4-6	***	65-75

*The minimum Marshall Stability for Type S mixes used on limited access facilities (Interstate, Turnpike, and Expressways) shall be 1,800 lbs.
**The maximum Flow value during production shall not exceed one point more than shown in the Table.
***The ratio of the percentage by weight of total aggregate passing the No. 200 sieve to the effective asphalt content expressed as a percentage by weight of total mix shall be in the range of 0.6 to 1.2.

Table 331-2 SI Units
Marshall Design Properties For Bituminous Concrete Mixes

Mix Type	Minimum Marshall Stability (kN)	Flow** (mm)	Minimum VMA (%)	Air Voids (%)	Minimum Effective Asphalt Content (%)	VFA Voids Filled with Asphalt (%)
S-I	6.7*	2.0-3.3	14.5	4-5	***	65-75
S-II	6.7*	2.0-3.3	13.5	4-5	***	65-75
S-III	6.7*	2.0-3.3	15.5	4-6	***	65-75
Type II	2.2-3.3	1.8-3.8	18	5-16	6.0	-
Type III	3.3-4.4	1.8-3.8	15	5-12	5.5	-
SAHM	1.3-2.2	1.8-3.8	15	5-16	6.0	-
ABC-1	2.2	1.8-3.8	15	5-16	6.0	-
ABC-2	3.3	1.8-3.8	15	5-14	5.5	-
ABC-3	4.4	2.0-3.3	14	4-7	***	65-78
FC-2	-	-	-	-	-	-
FC-3	6.7	2.0-3.3	15.5	4-6	***	65-75

*The minimum Marshall Stability for Type S mixes used on limited access facilities (Interstate, Turnpike, and Expressways) shall be 8.0 kN.
**The maximum Flow value during production shall not exceed 0.25 mm more than shown in the Table.
***The ratio of the percentage by weight of total aggregate passing the 75Φm sieve to the effective asphalt content expressed as a percentage by weight of total mix shall be in the range of 0.6 to 1.2.

The Engineer will accept the work on a LOT to LOT basis in accordance with the applicable requirements of Sections 5, 6, and 9. The size of the LOT will be as specified in 331-5 for the bituminous mixture produced at the plant and as stipulated in 330-11 and 330-13 for the material placed on the roadway.

331-2 Materials.

331-2.1 General Specifications: Meet the requirements specified in Division III. Specific references are as follows:

(1) Asphalt Cement Viscosity Grade AC-30 916-1
(2) Mineral Filler .... 917-1 and 917-2
(3) Coarse Aggregate, Stone, Slag or Crushed Gravel ....*Section 901
(4) Fine Aggregate ....Section 902

*Use crushed gravel in asphalt concrete mixtures. In addition, the asphalt concrete mixtures containing crushed gravel as the course aggregate component must show no potential for stripping during laboratory testing, before mix design verification.

Reclaimed Portland Cement Concrete Pavement may be used as a coarse aggregate or screenings component subject to meeting all applicable specifications.

The Engineer will sample all materials shipped to the asphalt plant at their destination.

331-2.2 Specific Requirements:

331-2.2.1 Condition of Aggregate: Use clean aggregate containing no deleterious substances. Do not use coarse or fine aggregate which contains more than 0.5% of phosphate.

331-2.2.2 Fine Aggregate and Mineral Filler: In laboratory tests, and for the purpose of proportioning the paving mixture, consider all material passing the No. 10 [2.00 mm] sieve and retained on the No. 200 [75 µm] sieve as fine aggregate, and the material passing the No. 200 [75 µm] sieve as mineral filler.

331-2.2.3 Screenings: Do not use any screenings in the combination of aggregates containing more than 15% of material passing the No. 200 [75 µm] sieve. When two screenings are blended to produce the screening component of the aggregate, one of such screenings may contain up to 18% of material passing the No. 200 [75 µm] sieve, as long as the combination of the two does not contain over 15% material passing the No. 200 [75 µm] sieve. Screenings may be washed to meet these requirements.

331-2.2.4 Use of Reclaimed Asphalt Pavement (RAP): RAP may be used as a component material of the bituminous mixture subject to the following:

1. Assume responsibility for the design of asphalt mixes which incorporate RAP as a component part.

2. Do not allow RAP to exceed 60% by weight of total aggregates for Asphalt Base Courses nor more than 50% by weight of total aggregates for Structural and Leveling Courses. Do not use RAP in Friction Courses.

3. Mount a grizzly or grid with openings of a sufficient size to prevent clogging of the cold feed over the RAP cold bin.

Use a grizzly or grid over the RAP cold bin, in-line roller crusher, screen, or other suitable means to prevent oversized RAP material from showing up in the completed recycled mixture.

If oversized RAP material appears in the completed recycled mix, cease plant operations and take appropriate corrective action.

4. Ensure that the RAP material as stockpiled is reasonably uniform in characteristics and contains no aggregate particles which are soft or conglomerates of fines.

5. Ensure that the RAP has a minimum average asphalt content of 4% by weight of total mix. The Department reserves the right to sample the stockpile in order that this requirement is met.

When milling is required on the project and a Composition of Existing Pavement is included in the Contract Documents, and the Contractor elects to use the milled material as a component of the asphalt mixture, use the following procedures for obtaining representative samples for the mix design:

1. Cut ten 6-inch [150 mm] cores in area(s) approved by the Engineer. Fill the core holes immediately prior to opening to traffic.

2. Representative samples may also be obtained by milling the existing pavement to the full depth shown on the plans for pavement removal for a length of approximately 200 feet [60 m]. Immediately replace the pavement removed with the specified mix in the Contract.

3. Submit a request in writing to the Engineer for any variance from the above outlined methods of obtaining samples for mix designs.

When the RAP to be used as a component in a mix design is stockpiled from a previous DOT project and the Composition of Existing Pavement is known, design the mix and submit to the Department for verification.

When the composition of stockpiled RAP to be used as a component in a mix design is not known, design the mix as follows:

1. Submit a bag of RAP, composed of samples from several locations in the stockpile(s), to the Department at least four weeks prior to the planned start of mix design. The Engineer will run viscosities on the reclaimed asphalt pavement and furnish the information to the Contractor.

2. Run a minimum of six extraction gradation analyses of the RAP. Take the samples at random locations around the stockpile(s).

3. Request the Engineer to make a visual inspection of the stockpile(s) of RAP. Based on visual inspection, the Engineer will determine the suitability of the stockpiled materials.

4. When the proposed mix design is submitted to the Department for verification, submit the data from the extraction gradation analyses required above.

331-2.2.5 Recycling Agents: When RAP is approved for use as a component material, use a recycling agent meeting the requirements specified in 916-2 in the mix.

The Engineer will select the best formulation suited for the project and reserves the right to request reasonable changes throughout the construction duration.

331-2.2.6 Use of Recycled Crushed Glass: Recycled crushed glass may be used as a component of the bituminous mixture subject to the following:

1. Consider the recycled crushed glass a local material and meet all requirements specified in 902-6.

2. The percentage of recycled crushed glass in any bituminous mixture does not exceed 15% of the total aggregate weight.

3. The asphalt binder used with mixtures containing recycled crushed glass contains 0.5% anti-stripping agent from an approved source. The addition of the specified amount of anti-stripping agent must be certified by the supplier.

4. Test bituminous mixtures containing recycled crushed glass in accordance with AASHTO T 283 as part of the mix design approval. The minimum tensile strength ratio must not be less than 80%. An increase in the amount of anti-stripping agent may be necessary in order to meet this requirement.

5. Recycled crushed glass must not be used in friction course mixtures nor in structural course mixtures which are to be used as the final wearing course.

331-3 Permissible Variation for the Coarse Aggregate.

Size and uniformly grade or combine the aggregate or aggregates shipped to the job in such proportions that the resulting mixture meets the grading requirements of the mix design.

331-4 General Composition of Mixture.

331-4.1 General: Use a bituminous mixture composed of a combination of aggregate (coarse, fine or mixtures thereof), mineral filler, if required, and bituminous material. Ensure that not more than 20% by weight of the total aggregate used is silica sand or local materials as defined in Section 902. Consider the silica sand and local materials contained in any RAP material, if used in the mix, in this limitation. Size, grade and combine the several aggregate fractions in such proportions that the resulting mixture meets the grading and physical properties of the verified mix design.

RAP meeting the requirements of 331-2.2.4 may be approved as a substitution for a portion of the combination of aggregates, subject to all applicable specification requirements being met.

331-4.2 Grading Requirements: In all cases, use a mix design within the design ranges specified in Table 331-1.

331-4.3 Mix Design:

331-4.3.1 General: Prior to the production of any asphaltic paving mixture, submit a mix design and representative samples of all component materials to the Department at least two weeks before the scheduled start of production. The Engineer will verify the mix design before use. Send a copy of the proposed mix design to the Engineer at the same time. (Open-graded mixes will be designed by the Engineer.) Furnish the following information:

1. The specific project on which the mixture will be used.

2. The source and description of the materials to be used.

3. The gradation and approximate proportions of the raw materials as intended to be combined in the paving mixture. The gradation of the component materials shall be representative of the material at the time of use.

4. A single percentage of the combined mineral aggregate passing each specified sieve. Degradation of the aggregate due to processing (particularly No. 200 [75 Φm]) should be accounted for and identified for the applicable sieves.

5. A single percentage of asphalt by weight of total mix intended to be

incorporated in the completed mixture, shown to the nearest 0.1%. For structural mixes (S-I, S-II and S-III) establish the optimum asphalt content at a level corresponding to a minimum of 4.5% air voids. For FC-3 mixes, establish optimum asphalt content at a level corresponding to a minimum of 5.0% air voids.

6. A single temperature at which the mixture is intended to be discharged from the plant.

7. The laboratory density of the asphalt mixture for all mixes except Open-Graded Friction Courses.

8. Evidence that the completed mixture will meet all specified physical requirements.

9. The name of the individual responsible for the Quality Control of the mixture during production.

331-4.3.2 Revision of Mix Design: Submit all requests for revisions to approved mix designs, along with supporting documentation, in writing to the Engineer. In order to expedite the revision process, a verbal revision request or discussion of the possibility of a revision request may be made, but must be followed up with a written request. The verified mix design will remain in effect until a change is authorized by the Engineer. In no case will the effective date of the revision be established earlier than the date of the first communication with the Engineer regarding the revision.

Provide a new mix design for any change in source of aggregate.

331-4.3.3 Resistance to Plastic Flow: Include with the submitted mix design test data showing that the material as produced will meet the requirements specified in Table 331-2 when tested in accordance with FM 1-T 245. Further, determine the bulk specific gravity of the laboratory compacted bituminous mixture in accordance with FM 1-T 166.

Determine the percent of unfilled voids and the percent of aggregate voids filled with asphalt using the maximum specific gravity of the bituminous mixture and on the asphalt content of each group of specimens prepared from the same sample. Determine maximum specific gravity of the bituminous mixture by FM 1-T 209.

331-4.4 Contractor's Quality Control:

331-4.4.1 Personnel: In accordance with the requirements of 330-2.2 provide the necessary quality control personnel. Ensure that the Quality Control Technician is certified by the Department and possesses a valid certificate of qualification. When it becomes evident to the Department that the Quality Control Technician cannot perform as required by the position, the Department will revoke the certification and require replacement with a certified technician.

331-4.4.2 Extraction Gradation Analysis: Sample the bituminous mixture at the plant in accordance with FM 1-T 168. With the exception of friction courses, determine the percent bitumen content of the mixture in accordance with FM 5-544, and determine the percent passing the standard sieves in accordance with FM 5-545. Determine the percent bitumen content and the percent passing the standard sieves for friction course mixtures in accordance with FM 5-563 and FM 1-T 030, respectively. If the Contractor and Engineer agree, FM 5-563 and FM 1-T 030 may be used for acceptance on all mixtures. Show all test results to the nearest 0.01. Carry all calculations to the nearest 0.001 and rounded to the nearest 0.01, in accordance with the Department's rules of rounding.

Run a minimum of one extraction gradation analysis of the mixture for each day's or part of a day's production and immediately following any change in the production process. Take the quality control sample of mixture for the extraction gradation analysis each day as soon as the plant operations have stabilized. Obtain the results in a timely manner (no later than the end of the day) so that adjustments can be made if necessary.

On initial use of a Type S or FC-3 mix design at a particular plant, as a minimum, run an additional extraction gradation analysis if more than 500 tons [450 metric tons] of mixture are produced on the first day of production.

Extraction gradation analysis will not be required on the days when mix production is less than 100 tons [90 metric tons]. However, when mix production is less than 100 tons [90 metric tons] per day on successive days, run the test when the accumulative tonnage on such days exceeds 100 tons [90 metric tons].

Use the target gradation and asphalt content as shown on the mix design. Any changes in target will require a change in the mix design in accordance with 331-4.3.2.

If the percentage of bitumen deviates from the optimum asphalt content by more than 0.55% or the percentage passing any sieve falls outside the limits shown in Table 331-3, make the necessary correction. If the results for two consecutive tests deviate from the optimum asphalt content by more than 0.55% or exceeds the limits as shown in Table 331-3 for any sieve, stop the plant operation until the problem has been corrected. In addition, if the results of two consecutive tests show an amount greater than 99.0% passing the 2 inch [12.5 mm] sieve for Type S-I, an amount greater than 99.0% passing the : inch [19.0 mm] sieve for Type S-II, or an amount greater than 99.0% passing the δ inch [9.5 mm] sieve for Types S-III or FC-3, stop the plant operation until the problem has been corrected.

Maintain control charts showing the results of the extraction gradation analysis (bitumen content and sieve analysis).

Table 331-3
Tolerances for Quality Control Tests (Extraction Gradation Analysis)

Sieve Size	Percent Passing
1 inch [25.0 mm]	7
: inch [19.0 mm]	7
2 inch [12.5 mm]	7
δ inch [9.5 mm]	7
No. 4 [4.75 mm]	7
No. 10 [2.00 mm]	5.5
No. 40* [*425 μm]	4.5
No. 80* [*180 μm]	3
No. 200 [75 μm]	2

*Does not apply to SAHM, ABC-1 or Type II.

331-4.4.3 Plant Calibration: At or before the start of mix production, perform a wash gradation on a set of hot bin samples for batch or continuous mix plants or belt cut for drum mix plants to verify calibration of the plant. When approved by the Engineer, extraction gradation analysis of the mix may be used to verify calibration of the plant. This extraction gradation analysis may also be used to fulfill the quality control requirements for the first days production.

331-4.4.4 Viscosity of Asphalt in Mixes Containing RAP: When RAP is a component material, the viscosity of the asphalt material in the bituminous mixture, determined by the Engineer in accordance with FM 1-T 202, shall be 6,000 ∀ 2,000 poises [600 ∀ 200 Pa≅s]. This determination will be made on samples obtained by the Department on a random basis at a frequency of approximately one per 2,000 tons [1,800 metric tons] of mix.

If the viscosity is determined to be out of the specified tolerance, adjust the recycling agent formulation or blend of reclaimed asphalt material used in the mixture to bring the viscosity within tolerance.

331-5 Acceptance of the Mixture.

331-5.1 General: The Engineer will accept the bituminous mixture at the plant, with respect to gradation and asphalt content, on a LOT to LOT basis. The material will be tested for acceptance in accordance with the provisions of 330-2 and the following requirements. However, the Engineer will reject any load or loads of mixture which are unacceptable for reason of being excessively segregated, aggregates improperly coated, or of excessively high or low temperature for use in the work.

For initial use of a Type S or FC-3 mix design with a Florida limestone source north of the 28th parallel at a particular plant, limit the first day's production to a maximum of 300 tons [275 metric tons]. Resume production upon notification of acceptable Marshall properties as determined in accordance with 331-5.5

A standard size LOT at the asphalt plant will consist of 4,000 tons [3,600 metric tons] with four equal sublots of 1,000 tons [900 metric tons] each. As an exception, the first LOT for the initial use of a Type S or FC-3 mix design with a particular plant will consist of four sublots, the first sublot of 500 tons [450 metric tons] or the first day's production (300 tons [275 metric tons] maximum for mix design with a Florida limestone source north of the 28th parallel), the second sublot of 500 tons [450 metric tons], and the remaining two sublots of 1,000 tons [900 metric tons] each.

A partial LOT may occur due to the following:

(1) the completion of a given mix type on a project.

(2) an approved LOT termination by the Engineer due to a change in process, extended delay in production, or change in mix design.

If the partial LOT contains one or two sublots with their appropriate test results, then the previous full-size LOT will be redefined to include this partial LOT and the evaluation of the LOT will be based on either five or six sublot determinations. If the partial LOT contains three sublots with their appropriate test results, this partial LOT will be redefined to be a whole LOT and the evaluation of it will be based on three sublot determinations.

When the total quantity of any mix is less than 3,000 tons [2,700 metric tons], the partial LOT will be evaluated for the appropriate number of sublots from n=1 to n=3. When the total quantity of any mix type is less than 500 tons [450 metric tons], the Department will accept the mix on the basis of visual inspection. The Department may run extraction and gradation analysis for information purposes; however, the provisions for partial payment will not apply.

On multiple project contracts, the LOT(s) at the asphalt plant will carry over from project to project.

331-5.2 Acceptance Procedures: Control all operations in the handling, preparation, and mixing of the asphalt mix so that the percent bitumen and the percents passing the No. 4, No. 10, No. 40 and No. 200 [4.75 mm, 2.00 mm, 425 μm and 75 μm] sieves will meet the approved job mix formula within the tolerance shown in Table 331-5.

Table 331-5
Tolerances for Acceptance Tests

Characteristic	Tolerance*
Asphalt Content (Extraction)	∀0.55%
Asphalt Content (Printout)	∀0.15%
Passing No. 4 [4.75 mm] sieve	∀7.00%
Passing No. 10 [2.00 mm] sieve	∀5.50%
Passing No. 40 [425 μm] sieve **	∀4.50%
Passing No. 200 [75 μm] sieve	∀2.00%

*Tolerances for sample size of n=1. See Table 331-6 for other sample sizes n=2 through n=6.
**Applies only to Types S-I, S-II, S-III, and FC-3.

Acceptance of the mixture will be on the basis of test results on consecutive random samples from each LOT. One random sample will be taken from each sublot. The bituminous mixture will be sampled and tested at the plant as specified in 331-4.4.2.

Calculations for the acceptance test results for bitumen content and gradation (percentages passing No. 4, No. 10, No. 40 and No. 200 [4.75 mm, 2.00 mm, 425 μm and 75 μm] sieves) will be shown to the nearest 0.01. Calculations for arithmetic averages will be carried to the nearest 0.001 and rounded to the nearest 0.01 in accordance with the Department's rules of rounding.

Payment will be made on the basis of Table 331-6, AAcceptance Schedule of Payment≅. The process will be considered out of control when the deviation of any individual test result from the mix design falls in the 80% pay factor for the Aone test≅ column of Table 331-6. When this happens, the LOT will be automatically terminated and production stopped. The approval of the Engineer will be required prior to resuming production of the mix. Acceptance of the LOT will then be determined in accordance with Table 331-6.

All acceptance tests will be completed on the same day the sample was taken, when possible, and on no occasion will they be completed later than the following work day.

Table 331-6 Acceptance Schedule of Payment (Asphalt Plant Mix Characteristics)						
Average of Accumulated Deviations of the Acceptance Tests from the Mix Design.						
Pay Factor	1-Test	2-Tests	3-Tests	4-Tests	5-Tests	6-Tests
Asphalt Cement Content (Extraction - FM 5-544 or 5-563)						
1.00	0.00-0.55	0.00-0.43	0.00-0.38	0.00-0.35	0.00-0.33	0.00-0.31
0.95	0.56-0.65	0.44-0.50	0.39-0.44	0.36-0.40	0.34-0.37	0.32-0.36
0.90	0.66-0.75	0.51-0.57	0.45-0.50	0.41-0.45	0.38-0.42	0.36-0.39
0.80*	over 0.75	over 0.57	over 0.50	over 0.45	over 0.42	over 0.39
Asphalt Cement Content (Printout)						
1.00	0.00-0.15	0.00-0.15	0.00-0.15	0.00-0.15	0.00-0.15	0.00-0.15
0.95	0.16-0.25	0.16-0.25	0.16-0.25	0.16-0.25	0.16-0.25	0.16-0.25
0.90	0.26-0.35	0.26-0.35	0.26-0.35	0.26-0.35	0.26-0.35	0.26-0.35
0.80*	over 0.35	over 0.35	over 0.35	over 0.35	over 0.35	over 0.35
No. 4 [4.75 mm] sieve**						
1.00	0.00-7.00	0.00-5.24	0.00-4.46	0.00-4.00	0.00-3.68	0.00-3.45
0.98	7.01-8.00	5.25-5.95	4.47-5.04	4.01-4.50	3.69-4.13	3.46-3.86
0.95	8.01-9.00	5.96-6.66	5.05-5.62	4.51-5.00	4.14-4.58	3.87-4.27
0.90	9.01-10.00	6.67-7.36	5.63-6.20	5.01-5.50	4.59-5.02	4.28-4.67
0.80*	over 10.00	over 7.36	over 6.20	over 5.50	over 5.02	over 4.67
No. 10 [2.00 mm] sieve**						
1.00	0.00-5.50	0.00-4.33	0.00-3.81	0.00-3.50	0.00-3.29	0.00-3.13
0.98	5.51-6.50	4.34-5.04	3.82-4.39	3.51-4.00	3.30-3.74	3.14-3.54
0.95	6.51-7.50	5.05-5.74	4.40-4.96	4.01-4.50	3.75-4.18	3.55-3.95
0.90	7.51-8.50	5.75-6.45	4.97-5.54	4.51-5.00	4.19-4.63	3.96-4.36
0.80*	over 8.50	over 6.45	over 5.54	over 5.00	over 4.63	over 4.36
No. 40 [425 Φm] sieve**						

Table 331-6 Acceptance Schedule of Payment (Asphalt Plant Mix Characteristics)						
Average of Accumulated Deviations of the Acceptance Tests from the Mix Design.						
Pay Factor	1-Test	2-Tests	3-Tests	4-Tests	5-Tests	6-Tests
1.00	0.00-4.50	0.00-3.91	0.00-3.65	0.00-3.50	0.00-3.39	0.00-3.32
0.98	4.51-5.50	3.92-4.62	3.66-4.23	3.51-4.00	3.40-3.84	3.33-3.72
0.95	5.51-6.50	4.63-5.33	4.24-4.81	4.01-4.50	3.85-4.29	3.73-4.13
0.90	6.51-7.50	5.34-6.04	4.82-5.39	4.51-5.00	4.30-4.74	4.14-4.54
0.80*	over 7.50	over 6.04	over 5.39	over 5.00	over 4.74	over 4.54
No. 200 [75Φm] sieve**						
1.00	0.00-2.00	0.00-1.71	0.00-1.58	0.00-1.50	0.00-1.45	0.00-1.41
0.95	2.01-2.40	1.72-1.99	1.59-1.81	1.51-1.70	1.46-1.63	1.42-1.57
0.90	2.41-2.80	2.00-2.27	1.82-2.04	1.71-1.90	1.64-1.80	1.58-1.73
0.80*	over 2.80	over 2.27	over 2.04	over 1.90	over 1.80	over 1.73

*If approved by the Engineer based on an engineering determination that the material is acceptable to remain in place, the Contractor may accept the indicated partial pay. Otherwise, remove and replace the material at no cost to the Department at any item.
**When there are two or more reduced payments for these items in one LOT of material, only the greatest reduction in payment will be applied. CAUTION: This rule applies only to these four gradation test results.
NOTES:
(1) The No. 40 [425 Φm] sieve applies to Type S-I, S-II, S-III and FC-3.
(2) Deviations are absolute values with no plus or minus signs.

331-5.3 Automatic Batch Plant With Printout: Acceptance determinations for asphalt content for mixtures produced by automatic batch plants with printout will be based on the calculated bitumen content using the printout of the weights of asphalt actually used. Acceptance determinations for gradations (No. 4, No. 10, No. 40 and No. 200 [4.75 mm, 2.00 mm, 425 µm and 75 µm] sieves) will be based on the actual test results from extraction gradation analyses. Payment will be made based on the provisions of Table 331-6.

331-5.4 Acceptance on the Roadway: The bituminous mixture will be accepted on the roadway with respect to compacted density and surface tolerance in accordance with the applicable requirements of 330-11 and 330-13.

331-5.5 Additional Tests: The Engineer reserves the right to run any test at any time for informational purposes and for determining the effectiveness of the Contractor's quality control.

331-5.5.1 Determination of Marshall and Volumetric Properties: The Engineer will determine the Marshall and Volumetric Properties of the mix at a minimum frequency of one set per LOT, to determine whether or not the produced mix is meeting the specification requirements. The Department will sample and prepare test specimens and test them in accordance with FM 5-511 for Marshall stability and flow, FM 1-T 209 for maximum specific gravity, and FM 1-T 166 for density. Volumetric properties will be determined for Type S and FC-3 mixes only.

331-5.5.2 Failing Marshall Properties: When the average value of the specimens fails to meet specification requirements for stability or flow, the Engineer may stop the plant operations until all specification requirements can be met or until another verified mix design has been approved. Make revisions to a mix design in accordance with 331-4.3.2.

331-5.5.3 Failing Volumetric Properties (Type S and FC-3 mixes only): When the Engineer determines the air void content to be less than 3.0%, or greater than 6.5%, make appropriate adjustments to the mix. When the air void content is determined to be less than 2.5% or greater than 7.0% on any one test, or less than 3.0% on two consecutive tests, cease operations until the problem has been resolved.

331-5.5.4 Resuming Production: In the event that plant operations are stopped due to a failure to meet specification requirements, obtain the Engineer=s approval before resuming production of the mix. Limit production to a maximum of 300 tons [270 metric tons]. At this time, the Marshall and volumetric properties of the mix will be verified. After the Marshall and volumetric properties are verified, full scale production of the mix may be resumed.

331-5.5.5 Disposition of In-Place Material: Any material in-place that is represented by the failing test results (low stability, high flow, or less than 2.5% air voids) will be evaluated by the Engineer to determine if removal and replacement is necessary. Remove and replace any in-place material, if required, at no cost to the Department.

331-6 Method of Measurement.

The quantity to be paid for will be the weight of the mixture, in tons [metric tons], completed and accepted. The weight will be determined as provided in 320-2 (including the provisions for the automatic recordation system).

The bid price for the asphalt mix will include the cost of the liquid asphalt or the asphalt recycling agent. There will be no separate payment or unit price adjustment for the bituminous material in the asphalt mix.

331-7 Basis of Payment:

Price and payment will be full compensation for all the work specified under this Section, including the applicable requirements of Sections 320 and 330.

Payment will be made under:

Item No. 331- 2- Type S Asphaltic Concrete - per ton.
Item No. 2331- 2- Type S Asphaltic Concrete - per metric ton.

SECTION 332

TYPE II ASPHALTIC CONCRETE

332-1 Description.

Construct a Type II Asphaltic Concrete pavement.

Meet the plant and equipment requirements as specified in Section 320. Meet the general construction requirements, including the methods of calculation for thickness of pavement to be paid for, as specified in Section 330.

The Engineer will accept work on a LOT to LOT basis in accordance with the applicable requirements of Sections 5 and 6. The Engineer will determine the size of the LOT as specified in 331-5 for the bituminous mixture accepted at the plant and as specified in 330-11 for the material accepted on the roadway.

332-2 Materials.

332-2.1 Bituminous Material: Use Asphalt Cement, Viscosity Grade AC-20 or AC-30 meeting the requirements of 916-1.

332-2.2 Aggregate:

332-2.2.1 General: Use aggregate containing no appreciable amount of phosphate and consisting of either crushed slag, crushed stone, crushed gravel, coquina shell, oyster shell, or other crushed aggregate screenings from a Department-approved source. The Contractor may use any combination of these aggregates with sand that meets the gradation and Marshall properties requirements specified, except shell in the surface course.

332-2.2.2 Special Requirements for Gravel: Use crushed gravel containing no less than 85% particles which possess a minimum of three crushed faces, produced from gravel that is free of clay balls and excessive quantities of loam, roots, or other deleterious materials.

332-2.2.3 Sand: Use sand composed of hard, durable grains, containing no excessive quantities of loam or other deleterious substances. If clay is present, ensure that the quantity does not exceed 7%. Ensure that any clay present is the type which will not produce clay balls in the mixture. Use nonplastic sand suitable for use in bituminous mixtures as determined by laboratory tests. If the sand deposit consists of stratified layers of varying characteristics and gradation, employ such means as necessary to secure a uniform material.

332-2.3 Mineral Filler: If needed, meet the requirements of Section 917.

332-2.4 Testing: The Engineer will sample all materials shipped to the asphalt plant at their destination.

332-3 Composition of Mixture.

332-3.1 General: Use a bituminous mixture composed of a combination of aggregate (coarse, fine, or mixtures thereof), mineral filler if required, and bituminous material. Size, uniformly grade, and combine the several aggregate fractions in such proportions that the resulting mixture meets the grading and physical properties of the verified mix design.

The Contractor may use RAP meeting the requirements of 331-2.2.4 as a substitution for a portion of the combination of aggregates. If using RAP, the Contractor may use a recycling agent in accordance with the requirements of 331-2.2.5 in the mix in lieu of asphalt cement.

The Contractor may use recycled crushed glass meeting the requirements of 331-2.2.6 as a substitution for a portion of the combination of aggregates.

332-3.2 Grading Requirements:

332-3.2.1 General: Use a mix design that has been verified by the Engineer and meets the design range specified in Table 331-1.

332-3.2.2 Gradation: When tested before entering the asphalt plant in the combination to be used, ensure that the aggregate, including any mineral filler, does not contain more than 12% by weight of material passing the No. 200 [75 μm] sieve. Do not use any screenings in the combination of aggregate that contain more than 15% of material passing the No. 200 [75 μm] sieve. When blending two screenings to produce the screenings component of the aggregate, the Contractor may allow any component of such screenings to contain up to 18% of material passing the No. 200 [75 μm] sieve. The Contractor may wash screenings to meet these requirements. Use screenings that are free from lumps and foreign matter.

332-3.2.3 Percentage of Sand: Allow no more than 40% by weight of the total aggregate used to be sand.

When using RAP as an aggregate, do not allow the sand size portion of the RAP material plus the sand introduced as a separate component to exceed 40% by weight of the total aggregate.

332-3.3 Mix Design:

332-3.3.1 General: Meet the mix design requirements of 331-3.3. In addition to these requirements, include, in the mix design, test data showing that the material as produced will meet the requirements of Table 331-2.

332-3.3.2 Stability: Combine the constituents of the mixture in such proportions as to produce a mix having Marshall properties within the limits shown in Table 331-2.

332-3.4 Contractor's Quality Control: Provide the necessary quality control of the bituminous mixture and construction in accordance with the provisions of 330-2.2 and 331-4.4. Furnish materials that meet the verified mix design. For the extraction gradation analysis, meet the provisions of 331-4.4.2 and Table 331-3. For plant calibration, meet the provisions of 331-4.4.3 and Table 331-3.

332-4 Acceptance of Mixture.

332-4.1 Acceptance at the Plant: The Engineer will accept the bituminous mixture at the plant with respect to gradation and asphalt content in accordance with the requirements of 331-5.

332-4.2 Acceptance on the Roadway: The Engineer will accept the bituminous mixture on the roadway with respect to compacted density and surface tolerance in accordance with the applicable provisions of 330-11 and 330-13.

332-4.3 Additional Tests: The Engineer will apply the provisions of 331-5.5 to Type II Asphalt Concrete.

332-5 Method of Measurement.

The quantities to be paid for will be measured as specified for Type S Asphaltic Concrete under the applicable provisions of 331-6.

332-6 Basis of Payment.

Price and payment will be full compensation for all work specified under this Section.

Payment will be made under:

Item No. 332- 2- Type II Asphaltic Concrete - per ton.
Item No. 2332- 2- Type II Asphaltic Concrete - per metric ton.

SECTION 333

TYPE III ASPHALTIC CONCRETE

333-1 Description.

Construct an asphaltic concrete pavement course composed of a mixture of stone or slag screenings with silica sand and asphalt cement, and mineral filler if needed.

Meet the plant and equipment requirements as specified in Section 320. Meet the general construction requirements as specified in Section 330.

The Engineer will accept work on a LOT to LOT basis in accordance with the applicable requirements of Sections 5 and 6. The Engineer will determine the size of the LOT as specified in 331-5 for the bituminous mixture accepted at the plant and as specified in 330-11 for the material accepted on the roadway.

333-2 Materials.

333-2.1 Bituminous Material: Use Asphalt Cement, Viscosity Grade AC-20 or AC-30 meeting the requirements of 916-1.

333-2.2 Aggregate: Use aggregate consisting of crushed stone or crushed slag screenings, or a combination of these screenings with silica sand, that meets the gradation requirements and that provides the required stability of the mix, as specified below. Use crushed stone or crushed slag screenings that meet the requirements of Section 901. Use sand that meets the requirements of 332-2.2.3. Do not use aggregate containing any appreciable amount of phosphate.

333-2.3 Mineral Filler: If needed, meet the requirements of Section 917.

333-3 Composition of Mixture.

333-3.1 General: Use a bituminous mixture composed of a combination of aggregate (coarse, fine, or mixtures thereof), mineral filler if required, and bituminous material. Size, uniformly grade, and combine the several aggregate fractions in the proportions that the resulting mixture meets the grading and physical properties of the verified mix design.

The Contractor may use RAP meeting the requirements of 331-2.2.4 as a substitution for a portion of the combination of aggregates. If using RAP, the Contractor may use a recycling agent in accordance with the requirements of 331-2.2.5 in the mix in lieu of asphalt cement.

The Contractor may use recycled crushed glass meeting the requirements of 331-2.2.6 as a substitution for a portion of the combination of aggregates.

333-3.2 Grading Requirements:

333-3.2.1 General: Use a mix design that has been verified by the Engineer and meets the design range specified in Table 331-1.

333-3.2.2 Gradation: When tested before entering the asphalt plant in the combination to be used, ensure that the aggregate, including any mineral filler, does not contain more than 10% by weight of material passing the No. 200 [75 μm sieve].

Do not use any screenings in the combination of aggregate that contain more than 15% of material passing the No. 200 [75 µm] sieve. When blending two screenings to produce the screenings component of the aggregate, the Contractor may allow any component of such screenings to contain up to 18% of material passing the No. 200 [75 µm] sieve. The Contractor may wash screenings to meet these requirements. Use screenings that are free from lumps and foreign matter.

333-3.2.3 Proportions of Sand and Screenings: Allow no more than 25% by weight of the total aggregate used to be local sand. In addition to the local sand, the Contractor may use commercial washed sand in a quantity not to exceed 15% by weight of the total aggregate. Obtain the commercial washed sand from an approved source having a Department sand mine number and meeting the requirements of Section 902 except those in 902-2.2.

If used in the mixture, consider the sand portion of RAP material to be local sand.

333-3.3 Mix Design:

333-3.3.1 General: Meet the mix design requirements of 331-4.3. In addition to these requirements, include, in the mix design, test data showing that the material as produced will meet the requirements of Table 331-2.

333-3.3.2 Stability: Combine the constituents of the mixture in such proportions as to produce a mixture having Marshall properties within the limits shown in Table 331-2.

333-3.4 Contractor's Quality Control: Provide the necessary control of the bituminous mixture and construction in accordance with the applicable provisions of 330-2.2 and 331-4.4. Furnish materials that meet the verified mix design. For the extraction gradation analysis, meet the provisions of 331-4.4.2 and Table 331-3. For plant calibration, meet the provisions of 331-4.4.3 and Table 331-3.

333-4 Acceptance of Mixture.

333-4.1 Acceptance at the Plant: The Engineer will accept the bituminous mixture at the plant with respect to gradation and asphalt content in accordance with the requirements of 331-4.

333-4.2 Acceptance on the Roadway: The Engineer will accept the bituminous mixture on the roadway with respect to compacted density and surface tolerance in accordance with the applicable provisions of 330-11 and 330-13.

333-4.3 Additional Tests: The Engineer will apply the provisions of 331-5.5 to Type III Asphaltic Concrete.

333-5 Method of Measurement.

The quantities to be paid for will be measured as specified for Type S Asphaltic Concrete under the applicable provisions of 331-6.

333-6 Basis of Payment.

Price and payment will be full compensation for all work specified under this Section.

Payment will be made under:

Item No. 333- 2- Type III Asphaltic Concrete - per ton.
Item No. 2333- 2- Type III Asphaltic Concrete - per metric ton.

SECTION 334

SUPERPAVE ASPHALT CONCRETE

334-1 Description.

334-1.1 General: Construct a Superpave Asphalt Concrete course using the type of mixture specified in the Contract, or when offered as alternates, as selected. Superpave mixes are identified as Type SP-9.5, Type SP-12.5 or Type SP-19.0.

Meet the requirements of Section 320 for plant and equipment. Meet the general construction requirements of Section 330, with the exception that the density requirements of 334-5.4 shall be met.

The Engineer will accept the work on a LOT to LOT basis in accordance with the applicable requirements of Sections 5, 6, and 9. The size of the LOT will be as specified in 334-5 for the asphalt mixture produced at the plant and as specified in 334-5.4 and 330-13 for the material placed on the roadway.

334-1.2 Traffic Levels: The requirements for Type SP Asphalt Concrete mixtures are based on the design traffic level of the project, expressed in 22,000 pound [80 kN] Equivalent Single Axle Loads (ESAL=s). The seven traffic levels are as shown in Table 334-1.

Table 334-1
Superpave Traffic Levels

Traffic Level	Traffic Level (1x10^6 ESAL=s)
1	# 0.3
2	0.3 to # 1
3	1 to # 3
4	3 to # 10
5	10 to # 30
6	30 to # 100
7	> 100

The traffic level(s) for the project are as specified in the Contract. The Contractor may substitute a Type SP mix one traffic level higher than the traffic level specified in the Contract, at no cost to the Department. Where Type S Asphalt Concrete is specified in the Contract, if approved by the Engineer, the equivalent fine Type SP Asphalt Concrete mixture (Traffic Level 4) may be selected as an alternate at no additional cost to the Department. The equivalent mixes are as follows:

Type S-I ....Type SP-12.5
Type S-II...Type SP-19.0

Type S-III...Type SP-9.5

334-1.3 Layer Thicknesses: The Superpave mixes are categorized as either Acoarse≅ or Afine≅, depending on the overall gradation of the mixture. Coarse mixes are defined as having a gradation that passes below the restricted zone, defined in 334-2.3, when plotted on an FHWA 0.45 Power Gradation Chart. Fine mixes are defined as having a gradation that passes above the restricted zone.

334-1.3.1 Fine Mixes: The allowable structural layer thicknesses for fine Type SP Asphalt Concrete mixtures are as follows:

Type SP-9.5 ....: inch - 13 inches [20 mm - 30 mm]
Type SP-12.5 ....13 inches - 22 inches [30 mm - 60 mm]
Type SP-19.0 ....2 inches - 2: inches [50 mm - 70 mm]

In addition to the minimum and maximum thickness requirements, the following restrictions are placed on fine mixes when used as a structural course:

Type SP-9.5 - Limited to the final (top) structural layer, one layer only.

Type SP-12.5 - May not be used in the first layer of courses over 32 inches [90 mm] thick, nor in the first layer of courses over 2: inches [70 mm] thick on limited access facilities.

Type SP-19.0 - May not be used in the final (top) structural layer.

334-1.3.2 Coarse Mixes: The allowable structural layer thicknesses for coarse Type SP Asphalt Concrete mixtures are as follows:

Type SP-9.5 ....12 inches - 2 inches [40 mm - 50 mm]
Type SP-12.5 ....2 inches - 3 inches [50 mm - 80 mm]
Type SP-19.0 ....3 inches - 32 inches [80 mm - 90 mm]

In addition to the minimum and maximum thickness requirements, the following restrictions are placed on coarse mixes when used as a structural course:

Type SP-19.0 - May not be used in the final (top) structural layer.

334-1.3.3 Additional Requirements: The following requirements also apply to coarse and fine Type SP Asphalt Concrete mixtures:

1. A minimum 12 inch [40 mm] initial lift is required over an Asphalt Rubber Membrane Interlayer (ARMI).

2. When construction includes the paving of adjacent shoulders (#5 feet [#1.5 m] wide), the layer thickness for the upper pavement layer and shoulder shall be the same and paved in a single pass, unless shown differently in the plans.

3. All overbuild layers shall be fine Type SP Asphalt Concrete with the traffic level as stated in the Contract, up to a maximum of Traffic Level 4. Use a Traffic Level 4 mix for areas with higher traffic levels. Use the minimum and maximum layer thicknesses as specified in 334-1.3.1 unless shown differently in the plans.

4. On variable thickness overbuild layers, the minimum allowable thickness may be reduced by δ inch [10 mm], and the maximum allowable thickness may be increased δ inch [10 mm], unless shown differently in the plans.

334-2 Materials.

334-2.1 General Requirements: Meet the material requirements specified in Division III. Specific references are as follows:

Asphalt Cement Viscosity Grade AC-30, or Recycling Agent	916-1 and 916-2
Asphalt Binder PG 64-22	AASHTO MP-1
Mineral Filler	917-1 and 917-2
Coarse Aggregate, Stone, Slag or Crushed Gravel	Section 901
Fine Aggregate	Section 902

334-2.2 Gradation Requirements: Combine the coarse and fine aggregate in proportions that will produce an asphalt mixture meeting all of the requirements defined in this Specification and conform to the gradation requirements at design as defined in Table 334-2. Aggregates from various sources may be combined.

Table 334-2
Aggregate Gradation Control Points
(Gradation Design Ranges)

	Superpave Mixture (Percent Passing)					
	SP-9.5		SP-12.5		SP-19.0	
Sieve Size	Min.	Max.	Min.	Max.	Min.	Max
1 inch [25.0 mm]	-	-	-	-	100	-
: inch [19.0 mm]	-	-	100	-	90	100
2 inch [12.5 mm]	100	-	90	100	-	90
δ inch [9.5 mm]	90	100	-	90	-	-
No. 4 [4.75 mm]	-	90	-	-	-	-
No. 8 [2.36 mm]	32	67	28	58	23	49
No. 200 [75 Φm]	2	10	2	10	2	8

334-2.3 Restricted Zone: The gradation identified in 334-2.2 shall not pass through the restricted zones specified in Table 334-3. For Traffic Levels 5, 6 and 7 the design gradation shall pass below the restricted zone, when plotted on an FHWA 0.45 Power Gradation Chart. Unless otherwise noted in the plans, for Traffic Levels 1, 2, 3 and 4, the design gradation may pass either above or below the restricted zone, provided the lift thickness requirements specified in 334-1.3 are met.

334-2.4 Aggregate Consensus Properties: Meet the following consensus properties at design for the aggregate blend:

334-2.4.1 Coarse Aggregate Angularity: When tested in accordance with ASTM D 5821, meet the coarse aggregate angularity requirement defined in Table 334-4.

334-2.4.2 Fine Aggregate Angularity: When tested in accordance with AASHTO T-304, meet the fine aggregate angularity requirement defined in Table

334-5.

Table 334-3
Aggregate Gradation Restricted Zone
(Design Only)

Sieve Size within Restricted Zone	Boundaries of Restricted Zone Superpave Mixture (Percent Passing)					
	SP-9.5		SP-12.5		SP-19.0	
	Min.	Max.	Min.	Max.	Min.	Max
No. 4 [4.75 mm]	-	-	-	-	-	-
No. 8 [2.36 mm]	47.2	47.2	39.1	39.1	34.6	34.6
No. 16 [1.18 mm]	31.6	37.6	25.6	31.6	22.3	28.3
No. 30 [600 Φm]	23.5	27.5	19.1	23.1	16.7	20.7

Table 334-4
Coarse Aggregate Angularity Criteria
(Minimum Percent Fractured Faces)

Traffic Level	Depth of Top of Pavement Layer From Surface			
	#4 inches [#100 mm]		>4 inches [>100 mm]	
	1 or More Fractured Faces (%)	2 or More Fractured Faces (%)	1 or More Fractured Faces (%)	2 or More Fractured Faces (%)
1	55	-	-	-
2	65	-	-	-
3	75	-	50	-
4	85	80	60	-
5	95	90	80	75
6	100	100	95	90
7	100	100	100	100

Table 334-5
Fine Aggregate Angularity Criteria

Traffic	Depth of Top of Pavement Layer From Surface

	#4 inches [#100 mm] Minimum Uncompacted Void Content (%)	>4 inches [>100 mm] Minimum Uncompacted Void Content (%)
1	-	-
2	40	-
3	40	40
4	45	40
5	45	40
6	45	45
7	45	45

334-2.4.3 Flat and Elongated Particles: When tested in accordance with ASTM D 4791, use a ratio of maximum to minimum dimensions of 5:1 and do not exceed 10% as the maximum amount of flat and elongated particles for the coarse aggregate blend for all projects with Traffic Levels 3 and higher. This criteria does not apply for projects with lower traffic levels.

334-2.4.4 Clay Content: When tested in accordance with AASHTO T 176, meet the sand equivalent value for fine aggregate blend defined in Table 334-6.

Table 334-6
Clay Content

Traffic Level	Sand Equivalent Minimum (%)
1	40
2	40
3	40
4	45
5	45
6	50
7	50

334-2.5 Specific Requirements:

334-2.5.1 Condition of Aggregate: Provide clean aggregate that contains no deleterious substances. Do not use coarse or fine aggregate containing more than 0.5% of phosphate.

334-2.5.2 Fine Aggregate and Mineral Filler: In laboratory tests, and for the purpose of proportioning the paving mixture, all material passing the No. 8 [2.36 mm] sieve and retained on the No. 200 [75 Φm] sieve will be considered as fine aggregate, and the material passing the No. 200 [75 Φm] sieve will be considered as mineral filler.

334-2.5.3 Screenings: Do not use any screenings in the combination of aggregates which contain more than 15% of material passing the No. 200 [75 Φm] sieve. When blending two screenings to produce the screening component of the aggregate, one of the screenings may contain up to 18% of material passing the No. 200 [75 Φm] sieve, provided the combination of the two does not contain over 15% material passing the No. 200 [75 Φm] sieve. Screenings may be washed to meet these requirements.

334-2.5.4 Use of Reclaimed Asphalt Pavement:

334-2.5.4.1 General Requirements: Reclaimed Asphalt Pavement (RAP) may be used as a component material of the asphalt mixture subject to the following:

1. The Contractor assumes responsibility for the design of asphalt mixes which incorporate RAP as a component material.

2. For design purposes, the Contractor assumes responsibility for establishing accurate specific gravity values for the RAP material. This may be accomplished by one of the following methods:

a) Calculation of the bulk specific gravity value based upon the effective specific gravity of the RAP, determined on the basis of the asphalt binder content and maximum specific gravity. The Engineer will approve the estimated asphalt binder absorption value used in the calculation.

b) Testing of the extracted aggregate obtained through a vacuum extraction or ignition oven extraction.

3. For projects with Traffic Levels 5, 6 and 7, do not permit the amount of RAP material used in the mix to exceed 30% by weight of total aggregate. For projects with Traffic Levels 1, 2, 3 and 4, do not permit the amount of RAP material used in the mix to exceed 50% by weight of total aggregate.

4. Use a grizzly or grid over the RAP cold bin, in-line roller crusher, screen, or other suitable means to prevent oversized RAP material from showing up in the completed recycled mixture.

If oversized RAP material appears in the completed recycled mix, take the appropriate corrective action immediately. If the appropriate corrective actions are not immediately taken, stop plant operations.

5. Provide stockpiled RAP material that is reasonably consistent in characteristics and contains no aggregate particles which are soft or conglomerates of fines.

6. Provide RAP having a minimum average asphalt content of 4.0% by weight of total mix. The Engineer may sample the stockpile to verify that this requirement is met.

334-2.5.4.2 Special Requirements For RAP Milled From Projects: When milling is required on the project and a Composition of Existing Pavement is included in the Contract Documents, and the use of the milled material as a component of the asphalt mixture is elected, use the following procedures for obtaining representative samples for the mix design:

1. Cut a minimum of ten 6 inch [150 mm] cores in area(s) approved by the Engineer. Fill the core holes prior to opening to traffic. Assume responsibility for accounting for the degradation that will occur during the milling operation.

2. Representative samples may also be obtained by milling the existing pavement to the full depth shown on the plans for pavement removal for a

length of approximately 200 feet [60 m]. If required to maintain traffic, immediately replace the pavement removed with the mix specified in the Contract. This mix will be paid for at the Contract unit price.

3. Submit a written request to the Engineer for any variance from the above outlined methods of obtaining samples for mix designs.

334-2.5.4.3 Requirements For RAP Stockpiled From a Previous FDOT Project: When the RAP to be used as a component in a mix design is stockpiled from a previous FDOT project and the Composition of Existing Pavement is known, design the mix and submit to the Engineer for approval.

334-2.5.4.4 Requirements For RAP With Unknown Characteristics: When the composition of stockpiled RAP to be used as a component in a mix design is not known, use the following procedures for design:

1. Submit a bag of RAP, composed of samples from a minimum of three separate locations in the stockpile(s) to the Engineer at least four weeks prior to the planned start of mix design. The Engineer will run viscosities on the RAP and furnish the information to the Contractor.

2. Run a minimum of six extraction gradation analyses and six determinations of bulk specific gravity of the RAP. Take samples at random locations around the stockpile(s).

3. Request the Engineer to make a visual inspection of the stockpile(s) of RAP. Based on visual inspection, the Engineer will determine the suitability of the stockpiled materials. Once the RAP stockpile has been approved, do not add additional material without prior approval of the Engineer.

4. Submit the data required above when submitting the proposed mix design to the Department for approval.

334-2.5.5 Recycling Agents: When RAP is approved for use as a component material, use a recycling agent meeting the requirements of 916-2 in the mix.

The Engineer will select the best formulation suited for the project and reserves the right to request reasonable changes throughout the construction duration.

334-3 Permissible Variation for the Coarse Aggregate.

Size and consistently grade or combine the aggregate or aggregates shipped to the job in such proportions that the resulting mixture meets the grading requirements of the mix design.

334-4 General Composition of Mixture.

334-4.1 General: Compose the asphalt mixture using a combination of aggregate (coarse, fine or mixtures thereof), mineral filler, if required, and asphalt binder material. Size, grade and combine the aggregate fractions to meet the grading and physical properties of the approved mix design. Aggregates from various sources may be combined.

334-4.2 Mix Design:

334-4.2.1 General: Design the Superpave asphalt mixture in accordance with AASHTO PP-28 or The Asphalt Institute's Superpave Mix Design Manual, to meet the requirements of this Specification. Short-term oven age the mixture for two hours at the compaction temperature at a thickness of 1 to 2 inches [25 to 50 mm]. Prior to the production of any Superpave asphalt mixture, submit the proposed mix design with supporting test data indicating compliance with all Superpave mix design criteria. Include representative samples of all component materials, including asphalt cement. Allow the Engineer a maximum of three weeks to either conditionally verify or reject the mix as designed. The Engineer will provide final verification of the mix design when the requirements of 334-4.4.2 have been met.

At the sole option of the Engineer, Type SP asphalt mixes may be used based on evidence of final verification and satisfactory performance in previous production for that particular mix.

334-4.2.2 Grading Requirements: Meet the gradation design ranges of Table 334-2.

334-4.2.3 Gyratory Compaction: Compact the design mixture in accordance with AASHTO TP-4. Compact the mixture to the maximum number of gyrations and back calculate to the design number of gyrations. Use the number of gyrations as defined in Table 334-7.

Table 334-7
Superpave Design Gyratory Compactive Effort

Traffic Level	$N_{initial}$	N_{design}	$N_{maximum}$
1	7	68	104
2	7	76	117
3	7	86	134
4	7	86	134
5	8	96	152
6	8	96	152
7	8	96	152

334-4.2.4 Volumetric Criteria: Use an air void content of the mixture at design of 4.0% at the design number of gyrations (N_{design}). Meet the requirements of Table 334-8.

Table 334-8
Mixture Densification Criteria

	% G_{mm}		
Traffic Level	$N_{initial}$	N_{design}	$N_{maximum}$
1	# 91.5	96.0	# 98.0
2	# 90.5	96.0	# 98.0
3	# 90.0	96.0	# 98.0
4	# 89.5	96.0	# 98.0
5	# 89.0	96.0	# 98.0

Table 334-8
Mixture Densification Criteria

	% G_{mm}		
Traffic Level	$N_{initial}$	N_{design}	$N_{maximum}$
6	# 89.0	96.0	# 98.0
7	# 89.0	96.0	# 98.0

334-4.2.5 VMA Criteria: Meet the requirements of Table 334-9 for voids in the mineral aggregate (VMA) of the mixture at the design number of gyrations.

Table 334-9
VMA Criteria

Type Mix	Minimum VMA (%)
SP-9.5	15.0
SP-12.5	14.0
SP-19.0	13.0

334-4.2.6 VFA Criteria: Meet the requirements of Table 334-10 for voids filled with asphalt (VFA) of the mixture at the design number of gyrations.

Table 334-10
VFA Criteria

Traffic Level	Design VFA (%)
1	70 - 80
2	65 - 78
3	65 - 78
4	65 - 75
5	65 - 75
6	65 - 75
7	65 - 75

Note: For Type SP-9.5 mixtures at Traffic Levels 4-7, the maximum design VFA value is 76.

334-4.2.7 Dust Proportion: Use a dust to effective asphalt binder content by weight between 0.6 to 1.2 for fine mixes and 0.6 to 1.6 for coarse mixes.

334-4.2.8 Moisture Susceptibility: Provide a mixture (4 inch [100 mm] specimens) having a retained tensile strength ratio of at least 80% when compacted to 7 ∀ 0.5% air voids, and a minimum tensile strength (dry and unconditioned) of 120 psi [825 kPa]. Test the specimens in accordance with AASHTO T 283 with the following exceptions: saturate the specimens to a minimum saturation level of 90% and include one freeze-thaw cycle. If necessary, add an approved liquid anti-stripping agent in order to meet this criteria.

334-4.2.9 Water Permeability: Do not exceed a maximum coefficient of permeability (coarse mixes only) of the mixture of 125 x 10^{-5}cm/s when compacted to 6% air voids and tested in accordance with FM 5-565.

Trim the compacted specimen at both ends to the minimum thickness in 334-1.3 prior to testing.

334-4.2.10 Additional Information: In addition to the requirements listed above, provide the following information with each proposed mix design submitted for verification:

1. The specific project on which the mixture will be used.

2. The design traffic level and the maximum number of gyrations ($N_{maximum}$).

3. The source and description of the materials to be used.

4. The DOT source number and the DOT product code of the aggregate components furnished from a DOT approved source.

5. The gradation and approximate proportions of the raw materials as intended to be combined in the paving mixture. The gradation of the component materials shall be representative of the material at the time of use.

6. A single percentage of the combined mineral aggregate passing each specified sieve. Degradation of the aggregate due to processing (particularly -No. 200 [-75 Φm]) should be accounted for and identified for the applicable sieves.

7. A single percentage of asphalt binder by weight of total mix intended to be incorporated in the completed mixture, shown to the nearest 0.1%.

8. A single temperature at which the mixture is intended to be discharged from the plant and compacted at the roadway.

9. Evidence that the completed mixture will conform to all specified physical requirements.

10. The name of the individual responsible for the Quality Control of the mixture during production.

11. The ignition oven calibration factor.

334-4.3 Revision of Mix Design: Submit all requests for revisions to verified mix designs, along with supporting documentation, to the Engineer. In order to expedite the revision process, the request for revision or discussions on the possibility of a revision may be made verbally, but must be followed up by a written request. The verified mix design will remain in effect until a change is authorized by the Engineer. In no case may the effective date of the revision be established earlier than the date of the first communication between the Contractor and the Engineer regarding the revision.

A new design mix will be required for any substitution of an aggregate product with a different aggregate code, unless approved by the Engineer.

334-4.4 Contractor's Quality Control:

334-4.4.1 Personnel: In accordance with the requirements of 330-2.2, Quality Control by the Contractor, provide the necessary quality control personnel. Employ a Quality Control Technician who is certified by the Department and possesses a valid certificate of qualification. When it becomes evident to the Department that the Quality Control Technician cannot perform as required by the position, the Department will revoke the certification and require replacement with another certified technician. Turn over a copy or summary of all Quality Control test data to the Department when the project is completed.

334-4.4.2 Initial Production Test Strip: For initial use of a Type SP mix design at a particular plant, limit full-scale production and placement of the mix to a test strip of 500 tons [450 metric tons] (for each mix) to demonstrate the capability of producing, placing, and compacting the mix as specified. Upon agreement between the Contractor and the Engineer, test strips of up to 1,000 tons [900 metric tons] may be used. Initial production requirements do not apply if the total quantity of mix to be placed is less than 2,200 tons [2,000 metric tons].

334-4.4.2.1 Calibration of the Superpave Gyratory Compactor: Calibrate the Superpave Gyratory Compactor in accordance with the manufacturer=s recommendations prior to producing the Superpave mixture for the test strip. Check the height calibration, the speed of rotation, ram pressure and angle of gyration. (Following completion of the test strip, calibrate the height daily, the ram pressure and speed of rotation weekly, and the angle of gyration monthly.)

334-4.4.2.2 Plant Testing Requirements: During the initial production period, take a minimum of three separate sets of mixture samples which will be used for extraction gradation analysis and determination of volumetric properties. Provide a split sample of one of the samples for comparison testing with the Engineer.

334-4.4.2.3 Roadway Testing Requirements: Assume responsibility for cutting 3- 6 inch [150 mm] diameter roadway cores at locations determined by the Engineer for evaluation of permeability by the Department. The Department will have a maximum of three working days from the date the cores are obtained to complete the evaluation. (Permeability criteria applies only to coarse mixes when the average density for the test strip is less than 93.5% of G_{mm}).

For density determination, obtain 6 inch [150 mm] diameter roadway cores at random locations as directed by the Engineer within the test strip, at a frequency shown in Table 334-14.

334-4.4.2.4 Criteria for Passing Test Strip: Resume production when authorized by the Engineer based upon acceptable extraction gradation analysis as determined in accordance with 334-4.4.3, acceptable volumetric properties as determined in accordance with 334-4.4.4, acceptable density in accordance with 334-5.4.1, a coefficient of permeability of less than 125 x 10^{-5}cm/s as determined in accordance with FM 5-565 (permeability criteria applies only to coarse mixes when the average density for the test strip is less than 93.5% of G_{mm}), and a favorable comparison with the Engineer=s test results (G_{mb} at N_{design} (within 1%) and G_{mm} (within 0.019) only). In the event that the test strip fails to meet any of the above mentioned criteria, remove and replace the material at no cost to the Department if so directed by the Engineer.

334-4.4.3 Extraction Gradation Analysis: The Engineer will sample the asphalt mixture at the plant in accordance with FM 1-T 168. The percent asphalt binder content of the mixture will be determined in accordance with FM 5-563 (ignition oven). The gradation of the extracted mixture will be determined in accordance with FM 1-T 030. Perform the extraction and gradation analysis in accordance with FM 5-544 and 5-545, respectively, if the calibration factor for the mix exceeds 0.50%. All test results will be shown to the nearest 0.01. All calculations will be carried to the nearest 0.001 and rounded to the nearest 0.01, in accordance with the Department's rules of rounding.

Run an extraction gradation analysis on the mixture at a minimum frequency of once per production day when the daily production is less than 1,000 tons [900 metric tons]. If the daily production exceeds 1,000 tons [900 metric tons], perform the extraction gradation analysis of the mix a minimum of two times per production day.

During normal production, the Engineer will not require extraction gradation analysis on days when mix production is less than 100 tons [90 metric tons]. However, when mix production is less than 100 tons [90 metric tons] per day on successive days, run the test when the accumulative tonnage on such days exceeds 100 tons [90 metric tons].

The target gradation and asphalt content will be as shown on the mix design. Any changes in target will require a change in the mix design in accordance with 334-4.3.

If the percentage of asphalt binder deviates from the optimum asphalt binder content by more than 0.55%, or the percentage passing any sieve falls outside the limits in Table 334-11, immediately resample the mix and test to validate the previous test result, and if needed, make the necessary correction. If the results for two consecutive tests deviate from the optimum asphalt binder content by more than 0.55%, or exceed the limits in Table 334-11 for any sieve, notify the Engineer and take immediate steps to identify and correct the problem, then resample the mix. If the results from this test deviate from the optimum asphalt binder content by more than 0.55%, or exceed the limits in Table 334-11 for any sieve, stop the plant operation until the problem has been corrected.

Table 334-11
Tolerances for Quality Control Tests
(Extraction Gradation Analysis)

Sieve Size	Percent Passing
1 inch [25.0 mm]	7.0
: inch [19.0 mm]	7.0
2 inch [12.5 mm]	7.0
δ inch [9.5 mm]	7.0
No. 4 [4.75 mm]	7.0
No. 8 [2.36 mm]	5.5
No. 16 [1.18 mm]	5.0
No. 30 [600 Φm]	4.5
No. 50 [300 Φm]	4.5
No. 100 [150 Φm]	3.0
No. 200 [75 Φm]	2.0

Maintain control charts showing the results of the extraction gradation analysis (asphalt binder content and sieve analysis).

334-4.4.4 Volumetric Control: During production of the mix, monitor the volumetric properties of the Superpave mix with a Superpave Gyratory Compactor to determine the air voids, VMA, VFA, and dust-to-effective asphalt binder ratio (dust proportion) at N_{design}.

For coarse mixes, take appropriate corrective actions in order to maintain an air void content at N_{design} between 2.5 and 5.0% during production. When the air void content at N_{design} drops below 2.0 or exceeds 5.5% on any one test, or is less than 2.5% on two consecutive tests, stop plant operations until the appropriate corrective actions are made and the problem is resolved to the satisfaction of the Engineer.

For fine mixes, take appropriate corrective actions to maintain an air void content at N_{design} between 3.0 and 5.0% during production. When the air void content at N_{design} drops below 2.5 or exceeds 6.5% on any one test, or is less than 3.0% on two consecutive tests, stop plant operations until the appropriate corrective actions are made and the problem is resolved to the satisfaction of the Engineer.

Determine the volumetric properties of the mixture at a minimum frequency of once per production day when the daily production is less than 1,000 tons [900 metric tons]. If the daily production exceeds 1,000 tons [900 metric tons], monitor the volumetric properties two times per production day.

During normal production, volumetric properties of the mixture will not be required on days when mix production is less than 100 tons [90 metric tons]. However, when mix production is less than 100 tons [90 metric tons] per day on successive days, run the test when the accumulative tonnage on such days exceeds 100 tons [90 metric tons].

Testing required for volumetric property determination includes AASHTO TP-4, FM 1-T 209, FM 5-563 and FM 1-T 030.

In addition to the requirements of 330-2.2, maintain control charts showing the results of the volumetric testing (air voids, G_{mm}, G_{mb}).

334-4.4.5 Plant Calibration: At or before the start of mix production, perform an extraction gradation analysis of the mix to verify calibration of the plant. This extraction gradation analysis may also be used for the first test of the first day=s production.

334-4.4.6 Viscosity of Asphalt Binder in Mixes Containing Reclaimed Asphalt Pavement: When RAP is a component material, the viscosity of the asphalt binder material in the asphalt mixture, determined by the Materials Office in accordance with FM 1-T 202, will be within the range of 6,000 ∀ 2,000 poises [400-1200 Pa≅s]. This determination will be made on samples obtained by the Engineer on a random basis at a frequency of approximately one per 2,000 tons [1,800 metric tons] of mix.

If the viscosity is determined by the Engineer to be out of the specified tolerance, adjust the recycling agent formulation or blend of RAP used in the mixture to bring the viscosity within tolerance.

334-5 Acceptance of the Mixture.

334-5.1 General: The asphalt mixture will be accepted at the plant, with respect to gradation and asphalt binder content, on a LOT to LOT basis. The material will be tested for acceptance in accordance with the provisions of 330-2 and the following requirements. However, any load or loads of mixture which, in the opinion of the Engineer, are unacceptable for reasons of excessive segregation, aggregates improperly coated, or of excessively high or low temperature will be rejected for use in the work.

A standard size LOT at the asphalt plant will consist of 4,000 tons [3,600 metric tons] with four equal sublots of 1,000 tons [900 metric tons] each.

A partial LOT may occur due to the following:

(1) the completion of a given mix type on a project.

(2) an approved LOT termination by the Engineer due to a change in process, extended delay in production, or change in mix design.

If the partial LOT contains one or two sublots with their appropriate test results, then the previous full-size LOT will be redefined to include this partial LOT and the evaluation of the LOT will be based on either five or six sublot determinations. If the partial LOT contains three sublots with their appropriate test results, this partial LOT will be redefined to be a whole LOT and the evaluation of it will be based on three sublot determinations.

When the total quantity of any mix is less than 3,000 tons [2,700 metric tons], the partial LOT will be evaluated for the appropriate number of sublots from n=1 to n=3. When the total quantity of any mix type is less than 500 tons [450 metric tons], the Engineer will accept the mix on the basis of visual inspection. The Engineer may run extraction and gradation analysis for verification purposes; however, the provisions for partial payment will not apply.

On multiple project contracts, the LOT(s) at the asphalt plant will carry over from project to project.

334-5.2 Acceptance Procedures: Control all operations in the handling, preparation, and mixing of the asphalt mix so that the percent bitumen and the percents passing the No. 8 [2.36 mm] and No. 200 [75 Φm] sieves will meet the verified job mix formula within the tolerance shown in Table 334-12.

Table 334-12
Tolerances for Acceptance Tests

Characteristic	Tolerance*
Asphalt Content (Extraction)	∀0.55%
Asphalt Content (Printout)	∀0.15%
Passing No. 8 [2.36 mm] Sieve	∀5.50%
Passing No. 200 [75 Φm] Sieve	∀2.00%

*Tolerances for sample size of n=1. See Table 334-13 for other sample sizes n=2 through n=6.

Acceptance of the mixture will be on the basis of test results on consecutive random samples from each LOT. The Engineer will take one random sample from each sublot. The asphalt mixture will be sampled at the plant in accordance with FM 1-T 168. The percent asphalt binder content of the mixture will be determined in accordance with FM 5-563 (ignition oven). The percentages passing the No. 8 [2.36 mm] and No. 200 [75 Φm] sieves will be determined in accordance with FM 1-T 030. The Engineer will perform the extraction and gradation analysis in accordance with FM 5-544 and 5-545, respectively, if the calibration factor for the mix exceeds 0.50%.

Calculations for the acceptance test results for bitumen content and gradation (percentages passing the No. 8 [2.36 mm] and No. 200 [75 Φm] sieves) will be shown to the nearest 0.01. Calculations for arithmetic averages will be carried to the 0.001 and rounded to the nearest 0.01 in accordance with the Department's rules of rounding.

Payment will be made on the basis of Table 334-13 AAcceptance Schedule of Payment≅. The process will be considered out of control when the deviation of any individual test result from the mix design falls in the 80% pay factor for the Aone test≅ column of Table 334-13. When this happens, the LOT will be automatically terminated and acceptance of the LOT determined in accordance with Table 334-13.

Table 334-13
Acceptance Schedule of Payment
(Asphalt Plant Mix Characteristics)

Average of Accumulated Deviations of the Acceptance Tests from the Mix Design						
Pay Factor	1-Test	2-Tests	3-Tests	4-Tests	5-Tests	6-Tests
Asphalt Binder Content (Extraction)						
1.00	0.00-0.55	0.00-0.43	0.00-0.38	0.00-0.35	0.00-0.33	0.00-0.31
0.95	0.56-0.65	0.44-0.50	0.39-0.44	0.36-0.40	0.34-0.37	0.32-0.36
0.90	0.66-0.75	0.51-0.57	0.45-0.50	0.41-0.45	0.38-0.42	0.36-0.39
0.80*	over 0.75	over 0.57	over 0.50	over 0.45	over 0.42	over 0.39
No. 8 [2.36 mm] Sieve **						
1.00	0.00-5.50	0.00-4.33	0.00-3.81	0.00-3.50	0.00-3.29	0.00-3.13
0.98	5.51-6.50	4.34-5.04	3.82-4.39	3.51-4.00	3.30-3.74	3.14-3.54
0.95	6.51-7.50	5.05-5.74	4.40-4.96	4.01-4.50	3.75-4.18	3.55-3.95
0.90	7.51-8.50	5.75-6.45	4.97-5.54	4.51-5.00	4.19-4.63	3.96-4.36
0.80*	over 8.50	over 6.45	over 5.54	over 5.00	over 4.63	over 4.36
No. 200 [75 μm] Sieve **						
1.00	0.00-2.00	0.00-1.71	0.00-1.58	0.00-1.50	0.00-1.45	0.00-1.41
0.95	2.01-2.40	1.72-1.99	1.59-1.81	1.51-1.70	1.46-1.63	1.42-1.57
0.90	2.41-2.80	2.00-2.27	1.82-2.04	1.71-1.90	1.64-1.80	1.58-1.73
0.80*	over 2.80	over 2.27	over 2.04	over 1.90	over 1.80	over 1.73

*If approved by the Engineer based on an engineering determination that the material is

Table 334-13
Acceptance Schedule of Payment
(Asphalt Plant Mix Characteristics)

Average of Accumulated Deviations of the Acceptance Tests from the Mix Design						
Pay Factor	1-Test	2-Tests	3-Tests	4-Tests	5-Tests	6-Tests

acceptable to remain in place, the indicated partial pay may be accepted. Otherwise, the Engineer will require removal and replacement at no cost. The Contractor may remove and replace at no cost to the Department at any time.
**When there are two reduced payments for these items in one LOT of material, only the greatest reduction in payment will be applied. CAUTION: This rule applies only to these two gradation test results.
Note: Deviations are absolute values with no plus or minus signs.

When possible, the Engineer will complete all acceptance tests on the same day the sample was taken, and on no occasion will they be completed later than the following work day.

334-5.3 Automatic Batch Plant With Printout: Acceptance determinations for asphalt content and gradation for mixtures produced by automatic batch plants with printout will be based on extraction results as specified in 334-5.2.

334-5.4 Acceptance on the Roadway:

334-5.4.1 Density Control: The in-place density of each course of asphalt mix construction will be evaluated by the use of 6 inch [150 mm] diameter roadway cores. The required average density of a completed course will be based on the maximum specific gravity (G_{mm}) of the as-produced mix.

The Engineer will not perform density testing on patching courses, leveling courses, open-graded friction courses, or any course with a specified thickness less than 1 inch [25 mm] or a specified spread rate less than 105 lb/yd^2 [57 kg/m^2]. In addition, density testing will not be performed on the following areas when they are less than 1,000 feet [300 m] in length: crossovers, intersections, turning lanes, acceleration lanes or deceleration lanes. Compact these courses (with the exception of open-graded friction courses) in accordance with the rolling procedure as approved by the Engineer.

334-5.4.1.1 LOTs: For the purpose of acceptance and determination of payment, each day's production will be divided into LOTs, and all LOTs are to be closed out at the end of the day. The standard size of a LOT will consist of 5,000 feet [1,500 m] of any pass made by the paving train regardless of the width of the pass. Changes in thickness, mix design, or underlying layer shall constitute a separate LOT. Mix placed on the shoulder shall also be considered a separate LOT. Pavers traveling in echelon will be considered as two separate passes. When at the end of a day's production (production day) or the completion of a given course, layer, or mix, or at the completion of the project, a LOT size is determined to be less than 5,000 feet [1,500 m], it is considered a partial LOT. Partial LOTs are to be handled as follows:

If the length of the partial LOT is 2,000 feet [600 m] or less, then the previous full-size LOT will be redefined to include this partial LOT and the number of tests required for the combined LOT will be as shown in Table 334-14. If the partial LOT is 2,000 feet [600 m] or less, and a previous full-size LOT from the same day, mix, layer and project is not available, then the partial LOT will be evaluated separately and the number of tests required for the partial LOT will be as shown in Table 334-14. If the partial LOT is greater than 2,000 feet [600 m] long, it will be evaluated separately, with the number of tests required as shown in Table 334-14.

Table 334-14
Density Testing Requirements for Partial LOTs

LOT Size (feet) [(m)]	Number of Tests
Less than 3,000 [900]	3
3,001 - 4,000 [901 - 1,200]	4
4,001 - 5,000 [1,201 - 1,500]	5
5,001 - 6,000 [1,501 - 1,800]	6
6,001 - 7,000 [1,801 - 2,100]	7
Greater than 7,000 [2,100]	2 LOTs

334-5.4.1.2 Target Maximum Specific Gravity: The target maximum specific gravity of the mix will be based on the average daily value as determined by the Contractor's Quality Control testing described in 334-4.4.4. Obtain two separate samples for maximum specific gravity determination on a daily basis. If only one maximum specific gravity test value is available, this value shall be used as the target maximum specific gravity. If a maximum specific gravity value is not determined for a day=s production, the previous day=s value will be used. Obtain, under the Engineer=s supervision, split samples of the asphalt mixture used for the maximum specific gravity test for verification purposes. The minimum size of the split sample will be 4,000 g. The split samples will become the property of the Department. In the event of an obvious sampling or testing error, the Engineer may allow the Contractor to retest a portion of the split sample. The Engineer will run verification tests on the split samples in order to determine the acceptability of the Contractor=s test results. If the verification test result differs from the Quality Control test result by more than 0.019 for two consecutive tests, the target G_{mm} value will be established by the Department=s result until the cause of the discrepancy is identified and resolved to the satisfaction of the Engineer.

334-5.4.1.3 Quality Control of In-Place Compaction: Develop and implement a method to control the compaction of the pavement and ensure its compliance with the minimum specified density requirements. Include density determinations by the use of a nuclear density gauge at a frequency of one test per 1,000 feet [300 m] of compacted pavement in the quality control method. Other density measuring devices may be used in lieu of the nuclear density gauge, provided that it is demonstrated to the satisfaction of the Engineer that the device can accurately measure the relative level of density in the pavement on a consistent basis.

334-5.4.1.4 Acceptance: The completed pavement will be accepted with respect to density on a LOT basis. For each LOT, 6 inch [150 mm] diameter roadway cores will be obtained at random locations within the LOT, at the frequency shown in Table 334-14. Obtain the roadway cores at the random locations as directed by the Engineer, at the end of each day=s production prior to opening the roadway to traffic. The locations of the cores will be determined in the longitudinal direction by the use of statistically derived stratified random number tables furnished by the Department. The locations of the cores transversely will be uniformly spaced across the width of the pavement, with no cores located closer than 1 foot [0.3 m] of any unsupported edge. These will also be used for partial LOTs. Assume responsibility for maintenance of traffic, coring, patching the core holes, and trimming the cores to the proper thickness prior to density testing.

The density of the cores will be determined in accordance with FM 1-T 166, and will be averaged for each LOT. To receive full payment for density, the average density of a LOT shall be a minimum of 93.5% of G_{mm} for coarse mixes, and 92% of G_{mm} for fine mixes. Partial payment will be made for those LOTs that have an average density less than 93.5% of G_{mm} based on Table 334-15 (for coarse mixes), and less than 92% of G_{mm} based on Table 334-16 (for fine mixes).

Once the average density of a LOT has been determined, do not provide additional compaction to raise the average.

Table 334-15
Payment Schedule For Density (For Coarse Mixes)

Percent of Maximum Specific Gravity	Percent of Payment
94.5 and above	105*
93.5 to less than 94.5	100
93.0 to less than 93.5	95
Less than 93.0	**

*The maximum payment for all LOTs with one or more individual density values less than 92.5% or greater than 96.5% shall be 100%. The maximum payment for all shoulders shall be 100%.
** In the event that the density of a LOT is less than 93.0% of G_{mm}, the Department will assess the pavement=s permeability in accordance with FM 5-565. If the coefficient of permeability is less than or equal to 125 x 10^{-5} cm/s, the pavement will be accepted at 90% pay. If the coefficient of permeability is greater than 125 x 10^{-5} cm/s, the Engineer may require removal and replacement at no cost, or may accept the pavement at 90% pay. The Contractor may remove and replace at no cost to the Department at any time.

Table 334-16
Payment Schedule For Density (For Fine Mixes)

Percent of Maximum Specific Gravity	Percent of Payment
92.0 and above	100
91.0 to less than 92.0	95
90.0 to less than 91.0	90
Less than 90.0 *	75

*If approved by the Engineer based on an engineering determination that the material is

Table 334-16
Payment Schedule For Density (For Fine Mixes)

Percent of Maximum Specific Gravity	Percent of Payment

acceptable to remain in place, the Contractor may accept the indicated partial pay. Otherwise the Department will require removal and replacement at no cost. The Contractor may remove and replace at no cost to the Department at any time.

334-5.4.1.5 Additional Density Requirements:

1) If two consecutive LOTS are less than 93.5% of G_{mm} (for coarse mixes only), stop paving operations until appropriate corrective actions are made. Obtain the Engineer=s approval prior to resuming production of the mix. Limit production to 1,000 tons [900 metric tons] until passing density values are obtained.

2) On shoulders with a width of 5 feet [1.5 m] or less, the Engineer will not require density. Compact the pavement in accordance with the rolling procedure (equipment and pattern) approved by the Engineer. Stop the production of the mix if the rolling procedure deviates from the approved procedure.

3) The maximum width of the mainline (non-shoulder) pavement to be placed (for coarse mixes only) during one pass of the paving train is 13 feet [4.1 m]. As an exception, widths greater than 13 feet [4.1 m] will be permitted if the Contractor can demonstrate the ability to obtain density uniformly across the full width of the pavement.

334-5.4.2 Surface Tolerance: The asphalt mixture will be accepted on the roadway with respect to surface tolerance in accordance with the applicable requirements of 330-13.

334-5.5 Additional Tests: The Department reserves the right to run any test at any time for informational purposes and for determining the effectiveness of the Contractor's quality control.

334-5.5.1 Verification of Densification and Volumetric Properties: The Engineer will verify the densification properties of the mix during production with the Superpave Gyratory Compactor and will determine volumetric properties of the mix (air voids, VMA, VFA, and dust-to-effective asphalt binder ratio).

For coarse mixes, take appropriate corrective actions to maintain an air void content at N_{design} between 2.5 and 5.0% during production. When the air void content at N_{design} drops below 2.0 or exceeds 5.5% on any one test, or is less than 2.5% on two consecutive tests, stop plant operations until the appropriate corrective actions are made and the problem is resolved.

For fine mixes, take appropriate corrective actions in order to maintain an air void content at N_{design} between 3.0 and 5.0% during production. When the air void content at N_{design} drops below 2.5 or exceeds 6.5% on any one test, or is less than 3.0% on two consecutive tests, stop plant operations until the appropriate corrective actions are made and the problem is resolved.

When plant operations are stopped for coarse or fine mixes that have failing volumetric properties, obtain the Engineer=s approval prior to resuming production of the mix. Limit production to 500 tons [450 metric tons] until passing volumetric properties are obtained.

334-5.5.2 Disposition of In-Place Material: Any material that is represented by the failing test results (less than 2.0% air voids at N_{design} for coarse mixes and less than 2.5% air voids at N_{design} for fine mixes) will be evaluated by the Engineer to determine if removal and replacement is necessary. Remove and replace any material, if required, at no cost to the Department.

334-6 Method of Measurement.

For the work specified under this Section (including the pertinent provisions of Sections 320 and 330), the quantity to be paid for will be the weight of the mixture, in tons [metric tons].

The bid price for the asphalt mix will include the cost of the liquid asphalt or the asphalt recycling agent. There will be no separate payment or unit price adjustment for the asphalt binder material in the asphalt mix. For the calculation of unit price adjustments of bituminous material specified in 9-2.1.1, the average asphalt content of Superpave mixes to be used in these calculations shall be set at 6.5%. The weight will be determined as provided in 320-2 (including the provisions for the automatic recordation system).

334-7 Basis of Payment:

Price and payment will be full compensation for all the work specified under this Section (including the applicable requirements of Sections 320 and 330).

Payment shall be made under:

Item No. 334- 1 - Superpave Asphaltic Concrete - per ton.
Item No. 2334- 1 - Superpave Asphaltic Concrete - per metric ton.

SECTION 335

SAND-ASPHALT HOT MIX

335-1 Description.

Construct a sand-asphalt hot mix base course, leveling course, or surface course.

Meet the requirements for plant and equipment as specified in Section 320. Meet the general construction requirements for all asphaltic concrete pavements and bases as specified in Section 330. Meet the sand-asphalt base course construction requirements as specified in Section 280.

The Engineer will accept work on a LOT by LOT basis in accordance with the applicable requirements of Sections 5 and 6. The Engineer will determine the size of the LOT as specified in 331-5 for the bituminous mixture accepted at the plant and as specified in 330-11 for material accepted on the roadway.

335-2 Materials.

335-2.1 Bituminous Material: Use Asphalt Cement, Viscosity Grade AC-20 or AC-30 meeting the requirements of 916-1.

335-2.2 Aggregate:

335-2.2.1 General: Use aggregate material composed of one or more of the following:

a. Local sand.

b. A blend of local sands.

c. A local sand with some additive, such as mineral filler, commercial sand, crushed shell, rock screenings, or other approved material. Meet the commercial material requirements specified in Division III.

d. Manufactured aggregate.

Restrict the maximum size of the aggregate material using scalping screens having an opening of ε inch [16.0 mm] square. Ensure that the material is graded from coarse to fine, and that it all passes a 2 inch [12.5 mm] sieve. Do not use aggregate or mineral filler containing more than 1% of phosphate.

335-2.2.2 Sand: Use sharp and nonplastic local sand, containing not more than 7% by weight of clay, composed of hard, durable grains free of loam, roots, and other deleterious substances, and suitable for use in a bituminous mix, as determined by laboratory tests. If the local sand deposit consists of stratified layers of varying characteristics and gradation, employ such means as necessary to secure a uniform material. Should the loss of fines during drying operations be such that the stability of the mixture is reduced below the minimum specified, add mineral filler or other approved material in such quantities as necessary to compensate for the loss in stability. Ensure that any clay present is the type which will not produce clay balls in the mixture.

335-2.3 Mineral Filler: If needed, meet the requirements of Section 917.

335-2.4 Testing. The Engineer will sample all materials shipped to the asphalt plant at their destination.

335-3 Composition of Mixture.

335-3.1 General: Use a bituminous mixture composed of a combination of fine aggregate, mineral filler if required, and bituminous material. Size, uniformly grade, and combine the aggregate fractions in the proportions specified in Table 331-1 so that the resulting mixture meets the physical properties and the requirements of the verified mix design.

The Contractor may use RAP meeting the requirements of 331-2.2.4 as a substitution for a portion of the combination of aggregates. If using RAP, the Contractor may use a recycling agent in accordance with the requirements of 331-2.2.5 in the mix in lieu of asphalt cement.

The Contractor may use recycled crushed glass meeting the requirements of 331-2.2.6 as a substitution for a portion of the combination of aggregates.

335-3.2 Mix Design:

335-3.2.1 General: Meet the mix design requirements of 331-4.3. In addition to these requirements, include, in the mix design, test data showing that the material as produced will meet the requirements of Table 331-2.

335-3.2.2 Grading Requirements: Meet the requirements of 332-4.2 for aggregate combination including mineral filler

335-3.2.3 Stability: Combine the constituents of the mixture in such proportions as to produce a mixture having Marshall properties within the limits shown in Table 331-2.

335-3.3 Contractor's Quality Control: Provide the necessary quality control of the bituminous mixture and construction in accordance with the applicable provisions of 330-2.2 and 331-3.4. Furnish materials that meet the verified mix design. For extraction gradation analysis, meet the provisions of 331-4.4.2 and Table 331-3. For plant calibration, meet the provisions of 331-4.4.3 and Table 331-3.

335-4 Acceptance of Mixture.

335-4.1 Acceptance at the Plant: The Engineer will accept the bituminous mixture at the plant with respect to gradation and asphalt content in accordance with the applicable requirements of 331-4.

335-4.2 Acceptance on the Roadway: The Engineer will accept the bituminous mixture on the roadway with respect to compacted density and surface tolerance in accordance with the provisions of 330-11 and 330-13.

335-4.3 Additional Tests: The Engineer will apply the provisions of 331-5.5 to Sand-Asphalt Hot Mix.

335-5 Method of Measurement.

The quantities to be paid for will be measured as specified for Type S Asphaltic Concrete under the applicable provisions of 331-6.

335-6 Basis of Payment.

Prices and payments will be full compensation for all work specified under this Section.

Payment will be made under:

Item No. 335- 2- Sand-Asphalt Hot Mix - per ton.
Item No. 2335- 2- Sand-Asphalt Hot Mix - per metric ton.

SECTION 336

ASPHALT RUBBER BINDER

336-1 Description.

Produce asphalt rubber binder for use in Asphaltic Concrete Friction Courses and Asphalt Rubber Membrane Interlayers.

336-2 Materials.

336-2.1 Asphalt Cement: For the particular grade of asphalt cement as specified in Table 336-1, meet the requirements of Section 916.

336-2.2 Ground Tire Rubber: For the type of ground tire rubber, meet the requirements of Section 919.

336-3 Asphalt Rubber Binder.

Thoroughly mix and react the asphalt cement and ground tire rubber in accordance with the requirements of Table 336-1. Use a rubber type that is in accordance with the verified mix design. Accomplish blending of the asphalt cement and ground tire rubber at the asphalt supplier's terminal or at the project site.

336-4 Equipment.

Use blending equipment that is designed for asphalt rubber binder and capable of producing a homogeneous mixture of ground tire rubber and asphalt cement meeting the requirements of Table 336-1. The Contractor may use a batch type or continuous type blending unit that provides for sampling of the blended and reacted asphalt rubber binder material during normal production. Once every six months, certify the accuracy of the meter used to determine the asphalt rubber binder content of bituminous mixtures. Obtain such certification from an approved scale technician.

In order to meet specification requirements, keep the asphalt rubber uniformly blended while in storage. Equip storage tanks with a sampling device.

336-5 Testing and Certification Requirements.

336-5.1 Blending at Project Site: The Engineer will monitor the ground tire rubber content in the asphalt rubber binder on a daily basis based on the following:

(1) the weight of the ground tire rubber used and the gallons [liters] of asphalt rubber binder used, or (2) the weight of the ground tire rubber used and the number of gallons [liters] of asphalt cement used. The Engineer will use the weight per gallon [liter] for the various types of asphalt rubber binder shown in Table 336-1 for the calculations in (1) above.

336-5.2 Blending at Asphalt Supplier's Terminal: Where blending the asphalt rubber binder at the asphalt supplier's terminal, certify that for each load delivered to the project site, the asphalt rubber binder has been produced in accordance with and meets the requirements of 336-3. In addition, include, with the certification, the certifications for the asphalt cement and ground tire rubber, as specified in 916-1.2 and 919-6, respectively.

336-5.3 Testing of Asphalt Rubber Binder:

336-5.3.1 Quality Control Requirements: Test the asphalt rubber binder for the viscosity requirement of Table 336-1 at the following frequencies and situations:

1. One per batch (for batch blending) or two per day (for continuous blending) during blending at the project site.
2. Each load delivered to the project site when blended at the asphalt supplier's terminal.
3. Beginning of each day from the storage tank when storing the asphalt rubber binder at the project site.

Obtain the viscosity testing equipment specified in FM 5-548 and make it available to the Department for acceptance purposes.

In the event that the Quality Control and Acceptance samples are being tested simultaneously, the Contractor may use the Acceptance Test results for quality control.

336-5.3.2 Acceptance Requirements: The Engineer will test the asphalt rubber in accordance with FM 5-548 to ensure conformance with the minimum viscosity requirement as specified in Table 336-1 at the following specific frequencies and situations:

1. One per batch (for batch blending) or two per day (for continuous blending) during blending at the project site.
2. Beginning of each day from the storage tank when storing the asphalt

rubber binder at the project site.

If the asphalt rubber binder does not meet the minimum viscosity requirement, make the appropriate adjustments in order to (1) correct the viscosity of the blended material, and (2) correct the blending operation. These corrective actions may include increasing the ground tire rubber content, lowering the blended temperature, or increasing the reaction time. In the event that the corrective actions taken fail to correct the problem, or the material consistently fails to meet the minimum viscosity requirement, stop all asphalt rubber production operations and solve the problem. Do not resume production operations until the Engineer grants approval. The Engineer will evaluate any mix placed with low viscosity asphalt rubber binder to determine if the Contractor should remove and replace it. In the event that the viscosity of the asphalt rubber binder increases to the extent that paving operations of the mixture are adversely affected (i.e. density or texture problems occur), stop plant operations and resolve the problem.

Table 336-1

Asphalt Rubber Binder

Binder Type	ARB 5	ARB 12	ARB 20
Rubber Type	TYPE A (or B)*	TYPE B (or A)**	TYPE C (or B or A)**
Minimum Ground Tire Rubber (by weight of asphalt cement)	5%	12%	20%
AC Grade	AC 30	AC 30	AC 20
Minimum Temperature	300EF [150EC]	300EF [150EC]	335EF [170EC]
Maximum Temperature	335EF [170EC]	350EF [175EC]	375EF [190EC]
Minimum Reaction Time	10 minutes	15 minutes (Type B)	30 minutes (Type C)
Unit Weight @ 60EF [15EC ***]	8.6 lbs/gal [1.03 kg/L]	8.7 lbs/gal [1.04 kg/L]	8.8 lbs/gal [1.05 kg/L]
Minimum Viscosity ****	4.0 Poise @ 300EF [0.4 Pa≅s @ 150EC]	10.0 Poise @ 300EF [1.0 Pa≅s @ 150EC]	15.0 Poise @ 350EF [1.5 Pa≅s @ 175EC]

* Use of Type B rubber may require an increase in the mix temperature in order to offset higher viscosity values.
** Use of finer rubber could result in the reduction of the minimum reaction time.
*** Conversions to standard 60EF [15EC] are as specified in 300-8.3.
**** FM 5-548, Viscosity of Asphalt Rubber Binder by use of the Rotational Viscometer.
NOTE: The Contractor may adjust the minimum reaction time if approved by the Engineer depending upon the temperature, size of the ground tire rubber and viscosity measurement determined from the asphalt rubber binder material prior to or during production. Apply the asphalt rubber binder for use in membrane interlayers within a period of six hours, unless some form of corrective action such as cooling and reheating is approved by the Engineer.

336-6 Use of Excess Asphalt Rubber.

The Contractor may use excess asphalt rubber in other asphaltic concrete mixtures requiring the use of an AC-30 by blending with straight AC-30 so that the total amount of ground tire rubber in the binder is less than 2.0%. The Contractor may use excess asphalt rubber in asphaltic concrete mixtures requiring the use of a recycling agent in a recycled mixture by blending with a recycling agent in such proportions that the total amount of ground tire rubber in the recycling agent is less than 1.0%.

336-7 Basis of Payment.

Payment for Asphalt Rubber Binder will be included in Sections 337 and 341, as appropriate.

SECTION 337

ASPHALT CONCRETE FRICTION COURSES

337-1 Description.

Construct an asphalt concrete friction course. This Section specifies mixes designated as Friction Course 2 (FC-2), Friction Course 3 (FC-3), Friction Course 5 (FC-5) and Friction Course 6 (FC-6).

Meet the plant and equipment requirements of Section 320, as modified herein. Meet the general construction requirements of Section 330, as modified herein.

337-2 Materials.

337-2.1 General Requirements: Meet the requirements specified in Division III as modified herein. The Engineer will base continuing approval of material sources on field performance.

337-2.2 Asphalt Rubber Binder: Meet the requirements of Section 336, and any additional requirements or modifications specified herein for the various mixtures.

337-2.3 Coarse Aggregate: Meet the requirements of Section 901, and any additional requirements or modifications specified herein for the various mixtures.

337-2.4 Fine Aggregate: Meet the requirements of Section 902, and any additional requirements or modifications specified herein for the various mixtures.

337-2.5 Hydrated Lime: Meet the requirements of AASHTO M303 Type 1.

Provide certified test results for each shipment of hydrated lime indicating compliance with the specifications.

337-2.6 Fiber Stabilizing Additive (Required for FC-5 only): Use either a mineral or cellulose fiber stabilizing additive. Meet the following requirements:

337-2.6.1 Mineral Fibers: Use mineral fibers made from virgin basalt, diabase, or slag treated with a cationic sizing agent to enhance the disbursement of the fiber, as well as to increase adhesion of the fiber surface to the bitumen. Meet the following requirements for physical properties:

1. Size Analysis

Average fiber length.................... 0.25 inch [6.0 mm] (maximum)

Average fiber thickness....... 0.0002 inch [0.005 mm] (maximum)

2. Shot Content (ASTM C612)

Percent passing No. 60 [250 μm] Sieve .... 90 - 100

Percent passing No.230 [63 μm] Sieve .... 65 - 100

Provide certified test results for each batch of fiber material indicating compliance with the above tests.

337-2.6.1.1 Notice of Patented Process: Take notice that the use of mineral fibers treated with cationic sizing agent and the size analysis range for average fiber thickness are subject to U.S. Patent No. 4,613,376, held by Fiberand Corporation, 7150 Southwest 62nd Avenue, South Miami, Fl. 33143. Obtain all mineral fibers required to meet the FC-5 requirements of this Contract only from Fiberand Corporation or a duly authorized licensee of Fiberand. Assume responsibility, pursuant to 7-3, for obtaining any and all necessary rights to use such processes and pay any and all royalties, license fees or other costs incurred in order to meet the FC-5 requirements of this Contract. Include any and all royalties, license fees and other costs arising due to the existence of U.S. Patent No. 4,613,376 in the bid unit price for friction course FC-5.

337-2.6.2 Cellulose Fibers: Use cellulose fibers meeting the following requirements:

1. Fiber length................................... 0.25 inch [6.0 mm] (maximum)
2. Sieve Analysis
   a. Alpine Sieve Method
      Percent passing No. 100 [150 Φm] sieve....................... 60-80
   b. Ro-Tap Sieve Method
      Percent passing No. 20 [850Φm] sieve.......................... 80-95
      Percent passing No. 40 [425Φm] sieve.......................... 45-85
      Percent passing No. 100 [150Φm sieve........................... 5-40
3. Ash Content: ....18% non-volatiles (∀5%)
4. pH: .... 7.5 (∀1.0)
5. Oil Absorption: ....5.0 (∀1.0) (times fiber weight)
6. Moisture Content: ....5.0 (maximum)

Provide certified test results for each batch of fiber material indicating compliance with the above tests.

337-3 General Composition of Mixes.

337-3.1 General: Use a bituminous mixture composed of aggregate (coarse, fine, or a mixture thereof), asphalt rubber binder, and in some cases, fibers and/or hydrated lime. Size, uniformly grade and combine the aggregate fractions in such proportions that the resulting mix meets the requirements of this Section. The use of RAP material will not be permitted.

337-3.2 Specific Component Requirements by Mix:

337-3.2.1 FC-2:

337-3.2.1.1 Aggregates: In addition to the requirements of Section 901, meet the following coarse aggregate requirements. Use either crushed granite, crushed slag, or lightweight aggregates approved by the Engineer. Crushed limestone from the Oolitic formation may be used if it contains a minimum of 12 %

non-carbonate material as determined by FM 5-510 and the Engineer grants approval of the source prior to its use. Aggregates other than those listed above may be used if approved by the Engineer.

337-3.2.1.2 Asphalt Rubber: Use an ARB-12 asphalt rubber.

337-3.2.2 FC-3:

337-3.2.2.1 Aggregates: In addition to the requirements of Section 901, meet the following coarse aggregate requirements. Use either crushed gravel, crushed granite, crushed slag, or crushed limestone from the Oolitic formation as specified for use in FC-2. Aggregates other than those listed above may be used if approved by the Engineer.

In addition to the requirements of Section 902, meet the following fine aggregate requirements. Use crushed screenings or a combination of crushed screenings and local materials. Use crushed screenings composed of hard, durable particles resulting from crushing or processing the coarse aggregate as specified above. Screenings from other approved sources may be used provided that the total of these screenings along with silica sand or local materials does not exceed 40%. Ensure that not more than 20% by weight of the total aggregate used is silica sand or local materials defined in Section 902.

337-3.2.2.2 Asphalt Rubber: Use an ARB-5 asphalt rubber.

337-3.2.3 FC-5:

337-3.2.3.1 Aggregates: Use an aggregate blend which consists of either 100% crushed granite or 100% crushed Oolitic limestone.

In addition to the requirements of Section 901, meet the following coarse aggregate requirements. Use either crushed granite or crushed limestone. Use crushed limestone from the Oolitic formation, which contains a minimum of 12% non-carbonate material (as determined by FM 5-510), and has been approved for this use.

In addition to the requirements of Section 902, meet the following fine aggregate requirements. Use either crushed granite screenings, or crushed Oolitic limestone screenings for the fine aggregate.

337-3.2.3.2 Asphalt Rubber: Use an ARB-12 asphalt rubber.

337-3.2.3.3 Hydrated Lime: Add the lime at a dosage rate of 1.0% by weight of the total dry aggregate to mixes containing granite.

337-3.2.3.4 Fiber Stabilizing Additive: Add either mineral fibers at a dosage rate of 0.4% by weight of the total mix, or cellulose fibers at a dosage rate of 0.3% by weight of total mix.

337-3.2.4 FC-6:

337-3.2.4.1: Aggregates: Use coarse and fine aggregate components which also meet the aggregate requirements for an SP-9.5 or SP-12.5 Superpave mix as specified in Section 334.

In addition to the requirements of Section 901, meet the following coarse aggregate requirements. Use either crushed granite, crushed slag, crushed river gravel, lightweight aggregate (that has been approved for this use), or crushed limestone for the coarse aggregate component. Use crushed limestone from the Oolitic formation, which contains a minimum of 12% non-carbonate material (as determined by FM 5-510), and is approved for this use. In addition, other types of aggregates may be used if approved for this use by the Engineer.

In addition to the requirements of Section 902, meet the following fine aggregate requirements. Use crushed screenings or a combination of crushed screenings and local materials for the fine aggregate components. Use crushed screenings composed of hard, durable particles resulting from the crushing or processing of coarse aggregate as specified above. In addition, screenings from other approved sources may be used provided that the total of these screenings (along with silica sand or local materials) does not exceed 40%.

337-3.2.4.2: Asphalt Rubber: Use an ARB-5 asphalt rubber.

337-3.3 Grading Requirements:

337-3.3.1 FC-2 and FC-3: Use a mixture with a gradation within the design range specified in Table 331-1.

337-3.3.2 FC-5: Use a mixture having a gradation at design within the ranges shown in Table 337-1.

Table 337-1
FC-5 Gradation Design Range

3/4 inch [19.00 mm]	2 inch [12.50 mm]	3/8 inch [9.50 mm]	No.4 [4.75 mm]	No.10 [2.00 mm]	No. 40 [425 μm]	No. 80 [180μm]	No. 200 [75 μm]
100	85-100	55-75	15-25	5-10	-	-	2-4

337-3.3.3 FC-6: Meet the design gradation requirements for a SP-9.5 Superpave mix passing below the restricted zone, or the design gradation requirements for a SP-12.5 Superpave mix passing above the restricted zone, as specified in Section 334.

337-4 Mix Design.

337-4.1 FC-2 and FC-5: The Department will design the FC-2 and FC-5 mixtures. Furnish materials and the appropriate information (source, gradation, etc.) as specified in 331-4.3. The Department will have two weeks to design the mix.

The Department will establish the design binder content for FC-2 within the following ranges based on aggregate type:

Aggregate Type	Binder Content % by weight of total mix
Crushed Granite	5.5-7.0
Crushed Slag	6.0-8.0
Crushed Limestone (Oolitic)	6.5-7.5
Lightweight	12.5-15.0

The Department will establish the design binder content for FC-5 within the following ranges based on aggregate type:

Aggregate Type	Binder Content
Crushed Granite	5.5 - 7.0
Crushed Limestone (Oolitic)	6.5 - 7.5

337-4.2 FC-3: Provide a mix design conforming to the requirements of 331-4.3. Submit data showing that the mix design meets the requirements of Table 331-2 using conventional AC-30. Then, for production, substitute the asphalt rubber binder at the optimum conventional binder content and show it as the optimum binder content on the verified mix design.

337-4.3 FC-6: Provide a mix design conforming to the requirements of 334-4.2 for Traffic Level 4 unless otherwise designated in the plans. Develop the mix design using conventional AC-30. Then substitute the asphalt rubber at the optimum conventional binder content for production and show as the optimum binder content on the approved mix design.

337-5 Contractor's Quality Control.

Provide the necessary quality control of the friction course mix and construction in accordance with the applicable provisions of Section 330 and 331-4.4 for FC-2, FC-3 and FC-5, and Section 330 and 334-4.4 for FC-6. After the mix design has been approved, furnish the material to meet the approved mix design in accordance with the provisions of 331-4.4.2 and Table 331-3 for FC-2, FC-3 and FC-5, and 334-4.4 for FC-6. Calibrate the plant in accordance with 331-4.4.3 and Table 331-3.

The Engineer will monitor the spread rate periodically to ensure uniform thickness. Provide quality control procedures for daily monitoring and control of spread rate variability. If the spread rate varies by more than 5% of the spread rate set by the Engineer in accordance with 337-8, immediately make all corrections necessary to bring the spread rate into the acceptable range.

337-6 Acceptance of Mix.

337-6.1 Acceptance at the Plant: The bituminous mix will be accepted at the plant with respect to gradation and asphalt content in accordance with the applicable requirements of 331-5 for FC-2, FC-3 and FC-5, and 334-5 for FC-6, with the exception that the asphalt content of the mixture will be determined in accordance with FM 5-563, and the gradation will be determined in accordance with FM 1-T 030.

337-6.2 Acceptance on the Roadway: The FC-3 mix will be accepted on the roadway with respect to density in accordance with the applicable provisions of 330-11. There will be no density requirements for FC-2 and FC-5.

The FC-2, FC-3 and FC-5 mixtures will be accepted on the roadway with respect to surface tolerance in accordance with the applicable provisions of 330-13.

The FC-6 mix will be accepted on the roadway with respect to density and surface tolerance in accordance with the applicable provisions of 334-5.4.

337-6.3 Additional Tests: The provisions of 331-5.5 will apply to FC-2, FC-3 and FC-5. The provisions of 334-5.5 will apply to FC-6.

337-7 Special Construction Requirements

337-7.1 Hot Storage of FC-2 and FC-5 Mixtures: When using surge or storage bins in the normal production of FC-2 and FC-5, do not leave the mixture in the surge or storage bin for more than one hour.

337-7.2 Longitudinal Grade Controls for Open-Graded Friction Courses: On FC-2, do not use a longitudinal grade control (skid, ski, or traveling stringline). Use a joint matcher. On FC-5, use either longitudinal grade control (skid, ski or traveling stringline) or a joint matcher.

337-7.3 Temperature Requirements for FC-2:

337-7.3.1 Air Temperature at Laydown: Spread the mixture only when the air temperature, taken as the temperature in the shade away from artificial heat, is at or above 60EF [15EC].

337-7.3.2 Temperature of the Mixture: Heat and combine the asphalt rubber binder and aggregate in a manner which will produce a mixture having a temperature, when discharged from the plant, of 290EF [145EC], or as directed by the Engineer. Meet the temperature tolerance requirements specified in Table 330-2. Meet all other requirements of 330-7.3.

337-7.4 Compaction of FC-2: Perform only seal rolling using a tandem

$$PLI = \frac{Total\ Weight\ of\ \ Roller\ (pounds)}{Total\ Width\ of\ \ Drums\ (inches)}$$

steel-wheel roller. Do not allow the weight of the steel-wheel roller to exceed 135 lb/in (PLI) [2.4 kg/mm] of drum width.

Non SI Units
SI Units

$$kg/mm = \frac{Total\ Weight\ of\ \ Roller\ (kilograms)}{Total\ Width\ of\ \ Drums\ (millimeters)}$$

Perform seal rolling with a single coverage and with a nominal amount of overlap. Where the lane being placed is adjacent to a previously laid mat, do not pinch the longitudinal joint with the roller on the cold mat. Pinch the longitudinal joint with the roller on the mat being rolled, overlapping onto the cold mat by no more than 3 inches [75 mm]. Never allow a roller on the mat after completing the seal rolling.

337-7.5 Temperature Requirements for FC-3:

337-7.5.1 Air Temperature at Laydown: Spread the mixture only when the air temperature, taken in the shade away from artificial heat, is at or above 45EF [7EC].

337-7.5.2 Temperature of the Mixture: Heat and combine the asphalt rubber binder and aggregate in a manner which will produce a mixture having a temperature, when discharged from the plant, of 310EF [155EC], or as directed by the Engineer. Meet the temperature tolerance requirements specified in Table 330-2. Meet all other requirements of 330-7.3.

337-7.6 Temperature Requirements for FC-5:

337-7.6.1 Air Temperature at Laydown: Spread the mixture only when the air temperature (the temperature in the shade away from artificial heat) is at or above 65EF [18EC].

337-7.6.2 Temperature of the mix: Heat and combine the asphalt rubber binder and aggregate in a manner to produce a mix having a temperature, when discharged from the plant, of 320EF [160EC], or as specified by the Engineer. The tolerance from this established temperature is specified in Table 330-2. All other requirements of 330-7.3 will apply to FC-5, except any load or portion of a load of asphalt mix at the plant or on the road with a mix temperature exceeding 345EF [175EC] will be rejected.

337-7.7 Compaction of FC-5: Provide 2, 8-10 ton static steel-wheeled rollers. (Any variation of this equipment requirement must be approved by the Engineer.) The Engineer will establish the appropriate rolling pattern for the pavement. If the rollers crush the aggregate, use a tandem steel-wheel roller weighing not more than 135 lb/in (PLI) [2.4 kg/mm] of drum width as determined in accordance with 337-7.4.

337-7.8. Temperature Requirements for FC-6:

337-7.8.1 Air Temperature at Laydown: Spread the mixture only when the air temperature (the temperature in the shade away from artificial heat) is at or above 45EF [7EC].

337-7.8.2 Temperature of the mix: Heat and combine the asphalt rubber binder and aggregate in a manner to produce a mix having a temperature, when discharged from the plant, of 310EF [155EC]. The tolerance from this established temperature is specified in Table 330-2. All other requirements of 330-7.3 will apply to FC-6.

337-7.9 Prevention of Adhesion: To minimize adhesion to the drum during the rolling operations, the Contractor may add a small amount of liquid detergent to the water in the roller.

At intersections and in other areas where the pavement may be subjected to cross-traffic before it has cooled, spray the approaches with water to wet the tires of the approaching vehicles before they cross the pavement.

337-7.10 Transportation Requirements of Friction Course Mixtures: Cover all loads of friction course mixtures with a tarpaulin.

337-8 Thickness of Friction Courses.

The thickness of the friction courses will be based on the spread rate set by the Engineer. Plan quantities are based on the maximum spread rate within the ranges shown below. Pay quantities may be less, based on the spread rate set by the Engineer.

337-8.1 Spread Rate for FC-2: For FC-2 with granite, oolitic limestone, or other conventional aggregate, the Engineer will set the spread rate within the range of 50 - 60 lb/yd^2 [27 - 34 kg/m5]. For FC-2 with lightweight aggregate, the Engineer will set the spread rate within the range of 28 - 35 lb/yd^2 [15 - 19 kg/m5].

337-8.2 Spread rate for FC-3: The Engineer will set the spread rate within the range of 100 - 110 lb/yd^2 [54 - 60 kg/m^2].

337-8.3 Spread Rate of FC-5: The Engineer will set the spread rate within the range of 70 - 80 lb/yd^2 [38 - 44 kg/m^2].

337-8.4 Spread Rate of FC-6: The Engineer will set the spread rate within the range of 150 - 160 lb/yd^2 [80 - 88 kg/m^2].

337-9 Special Equipment Requirements for FC-5.

337-9.1 Fiber Supply System: Use a separate feed system to accurately proportion the required quantity of mineral fibers into the mixture in such a manner that uniform distribution is obtained. Interlock the proportioning device with the aggregate feed or weigh system to maintain the correct proportions for all rates of production and batch sizes. Control the proportion of fibers to within plus or minus 10% of the amount of fibers required. Provide flow indicators or sensing devices for the fiber system, interlocked with plant controls so that the mixture production will be interrupted if introduction of the fiber fails.

When a batch plant is used, add the fiber to the aggregate in the weigh hopper or as approved and directed by the Engineer. Increase the batch dry mixing time by 8 to 12 seconds, or as directed by the Engineer, from the time the aggregate is completely emptied into the pugmill. Ensure that the fibers are uniformly distributed prior to the addition of asphalt rubber into the pugmill.

When a drum-mix plant is used, add and uniformly disperse the fiber with the aggregate prior to the addition of the asphalt rubber. Add the fiber in such a manner that it will not become entrained in the exhaust system of the drier or plant.

337-9.2 Hydrated Lime Supply System: For FC-5 mixes containing granite, use a separate feed system to accurately proportion the required quantity of hydrated lime into the mixture in such a manner that uniform coating of the aggregate is obtained prior to the addition of the asphalt rubber. Add the hydrated lime in such a manner that it will not become entrained in the exhaust system of the drier or plant. Interlock the proportioning device with the aggregate feed or weigh system to maintain the correct proportions for all rates of production and batch sizes and to ensure that all mixture produced is properly treated with hydrated lime. Control the proportion of hydrated lime to within plus or minus 10% of the amount of hydrated lime required. Provide and interlock flow indicators or sensing devices for the hydrated lime system with plant controls so that the mixture production will be interrupted if introduction of the hydrated lime fails. The addition of the hydrated lime to the aggregate may be accomplished by Method (A) or (B) as follows:

337-9.2.1 Method (A) - Dry Form: Add hydrated lime in a dry form to the mixture according to the type of asphalt plant being used.

When a batch plant is used, add the hydrated lime to the aggregate in the weigh hopper or as approved and directed by the Engineer. Increase the batch dry mixing time by eight to twelve seconds, or as directed by the Engineer, from the time the aggregate is completely emptied into the pugmill. Uniformly distribute the hydrated lime prior to the addition of asphalt rubber into the pugmill.

When a drum-mix plant is used, add and uniformly disperse the hydrated lime to the aggregate prior to the addition of the asphalt rubber. Add the hydrated lime in such a manner that it will not become entrained in the exhaust system of the drier or plant.

337-9.2.2 Method (B) - Hydrated Lime/Water Slurry: Add the required quantity of hydrated lime (based on dry weight) in a hydrated lime/water slurry form to the aggregate. Provide a solution consisting of hydrated lime and water in concentrations as directed by the Engineer. Use a plant equipped to blend and maintain the hydrated lime in suspension and to mix it with the aggregates uniformly in the proportions specified.

337-10 Method of Measurement.

The quantity to be paid for will be the weight, in tons [metric tons], as determined in accordance with 320-2 (including provisions for the automatic recordation system). The pay quantity will be based on the average spread rate for the project, limited to a maximum of 105% of the spread rate set by the Engineer in accordance with 337-8.

337-11 Basis of Payment.

Price and payment will be full compensation for all the work specified under this Section, including the cost of the asphalt rubber (asphalt cement, ground tire rubber, anti-stripping agent, blending, and handling), as well as fiber stabilizing additive and hydrated lime (if required).

Payment will be made under:

Item No. 337- 7- Asphaltic Concrete Friction Course -per ton.
Item No. 2337- 7- Asphaltic Concrete Friction Course -per metric ton.

SECTION 339

MISCELLANEOUS ASPHALT PAVEMENT

339-1 Description.

Construct asphalt pavement in areas where vehicular traffic does not travel, such as pavement under guardrail, bicycle paths, median pavement, sidewalks, etc.

Also, chemically treat the underlying soil to prevent plant growth.

339-2 Materials.

For the pavement, use any plant-mixed hot bituminous mixture meeting the requirements of a mix design verified by the Engineer, except do not use open-graded friction course (FC-2). For bicycle paths, use a mixture that produces a finished pavement which will not distort or mar under bicycle or mower wheel loads.

In general, the Engineer will accept the mixture on the basis of visual inspection with no further testing required.

339-3 Foundation and Soil Treatment.

Prior to placing of the hot bituminous mixture, shape the soil on which the pavement is to be constructed to a surface true to the lines, grades and typical cross-sections shown in the plans, and compact the soil to a firm state.

Immediately before placing the pavement, uniformly apply a pre-emergent herbicide that carries an approved label for use under paved surfaces to the foundation soil in accordance with directions on the label. Contact the local County Extension Office for a list of approved herbicides. Prevent damage to vegetation adjacent to the paved area when applying herbicide.

Replace, at no expense to the Department, any plant growth damaged as the result of soil treatment solution being applied to areas outside those designated to receive treatment.

339-4 Placing Mixture.

Uniformly place the hot bituminous mixture by machine or hand methods at the rate of spread indicated in the plans or as otherwise directed by the Engineer. If posts are to be constructed within the pavement area, the Contractor may cut holes for installation through the completed pavement. After completing installation of posts and compaction of the backfill material, patch the area around each post with fresh hot bituminous mixture.

If directed by the Engineer, place miscellaneous asphalt pavement prior to placement of the final surface course.

339-5 Compacting Mixture.

Uniformly compact the hot bituminous mixture with lightweight rollers or vibratory compactors as directed by the Engineer. The Contractor may use hand tamps for compaction in areas which are inaccessible to other compaction equipment.

The Engineer will not require a specific density.

339-6 Surface Requirements.

Provide a finished surface that is reasonably smooth, of uniform texture, and shaped so as to drain without ponding of water.

Upon completion of the pavement, shape the surface of the adjacent earth to match the pavement edges.

339-7 Method of Measurement.

The quantity to be paid for will be the weight, in tons [metric tons], determined by weighing in trucks on scales meeting the requirements of 320-2.2 or from the total weight of batches placed in trucks as determined by an automatic printer system meeting the requirements of 320-2.4.

339-8 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section, including shaping and compacting the foundation, soil sterilization treatment, furnishing of the bituminous material used in the mixture, and shaping of adjacent earth surfaces.

Payment will be made under:

Item No. 339- 1- Miscellaneous Asphalt Pavement - per ton.
Item No. 2339- 1- Miscellaneous Asphalt Pavement - per metric ton.

SECTION 341

ASPHALT RUBBER MEMBRANE INTERLAYER

341-1 Description.

Construct an asphalt rubber membrane interlayer composed of a separate application of asphalt rubber binder covered with a single application of aggregate.

341-2 Materials.

341-2.1 Asphalt Rubber Binder: Use ARB-20 meeting the requirements of Section 336.

341-2.2 Cover Material: Use Size No. 6 stone, slag, or gravel meeting the requirements of Section 901.

341-3 Equipment.

341-3.1 Power Broom: Provide a power broom for cleaning the existing pavement capable of removing all loose material from the surface.

341-3.2 Spreading Equipment: Provide a self-propelled aggregate spreader that can be adjusted to accurately apply the cover material at the specified rate and that spreads the material uniformly.

341-3.3 Rollers: Provide self-propelled, pneumatic-tired traffic type rollers equipped with at least seven smooth-tread, low-pressure tires, and capable of carrying a gross load of at least 8 tons [7 metric tons]. Maintain a minimum tire inflation pressure of 90 psi [600 kPa] such that in no two tires the air pressure varies more than 5 psi [35 kPa]. Load the traffic roller as directed by the Engineer.

341-3.4 Mixing Equipment: Use mixing equipment for asphalt rubber binder designed for that purpose and capable of producing and maintaining a homogeneous mixture of rubber and asphalt cement at the specified temperature.

341-3.5 Pressure Distributor: Use a pressure type distributor to apply asphalt rubber binder capable of maintaining a homogeneous mixture of rubber and asphalt cement at the specified temperature and consistently apply the material in a uniform manner.

341-4 Preparation of Asphalt Rubber Binder.

Combine the materials as rapidly as possible for such a time and at such a temperature that the consistency of the binder approaches that of a semi-fluid material. Use the time and temperature for blending of the asphalt rubber binder as specified in Table 336-1. The Engineer will be the sole judge of when the material has reached application consistency and will determine if an extender oil or diluent is needed for that purpose. After reaching the proper consistency, proceed with application immediately. Never hold the mixture at temperatures over 350EF [175EC] for more than six hours after reaching that point.

341-5 Construction Procedure.

341-5.1 Preparation of Surface: Prior to application of the asphalt rubber binder, clean the existing pavement as specified in 300-4.

341-5.2 Application of Asphalt Rubber Binder: Apply the asphalt rubber binder only under the following conditions:

a. The air temperature is above 50EF [10EC] and rising.

b. The pavement is absolutely dry.

c. The wind conditions are such that cooling of the asphalt rubber binder will not be so rapid as to prevent good bonding of the aggregate.

Uniformly apply the asphalt rubber binder, at the rate of 0.6 to 0.8 gal/yd^2 [2.7 to 3.6 L/m^2] as directed by the Engineer. Use an application rate based on the unit weight as shown in Table 336-1. For conversions to standard 60EF [15EC], refer to 300-8.3.

341-5.3 Application of Cover Material: Immediately after application of the asphalt rubber binder, uniformly spread cover material at a rate of 0.26 and 0.33 ft^3/yd^2 [0.0088 to 0.0112 m^3/m^2]. The Engineer will set the exact rate. For the cover material, use aggregate that is reasonably free of any adherent coatings and that does not contain excessive moisture. Immediately after the application of cover material, check the surface to ensure a uniform distribution of cover material and a smooth surface.

Do not separate the application of the asphalt rubber binder and the application of the cover material by more than 300 feet [90 m].

341-5.4 Rolling: In order to ensure maximum embedment of the aggregate, cover the entire width of the mat immediately by traffic rollers. For the first coverage, provide a minimum of three traffic rollers in order to accomplish simultaneous rolling in echelon of the entire width of the spread.

After initial rolling, immediately correct all portions of the completed surface, that the Engineer deems are defective (not properly covered by aggregates, fat spots, excessive free aggregate, etc.).

Following the first coverage, make additional coverages with traffic rollers as directed by the Engineer.

341-5.5 Traffic Control: For the normal sequence of construction operations, place the first course of asphalt concrete overlay over the membrane prior to opening to traffic.

341-6 Unacceptable Asphalt Rubber Membrane Interlayer.

If the asphalt rubber membrane interlayer is unacceptable due to incorrect blending, application rate, or not meeting the requirements of this Section, or damaged prior to placement of the asphaltic concrete layer, remove and replace it as directed by the Engineer. Do not apply excessive amounts of asphalt rubber binder.

341-7 Placement of Asphalt Concrete Overlay.

Ensure that the thickness and temperature of the initial layer of asphalt concrete placed on top of the asphalt rubber membrane interlayer are such that the overlay bonds to the interlayer and the underlying layer without voids or excessive binder. Core the asphalt overlay as directed by the Engineer to evaluate the binder and aggregate spread rates, as well as the effectiveness of the asphalt concrete overlay in producing a well-bonded interlayer.

341-8 Method of Measurement.

341-8.1 Asphalt Rubber Membrane Interlayer: The quantity to be paid for will be the area, in square yards [square meters], completed and accepted.

341-8.2 Bituminous Material (Asphalt Rubber Binder-Interlayer): The quantity to be paid for will be the volume, in gallons [liters], determined as provided in 300-8.

341-9 Basis of Payment.

341-9.1 Asphalt Rubber Membrane Interlayer: Price and payment will be full compensation for all work specified in this Section, including furnishing cover materials, handling, spreading, rolling, and other incidental work necessary to complete this item.

341-9.2 Bituminous Material (Asphalt Rubber Binder-Interlayer): Price and payment will be full compensation for furnishing asphalt cement, ground tire rubber, and blending and handling.

341-9.3 Payment Items: Payment will be made under:

Item No. 341- 70-	Asphalt Rubber Membrane Interlayer - per square yard.
Item No. 2341- 70-	Asphalt Rubber Membrane Interlayer - per square meter.
Item No. 300- 1-19-	Bituminous Material (Asphalt Rubber Binder-Interlayer) - per gallon.
Item No. 2300- 1-19-	Bituminous Material (Asphalt Rubber Binder-Interlayer) - per liter.

SECTION 346

PORTLAND CEMENT CONCRETE

346-1 Description.

Use concrete composed of a mixture of portland cement, aggregate, water, and, where specified, admixtures and pozzolan. Deliver the portland cement concrete to the site of placement in a freshly mixed, unhardened state.

Meet the production and quality control of concrete provisions of this Section and the Florida Department of Transportation Standard Operating Procedures.

346-2 Materials.

346-2.1 General: Meet the following requirements:

Coarse Aggregate ....Section 901
Fine Aggregate* ....Section 902
Portland Cement..Section 921
Water ....Section 923
Admixtures ....Section 924
Fly Ash, Slag** and Microsilica (Pozzolanic Materials).........Section 929
*The Engineer will allow only silica sand except as provided in 902-5.2.3.
**The Engineer will allow only granulated blast furnace slag.

Use the materials containing no hardened lumps, crusts or frozen matter, and that are not contaminated with dissimilar material.

346-2.2 Types of Cement: Unless a specific type of cement is designated elsewhere, use Type I, Type IP, Type IS, Type IP(MS), Type II, or Type III cement in all classes of concrete.

Use only the types of cements designated for each environmental condition in structural concrete.

TABLE 1

BRIDGE SUPERSTRUCTURES

Component	Slightly Aggressive Environment	Moderately Aggressive Environment	Extremely Aggressive Environment
Precast Superstructure and Prestressed Elements	Type I, Type II, Type III, Type IP, Type IS, or Type IP (MS)	Type I, Type II, and Type III all with Fly Ash or Slag; Type IP, Type IS, or Type IP(MS)	Type II with Fly Ash or Type II with Slag
C.I.P. Superstructure Slabs and Barriers	Type I, Type II, Type IP, Type IS, or Type IP(MS)	Type I with Fly Ash or Slag, Type II, Type IP, Type IS, or Type IP(MS)	Type II with Fly Ash or Type II with Slag

BRIDGE SUBSTRUCTURE, DRAINAGE STRUCTURES AND OTHER STRUCTURES

Component	Slightly Aggressive Environment	Moderately Aggressive Environment	Extremely Aggressive Environment
All Structure Components	Type I, Type II, Type III, Type IP, Type IS, or Type IP (MS)	Type I with Fly Ash or Slag, Type II, Type IP, Type IP(MS), or Type IS	Type II with Fly Ash or Type II with Slag

346-2.3 Use of Fly Ash, Slag, Microsilica, and Other Pozzolanic Materials: The Contractor may use fly ash, slag, microsilica and other pozzolanic materials as a cement replacement in all classes of concrete (when Type I, Type II, or Type III cement is used) with the following limitations:

(1) When fly ash, slag or microsilica is used as a cement replacement, use it on a pound per pound [kilogram per kilogram] basis. Calculate cement replacement as shown in the example.

Example - Assume a total cementitious content of 752 pounds [341 kg]. Calculate the required microsilica for a 7.6% replacement as 752 by .076 = 57 pounds [341 by .076 = 26 kg]. Calculate the required fly ash for a 20% replacement as 752 by 0.20 = 151 pounds [341 by 0.20 = 68 kg]. Cement required is

544 pounds [247 kg].

(2) Ensure that the quantity of cementitious material replaced with fly ash in mass concrete is greater than 18% and less than 50% by weight of the total cementitious content. The minimum cementitious content for each class of concrete is shown in the Master Proportion Table (Table 3).

(3) Ensure that the quantity of cementitious material replaced with fly ash in drilled shaft concrete is 35 ∀ 2% by weight of the total cementitious content.

(4) For all other concrete uses not covered in (2) and (3) above, ensure that the quantity of cementitious material replaced with fly ash is greater than 18% and less than 22% by weight of the total cementitious content.

(5) Ensure that the pozzolan constituent of Type IP(MS) is in the range of 15 to 40% by weight of the portland-pozzolan cementitious material.

(6) Obtain the Engineer's approval to use pozzolanic materials other than Class F fly ash.

(7) Ensure that the quantity of cementitious material replaced with slag in drilled shaft concrete is 60 ∀ 2% by weight of the total cementitious content.

(8) For all other concrete uses not covered in (7) above, ensure that the quantity of cementitious material replaced with slag is not less than 25% or greater than 70% of the total cementitious content when used in Slightly and Moderately Aggressive environments, and not less than 50% or greater than 70% of the total cementitious content when used in Extremely Aggressive environments. When used in combination with microsilica, ensure that the slag does not replace less than 50% or more than 55% of the total cementitious content.

(9) Ensure that the quantity of cementitious material replaced with microsilica is not less than 7% or greater than 9%. Use high range water reducing admixtures in concrete mixes incorporating microsilica.

346-2.4 Coarse Aggregate Gradation: Produce all concrete using Size No. 57 or Size No. 67 coarse aggregate except as follows:

(1) With the Engineer's approval, the Contractor may use Size No. 8 or Size No. 89 either alone or blended with Size No. 57 or Size No. 67 for concrete construction that is heavily reinforced or for barrier wall or curb construction using slip forms.

(2) The Engineer may approve other gradations of aggregates. The Engineer will consider requests for approval of other gradations individually and will require the Contractor to submit sufficient statistical data to establish production quality and uniformity of the subject aggregates, and to establish the quality and uniformity of the resultant concrete. Furnish aggregate gradations sized larger than nominal maximum size of 1.5 inch [37.5 mm] as two components.

(3) Select the maximum coarse aggregate size so as not to violate the reinforcement spacing provisions given for reinforced concrete in the AASHTO Standard Specifications for Highway Bridges.

346-2.5 Admixture Requirements:

346-2.5.1 Chemical Admixtures: Use concrete containing a water-reducing admixture (Type A) or water-reducing and retarding admixture (Type D). Use a dosage rate that is generally in accordance with the manufacturer's recommended dosage rate. When necessary, adjust the dosage rate.

The Engineer may approve the use of other admixtures. The Engineer will require the Contractor to submit statistical evidence supporting successful laboratory and field trial mixes which demonstrate improved concrete quality or handling characteristics.

The Engineer will not allow chemical admixtures or additives containing calcium chloride (either in the raw materials or introduced during the manufacturing process) in reinforced concrete.

346-2.5.2 Air Entrainment Admixtures: Ensure that all concrete except counterweight concrete contains an air entraining admixture. Establish dosage rates by trial mixes, and adjust them to meet field conditions.

346-2.5.3 High Range Water Reducing Admixtures: Use high range water reducing admixtures in concrete mixes incorporating microsilica. The Contractor may propose the use of an approved High Range Water Reducer (HRWR) admixture, either Type F or Type G. In a proposal to use HRWR for precast items, include a list of precast items for which it is proposed. The Contractor may also propose the use of HRWR for cast-in-place concrete, except for concrete used in drilled shafts. In a proposal to use HRWR for cast-in-place items, include a detailed listing of the areas, locations, elements, etc. for which its use is proposed and the anticipated benefits to be derived from the use of HRWR in each instance.

Perform all testing for plastic concrete properties after the HRWR has been added to the concrete mix.

The Department will not consider Value Engineering credits or other price adjustments for proposals to utilize HRWR in order to reduce the specified minimum cementitious requirements for the various classes of concrete.

In a proposal to use HRWR in concrete, include the following:

A certification from the HRWR supplier that the HRWR admixture proposed meets the requirements of ASTM C 494, Type F or G. Ensure that the certificate states that the one year tests representing the admixture to be supplied have been performed by an independent laboratory approved by the Cement and Concrete Reference Laboratory (CCRL) and that the records of such tests will be furnished to the Department on request. Ensure that the certification also includes an additional statement from the HRWR supplier or an approved independent testing laboratory that the proposed HRWR admixture is compatible with all other admixtures to be included in the concrete design mix.

When a HRWR admixture is proposed for use in the design mix, propose a target slump value. Ensure that the target slump does not exceed 7 inches [180 mm]. Meet the other control requirements and ranges as specified herein.

Include with the confirming data all details of the design mix ingredients, all required certificates from the supplier and independent testing laboratory, and a certificate from the Witnessing Department Engineer. Ensure that the certificate states that the Contractor has demonstrated through production and placement of the required number of batches that concrete containing HRWR has been produced meeting all test requirements, that the HRWR concrete has been satisfactorily mixed in accordance with the Contractor's proposed methods and sequences, and that the concrete was acceptably placed, consolidated and cured.

Before the Engineer approves any design mix, demonstrate through production of at least three batches (3 yd^3 [2.3 m^3] minimum size each) of concrete containing the HRWR that the concrete plant can produce concrete consistently meeting specified slump, air content, and compressive strength requirements. Also demonstrate to the Witnessing Department Engineer that the concrete containing the HRWR admixture in accordance with the proposed design mixes can be placed, consolidated and finished under conditions existing for the proposed uses. Obtain the Engineer's approval before using HRWR concrete design mixes.

The Engineer may approve proposed HRWR mixes for concrete, centrally mixed at the placement site, without the production of demonstration batches providing you meet the requirements of 346-6.2, and:

(1) A previously approved HRWR mix of the same class has demonstrated satisfactory performance under the proposed job placing conditions with a minimum of 15 consecutive Department acceptance tests which met all plastic and hardened concrete test requirements.

(2) The cement and water reducing admixtures used in the proposed mix are the same materials from the same source used in the previously approved mix (Item (1) above), and the other materials and mix proportions are approved as similar by the Engineer.

Dispose of concrete produced for demonstration purposes at no expense to the Department. Subject to the Engineer's approval, the Contractor may incorporate this concrete into unreinforced concrete items.

Include with each design mix a description of methods, sequences, times and places that the HRWR will be introduced into the concrete mix for each proposed use. Adjust methods, sequences, times and places for introduction of the HRWR to suit the requirements for each proposed use and condition. The Contractor may transfer design mixes including a HRWR based on demonstrated ability of the mix to perform its intended function.

The Engineer will consider design mixes submitted for approval upon receiving certification from the Witnessing Department Engineer that the Contractor has demonstrated the ability to produce concrete containing a HRWR admixture in accordance with the proposed design mixes, meeting minimum strength requirements within specified ranges for slump and air, and which can be placed, consolidated and finished under conditions existing for the proposed uses. In addition, the Witnessing Department Engineer will include in the certification the test values of the slump, air and 28-day strength tests for all demonstration batches of concrete, and an evaluation and description of the Contractor's actual sequences, methods and time required for the placement and consolidation of each batch of concrete. Also include in the certification, the Witnessing Department Engineer's evaluation of the appearance, apparent consolidation and finish texture after form removal of each item cast.

Except for casting unreinforced concrete items as approved by the Engineer, do not produce or place demonstration concrete containing a HRWR admixture for payment under Contract pay items until design mixes containing the HRWR have been approved. To qualify for payment under Contract pay items, ensure that unreinforced demonstration concrete, cast with the approval of the Engineer, meets minimum strength and entrained air requirements contained in these Specifications, and that the slump is within 1.5 inch [40 mm] of the target slump proposed by the Contractor.

346-2.5.4 Corrosion Inhibitor Admixture: Ensure that concrete containing a corrosion inhibitor admixture also contains cementitious materials consisting of Type II cement and Class F fly ash. The Contractor may use ground granulated blast furnace slag in lieu of fly ash.

Ensure that concrete containing a corrosion inhibitor admixture also contains a water reducing retardant admixture (Type D). The Contractor may also need to use a high range water reducer Type F (or Type G) to provide the required workability and to normalize the setting time of concrete. Ensure that all admixtures are compatible with the corrosion inhibitor admixture.

346-2.6 Mixing Different Coarse Aggregates: The Engineer may allow the substitution of coarse aggregate of the same type from a different source in an approved concrete mix when the aggregate to be substituted is also from an approved source and has similar physical and chemical properties. If unsatisfactory results are obtained with the different source aggregate, return to the aggregate from the originally approved aggregate source of supply.

346-3 Classification, Strength, Slump, and Air Content.

346-3.1 General: The separate classifications of concrete covered by this Section are designated as Class I, Class II, Class III, Class IV, Class V, and Class VI. Strength, slump, and air content of each class are specified in the following (Table 2):

TABLE 2

Class of Concrete	Specified Minimum Strength (28-day) (psi) [(MPa)]	Target Slump (inches) [(mm)](d)	Air Content Range (%)
STRUCTURAL CONCRETE			
I (Pavement) (b)	3,000 [21]	2 [50]	1 to 6
I (Special) (a)	3,000 [21]	3 [75]	1 to 6
II (a)	3,400 [23]	3 [75] (c)	1 to 6
II (Bridge Deck)	4,500 [31]	3 [75] (c)	1 to 6
III	5,000 [35]	3 [75] (c)	1 to 6
III (Seal)	3,000 [21]	8 [200]	1 to 6
IV	5,500 [38]	3 [75] (c)	1 to 6
IV (Drilled Shaft)	4,000 [28]	8 [200]	0 to 6
V (Special)	6,000 [41]	3 [75] (c) (e)	1 to 5
V	6,500 [45]	3 [75] (c)	1 to 5
VI	8,500 [59]	3 [75] (c)	1 to 5

(a) The Contractor may use concrete meeting the requirements of ASTM C 478 (4,000 psi) [ASTM C 478M (30 MPa)] in lieu of Class I or Class II concrete in precast items manufactured in plants which meet the Department's Standard Operating Procedures for Precast Drainage products. Apply the chloride content limits specified in 346-4.2 to all precast or cast-in-place box culverts.

(b) Ensure that consistency of the concrete is such that the edges of the pavement surface consistently meet the surface requirements in Section 350.

(c) The Engineer may allow higher target slump, not to exceed 7 inches [180 mm], when a high range water reducer is used.

(d) The Engineer may approve a reduction in the target slump for slipformed or prestressed elements.

(e) When the use of microsilica is required as a pozzolan in Class V (Special) concrete, ensure that the concrete does not exceed a permeability of 1,000 coulombs at 28-days when tested per AASHTO T 277. Submit 2, 4-inch [102 mm] diameter by 8 inch [203 mm] length cylindrical test specimens to the Engineer for permeability testing prior to mix design approval. The permeability of the concrete will be taken as the average of two tests. The Engineer may require permeability tests during production.

346-3.2 Drilled Shaft Concrete: When drilled shaft concrete is specified or required in the Contract Documents and is to be placed in any wet shaft, provide concrete in accordance with the following specified slump loss requirements. When concrete is placed in a dry excavation, do not test for slump loss, except where a temporary removable casing is required.

Ensure that drilled shaft concrete has a slump between 7 inches and 9 inches [180 mm and 230 mm] when placed and maintains a slump of 4 inches [100 mm] or more throughout the drilled shaft concrete elapsed time. Ensure that the slump loss is gradual as evidenced by slump loss tests described below. The concrete elapsed time is the sum of the mixing and transit time, the placement time and the time required for removal of any temporary casing that causes or could cause the concrete to flow into the space previously occupied by the temporary casing.

Provide slump loss tests before drilled shaft concrete operations begin, demonstrating that the drilled shaft concrete maintains a slump of at least 4 inches [100 mm] throughout the concrete elapsed time. Inform the Engineer at least 48 hours prior to performing such tests in order to allow arrangements to be made for a Department representative to witness the mixing and testing required. Perform slump loss testing of the drilled shaft mix using a laboratory acceptable to the Engineer. Use a laboratory that (1) has been inspected by the CCRL on a regular basis, with all deficiencies corrected, and under the supervision of a Specialty Engineer, or (2) meets all the requirements of ASTM C 1077.

Perform the following procedures for slump loss tests:

(1) Perform a test for time of setting of concrete mixtures by penetration resistance (FM 1-T 197).

(2) Prepare the mix for the slump loss test at a temperature consistent with the highest ambient and concrete temperatures expected during actual concrete placement. Obtain the Engineer's approval of the test temperature.

(3) Ensure that the mix is at least 3 yd^3 [2.3 m^3] and is mixed in a mixer

truck.

(4) After initial mixing, determine the slump, concrete temperature, ambient temperature and air content. Ensure that the concrete properties are within the required specification limits. Initiate the time of setting test (FM 1-T 197) at this time.

(5) Mix the concrete intermittently for 30 seconds every five minutes at the mixing speed of the mixer.

(6) Determine slump, concrete temperature, ambient temperature and air content at 30 minute intervals until the slump is 2 inches [50 mm] or less. Remix the mix for one minute at the mixing speed of the mixer before these tests are run.

(7) Begin all elapsed times when water is initially introduced into the mix.

(8) Ensure that the concrete maintains a slump of at least 4 inches [100 mm] for the anticipated elapsed time.

(9) Obtain the Engineer's approval of slump loss test results in terms of elapsed time prior to concrete placements.

346-3.3 Mass Concrete: When mass concrete is designated in the Contract Documents, provide an analysis of the anticipated thermal developments in the mass concrete elements for all expected project temperature ranges using the proposed mix design, casting procedures, and materials. Additionally, describe the measures and procedures intended for use to maintain a temperature differential of 35EF [20EC] or less between the interior and exterior portions of the designated mass concrete elements during curing. Submit both the mass concrete mix design and the proposed plan to monitor and control the temperature differential concurrently to the Engineer for approval a minimum of ten working days prior to concrete placement. Provide temperature monitoring devices approved by the Engineer to record temperature development between the interior and exterior portions of the elements at points approved by the Engineer. Read the monitoring devices and record the readings at not greater than 6-hour intervals, as approved by the Engineer, beginning when casting is complete and continuing until the maximum temperature differential is reached and begins dropping. If monitoring indicates the 35EF [20EC] differential has been exceeded, take immediate action to retard further growth in the temperature differential and make the necessary revisions to the approved plan to maintain the 35EF [20EC] or less differential on any remaining placements. Obtain the Engineer's approval of revisions to the approved plan prior to implementation.

346-4 Composition of Concrete.

346-4.1 Master Proportion Table: Proportion the materials used to produce the various classes of concrete in accordance with the following (Table 3):

	TABLE 3	
Class of Concrete	Minimum Total Cementitious Content lb/yd^3 [kg/m^3]	*Maximum Water Cement Ratio lb/lb [kg/kg]

	TABLE 3	
Class of Concrete	Minimum Total Cementitious Content lb/yd^3 [kg/m^3]	*Maximum Water Cement Ratio lb/lb [kg/kg]
I (Pavement)	508 [300]	0.50
I (Special)	508 [300]	0.50
II	564 [335]	0.49
II (Bridge Deck)	611 [365]	0.44
III	611 [365]	0.44
III (Seal)	611 [365]	0.52
IV	658 [390]	0.41
IV (Drilled Shaft)	658 [390]	0.41
V (Special)	752 [445]	0.37**
V	752 [445]	0.37**
VI	752 [445]	0.37

*The Engineer will calculate water cement ratio (W/C) based on the total cementitious material including microsilica, fly ash or slag.
**When the use of microsilica is required as a pozzolan, the Engineer will approve mix designs at a maximum water cement ratio of 0.35.

346-4.2 Chloride Content Limits for Concrete Construction:

346-4.2.1 General: Use the following maximum chloride content limits for the concrete application shown:

Application	Maximum Allowable Chloride Content lb/yd^3 [kg/m^3] Production	Mix Design
Non Reinforced Concrete	N/A	N/A
Reinforced Concrete that does not require Type II cement plus slag or pozzolan(s)	0.70 [0.42]	0.64 [0.38]
All applications that require Type II cement plus pozzolan(s)	0.40 [0.24]	0.34 [0.20]
Prestressed Concrete	0.40 [0.24]	0.34 [0.20]

Determine the chloride content as the average of three tests on samples taken from the concrete. Ensure that the range of results of the three tests does not exceed a chloride content of 0.08 lb/yd^3 [0.05 kg/m^3] of concrete. When test results are outside of the allowable range, run an additional three tests until the test results are within the allowable range. The Contractor may obtain samples from representative concrete cylinders or cores tested for compressive strength. If the cylinders or cores have been exposed to salt or aggressive environment, discard the outer 1 inch [25 mm] surface of the sample.

346-4.2.2 Sampling and Testing: Determine chloride content in accordance with FM 5-516.

(1) For all concrete requiring Type II cement with pozzolan(s) or slag and prestressed concrete, determine the chloride content on a frequency that is in accordance with these Specifications and the following procedures:

(a) When the chloride content is 0.25 lb/yd^3 [0.15 kg/m^3] or less, make subsequent tests on a frequency of not less than one for every four weeks of production as long as the test results remain at or below 0.25 lb/yd^3 [0.15 kg/m^3]. As an exception to the aforementioned testing frequency, when eight consecutive tests show chloride content below 0.25 lb/yd^3 [0.15 kg/m^3], the Engineer may reduce the frequency of testing.

(b) When the chloride content is greater than 0.25 [0.15] and less than or equal to 0.33 lb/yd^3 [0.20 kg/m^3], make subsequent tests at a frequency of not less than one for every two weeks of production, as long as the values remain at or below 0.33 lb/yd^3 [0.20 kg/m^3].

(c) When the chloride content is greater than 0.33 lb/yd^3 [0.20 kg/m^3], make subsequent chloride content tests for each day's production.

(2) For all reinforced concrete other than concrete requiring Type II cement with slag or pozzolan(s) and prestressed concrete, determine the chloride content on a frequency of not less than one test every four weeks. As an exception to the aforementioned testing frequency, when eight consecutive chloride content determinations are below 0.40 lb/yd^3 [0.24 kg/m^3] of concrete, the Engineer may reduce the frequency of testing.

For any case listed above, when the source of any concrete component material, including admixtures, is changed, determine the chloride content immediately.

Test results obtained at the frequency provided above represent the chloride content of all concrete placed subsequent to the preceding test for the determination of chloride content.

346-4.2.3 Certification: Determine the chloride content, and certify the test results of chloride determinations to the Department. Include in the certification all pertinent data required by the Department. The Department will require properly executed certifications showing the chloride content within the required limits for acceptance of all concrete produced in accordance with these Specifications.

346-4.2.4 Control Level for Corrective Action: If the test results indicate that the chloride level is greater than the following limits, suspend concrete production until implementing corrective measures.

(1) Chloride content of 0.65 lb/yd^3 [0.39 kg/m^3] or greater for reinforced concrete that does not require Type II cement plus slag or pozzolan(s).

(2) Chloride content of 0.35 lb/yd^3 [0.21 kg/m^3] or greater for

prestressed concrete and all applications that require Type II cement with slag or pozzolan(s).

The Engineer will reject the concrete exceeding the maximum allowable chloride content limits shown in 346-4.2.1, if an analysis by the Department indicates an unacceptable loss of concrete durability considering the environmental classification of the site.

346-5 Sampling and Testing Methods.

Perform concrete sampling and testing in accordance with the following standard Florida Test Methods:

Description	Method
Slump	FM 1-T 119
Air Content*	
Pressure Type meter	FM 1-T 152
Volumetric Type meter	FM 1-T 196
Chace	FM 1-T 199
Making and Curing Test Cylinders**	FM 1-T 023
Testing Cylinders**	FM 1-T 022
Taking and Testing Drilled Core Samples	FM 1-T 024
Early sampling of fresh concrete from revolving drum truck mixers or agitators	FM 5-501
Low Levels of Chloride in Concrete and Raw Materials	FM 5-516
Yield Test	FM 1-T 121
Temperature	ASTM C 1064
Sampling Fresh Cement Concrete	FM 1-T 141
Time of Setting of Concrete Mixtures by Penetration Resistance	FM 1-T 197

*Use the same type of meter for Quality Control tests as the Department uses for Quality Assurance testing. Where selecting pressure type meters, use an aggregate correction factor determined by the concrete producer for each mix design to be tested. Record and certify test results for correction factors for each type of aggregate at the plant. Use the Chace Air Indicator method for estimates only, and not for acceptance measurements.

**To determine when a precast member or a structure may be put into service, when a prestress force may be transferred, or when forms may be removed, use the results of a strength test which is the average of the compressive strengths of two test cylinders cast from concrete sampled from the LOT representing that member or structure. Cure the cylinders by methods identical to those used in curing the concrete member or structure.

346-6 Control of Quality.

346-6.1 General: Use a concrete plant approved by the Department for all concrete produced for incorporation into the work. Control Concrete production to meet the following criteria:

(1) Ensure that the average of any three consecutive strength test results does not fall below the specified minimum strength.

(2) Ensure that no strength test result falls more than 500 psi [3 MPa] below the specified minimum strength.

If the Contractor fails to meet the above specified criteria, the Department will automatically void plant approval. To obtain plant re-approval, implement corrective actions as approved by the Engineer. The Engineer may allow the Contractor to continue any ongoing concrete placement being supplied from a plant for which approval is voided during the progress of that placement; but the Engineer will not accept concrete from an unapproved plant for any new placement.

If the Department withdraws plant approval during production for a construction project, the Contractor is solely responsible to (a) obtain another approved concrete plant to produce the concrete, or (b) await re-approval of the concrete plant, prior to any further production and placement of concrete on the construction project. The Engineer will not allow changes in Contract Time or completion dates. The Contractor shall bear all delay costs or other costs associated with plant approval or disapproval.

In addition to plant approval, the Contractor and the concrete supplier shall exercise two levels of concrete quality control.

Exercise the first level of quality control in accordance with the approved Level I Quality Control Plan requirements in the Standard Operating Procedures. Include in the Level I Quality Control Plan all control activities for the production of concrete and its transport to the point of delivery at the site.

Exercise the second level of concrete quality control in accordance with the approved Level II Quality Control Plan requirements in the Standard Operating Procedures. Include in the Level II Quality Control Plan the necessary requirements to control the quality of the concrete between the point of delivery at the site and the final placement location, and other requirements contained in the Standard Operating Procedures.

Produce all concrete in accordance with an approved Quality Control Plan (including Level I and Level II) that has been developed and implemented by the Contractor and the concrete supplier in accordance with the Department's Standard Operating Procedures. These procedures require, in addition to a written Quality Control Plan, certified personnel and assurances that materials, plant, production, delivery and use of concrete comply with this Section.

346-6.2 Concrete Design Mix: Furnish concrete in accordance with the following requirements or order the concrete from a plant approved by the Department which has approved mix designs.

Prior to production of any concrete, submit a proposed mix design to the Engineer. Make a separate submittal for each class of concrete and each particular combination of component materials to be used at trial mix temperatures of 70 to

85EF [20 to 30EC], and for hot weather mixes as described in 346-6.2(5) at a minimum temperature of 94EF [35EC]. Use only design mixes approved by the State Materials Office. The approved concrete mix design will remain in effect until a change is authorized in writing by the Engineer.

Include the following with the mix design submittal:

(1) The Department approved source identification number for coarse and fine aggregates, along with the size of coarse aggregate and target Fineness Modulus for fine aggregate. Identify other component materials by manufacturer, brand name, and type.

(2) The actual proportions of raw materials intended to be combined to produce the concrete.

(3) The following mix data:

(a) Historical data from a minimum of 15 consecutive Department acceptance tests of production concrete made in accordance with the proposed mix design that demonstrates that the proposed mix has met all applicable plastic and hardened concrete specification criteria herein without failure. For drilled shaft concrete to be placed in (1) a wet shaft, or (2) a dry shaft requiring a temporary removable casing, provide acceptable slump loss test results. The Engineer will not approve hot weather mixes based on historical data. When required, establish the plant standard deviation and overdesign requirements as described below.

(b) Alternatively, test data from a single trial mix which demonstrates that concrete produced using the proposed mix, designated ingredients and designated water-cement ratio will have a slump within ∀ 0.5 inch [∀15 mm] of the target value (or for mixes utilizing HRWR, within ∀ 1 inch [∀25 mm] of the target value), air content of 2.5% to 5% and strength required to meet an overdesign which is the minimum required strength plus 1.6 standard deviations.

(4) The chloride content of the proposed design mix. The Engineer will not approve mix designs when the chloride content of the trial mix exceeds the limits shown in 346-4.2.1.

(5) For design mixes developed for use under hot weather concreting conditions:

(a) Hold the trial mix prepared at a minimum temperature of 94EF [34EC] in the mixer for 90 minutes after completion of initial mixing. The Engineer will not require extended mixing for precast/prestressed concrete when centrally mixed at the placement site.

On completion of the extended mixing period, ensure that the trial mix concrete has a slump within ∀0.75 inch [∀20 mm] of the target value (∀1 inch [∀25 mm] for mixes utilizing HRWR), and an air content between 2% and 5%.

Ensure that the mix temperature at the end of the extended mixing period is not less than 94EF [35EC].

During the extended mixing period, turn the drum intermittently for 30 seconds every five minutes. Cover the drum with wet burlap or an impermeable cover material during the rest periods.

At the end of the 90-minute period, remix the trial mix for a minimum of one minute and make a slump test to verify that the concrete is within the specified range for slump. If below the target range, the Contractor may adjust the slump by a water addition. After the water addition, remix the concrete for a minimum of two minutes.

The total water used in initial mixing and the final slump adjustment constitutes the design mix water content. Ensure that the total water content does not exceed the maximum water cement ratio of Table 346-3 for the respective class of concrete.

(b) Ensure that the heat of hydration of the cement does not exceed 80 cal/g [335 kJ/kg] at seven days measured as the average of three samples, and that no individual measurement exceeds 90 cal/g [375 kJ/kg].

Where fly ash is 18% or greater or slag is 50% or greater of the total cementitious material, ensue that the heat of hydration of the cement does not exceed 88 cal/g [370 kJ/kg] at seven days measured as the average of three samples, and ensure that no individual measurement exceeds 96 cal/g [400 kJ/kg].

Do not apply these requirements to Type III cement, as allowed in 346-2.2, when used for precast and prestressed superstructures; do not apply these requirements to cements used for steam cured concrete.

(c) Supplement standard curing practices with additional methods, supplies or equipment which further reduce moisture loss from exposed surfaces during the required 72-hour curing period. These methods may include but are not limited to the following examples:

(1) Continuous or intermittent regular water fogging.

(2) Insulated curing blankets approved by the Engineer.

(3) Curing compound applied at a rate of 1.25 times the minimum rate required in 400-16.1.2.

(6) For design mixes proposed for use in wet drilled shafts, demonstrate the additional requirements in 346-3.2.

Ensure that strength test data for establishing the standard deviation of the plant proposed for use represents concrete produced to meet the specified strength of the mix submitted for approval within 1,000 psi [7 MPa]. Ensure that the strength test data represents either a group of at least 30 consecutive tests or a statistical average for two groups totaling 30 or more tests. When the Engineer cannot determine the plant standard deviation from historical data, apply an overdesign requirement, based on a singular trial mix, that is the minimum required strength plus 1,200 psi [8 MPa] for minimum required concrete strengths of 5,000 psi [35 MPa] or less. For minimum required concrete strengths above 5,000 psi [35 MPa], apply an overdesign requirement that is the minimum required strength plus 1,400 psi [10 MPa].

Demonstrate the production and testing of the trial mix concrete in the presence of the Engineer. The Contractor may also demonstrate a proposed mix design at a water-cement ratio exceeding that proposed to meet the slump, air and strength requirements above (but not to exceed the maximum water-cement ratio in Table 3). The Engineer will allow the highest water-cement ratio so demonstrated to provide the required overdesign strength requirements as an adjustment during production to maintain both plastic property and strength requirements of delivered concrete.

Ensure that preparation and testing of the trial mixes is performed by a laboratory acceptable to the Engineer which (1) has been inspected by the CCRL on a regular basis, with all deficiencies corrected, and under the supervision of a Specialty Engineer, or (2) meets all the requirements of ASTM C 1077. The Engineer may give consideration to approval of laboratories operating under other independent inspection programs demonstrated to be equivalent to the programs recognized in (1) and (2) above. Ensure that the 28-day strength (or strength at any other designated age) of trial mixes meets the above stated overdesign requirements to ensure that concrete sampled and tested at the point of placement has a strength exceeding the specified minimum strength in Table 2.

Do not place concretes of different compositions such that the plastic concretes may combine, except where the plans require concrete both with and without microsilica or calcium nitrite in a continuous placement. Produce these concretes using two separate design mixes. Designate the mix with microsilica or calcium nitrite as the original mix, and the mix without microsilica or calcium nitrite as the redesigned mix. Ensure that both mixes contain the same cement, fly ash or slag, coarse and fine aggregates and compatible admixtures. Submit both mixes for approval as separate mix designs, both meeting all requirements of this Section. Ensure that the redesigned mix exhibits plastic and hardened qualities which are additionally approved by the Engineer as suitable for placement with the original mix. The Engineer will approve the redesigned mix for commingling with the original mix and for a specific project application only. Alternately, place a construction joint at the location of the change in concretes.

346-6.3 Delivery Certification: Furnish certification to the Department with each batch of concrete delivered before unloading at the site. Certification shall be in the form of a delivery ticket on which is printed, stamped or written the information required in the Standard Operating Procedures, Attachment E.

346-6.4 Tolerances: Meet the following tolerances from target values for plastic concrete properties specified in 346-3.1:

Property	Tolerance
Slump (Non-Drilled Shaft Concrete)	∀ 1.5 inch [∀40 mm]
Slump (Drilled Shaft Concrete)	∀ 1 inch [∀25 mm]
Air Content	As shown in the range in Table 2

The Engineer will reject concrete with slump exceeding the above tolerances or air content exceeding the ranges in Table 2. The Engineer will not allow concrete to remain in a transporting vehicle to reduce slump. Do not add water to concrete delivered to the site which is within the target range for slump (target value ∀0.75 inch [∀20 mm] for non-drilled shaft concrete and ∀1 inch [∀25 mm] for drilled shaft concrete), except in accordance with the approved Level II Quality Control Plan as allowed in the Standard Operating Procedures.

If the slump of non-drilled shaft concrete varies from the target value in excess of 0.75 inch [20 mm] (1 inch [25 mm] for concrete containing HRWR), immediately adjust the concrete mixture to correct the slump of succeeding batches.

For concrete used in slipforms, make adjustments when the slump exceeds the target value by 0.75 inch [20 mm] or is 1.5 inch [40 mm] below the target value. The Engineer will allow a reasonable time for adjustment, considering trucks already in route from the concrete plant. If the Contractor does not implement adjustments at the earliest possible time, the Engineer will reject the concrete and terminate further production until the Contractor makes corrections.

346-7 Concrete Plant Requirements.

346-7.1 General: Produce concrete at plants that qualify as approved sources in accordance with the Standard Operating Procedures for Quality Control of Concrete.

Use equipment for handling elements, mixing concrete, handling the mixed concrete, transporting and depositing the mixed concrete that has no detrimental effect on the hardened concrete. Do not use equipment with aluminum surfaces in physical contact with the elements of concrete or mixed product.

346-7.2 Measuring Materials:

346-7.2.1 Water: Measure water by volume or weight. Whichever method is used, construct the equipment so that the accuracy of measurement is not affected by variations in pressure in the water supply line. Use a meter or weighing device capable of being set to deliver the required quantity and to automatically cut off the flow when the required quantity has been discharged. Ensure that the measuring equipment has an accuracy, under all operating conditions, within 1% of the quantity of water required for the batch. Verify the accuracy of measuring devices at the request of the Department, or at least quarterly.

The Contractor may exceed design mix water-cement ratios at the job site only if the Engineer has verified each mix to meet the minimum overdesign compressive strength requirements specified herein at the higher water-cement ratio. Adjust the mix consistency at the job site, within the allowable limit for the addition of water, only upon initial arrival of the concrete to the job site, as shown in the Level II Quality Control Plan requirements in the Standard Operating Procedures, and not thereafter.

Adjust the weight of mixing water for a concrete mix containing the corrosion inhibitor admixture calcium nitrite to account for water in the calcium nitrite solution. For each gallon [liter] of calcium nitrite solution added to the concrete, deduct 0.84 gallon [0.84 liter] or 7.0 pounds [3.2 kg] of water from the weight of the mixing water.

346-7.2.2 Admixtures: Measure admixtures by weight or volume. Use measuring equipment that has an accuracy, under all operating conditions, within 3% of the quantity of admixture required for the batch. Measure microsilica slurry to an accuracy of 1%. Ensure that the admixture supplier certifies the accuracy of measuring devices. Measure each admixture separately, and add it to the mixing water in a separate sequence as the mixing water is introduced into the mix.

For the dispensing equipment for a corrosion inhibitor admixture calcium nitrite solution, meet the requirements for measuring water as stated in 346-7.2.1. Store the calcium nitrite solution (neutral set version) in a dark container to protect against photo degradation.

The Engineer may make exceptions to the above method of admixture addition if the Contractor achieves the desired goals of each admixture and does not sacrifice the accuracy of measurement.

346-7.2.3 Cement, Fly Ash, Slag, and Microsilica: Measure cement, fly ash, slag, and microsilica (excluding slurries) by weight within an accuracy of 1% of the required total amount, except that for concrete batches of 3 yd^3 [3 m^3] or less, the Engineer will allow accuracy of 2%. Weigh cement, fly ash, slag and microsilica separately from other materials. When weighing cement, fly ash, slag, and microsilica in a cumulative weigh hopper, weigh the cement first. Measure microsilica slurry as an admixture.

If bag cement is permitted, proportion the batch to use only whole bags.

346-7.2.4 Fine and Coarse Aggregates: Measure aggregates by weight or volume within an accuracy of 1% of the required amount. Apply aggregate surface moisture corrections.

346-7.3 Batching Plants:

346-7.3.1 Bins: Provide bins of adequate capacity for the required concrete production. Support the bins upon a rigid framework founded upon a stable foundation capable of holding them in a safe and secure position. Design each compartment to discharge efficiently and freely into the weigh hopper. Provide positive means of control so that as the quantity desired in the weigh hopper is approached, the material can be added slowly and the addition of further material can be stopped precisely. Use a discharging mechanism that prevents loss of material when it is closed. Construct aggregate storage bins sufficiently tight to prevent leakage of material, and divide them into at least one compartment for the fine aggregate and one compartment for each size of coarse aggregate to be used. Provide compartment partitions that are sufficiently tight and high enough to prevent intermingling of the several materials. Construct leak-proof and moisture-proof cement bins, and provide them with vibrators or other means to aid the flow of cement from the bin.

346-7.3.2 Weigh Hoppers: Provide weigh hoppers consisting of suitable containers freely suspended from scales and protected from the elements so that accuracy is not adversely affected. Equip the hoppers with a discharge mechanism which prevents leakage or loss of material when closed. Vent hoppers to permit air to escape and equip them with vibrators or other equipment that ensures complete and efficient discharge of materials.

346-7.3.3 Scales: Provide either beam type or springless dial type scales, or electronic devices such as load cells, manufactured by a recognized scale manufacturer. Where using beam type scales, provide suitable means to hold poises securely in position after they are set. Keep scales clean and in good operating condition. Where necessary, provide the scale operator with an unobstructed view of all indicating devices and convenient access to all controls. Use graduated weigh beam or dials to permit reading to 0.1% of the capacity of the scales.

Prior to beginning any work, ensure that all scales and other weighing devices used in batching are checked for accuracy by a qualified representative of a scale company registered with the Bureau of Weights and Measures of the Florida Department of Agriculture.

Recheck scales once every three months or more often if deemed necessary by the Engineer. Check scales up to at least the maximum load normally handled on each respective scale.

Maintain cement scales, pozzolan scales, and coarse and fine aggregate scales to an accuracy of 0.5% of the maximum load normally handled.

Affix a certificate of inspection bearing the date of the certification and signed by the scale company representative to each weighing device. Make available at the plant a copy of the scale company's report corresponding with the current certificate of inspection showing the date of inspection, signature of the scale company representative, the observed scale deviations for the loads checked, and a statement that the scale meets the requirements of Chapter 531 of the Florida Statutes pertaining to specifications, tolerances and regulations, as administered by the Bureau of Weights and Measures of the Florida Department of Agriculture.

Calibrate the dispensing equipment for calcium nitrite quarterly.

346-7.4 Mixers:

346-7.4.1 General Requirements: Provide mixers of an approved type that are capable of combining the components of the concrete into a thoroughly mixed and uniform mass, free from balls or lumps of cementitious material, and that are capable of discharging the concrete with a satisfactory degree of uniformity.

346-7.4.2 Design: Use truck mixers of the inclined axis revolving drum type, or concrete plant central mixers of the non-tilting, tilting, vertical shaft or horizontal shaft types.

Make available at the batching plant at all times a copy of the manufacturer's design, showing dimensions and arrangement of blades. The Contractor may use mixers that have been altered from such design in respect to blade design and arrangement, or to drum volume, when recommended by the manufacturer and approved by the Engineer.

Ensure that metal rating plates are attached to each mixer specifying its mixing speed, agitating speed, rated capacity and unit serial number.

346-7.4.3 Truck Mixers: Use truck mixers with a drum that is actuated by a power source independent of the truck engine or by a suitable power take-off. Ensure that either system used provides control of the rotation of the drum within the limits specified on the manufacturer's rating plate, regardless of the speed of the truck. Use truck mixers of the revolving drum type that are equipped with a hatch in the periphery of the drum shell which permits access to the inside of the drum for inspection, cleaning and repair of the blades.

Use truck mixers equipped with revolution counters of an approved type and mounting, by which the number of revolutions of the drum may be readily verified.

Ensure that the water supply system mounted on truck mixers is equipped with a volumetric water gauge or approved water meter in operating condition. Calibrate water measuring devices on truck mixers or other water sources used for concrete water adjustments annually.

Where job site water additions are controlled by a truck mixer volumetric gauge, park truck mixers in a level condition during on-site water adjustments so that the gauge is indicating a specific tank volume before and after the concrete adjustment. When water additions exceed 4 gal/yd^3 [20 L/m^3] of concrete, ensure that the water measuring equipment has an accuracy of within 3% of the indicated quantity.

346-7.4.4 Timers: Use stationary type mixers equipped with an approved timing device which will automatically lock the discharge lever when the drum is charged and release it at the end of the mixing period. In the event of failure of the timing device, the Engineer may allow operations to continue. Do not extend such operations beyond the end of that working day.

346-7.4.5 Cleaning and Maintenance of Mixers: Repair or replace mixer blades of revolving drum type mixers when the radial height of the blade at the point of maximum drum diameter is less than 90% of the design radial height. Repair or adjust mixers of other designs per manufacturer's instructions. Resolve questions of performance through mixer uniformity tests as described in ASTM C 94.

346-7.5 Trucks for Transporting Wet Batches: The Contractor may transport wet batches of concrete in either agitating or nonagitating trucks. Provide nonagitating trucks with bodies that are smooth, mortar tight containers with round internal corners, and capable of discharging the concrete at a satisfactorily controlled rate without segregation. Provide covers for nonagitating trucks for protection from the elements.

346-8 Mixing and Delivering Concrete.

346-8.1 General Requirements: Operate truck mixers at mixing speeds of 6 to 18 rpm and agitating speeds of 2 to 6 rpm (of the drum). Operate concrete plant mixers at speeds per the manufacturer's design or recommendation. Do not allow the volume of material mixed per batch to exceed the manufacturer's rated mixing capacity.

346-8.2 Central Mixing: After all materials are in the mixer, mix the concrete a minimum of two minutes or the manufacturer's recommended minimum, whichever is longer, unless a reduced mixing time is authorized by the Department. Mix concrete containing microsilica in accordance with the microsilica supplier's recommendations.

346-8.3 Transit Mixing: Initially mix each batch between 70 and 100 revolutions of the drum at mixing speed. When water is added at the job site, mix the concrete 30 additional mixing revolutions. When mixing for the purpose of adjusting consistency, do not allow the total number of revolutions at mixing speed to exceed 160. Discharge all concrete from truck mixers before total drum revolutions exceed 300.

Do not haul concrete in mixer trucks loaded with more than the rated capacity shown on their attached plates.

346-8.4 Mixing at the Site: For mixing concrete at the job site, use a mixer of sufficient capacity to prevent delays that may be detrimental to the quality of the work. Ensure that the accuracy of batching equipment is in accordance with requirements of this Section.

346-8.5 Charging the Mixer: Charge each batch into the drum so that some water enters both in advance of and after the cementitious material and aggregates. If using fly ash in the mix, charge it into the drum over approximately the same interval as the cement. Introduce microsilica into the mixer in accordance with the microsilica supplier's recommendations. The Contractor may use other time intervals for the introduction of fly ash into the mix when the Contractor demonstrates, using test requirements specified in ASTM C 94, that he can achieve uniformity of the concrete mix.

For concrete mixes containing the corrosion inhibitor calcium nitrite, charge the batch materials into the mixer in a sequence recommended by the calcium nitrite supplier.

346-8.6 Concreting in Cold Weather: Do not mix concrete when the air temperature is below 45EF [7EC] and falling. The Contractor may mix and place concrete when the air temperature in the shade, and away from artificial heat, is above 40EF [4EC] and rising. Do not heat aggregates or use salts to reduce the freezing temperature. Protect the fresh concrete from freezing until the concrete reaches a minimum compressive strength of 1,500 psi [10 MPa]. Do not apply this requirement where concrete is to be heat cured.

346-8.7 Concreting in Hot Weather: Hot weather concreting is defined as the production, placing and curing of concrete when the concrete temperature at placing exceeds 85EF [30EC] but is less than 100EF [40EC].

Unless the specified hot weather concreting special measures are in effect, including a design mix complying with 346-6.2, the Engineer will reject concrete exceeding 85EF [30EC] at the time of placement. Regardless of special measures taken, the Engineer will reject concrete exceeding 100EF [40EC]. Predict the concrete temperatures at placement time and implement hot weather measures to avoid production shutdown.

When the corrosion inhibitor calcium nitrite is used in a hot weather concrete mix, use a water reducing retardant admixture (Type D) and a high range water reducing admixture (Type F), and place the concrete in the early morning or at night.

346-8.8 Transit Time: Ensure compliance with the following maximum allowable time between the initial introduction of water into the mix and depositing the concrete in place:

Non-Agitator Trucks	Agitator Trucks
45 minutes 75 minutes*	60 minutes 90 minutes*

* When a water reducing and retarding admixture (Type D or Type G) is used.
All time limits are subject to the ability of the Contractor to properly place and consolidate the concrete. When unable to place and consolidate the concrete within the time limits specified above, reduce the time limits to those limits which will result in acceptable placement and consolidation.

346-9 Plastic Concrete Verification Sampling and Testing.

The Department will make initial verification tests on a sample from the initial delivery of each class of concrete to the job site each day to ensure compliance with the requirements in this Section for air content, temperature and slump. Furnish the Engineer sufficient concrete of each design mix as required by the Engineer for verification testing. Do not proceed with the placement operation until the delivered concrete complies with the specified tolerances in this Section for the plastic concrete. The Engineer will reject non-complying loads which cannot be adjusted at the job site in accordance with 346-6.4 and the Standard Operating Procedures. Ensure that corrections are made by the concrete producer on subsequent loads.

After the Contractor begins concrete placement, the Department will make intermediate verification tests, as determined necessary by the Engineer, to ensure compliance with specification requirements for concrete plastic properties. The Engineer will reject non-complying loads which cannot be adjusted at the job site in accordance with 346-6.4 and the Standard Operating Procedures.

If the Engineer obtains an intermediate verification test failure of a load of concrete before any concrete from that load is placed, the Engineer will reject the load. Continue placement operations with the next load that is in compliance with requirements for air content, temperature and slump. The Engineer will not terminate the LOT.

If the Engineer obtains an intermediate verification test failure of a load of concrete that has been partially placed, The Engineer will reject the remainder of that load and terminate the LOT. The Engineer will make acceptance cylinders representing that LOT from the same sample of concrete unless acceptance cylinders have previously been made representing that LOT.

Following termination of a LOT, the Engineer will re-initiate initial verification tests until such time as the air content, temperature and slump comply with specification requirements. The Engineer will initiate a new LOT once the testing indicates compliance with specification requirements.

When three consecutive LOTs, or when five LOTs in two days of production of the same design mix are outside the specified tolerances, suspend production. Make the necessary revisions to concrete operations or the Quality Control Plan to bring the concrete within allowable tolerances. Obtain the Engineer's approval of the revisions prior to resuming production.

346-10 Acceptance Sampling and Testing.

346-10.1 General: The Department will make acceptance testing on samples of the concrete delivered to the job site. Furnish the Engineer sufficient concrete of each design mix as required by the Engineer for acceptance testing.

Furnish and maintain, throughout the required curing period, facilities suitable for curing concrete test cylinders in accordance with the requirements of FM 1-T 023 including power supply, equipment and materials necessary for proper operation.

346-10.2 Sampling Frequency for Acceptance Tests: The Engineer will randomly sample and test concrete for each design mix for air content, temperature, slump and compressive strength in accordance with the following schedules as a minimum. The Engineer will select acceptance samples from each LOT on a random basis to represent the entire LOT of concrete. The Engineer may perform additional sampling and testing to satisfy the Department's Material Sampling, Testing and Reporting Guide requirements. If the Contractor stops concrete placement for more than 90 minutes, the Engineer will initiate a new LOT when the Contractor restarts concrete placement. The Engineer will terminate a LOT when any acceptance test fails.

Class Concrete	Maximum LOT Size

Class Concrete	Maximum LOT Size
I (Pavement)	1 mile [1.5 km] or 2 day=s production, whichever is less
I (Special)	150 yd^3 [125 m^3] or one day=s production, whichever is less
II, II (Bridge Deck), III, IV, IV (Drilled Shaft), V (Special), V, VI	50 yd^3 [40 m^3], or one day=s production, whichever is less
III (Seal)	Each Seal placement

346-10.3 Strength Test Definition: The Department will determine a strength test for a LOT as the average of the compressive strengths of two test cylinders cast from a sample of concrete from the LOT, except that if one test cylinder shows evidence of improper sampling, molding, handling, curing or testing, the Engineer will disregard that cylinder and the Department will determine the compressive strength value for the LOT as the test result of the remaining cylinder.

346-10.4 Acceptance of Hardened Concrete: The Engineer will accept (or reject) hardened concrete on the basis of strength test results as defined in 346-10.3. The Engineer will not discard a cylinder strength test result based on low strength (strength below the specified minimum strength as per the provisions of 346-3 and 346-10). The Engineer will accept at full pay only LOTs of concrete represented by strength test results which equal or exceed the respective specified minimum strength. The Department will obtain strength test results at the frequency specified in 346-10.2.

346-11 Investigation of Low Strength Concrete for Structural Adequacy.

346-11.1 General: When a concrete acceptance strength test result falls more than 10% or 500 psi [3.5 MPa] below the specified minimum strength, whichever is the lesser deviation from the specified minimum strength, and when the Department determines that an investigation is necessary, the Department will make an investigation into the structural adequacy of the LOT of concrete represented by that strength test result.

346-11.2 Determination of Structural Adequacy: When the Department determines a need to investigate structural adequacy, perform a structural analysis as shown in (b) below or take drilled core samples to determine the in-place strength of the LOT of concrete in question. If the Contractor takes cores, both the Contractor and the Department shall accept the core strength test results obtained as the in-place strength of the LOT of concrete in question. These core strength test results will be final and used in lieu of the cylinder strength test results for determination of structural adequacy.

If drilled cores are taken and the core strength test results are less than 10% below the specified minimum strength, and this deviation from the specified minimum strength does not exceed 500 psi [3.5 MPa], consider the concrete represented by the cores structurally adequate. If the core strength test results are more than 10% or 500 psi [3.5 MPa] below the specified minimum strength, whichever is the lesser deviation from the specified minimum strength, the Department will consider the concrete represented by the cores structurally questionable. Then the Contractor may either:

(a) Remove and replace the LOT of concrete in question at no additional expense to the Department, or

(b) Submit a structural analysis performed by a Specialty Engineer. If the results of the analysis, approved by the Department, indicate adequate strength to serve its intended purpose with adequate durability, the Contractor may leave the concrete in place. Otherwise, remove and replace the LOT of concrete in question at no additional expense to the Department.

The Engineer may accept low strength concrete at reduced payment in accordance with the provisions of 346-12.

346-11.3 Coring for Determination of Structural Adequacy: If the Contractor uses core samples from the hardened concrete to determine structural adequacy, the Contractor shall obtain the cores and repair the core holes. Drill the cores at the same approximate locations from which the test cylinder concrete was obtained, as approved by the Engineer. Select the location of the drilled cores so that the structure is not impaired and does not sustain permanent damage after repairing the core holes. When the Contractor supplies drilled core samples, the Engineer will require three undamaged samples. The Engineer will not accept cores taken without Department approval.

346-11.4 Core Conditioning and Testing: If the Contractor provides drilled core samples for determination of structural adequacy, the Department will test the cores in accordance with FM 1-T 024. The Department will immerse the cores in water for at least 40 hours, and test the cores wet.

346-11.5 Core Strength Representing In-Place Concrete Strength: The Department will consider the core strength obtained as the in-place concrete strength for structural determinations of the LOT of concrete in question. The Department will calculate the strength value to be the average of the compressive strengths of the three individual cores. The Department will accept this strength at its actual measured value, as determined by FM 1-T 024.

346-12 Pay Adjustments for Low Strength Concrete.

346-12.1 General: The Engineer may accept any LOT of concrete failing to meet the specified minimum strength as defined in 346-3, 346-10 and 346-11 when the Department determines that the concrete has been adequately consolidated, cured, and satisfactorily meets all other requirements of the Contract Documents, including structural adequacy. The Engineer will individually reduce in price, in accordance with 346-12, any LOT of low strength concrete accepted.

346-12.2 Basis for Pay Adjustments: When a concrete acceptance strength test result falls more than 10% or 500 psi [3.5 MPa] below the specified minimum strength, whichever is the lesser deviation from the specified minimum strength, the Contractor may elect to drill core samples from the respective LOT of concrete represented by the low acceptance strength test result for determining pay adjustments.

When cores are not taken, the Engineer will determine payment reductions based upon the results of strength tests performed on acceptance sample cylinders required in accordance with 346-10.

When the Contractor elects to supply drilled cores and submits acceptable drilled core samples to the Engineer for testing, the Engineer will determine payment reductions based upon the results of strength tests performed on those cores. Both the Contractor and the Department shall accept the results of strength tests of the drilled cores, subject to 346-12.5 and 346-12.6, as final and in lieu of the cylinder strength test results for determining pay adjustments.

Do not core hardened concrete for determining pay adjustments when the 28-day acceptance cylinder strength test results are less than 10% below the specified minimum strength, and this deviation from the specified minimum strength does not exceed 500 psi [3.5 MPa].

346-12.3 Coring for Determination of Pay Adjustments: If the Contractor elects to drill core samples from the hardened concrete for determination of pay adjustments, obtain the cores in accordance with 346-11.3.

346-12.4 Core Conditioning and Testing: If the Contractor elects to provide drilled core samples for determination of pay adjustments, the Department will test the cores in accordance with 346-11.4.

346-12.5 Core Strength Representing Equivalent 28-Day Strength: For cores tested no later than 42 days after the concrete was cast, the Engineer will accept the core strengths obtained as representing the equivalent 28-day strength of the LOT of concrete in question. The Department will calculate the strength value to be the average of the compressive strengths of the three individual cores. The Department will accept this strength at its actual measured value, as determined by FM 1-T 024.

346-12.6 Core Strength Adjustments: For cores tested later than 42 days after the concrete was cast, the Department will establish the equivalency between 28-day strength and strength at ages after 42 days based on test data developed by a Department approved testing laboratory to relate strength at the actual test age to 28-day strength for the particular class of concrete and design mix represented by the cores. Obtain such data at no additional expense to the Department. When such data is not available and cannot be produced, as determined by the Department, the Department will determine the equivalent 28-day strength by adjusting the tested core strengths according to the following relationship:

$$\text{Equivalent 28-Day Strength} = \frac{\text{Average Core Strength X 100}}{F}$$

where:

$F = 4.4 + 39.1 (\ln x) - 3.1 (\ln x)5$ (Type I Cement)

$F = -17.8 + 46.3 (\ln x) - 3.3 (\ln x)5$ (Type II Cement)

$F = 48.5 + 19.4 (\ln x) - 1.4 (\ln x)5$ (Type III Cement)

x = number of days since the concrete was placed

ln = natural log

346-12.7 Calculating Pay Adjustments: The Engineer will determine payment reductions for low strength concrete, accepted by the Department and represented by either cylinder or core strength test results below the specified minimum strength, in accordance with the following:

Reduction in Pay = $0.80/yd ^{3} [$1.05/m^3] for each 10 psi [70 kPa] of strength test value below the specified minimum strength.

The Engineer will denominate low strength concrete paid on a per foot [meter] basis in cubic yards [cubic meters] by multiplying the plan cross-section of the element incorporating the low strength concrete by the full length of that element, or by 150 feet [45 m], whichever is less.

The Engineer will apply a reduction in pay to the entire LOT of concrete represented by the low strength test results except as noted above for concrete paid on a per foot [meter] basis, where the amount might exceed one LOT.

SECTION 347

PORTLAND CEMENT CONCRETE - CLASS I

(NONSTRUCTURAL)

347-1 Description.

The requirements of this Section are applicable to concrete designated as Class I (Nonstructural), hereinafter referred to as concrete. Use concrete composed of a mixture of portland cement, aggregates and water, with or without admixtures, slag, or pozzolanic materials. Deliver the concrete to the site of placement in a freshly mixed, unhardened state.

347-2 Materials.

347-2.1 General: Certify that all materials used in concrete are from Department approved sources, and free from frozen or other detrimental matter.

Meet the following requirements:

(a) Portland Cement...Section 921
(b) Fine Aggregate ....Section 902
(c) Coarse Aggregate...Section 901
(d) Water ....Section 923
(e) Admixtures...Section 924
(f) Slag, Fly Ash and other Pozzolanic Materials....................Section 929

347-2.2 Admixture Requirements: Chemical admixtures may be added at the Contractor=s option at the dosage rates recommended by the manufacturer.

347-2.3 Substitution or Adjustment of Materials: Any approved component material in the design mix may be substituted or adjusted, using a material from an approved source. If unsatisfactory results are obtained with the different material, return to the originally approved material source for supply. Notify the Engineer prior to the substitution.

347-2.4 Material Storage:

347-2.4.1 Cementitious Material Storage: At each concrete production facility, as a minimum, provide a separate and clearly labeled weatherproof facility to store each brand or type of cementitious material without mixing or contamination. Provide a suitable, safe and convenient means of collecting cementitious material samples at each storage facility.

347-2.4.2 Aggregate Storage: At each concrete production facility, as a minimum, provide suitable bins, stockpiles or silos to store and identify aggregates without mixing, segregating or contaminating the different materials in regard to grade or source. Identify Department approved pit number and aggregate type/gradation. Handle the aggregates in a manner to minimize segregation and to recover material from storage for use in the mix in a manner that it will be within Specification limits. Continuously and uniformly sprinkle coarse aggregate with fresh water for 24 hours preceding introduction into the concrete mix. Maintain stored aggregates in a well drained condition to minimize free water content. Provide access for the Engineer to sample the aggregates from the recovery side of the storage facility.

347-3 Production, Mixing and Delivery.

347-3.1 Concrete Production Requirements: Produce concrete utilizing equipment which is in good operating condition and operated in a manner to ensure a consistent product meeting the requirements of the specifications. Within two hours prior to each day=s batching, determine the free moisture for the coarse and fine aggregates. On concrete placements expected to exceed three hours, perform an additional moisture test approximately half way through the batching operations. Adjust batch proportions accordingly. At least quarterly, check all scales, meters and other weighing or measuring devices, excluding admixture dispensers, for accuracy by a qualified representative of a scale company registered with the Bureau of Weights and Measures of the Florida Department of Agriculture prior to production of concrete. Minor adjustments to previously approved mix designs may be made without a new mix design request. Show batch adjustments on the concrete delivery tickets.

347-3.2 Mixers: Use mixers capable of combining the components of concrete into a thoroughly mixed and uniform mass, free from balls or lumps of cementitious material, and capable of discharging the concrete uniformly. Operate concrete mixers at speeds per the manufacturer=s design or recommendation. Do not exceed the manufacturer=s rated capacity for the volume of mixed concrete in the mixer, mixing drum or container.

347-3.3 Delivery: Do not exceed 120 minutes elapsed time between the initial addition of water to the mix and depositing the concrete at the point of final placement, subject to the ability to place and consolidate the concrete in accordance with specification requirements. Make adjustments to mix consistency at the site of placement only before any concrete from the load is placed. Do not make adjustments which will cause the allowable slump or maximum specified water cementitious ratio to be exceeded.

347-4 Control of Quality.

347-4.1 Concrete Mix Design: Prior to production of any concrete, submit a proposed mix design to the Engineer on the "Concrete Mix Design" form attached to the Contract Documents. Use only concrete mix designs having prior approval of the Engineer. The 28-day minimum compressive strength of concrete is 2,500 psi [17 MPa]. The minimum cementitious content of concrete is 470 lb/yd^3 [280 kg/m^3]. The maximum water cementitious ratio for concrete is 0.55 lb/lb [0.55 kg/kg]. The slump range is between 0 and 6 inches [0 and 150 mm]. Meet the theoretical yield requirements of the approved mix design on adjusted mixes. Note batch substitutions or adjustments on the AConcrete Mix Design≅ and ADelivery Ticket / Certification≅ forms. The Department may disqualify any concrete production facility for non-compliance with Specification requirements. The Department may disapprove any mix design which exhibits unacceptable strength or field performance.

347-4.2 Sampling and Testing: Assume responsibility for Quality Control sampling and testing of concrete. Use sampling methods approved by the Engineer. Test at least one representative sample of concrete from each day=s production of each design mix from each production facility. Make a slump test and cast four cylinders, each 6 by 12 inches [150 mm by 300 mm], from each sample. Test two cylinders for compressive strength seven days after casting, and the other two cylinders 28 days after casting. A strength test result will be the average of the compressive strengths of two cylinders cast from the same sample and tested on the same day. Maintain a running average of the latest three consecutive 28-day strength test results. If the average falls below 2,800 psi [19 MPa], test two representative samples of concrete from each day=s production of that design mix from each production facility as described above, until the average is above 2,800 psi [19 MPa]. Perform all sampling, curing and testing in accordance with Florida Methods (FM). Use personnel certified as ACI Field Testing Technician Grade I to perform all sampling and testing of plastic concrete. Use CCRL or CMEC inspected laboratories to perform all laboratory testing, including compressive strength testing of hardened concrete, with all deficiencies corrected. The Engineer may sample the concrete at the production facility or at the point of placement to verify the results of the Contractor=s Quality Control tests. Make the samples of plastic concrete available as determined necessary by the Engineer for testing. Document, certify and submit failing hardened concrete Quality Control test results on a form acceptable to the Engineer upon completion of the individual tests.

347-4.3 Records: Keep all records available for review by the Engineer. Keep the following records at each concrete production facility:

1. Approved concrete mix designs.
2. Materials source / Specification compliance (delivery tickets, certifications, certified mill test reports).
3. A copy of the scale company or testing agency report showing the observed deviations from quantities checked during calibration of the scales and meters. Certification document for the admixture weighing / measuring devices. Calibrate all measuring devices in accordance with Chapter 531, Florida Statutes, at the discretion of the Engineer.
4. Plastic and hardened concrete Quality Control test results.

5. Certifications of Testing Technicians and Testing Laboratories.

347-5 Certification and Acceptance.

Furnish Delivery Certification with each batch of concrete before unloading at the site of placement. Provide Delivery Certification on a delivery ticket on which is printed, stamped or written the information required on the Delivery Ticket/Certification attached to the Contract Documents. Record the actual material quantities incorporated into the mix on the ticket. Have the delivery ticket signed by the Batcher responsible for production of the concrete, certifying that the batch was produced in accordance with specification requirements, and that the running average of 28-day strength test results for that design mix indicate that the concrete delivered for placement should meet minimum 28-day compressive strength requirements. Also, have the Contractor=s representative responsible for handling and placing the concrete sign the delivery ticket certifying that the maximum specified water cement ratio was not exceeded due to any jobsite adjustments to the batch, and that the batch was handled and placed in accordance with specification requirements. Concrete acceptance by the Department will be by Certification to the Department on the delivery ticket, as described herein, by the Batcher and the Contractor, for each batch of concrete produced and incorporated into the work. If concrete produced, supplied, placed and tested in accordance with specification requirements fails to prove satisfactory and adequate to perform its intended purpose, as determined by the Engineer, remove and replace the concrete at no expense to the Department.

SECTION 350

CEMENT CONCRETE PAVEMENT

350-1 Description.

Construct portland cement concrete pavement in one course, on a prepared subgrade. Use either the fixed-form or the slip-form method of construction. When reinforced cement concrete pavement is specified or required, use concrete reinforced with steel bars or steel fabric, in accordance with details shown in the plans.

For aggregates, proportioning and mixing, and other provisions for the production of the concrete, meet the applicable provisions of Section 346.

Provide adequate lighting for all work done at night, including finishing, curing, and sawing joints. Unless lighting is provided for finishing, stop construction operations soon enough each day to permit finishing during daylight.

At least 20 days prior to paving, furnish the following information for the Engineer's review for specification compliance:

1. A detailed sequence and schedule of concrete placement operations including, but not necessarily limited to, width of pavement to be placed, proposed equipment, production rates, working hours, concrete hauling, and placement, curing, sawing, and sealing methods.

2. A detailed staking plan for subgrade controls including offset requirements.

3. A traffic control plan for pavement construction operations which includes provisions for the placement and maintenance of barriers required to protect the pavement from traffic for a minimum of 14 days after concrete placement.

350-2 Materials.

Meet the following requirements:

Concrete, Class I..Section 346
Curing Materials..Section 925
Embedded Items..Section 931
Joint Seal ....Section 932

350-3 Equipment.

350-3.1 General: Obtain the Engineer's approval of the equipment and tools to be used for handling materials and performing all parts of the work, as to their design, capacity, and mechanical condition. Deliver the equipment to the job site sufficiently ahead of the start of construction operations to allow the Engineer to examine it thoroughly for approval.

Provide equipment of such capacity that the paver operates continuously and at a constant rate of production, with starting and stopping held to a minimum.

Equip all equipment which operates on the side forms with scraping devices to clean accumulations from the top of the forms and wheels.

350-3.2 Equipment For Trimming of Subgrade: For equipment operating on the subgrade, provide an automatically controlled subgrade trimmer. Use a machine that is capable of trimming the subgrade to proper elevation within the tolerances established herein. Provide grade controls that operate by sensing from a taut line, set true to line and grade. Erect and maintain the taut line.

350-3.3 Forms:

350-3.3.1 Form Material: Provide steel forms, except that on curves with a radius of 45 m or less, provide flexible forms, or wooden forms that bend to the required arc.

350-3.3.2 Dimensions: Use forms with a minimum length of 10 feet [3 m], except where they are used on curves having a radius between 150 and 300 feet [45 and 90 m], in which case use a form length of 5 feet [1.5 m]. Use forms with a height that is equal to the edge thickness of the pavement. Use forms with a height greater than the edge thickness, provided the outer portion of the slab is thickened to equal the depth of the form by tapering at the rate of 1 inch of the extra thickness per foot [80 mm of the extra thickness per meter] of width. In such case, the Department will make no allowance for additional concrete. Do not use built-up forms.

350-3.3.3 Steel Forms: Use steel forms fabricated into an approved section and sufficiently strong to ensure rigidity under the impact, thrust, and weight of the heaviest equipment to be carried over the forms. Make the width of the base of the forms which is in direct contact with the soil at least equal to the height of the forms, but not less than 8 inches [200 mm]. Extend the flange braces outward on the base not less than two-thirds the height dimension of the form. Use steel forms of a thickness that is not less than 7/32 inch [5.5 mm]. When tested with a 10 foot [3.048 m] straightedge, ensure that the forms have no vertical variation in a 10 foot [3 m] length that is greater than χ inch [3 mm] from a true plane of the surface on the top of the form, and no lateral variation that is greater than 3 inch [6 mm] from a true plane surface on the vertical face of the form. Do not use steel forms if, when tested as a simple beam with a span of 9 feet 6 inches [2.9 m] and a load equal to that exerted by construction equipment placed upon them, the deflection is more than 3 inch [6 mm].

350-3.3.4 Form Connections: Provide connections between adjacent sections of the form, that form a lock joint, free from vertical movement in excess of χ inch [3 mm] and from horizontal movement in excess of 3 inch [6 mm], under the impact, thrust, and weight of the heaviest machine carried on the forms.

350-3.3.5 Defective Forms: Remove bent, twisted, or broken forms, and forms with battered top surfaces, from the work. Do not use repaired forms until they are inspected and approved by the Engineer.

350-3.3.6 Form Stakes: Provide at least three steel stakes for each 10 foot [3 m] length of form. Use stakes that are of sufficient size to prevent undue lateral movement of the form during paving operations. Fasten each of the stakes to the form by means of a suitable socket attached to the form. Equip each stake socket with steel wedges for securely keying the forms to the stakes. Locate a stake not more than 12 inches [300 mm] from the end of each section. Do not use forms with broken or badly worn sockets.

350-3.3.7 Form Tampers: Use adequate mechanical form tampers, capable of thoroughly compacting the soil under the forms, except when the forms rest on a cement-treated subgrade.

350-3.4 Spreader: Provide a mechanical spreader that is independently powered and capable of spreading the mixed concrete on the subgrade over the entire width and depth of the strip being paved in a manner which will prevent segregation of the materials. Use a spreader designed and constructed to permit the concrete to be struck-off to a uniform thickness.

350-3.5 Strike-Off, Consolidation, and Finishing for Fixed-Form Construction: Provide equipment for these operations that consists of a self-propelled unit, or units, that perform the following functions by mechanical means, in the sequence indicated:

(1) Strike-off.
(2) Vibratory Consolidation.
(3) Screeding.
(4) Floating.

Use equipment that is fully and accurately adjustable to produce a pavement meeting project requirements. Use equipment that is equipped with a double screed and is capable of operating in a consistent and smooth manner under all conditions of use.

350-3.6 Slip-Form Paver: Provide a slip-form paver that is self-propelled and equipped to spread, strike-off, consolidate, screed, and float-finish the freshly placed concrete in one complete pass of the equipment, in such a manner that a minimum amount of hand-finishing will be necessary to provide a dense and homogeneous pavement. Ensure that all of this equipment is of such dimensions and arrangement as to cover the full width of the pavement strip being laid. Use equipment that is adjustable as to crown and superelevation and that can shape and compact the concrete into a dense and stable mass, to the required cross-section. Ensure that the crown adjustment is readily controllable for accuracy in crown transitions.

Operate the paver on tracks having sufficient contact area to prevent track slippage under load. Ensure that the length of ground contact per track and the arrangement of tracks are adequate to meet the straightedge and other riding-quality requirements specified.

Accomplish screeding by either: (1) oscillating screeds, (2) an extrusion device, or (3) a combination of both.

If necessary, in order to produce a pavement of the required cross-section and meeting the surface requirements, equip the slip-form paver with traveling side forms of sufficient dimension and strength and of proper shape to support the concrete laterally for a sufficient length of time during placing and finishing.

If using trailing forms, provide forms that are rigidly supported laterally.

Equip the slip-form paver with automatic guidance and grade controls which operate by sensing from a taut line set true to line and grade. Erect and maintain the taut line.

Do not use automatic grade controls on the paver when the tracks of the slip-form paver are operating on econocrete base or previously placed concrete pavement. The Engineer may waive the use of automatic grade controls on the paver when the entire width of the tracks of the slip-form paver are operating on a subgrade which has been consistently trimmed to a tolerance of χ inch [3 mm] above or below true grade as established by the taut line set for that purpose.

The Engineer may allow variation from any specific feature of the slip-form paver as detailed above, provided the industry has generally accepted the proposed variation as an improved feature.

350-3.7 Vibratory Units: Consolidate the concrete for the full width of the strip being placed with either surface pan type or internal type vibrators.

For the surface vibrators, use a frequency of not less than 3,500 impulses per minute. For internal type vibrators, use a frequency of not less than 5,000 impulses per minute for tube vibrators and not less than 7,000 impulses per minute for spud vibrators. When using spud-type internal vibrators adjacent to forms, either hand-operated or attached to spreaders or finishing machines, use a frequency of not less than 3,500 impulses per minute. Measure the frequency of internal vibrators in plastic concrete. Mount spud vibrators such that the free tip trails, and space spud vibrators at a maximum interval of 30 inches [0.75 m].

Provide an amplitude of vibration with spud vibrators that is sufficient for the vibration to be perceptible on the surface of the concrete along the entire width of the strip being placed. Furnish a device for measuring and indicating the actual frequency of vibrations. Control all vibration by the forward movement of the spreader or finishing machine so that vibration automatically ceases when stopping the forward movement of the spreader.

350-3.8 Mechanical Floating Equipment: Provide equipment that consists of a supplementary self-propelled machine capable of further smoothing the concrete, removing excess mortar from the surface, and minimizing hand finishing.

Use a machine that leaves the surface of the concrete true to grade and crown and free of irregularities. If the Engineer permits adding water to assist the finishing operations, apply water as a fog spray by means of approved spray equipment.

350-3.9 Device for Application of Membrane Curing Compound: Provide equipment for applying membrane curing compound that is self-propelled and capable of uniformly applying the curing compound at the specified rate. Use equipment that continuously stirs the curing compound, by effective mechanical means, and that thoroughly atomizes the curing compound during the spraying operation so that the finished surface of the fresh concrete will not be marred. Cover the entire surface of the pavement and, with slip-form type paving, the vertical faces by a single pass of the machine. Only use spray nozzles that are equipped with appropriate wind guards to ensure uniform application.

The Contractor may use hand power-spray equipment to apply curing compound to areas where it is impracticable to operate the self-propelled equipment.

350-3.10 Equipment for Sealing Joints: Provide equipment for sealing the joints for each section of pavement. Use a heating kettle for hot-poured sealer that is of the indirect heating or double-boiler type, using oil as a heat transfer medium. Use a heating kettle that has a thermostatically controlled heat source, a built-in automatic agitator, and thermometers installed to indicate both the temperature of the melted sealing material and that of the oil bath. Use pouring equipment equipped with nozzles that discharge the seal at the bottom of the groove. Ensure that the apparatus develops sufficient pressure to extrude the joint sealer from the nozzles satisfactorily and to control the rate of application so as to completely fill the joint to within 3 inch [6 mm] of the surface of the pavement without spillage. Use an apparatus so constructed that it maintains the proper temperature of the sealing material for pouring, within 10EF [5EC].

350-3.11 Equipment for Paving Small or Narrow Areas: For variable width areas, other than mainline, ramps, and shoulders, the Engineer will not require the full paving train as specified for the standard run of paving. The Contractor may use such equipment as the Engineer may approve for such areas.

350-3.12 Hand Finishing Tools: Provide straightedges that have a blade length of 10 feet [3.048 m]. Use long-handled floats that have flat blades, approximately 4 feet [1.2 m] long by 5 to 8 inches [125 to 200 mm] wide, and that are designed so as to remain straight and true. Use a handle for both types of tool with a length that exceeds 2 the width of the strip being placed by 3 feet [1 m].

350-3.13 Texturing Machine: Provide a machine that consists of a supplementary machine capable of applying the final finish to the concrete pavement. Apply the finish by rectangular shaped spring steel tines rigidly mounted in a frame operating on an adjustable track mounted under the main frame of the machine. Use a machine that is constructed so as to provide for adjustment of the downward pressure on the tines as necessary to produce the desired finish under varying conditions of the concrete surface.

The Engineer may allow variation from any specific feature of the Texturing Machine as detailed above, provided that the Contractor can produce an equivalent final finish.

350-4 Subgrade Preparation.

Keep construction of the subgrade completed for a distance of at least 500 feet [150 m] ahead of the paving operation. Maintain the finished subgrade in a smooth, compact condition, and restore any areas which are disturbed prior to placing the concrete. Do not place concrete on a frozen subgrade.

Ensure that the subgrade is moist while placing the concrete. Uniformly apply water ahead of the paving operations, as directed by the Engineer.

Do not allow vehicles to travel on the prepared subgrade between the subgrade trimming machine and the paving operations unless specifically authorized.

Accurately trim the subgrade to the required elevation. Trim high areas to proper elevation. Fill low areas with suitable material, compacted to the specified density, or with concrete placed integrally with the pavement. When slip-form paving, include in the width to be trimmed the areas on which the tracks of the paver will operate.

Remove material planed from the subgrade before placing any concrete. The Engineer may waive the use of the planer for small or isolated areas or any areas where its use would be impracticable.

350-5 Setting Forms.

350-5.1 General: Accurately set the forms to line and grade and such that they rest firmly, throughout their entire length, upon the subgrade surface. Join forms neatly and tightly, and brace them to resist the pressure of the equipment operating on the forms. Obtain the Engineer's approval of the alignment and grade of all forms before and immediately prior to the placing of concrete.

Fill any subgrade that is below the established grade at the form line to grade with granular material, in lifts of 2 inch [13 mm] or less, for a distance of 18 inches [0.5 m] on each side of the pavement edge, and thoroughly compact the material. As an exception, when placing forms on a cement-treated subgrade, the Contractor may use wedging, provided that the wedging system used adequately supports the forms without causing detrimental deflection under the weight of the paving equipment.

350-5.2 Tamping: When placing forms on other than a cement-treated subgrade, adequately tamp the materials below and adjacent to the forms with form-tamping machines.

350-5.3 Advance Preparation of Forms: Keep sufficient forms on hand at all times, and set forms so that at least 500 feet [150 m] of forms on each side of the roadway will be accurately set, and maintained true to line and grade, in advance of the point where concrete is being placed. Provide sufficient forms so that it is not necessary to remove them in less than 12 hours after placing the concrete.

350-5.4 Cleaning and Oiling Forms: Thoroughly clean and oil the forms after each use and before placing concrete against them.

350-6 Protection from Weather.

Have available at the site, at all times when concrete paving operations are underway, materials for the protection of the surface and edges of the unhardened concrete. For the protection of the pavement edges, use any covering material, such as burlap, paper, or plastic sheeting material, suitable for the protection of the pavement surface.

When rain appears imminent, stop all paving operations, and have all available personnel cover the surface of the unhardened concrete with the protective covering.

During periods when the air temperature may fall below 35EF [1EC], advise the Engineer of plans for curing and protecting the fresh concrete before placing the concrete. Do not place any concrete until the Engineer has approved the proposed methods.

The Contractor is fully responsible for the quality and strength of the concrete placed in cold weather even if the Engineer approves of the provisions the Contractor employs for protecting the concrete placed during cold weather.

350-7 Placement of Reinforcement.

350-7.1 General: Where the plans call for reinforced concrete pavement, place the steel reinforcement in the pavement slab in accordance with the details shown in the plans.

Secure the reinforcement in position in advance of concrete placement or, with the Engineer's specific approval, place it in the plastic concrete by mechanical or vibratory means after spreading the concrete. At the time of the concrete placement, ensure that the reinforcing steel is free from dirt, oil, paint, grease, mill scale, and any loose or thick rust which could impair bonding of the steel with the concrete. Place the reinforcement as provided below.

350-7.2 Fabric: Place fabric reinforcement at right angles to the centerline of the pavement and accurately to the position and location shown in the plans. Lap adjacent sheets of fabric not less than 6 inches [150 mm]. Make the laps only in the longitudinal members.

350-7.3 Bars: Place bar reinforcement as shown in the plans. Securely wire together transverse and longitudinal bars at their intersections. Lap splices not less than 20 times the nominal diameter of the bar, and only in the longitudinal members.

350-8 Placing Concrete.

350-8.1 Distribution: Distribute the concrete on the subgrade to such depth that, when it is consolidated and finished, the slab thickness required by the plans will be obtained at all points and the surface will at no point be below the grade specified for the finished surface, after application of the allowable tolerance. Deposit the concrete on the subgrade in a manner which will require as little rehandling as possible. Continuously place concrete between transverse joints without using intermediate bulkheads.

Deposit concrete as near to expansion and contraction joint assemblies as possible without disturbing them. Do not dump concrete from the discharge bucket or hopper onto an assembly without centering the bucket or hopper directly over the assembly.

350-8.2 Use of Spreader: Place concrete on the subgrade by an approved spreading device. The Engineer will not require the Contractor to use a spreader for areas where the width of slab varies, for intersections, and for small or isolated areas where it would be impractical to use a spreader. Perform the necessary hand spreading with shovels (not with rakes). Ensure that workmen do not walk in the freshly deposited concrete with earth or other deleterious substances coated on their boots or shoes.

350-8.3 Placement Widths: The Contractor may construct the pavement either in lanes as determined by the longitudinal joints shown in the plans, or for the full width in one operation. Construct the pavement to the full width of the lane or slab in a single construction operation. When constructing pavement in separate lanes, do not deviate the junction line from the true line shown on the plans by more than 2 inch [13 mm] at any point. Tool the edges of the junction to the radius shown in the plans.

When constructing pavement in separate lanes, place the lanes adjacent to the low edge of the pavement, as shown on the typical section, first. The Engineer will not require the Contractor to alter placement operations where superelevation reverses the pavement cross slope from that shown on the typical section.

350-8.4 Hours of Operation: Stop placing concrete in time to complete finishing operations during daylight hours, or provide adequate approved lighting.

350-8.5 Consolidation Along Forms and Joints: Thoroughly consolidate concrete against and along the faces of all forms, and along the full length on both sides of all joint assemblies, by means of hand-operated, spud-type vibrators. Do not allow vibrators to come in contact with a joint assembly, the subgrade or a side form. Do not continue vibration at any one location so long as to produce puddling or the accumulation of excessive grout on the surface.

350-9 Slip-Form Paver.

When placing concrete with a slip-form paver, operate the paver with a continuous forward movement. If for any reason it is necessary to stop the forward movement of the paver, immediately stop operation of the vibrating or tamping elements. Do not apply tractive force to the paving machine except that which is controlled from the machine.

In case of an emergency, have available for use at the project site at least 100 feet [30 m] of forms.

Do not insert steel tie-bars into the unsupported side of the freshly formed slab. The Contractor may place tie-bars into position prior to extrusion from the paver by insertion through the forms, by insertion through a temporary support form placed against the form slab, or by other means approved by the Engineer. Use a method that results in placement of the tie-bars at the specified locations with no damage or disruption of the concrete.

350-10 Striking-off, Consolidating, and Finishing Concrete.

350-10.1 General Requirements: Immediately after placing the concrete, strike-off, consolidate, and finish it to produce a finished pavement in accordance with the cross-section, width, and surface finish required by the Contract Documents. Perform the sequence of operations as follows: strike-off; vibratory consolidation; screeding; floating; removal of laitance; straightedging; and final surface finish. Except as specified, perform strike-off, consolidation, screeding, and floating by the machine method.

350-10.2 Machine Method: Operate the machine over each area of pavement as few times and at such intervals as is necessary to give proper consolidation and to leave a surface of uniform texture. Avoid excessive operation over a particular area.

Perform strike-off, consolidation, and finishing in a manner such as to avoid damage to, or misalignment of, joint assemblies, reinforcing steel, dowels, and other embedded items.

350-10.3 Hand Methods:

350-10.3.1 Conditions under which Allowed: The Contractor may use hand methods in areas of narrow width or irregular dimensions, where operation of mechanical equipment is impracticable. In the event that mechanical equipment breaks down, the Contractor may use hand methods to finish only that concrete already deposited on the subgrade when the breakdown occurred.

350-10.3.2 Strike-off and Screeding: Use a portable screed of an approved design, constructed either of metal or of other suitable material shod with metal, to strike-off and screed the concrete. Use a screed that is sufficiently rigid to retain its shape and is at least 2 feet [0.6 m] longer than the maximum width of the strip to be screeded.

In operation, move the screed forward on the forms with a combined longitudinal and transverse shearing motion, moving always in the direction in which the work is progressing, and manipulate it so that neither end is raised from the side forms during the striking-off process. If necessary, repeat this until the surface is of uniform texture, true to grade and cross-section, and free from porous areas.

350-10.3.3 Consolidation: Use hand-operated spud-type vibrators to consolidate.

350-10.3.4 Floating: Use long-handled floats to float the concrete. Take the necessary care to avoid creating depressions or ridges during this operation.

350-10.4 Work Bridges: Provide work bridges or other devices necessary for access to the pavement surface for the purpose of inspection, finishing, straightedging, and performing corrective work.

350-11 Supplemental Floating.

In areas where performing machine strike-off, consolidation, and finishing, further smooth the surface of the concrete and remove the excess mortar from the surface. Carry a small amount of mortar ahead of the float device as it moves on the surface of the concrete. Operate the machine over the surface of the concrete as many times as required to obtain an acceptable surface, meeting the requirements specified herein. Waste excess mortar beyond the edge of the slab.

350-12 Final Finish.

350-12.1 Finishing: As the water sheen disappears from the surface of the pavement and just before the concrete achieves its initial set, drag a seamless length of damp burlap that extends the full width of the strip of the constructed pavement, longitudinally along the surface to produce a uniform gritty texture.

Use a burlap drag that consists of two layers of medium weight burlap with the trailing edge of the lower layer extending approximately 2 inches [50 mm] behind the upper layer. Support the burlap drag in a manner so that a length of at least 3 feet [1 m] of burlap is in contact with the pavement.

Except in areas where using hand methods to construct the pavement, support the lead end of the burlap drag by a traveling bridge. Maintain the drag clean and free from encrusted mortar. Replace the burlap with new material as necessary.

After applying the burlap drag finish, apply the final finish with the texturing machine. Control the time of applying this finish and the method of operating the texturing machine so as to minimize tearing of surface and unseating of aggregate particles.

Provide a final finish that consists of transverse grooves which are 0.08 to 0.12 inch [2 to 3 mm] in width and 0.10 to 0.15 inch [2.5 to 4 mm] in depth, spaced at random intervals between 2 to 1 inch [13 to 25 mm]. Operate the texturing machine in a manner that minimizes the overlapping of subsequent passes of the steel comb. Create short gaps in the grooved finish as necessary to avoid overlap between passes.

In areas of irregular dimensions or narrow widths, where operating the texturing machine is impracticable, the Contractor may apply the finish by approved hand methods that achieve the required finish with a minimum of surface tearing and unseating aggregate particles. Ensure that the surface resulting from this operation is uniform in appearance and free of irregular, rough, or porous areas.

350-12.2 Edging: After applying the final finish, but before the concrete has become nonplastic, carefully round the edges to a 3 inch [6 mm] radius on each side of transverse expansion joints and construction joints and along any structure extending into the pavement. Produce a well-defined and continuous radius, and obtain a smooth, dense mortar finish. Completely remove all concrete from the top of the joint filler.

Check all joints with a straightedge before the concrete has become nonplastic, and, if one side of the joint is higher than the other or the entire joint is higher or lower than the adjacent slabs, make corrections as necessary.

350-13 Curing.

350-13.1 General: After completing the finishing operations and as soon as the concrete has hardened sufficiently to not mar the surface, cover and cure the entire surface and, when the slip-form method is used, the edges of the newly placed concrete in accordance with one or more of the methods described below. In all cases in which curing requires the use of water, ensure that curing has prior right to use all water supplies. If the Contractor fails to provide sufficient curing materials to adequately cure the concrete in place in a timely manner, the Engineer will order an immediate suspension of concreting operations. Do not leave the concrete exposed for a period in excess of 30 minutes between stages of curing or during the curing period.

Continuously cure the freshly placed concrete for a period of 72 hours, exclusive of any periods when the temperature of the surface of the concrete falls below 50EF [10EC].

350-13.2 White-Pigmented Curing Compound: Under this method, uniformly apply white-pigmented curing compound to the surfaces to be cured, in a single coat, continuous film, at the minimum rate of 0.005 gal/ft^2 [0.2 L/m^2], by a mechanical sprayer.

At the time of use, thoroughly mix the compound until the pigment is uniformly dispersed throughout the vehicle.

Do not apply curing compound during periods of rainfall. Do not apply curing compound to the inside faces of joints to be sealed. Should the film become damaged from any cause within the required curing period, repair the damaged portions immediately with additional compound. If using side forms, upon their removal, immediately coat the sides of the slabs exposed to provide a curing treatment equal to that provided for the surface.

350-13.3 Burlap Mats: Under this method, cover the surfaces to be cured with burlap mats. Thoroughly saturate the mats with water before placing them. Use mats of such dimensions that as laid they extend to at least 2 feet [0.6 m] beyond the edges of the strip of concrete placed. Place and weigh down the mats so as to cause them to remain in intimate contact with the surface being cured, throughout the curing period. Maintain the mats fully moist and in position for the entire portion of the required burlap curing period.

350-13.4 Removal of Forms: Do not remove forms from freshly placed concrete until it has set for at least 12 hours. Remove forms carefully so as to avoid damage to the pavement. After removing the forms, immediately cure the sides of the slab in the same manner as the surface of the pavement.

350-14 Surface Requirements.

After curing, remove the curing material (except for the impervious coating), and thoroughly test the surface for pavement surface smoothness in accordance with 352-4(c). Plainly mark all variations from the required tolerances. Where pavement surfaces do not meet the smoothness requirements, the Engineer will require corrective work and retesting to ensure conformity.

Eliminate high spots exceeding χ inch in 10 feet [3.2 mm in 3 m], but not in excess of 0.3 inch in 25 feet [7.6 mm in 7.6 m], by grinding either with an approved machine or with a carborundum brick and water. Do not use bush-hammering or other destructive means for removing irregularities. As directed by the Engineer, retexture corrected high areas to give skid resistance comparable to the surrounding area.

Provide grinding equipment with a power driven self-propelled machine that is specifically designed to grind portland cement concrete pavement, with a minimum of a 3 foot [1 m] wide grinding head and diamond impregnated grinding blades. Produce, by grinding, a pavement surface that is true to grade and uniform in appearance with a longitudinal line type texture. Provide a line type texture that contains parallel longitudinal corrugations that present a narrow ridge corduroy type appearance. Ensure that the peaks of ridges are approximately 1/32 inch [0.8 mm] higher than the bottoms of the grooves with approximately 60 evenly spaced grooves per foot [300 mm].

Operate all milling, cutting, or grinding equipment to produce a reasonably uniform finished surface without spalling the pavement joints within corrected areas. The Engineer will not require extra grinding to eliminate minor depressions in order to provide 100% texturing of the pavement surface. Maintain the cross slope of the pavement as shown in the plans. Repair all joint seals destroyed by grinding at no expense to the Department.

Remove and replace any area of pavement which, after grinding, still shows a deviation in excess of the allowable tolerance. Ensure that the area removed and replaced is the full length between transverse joints and the full width of the lane involved.

Saw the area to be removed to a smooth vertical surface. Clean the face of the adjacent (hardened) concrete, and coat it with an epoxy bonding compound before placing the replacement concrete.

Bear the costs of all surface corrections required and of all required removal and replacement of defective surface concrete.

350-15 Joints.

350-15.1 General: Construct joints at the locations and in accordance with the details shown in the Roadway and Traffic Design Standards, Index No. 305 and the Contract Documents.

350-15.2 Longitudinal Joints:

350-15.2.1 Longitudinal Construction Joints: Where the pavement is poured in strips less than the full width of the pavement, construct longitudinal construction joints in accordance with the details shown in the plans. Where keyways are required, the Contractor may form them by placing an insert of the proper shape along the inside face of the side form or, when using the slip form method of paving, by an approved extrusion device. Use a method that produces a keyway of the shape and at the location indicated in the plans.

350-15.2.2 Longitudinal Lane-tie Joints: Construct longitudinal lane-tie joints within the limits of a strip of pavement, in accordance with the details shown in the plans. Construct the plane of weakness by sawing a groove in the hardened concrete. Complete sawing within 72 hours after placing the concrete.

350-15.2.3 Tie Bars and Bolt Assemblies: Place deformed steel tie bars or tie bolt assemblies at the required depth, parallel to the finished surface, at right angles to the joint and at the uniform spacing specified or required in the plans. Place them in the plastic concrete using approved equipment, or rigidly support them on the subgrade by approved devices capable of preventing displacement prior to placing of the concrete. Do not paint or coat the bars with any material before placing them in the concrete.

If placing tie bars along a longitudinal construction joint using the method of inserting bars with a 90 degree bend in the edge of the plastic concrete and after the concrete hardens straightening these bars, use Grade 40 [Grade 300] reinforcing steel for such tie bars. Replace any bar broken while being straightened in an approved manner.

350-15.2.4 Longitudinal Shoulder Joints (Concrete to Asphalt): Construct a continuous joint by sawing a groove into the asphalt pavement at the abutment with the concrete pavement. Produce a groove that is : inch [19 mm] wide and : inch [19 mm] deep, after sawing and cleaning.

Seal the joint with hot-poured type sealant.

350-15.3 Transverse Joints:

350-15.3.1 Transverse Construction Joints: Construct transverse construction joints at the end of all pours and at other locations where the paving operations are stopped for as long as 30 minutes. Do not place construction joints, however, within 10 feet [3 m] of any other transverse joint or within 10 feet [3 m] of either end of a section of pavement. If sufficient concrete has not been placed to form a slab at least 10 feet [3 m] long, remove the excess concrete, back to the last preceding joint. Form the joints by placing a wood or metal bulkhead accurately and securely in place, in a plane perpendicular to the profile and centerline of the pavement. Install dowel bars at the construction joints. Saw or form construction joints, in a manner similar to contraction joints, so that a groove will be formed for holding the joint sealing compound.

350-15.3.2 Transverse Contraction Joints: Construct transverse contraction joints at the interval indicated in the plans consisting of planes of weakness created by sawing a groove in the surface of the hardened concrete. Place the groove perpendicular to the surface of the pavement. Install load-transfer devices in transverse contraction joints.

Ensure that the sawing equipment does not damage the pavement, and saw the transverse contraction joints as soon as the pavement has hardened to the degree that tearing and raveling are not excessive and before uncontrolled shrinkage cracking begins.

Accomplish the joint sawing in two steps. Make the initial cut χ inch [3 mm] wide by a depth at least α of the pavement thickness, and in general when the concrete is between 4 and 12 hours old. Make a second saw cut, to provide the joint dimensions indicated in the plans, as soon as there is no danger of further raveling.

In cases where a strip of pavement is being placed immediately adjacent to a previously constructed strip of pavement, construct transverse contraction joints using extreme care to time sawing so as to prevent uncontrolled cracks.

Repair any uncontrolled cracks at no expense to the Department by removing and replacing the pavement across the full width of all affected lanes or shoulders and to the nearest transverse joint in each direction.

After the final sawing, clean the joint, install the bond breaker, and seal the joint.

350-15.3.3 Transverse Expansion Joints: Form transverse expansion joints using preformed joint filler, and provide them with dowel load transfer, in accordance with the details shown on the Roadway and Traffic Design Standards, or in the plans.

Form the joints during the placing of the concrete, by securely staking a metal bulkhead accurately in place at the joint location or by other methods which will securely brace and support the joint filler. Where using approved devices to keep the expansion joint filler and dowels securely in place, the Engineer will not require a bulkhead. Protect all transverse expansion joints at the bottom and side edges by a sheet metal strip as specified in 931-2.1 and as shown on the Roadway and Traffic Design Standards.

Cut the filler to the crown and shape of the slab cross-section and extended it to the subgrade. After installation, ensure that the top is not less than 1 inch [25 mm], and not more than 1.25 inches [30 mm], below the finished surface. Furnish the joint filler in lengths not less than the lane widths being poured, except that the Engineer will not require lengths greater than 12 feet [3.5 m]. Where more than one section is allowed and used in a joint, securely lace or clip the sections together.

Place the filler normal to the pavement surface. Stake the assembly into position in such a way as to hold the assembly securely in position throughout construction. Ensure that the assembly is true to the line prescribed, subject to a tolerance of 3 inch [6 mm] in the width of the slab. Obtain the Engineer's approval of the assembly and its installation before placing any concrete against it. Obtain the Engineer's approval of the cross-section and length of the stakes.

When laying the pavement in partial width slabs, place transverse joints in the succeeding slab in line with the like joints in the first slab. In the case of widening existing pavement, place transverse joints in line with like joints in the existing pavement or as otherwise shown in the plans.

350-15.4 Load-Transfer Devices: Provide dowel load-transfer devices in all transverse joints. Firmly hold dowel bars in a position parallel to the surface and the centerline of the slab, by approved steel supports and spacers of a type shown in the plans. The Engineer may approve the use of dowel bar supports or assemblies other than those specifically detailed in the plans. Allow the dowels to be free to move in one slab as the concrete contracts and expands. Paint the free end of each dowel with one coat of approved zinc rich paint (listed on the Qualified Products List), and grease it with an approved lubricant, to prevent the concrete from bonding to the dowel. Provide the free end of expansion joint dowels with the closest fitting metal cap or sleeve, equipped with a stop to prevent closing during placement operations. Maintain a clearance of 1 inch [25 mm] between the closed end of the cap and the dowel to accommodate future slab movement.

Position each dowel such that its final deviation from parallel to the surface of the pavement and parallel to the longitudinal centerline of the pavement does not exceed 2 inch [13 mm]. Position each dowel such that its final deviation from being centered on the joint does not exceed 2 inches [50 mm]. Position each dowel such that at no point in its length does it deviate from the surface of the pavement as shown in the plans in excess of 1 inch [25 mm].

Provide the Engineer with confirmation of the location of the dowel bars. The Contractor shall confirm that the paving operation has not displaced the dowels from their required positions. Perform confirmation checks daily for the first two days of the paving operation and weekly thereafter.

350-15.5 Expansion Joints Around Structures: Form expansion joints by placing premolded expansion joint material about all structures and features projecting through, into or against the pavement. Ensure that such joints are 2 inch [13 mm] in width.

350-15.6 Cleaning Joints and Cracks:

350-15.6.1 Cleaning Joints in New Pavement:

350-15.6.1.1 Sawed Joints: Immediately after sawing the joints which require sealing, completely remove the resulting slurry from the joint and the immediate area by flushing with a jet of water under pressure and by using other tools as necessary.

After flushing, blow out the joints with compressed air. After the flushed joints have dried, sandblast the joint faces to thoroughly remove all foreign material. Perform sandblasting in two passes, once for each face.

Patch all spalled edges with an epoxy compound.

Immediately prior to joint seal installation, clean the joints using compressed air to remove all traces of debris and dust within and on the joint surfaces.

350-15.6.1.2 Non-Sawed Joints: Thoroughly clean joints which require sealing of all foreign material for the full depth of the seal installation.

With the exception of slurry removal due to sawing, meet the cleaning requirements as specified for sawed joints.

350-15.6.2 Cleaning Joints in Existing Pavement: Remove all existing joint-sealing material and foreign material for the full depth of the new joint seal by sawing, wire brushing, sandblasting, or other methods approved by the Engineer.

Remove any existing sealant or parting strip material below the tape or backer rod bond breaker and replace it with additional bond breaker. When conditions require removal and replacement with additional bond breaker below the new joint seal, obtain the Engineer's approval of the type of bond breaker and its installation procedure. Perform cleaning by any method or combination of methods, as detailed in the plans.

Flush the joint with a pressurized jet of water, and use other tools as necessary, to remove loose remnants and debris.

After flushing, blow out the joints with compressed air. After the flushed joints have dried, sandblast the joint faces to thoroughly remove all foreign material. Perform sandblasting in two passes, once for each face.

Patch all spalled edges with an epoxy compound.

Immediately prior to joint seal installation, clean the joints using compressed air to remove all traces of debris and dust within and on the joint surfaces.

350-15.6.3 Cleaning Random Cracks in Existing Pavement: Do not begin cleaning random cracks in existing pavement until all other concrete pavement repairs have progressed to the point where those operations will not adversely affect the installation of the new seal.

Cut the random cracks to be repaired and sealed into grooved joints to the depth and width detailed in the plans. Clean the joints as specified in 350-15.6.2.

350-15.7 Sealing Joints and Cracks: Seal joints in new pavement before allowing any traffic or construction equipment on the pavement. Complete sealing within 72 hours (weather permitting) of sawing.

When using silicone and non-silicone sealants in the transverse and longitudinal joints, respectively, always use the silicone sealants first to prevent contamination at the intersection of the joint faces. Remove non-silicone sealant 1 foot [300 mm] in each direction from the transverse joints, and replace it with silicone sealant.

350-15.7.1 Hot-Poured Type Sealant: When the plans require hot poured sealant for specific joints, fill the joint thoroughly, without trapping air, ensuring the sealant is recessed below the pavement surface as required, and control the pouring rate to avoid spilling of sealant onto the adjacent pavement surface. If any spilling of sealant occurs, immediately remove and clean the entire surplus amount from the pavement surface. Place poured material when the ambient air temperature is 50EF [10EC] or greater.

350-15.7.2 Low Modulus Silicone Sealant: Use low modulus silicone sealant of either Type A (non-self-leveling silicone sealant), or Type B and/or Type C (self-leveling silicone sealant). Because Type A will not flow into the proper shape under its own weight, install and tool it so that the sealant is in firm contact with the joint faces and is formed into the appropriate shape as specified. Types B and C will normally flow into the proper shape without tooling. Exercise care to provide the required depth of recess above the sealant surface and below the pavement surface. Install the silicone sealant at temperatures above 40EF [5EC].

350-16 Thickness Determinations.

350-16.1 Core Borings: After completing the concrete pavement, including any corrective work to meet ride requirement, drill cores from the pavement to determine the actual thickness. When the Department is ready to core the finished pavement for thickness, provide traffic control, coring equipment, and operator to obtain the cores. The Engineer will select the coring locations and make the acceptance measurements. Take borings at random intervals and at various points on the cross-section so that each test boring represents an area not exceeding 2,500 yd^2 [2,000 m^2].

Replace the portions of the pavement removed by the borings at no expense to the Department.

350-16.2 Method of Calculating Average Thickness: The Department will determine the average thickness of pavement from the length of all cores taken as indicated above and will calculate it as follows:

(a) The Department will not take into account in the calculation any areas of pavement which are left in place, but for which no payment will be made.

(b) When the thickness as measured by the cores is more than 2 inch [13 mm] greater than the specified thickness, the Department will consider it in the calculation as the specified thickness plus 2 inch [13 mm].

(c) The Department will calculate the average thickness for the entire job as a unit.

350-17 Deficient Thickness.

350-17.1 General: The Department will not pay for any pavement which is more than 2 inch [13 mm] less than the specified thickness. When the pavement contains no longitudinal construction joint, the Department will not pay for the area of such pavement that is the product of the full width of the strip placed as a unit times the sum of the distances each way from the short core or cores to the cores on each side which show measurements within the tolerance limits. When the pavement contains longitudinal construction joints, for the width, the Department will use the width between longitudinal construction joint and the edge of pavement.

350-17.2 Deficient Pavement Requiring Removal: The Engineer will evaluate areas of pavement found deficient in thickness by more than 2 inch [13 mm] and if, in his judgment, the deficient area is sufficient to seriously impair the anticipated service life of the pavement, the Contractor shall remove such areas and replace them with concrete of the thickness shown in the plans. The Department will not pay for the area of pavement removed or for the materials or labor involved in its removal. When removing a section of pavement, remove the full length between transverse joints.

350-17.3 Deficient Pavement Left in Place: If the Engineer determines that the deficiency will not seriously impair the anticipated service life of the pavement, the

Contractor may elect to leave the pavement in place, but shall receive no compensation for the area of pavement.

350-17.4 Additional Borings: If the Contractor believes that the number of cores taken is not sufficient to indicate the thickness of the pavement, he may request that the Engineer select additional boring locations. The Department will deduct the cost of these additional borings from any sums due the Contractor, unless such borings indicate that the pavement within the questioned area is of specified or greater thickness.

350-18 Opening Pavement to Traffic.

Except as provided below, keep the pavement closed to traffic for a minimum period (exclusive of days when surface temperature of the concrete falls below 50EF [10EC]) of 14 calendar days after placement of the concrete. As an exception to the above, when Type III cement is used, the Engineer will reduce this minimum required period to 48 hours. The Engineer may permit opening of a section of pavement to traffic at an earlier time provided that representative test beams, made in accordance with AASHTO T 23 and tested in accordance with AASHTO T 97, indicate a flexural strength of at least 550 psi [3.75 MPa]. Cure these test beams in a manner identical to the corresponding section of pavement.

Protect the pavement from all traffic, including construction operations, until the specified period of time has elapsed. Provide protection that includes the erection and maintenance of signs, lights, barricades, etc., the construction and removal of temporary pavement, bridges, crossovers, etc., and the use of flagmen as may be necessary. Arrange the protective measures so as not to interfere with traffic in lanes being utilized for required maintenance of traffic.

Before opening the pavement to traffic, construct an earth berm along each edge. Build the berm to the full height of the pavement and at least 18 inches [0.5 m] wide, and sufficiently compact it to prevent underwash of the pavement. Maintain the berm until completing the final shoulders.

350-19 Method of Measurement.

350-19.1 Concrete Pavement: The quantities to be paid for will be the plan quantity, in square yards [square meters], of Plain Cement Concrete Pavement and of Reinforced Cement Concrete Pavement, omitting any areas not allowed for payment under the provisions of 350-17.3 and adjusted for average thickness as provided herein.

For purposes of payment, the average thickness of pavement will determine the final pay quantities for this pavement as follows:

The area of pavement represented by the difference between the calculated average thickness and the specified thickness will be converted into equivalent square yards [square meters] of specified thickness pavement, and the quantity thereby obtained will be added to, or deducted from, the quantity of pavement to be paid for, subject to the limitation that the maximum average of over-thickness permitted in the adjustment of the quantity of pavement to be paid for will be 3 inch [6 mm].

Where the plans call for cement concrete pavement that is to be covered with asphaltic concrete surface course, payment will be made for the total thickness of the combination as Plain Cement Concrete Pavement.

In such cases, price and payment will also include all costs of the asphaltic concrete surface course constructed in accordance with Section 331.

Reinforcing steel, placed and accepted, will be measured and paid for as provided in Section 415.

350-19.2 Joints and Cracks: The Contractor shall include the cost for Cleaning and Sealing Joints in the cost of the newly constructed pavement for: (1) transverse and longitudinal joint construction for new pavement; and (2) abutting joints between existing pavement and new pavement.

For replacing joint seals and sealing random cracks in existing portland cement concrete pavement, the quantity to be paid for will be as specified below:

(a) The length of pavement joint that have been satisfactorily cleaned and sealed in existing portland cement concrete pavement, as determined by field measurement along the joints, will be paid for at the Contract unit price per foot [per meter] for Cleaning and Resealing Joints.

(b) The length of random cracks in existing portland cement concrete pavement that have been satisfactorily cut, cleaned, and sealed, as determined by field measurement along the joints, will be paid for at the Contract unit price per foot [per meter] for Cleaning and Sealing Random Cracks.

350-20 Basis of Payment.

Prices and payments will be full compensation for all work specified in this Section, including any preparation of the subgrade not included in the work to be paid for under another Contract item; all transverse and longitudinal joint construction, including tie-bars and dowel bars; the furnishing of test specimens; repair of core holes; and all incidentals necessary to complete the work.

Payment will be made under:

Item No. 350- 1-	Plain Cement Concrete Pavement - per square yard.
Item No. 2350- 1-	Plain Cement Concrete Pavement - per square meter.
Item No. 350- 2-	Reinforced Cement Concrete Pavement - per square yard.
Item No. 2350- 2-	Reinforced Cement Concrete Pavement - per square meter.
Item No. 350-72-	Cleaning and Resealing Joints - per foot.
Item No. 2350-72-	Cleaning and Resealing Joints - per meter.
Item No. 350-78-	Cleaning and Sealing Random Cracks - per foot.
Item No. 2350-78-	Cleaning and Sealing Random Cracks - per meter.

SECTION 351

COLORING CONCRETE PAVEMENT SURFACES

351-1 Description.

Color the surfaces of the concrete pavement at the locations and within the limits shown in the plans. Use an iron oxide pigment or two coats of permanent black stain, or apply a mortar topping of colored concrete to the freshly placed pavement.

351-2 Materials.

(a) Use iron oxide pigment meeting the requirements of Section 927.

(b) Use permanent black stain of a good grade of commercial black stain, which provides a lasting color to the surface of the concrete, and which is approved by the Engineer for this use.

(c) For the iron oxide mixture, use water meeting the requirements of Section 923.

(d) For the mortar topping (for use in the alternate method specified in 351-4), use a good commercial grade of concrete coloring material approved by the Engineer for this use.

351-3 Construction Methods.

351-3.1 Iron Oxide Pigment: Apply the iron oxide pigment on the newly finished concrete as soon as job conditions permit, but in no event later than four hours after placing the concrete. Apply the iron oxide pigment dry, and then lightly sprinkle it with water or, if the Engineer so orders, apply it in the form of a stiff paste, made by mixing water with the powder. Use a cloth mop or brush for applying the paste.

Apply the coloring pigment at a rate of 5 to 6 lbs of dry powder per 100 ft^2 [2.5 to 3.0 kg of dry powder per 10 m^2] of concrete surface to be colored. The Engineer will designate the exact amount between these limits.

Work the oxide into the surface of the fresh concrete by using wooden floats, steel trowels, stiff bristle brushes, or other approved methods, to ensure a penetration of χ to 3 inch [3 to 6 mm] over the entire surface to be colored. The Contractor may use a wooden float, with nails driven through it and protruding approximately 3 inch [6 mm] on the finishing side, to ensure the required penetration. After mixing the coloring material well with the concrete, finish the surface smooth.

During the operations of placing and embedding the coloring material, use approved forms or other satisfactory methods to produce a neat, true edge and to prevent the adjacent surface from being stained or colored.

351-3.2 Applying Black Stain: Stain the areas to be colored with two coats of black permanent concrete stain, and apply a single finish or top coat over the stain.

Apply the permanent black stain at the rate of approximately 2 gallon of staining solution per 200 ft^2 [1 L of staining solution per 10 m^2] and, for the finish coat, approximately one gallon per 250 ft^2 [1.5 L per 10 m^2].

Do not apply the coloring until the concrete has aged for a period of at least 21 days.

351-4 Alternate Construction Methods.

In lieu of using the methods described above, the Contractor may meet the requirements of this Section by applying a mortar topping of colored concrete to the freshly placed pavement. The Engineer will designate the proportions of the mortar. Add the quantity of pigment to the mortar mix that is, as determined in the field, necessary to give the mix a deep blue-black color. Add pigment to the mix while adding the other solid ingredients.

Strike-off and consolidate the concrete pavement in accordance with Section 350, to an elevation 2 inch [13 mm] below finish grade. Apply the mortar topping within 30 minutes of the placing of the concrete pavement and while the pavement concrete is still fresh, so that no lamination results. After spreading the topping, straightedge and finish it as specified for concrete pavement in Section 350.

351-5 Basis of Payment.

The work specified will not be paid for directly but will be considered as subsidiary work pertaining to the items of concrete work on which the coloring material is applied.

SECTION 352

GRINDING CONCRETE PAVEMENT

352-1 Description.

Grind existing portland cement concrete pavement to substantially eliminate joint faulting and to restore proper drainage, riding characteristics, and skid resistance to the pavement surface.

352-2 Equipment.

Provide a power driven self-propelled machine that is specifically designed to grind portland cement concrete pavement with diamond-impregnated grinding blades. Provide, operate, and maintain in working condition sufficient equipment to ensure performance of the work in the allotted time. Use equipment of the size, shape, and dimensions that does not restrict the movement of traffic in areas outside the designated limits of construction. Use equipment that is capable of grinding specified surfaces without causing spalls at cracks, joints, or other locations.

352-3 Construction Methods.

Grind the areas of existing pavement surfaces designated on the plans. Do not grind bridge decks and roadway shoulders unless indicated on the plans or required to promote drainage.

Schedule and proceed with the construction operation in a manner that produces a uniform finished surface. Accomplish grinding in a manner that eliminates joint or crack faults while providing positive lateral drainage by maintaining a constant cross-slope between grinding extremities in each lane. Transition auxiliary or ramp lane grinding as required from the mainline edge to provide positive drainage and an acceptable riding surface.

Grind the entire area designated by the plans parallel to the centerline until the pavement surfaces of adjacent sides of transverse joints and cracks are in the same plane. Grind the concrete pavement to eliminate the faulting at joints and cracks, maintain the overall roughness within the limits specified, and texture the majority of the pavement surface. The Engineer will not require extra grinding to eliminate minor depressions in order to provide texturing for 100% of the pavement surface, but the Contractor shall ensure that minor depressions are not excessive. Grind sufficiently to avoid having excessive minor depressions. Continue grinding if accumulated total area of minor depressions exceed 30% of the total area of a 0.1 mile [0.1-km] section or if directed by the Engineer. Maintain the cross slope of the pavement as shown in the plans.

Establish and obtain the Engineer's approval of a means to continuously remove grinding residue.

Remove solid residue from pavement surfaces before traffic action or wind blows such residue. Do not allow residue to flow across lanes or shoulders used by public traffic or into gutters or other drainage facilities. However, in rural construction, the Contractor may disperse residue onto the adjacent grassed slopes where the residue runoff can percolate into the soil. Do not allow the discharge of any residue runoff into adjacent rivers, streams, lakes, ponds, or other open bodies of water.

352-4 Final Surface Finish.

Use a grinding process that produces a pavement surface that is true to grade and uniform in appearance with a longitudinal line type texture. Provide a line type texture that contains parallel longitudinal corrugations that present a narrow ridge corduroy type appearance. Provide a surface finish with the peaks of the ridges approximately 1/32 inch [1 mm] higher than the bottoms of the grooves and with approximately 60 evenly spaced grooves per foot [200 per meter].

Produce ground areas that are neat rectangular areas of uniform surface appearance having a constant lateral offset from the nearest parallel lane line or pavement edge and beginning and ending at lines perpendicular to the pavement centerline.

Test the pavement surface for pavement surface smoothness by either a 10 foot [3.048 m] long straightedge, a 10 foot [3.048 m] long rolling straightedge, or a California Type Profilograph (as specified below). For pavement surfaces not meeting the smoothness requirements, the Engineer will require corrective work and retesting to ensure conformity.

(a) Testing with a 10 foot [3.048 m] straightedge: Use this straightedge for longitudinal profiling, parallel to centerline, within 15 feet [4.5 m] of a bridge approach or existing pavement which is being joined. In addition, use it for all transverse profiling of cross slopes, approaches, and as otherwise directed with respect to (b) or (c) below.

Provide and operate the 10 foot [3.048 m] straightedge. When cement concrete pavement abuts bridge approaches or pavement not under this Contract, ensure that the longitudinal slope deviations of the finished pavement do not exceed χ inch [3 mm].

Produce transverse slope deviations of the finished pavement that do not exceed χ inch [3 mm] with the straightedge laid in a direction perpendicular to the centerline.

(b) Testing with a 10 foot [3.048 m] rolling straightedge: Use this straightedge for longitudinal profiling of short sections of mainline pavement lanes up to 250 feet [75 m] long, pavements (mainline or non-mainline) on horizontal curves having a centerline radius of curve less than 1,000 feet [300 m] and the pavement within the superelevation transition of such curves, turn lanes, ramps, tapers, and other non-mainline pavements as directed.

Furnish and operate the straightedge. Provide a 10 foot [3.048 m] rolling straightedge of a design acceptable to the Engineer, able to accurately measure surface irregularities exceeding χ inch [3 mm] in a 10 foot [3.048 m] effective length of the straightedge.

When tested with the straightedge, ensure that the finished pavement profile provides a uniform surface having no deviation greater than χ inch [3 mm]. Perform the profiling in lines parallel to the centerline, at not more than 4 foot [1.2 m] centers, and extending across the transverse joints.

The Contractor may confine checking through traffic lanes with the straightedge to joints and obvious irregularities as directed.

(c) Testing With A California Type Profilograph:

1. General: Use the profilograph on all longitudinal profiling of mainline full width pavement lanes longer than 250 feet [75 m] and as otherwise directed.

The following terms are defined:

a. Profilograph: a longitudinal profile testing apparatus used to measure a pavement's surface deviations.

b. Profile Trace: a line followed along the pavement's surface by a profile testing apparatus such as a profilograph.

c. Profilogram: a record (printed report) of an individual profile trace, a graphic chart of the measurements of a pavement's surface deviations.

d. Profile Index (PI): Ainches per mile [millimeters per kilometers] in excess of the 0.2 inch [5 mm] blanking band (as shown on a profilogram)" but is simply called a Profile Index.

e. Blanking Band: the 0.2 inch [5 mm] wide scale on a profilogram not considered when calculating a Profile Index.

2. Equipment: Furnish, calibrate, and operate a California Type Profilograph device as described below.

Operate the profilograph while the Engineer observes the operations. The Engineer will confirm that the Contractor is in compliance with Florida Method of Test for a California Type Profilograph (Electronic Model), Designation: FM 5-558.

The California Profilograph (Electronic Model) is specified due to its ability to perform computerized data analysis, and is manufactured by Cox and Sons, Inc. of Colfax, California - Model CS 8200 or better.

3. Surface Test: Produce a riding surface having a Profile Index meeting the requirements herein. Start and terminate the profile 15 feet [4.5 m] from each bridge approach or existing pavement which is being joined.

Take at least two pavement profile traces. Locate the position of the profiles in the traffic wheel paths. Take the profiles parallel to and approximately 3 feet [1 m] from the outside edges of each traffic lane. The Contractor may take additional profiles to define the limits of an out-of-tolerance surface variation.

Upon completion of each day's testing, submit the profilograms to the Engineer for review for determining which sections meet or do not meet these requirements. The Engineer will retain those profilograms meeting these requirements. The Engineer will return profilograms with deficiencies or provide copies (when the profilograms may be referred to frequently) to the Contractor for his use in correcting section deficiencies. The Engineer will retain the corrected profilograms, along with the deficient profilograms, for comparison purposes of the circumstances between the two profilograms.

Ensure that pavement so tested meets the following Profile Index requirements and is applicable to the profilogram for each profile trace run:

a. Ensure that pavement on tangent alignment and horizontal curves having a centerline radius of curve 2,000 feet [600 m] or more has a Profile Index of 7 inches per mile [110 mm/km] or less.

b. Ensure that pavement on horizontal curves having a centerline radius of curve 1,000 feet [300 m] or more but less than 2,000 feet [600 m] and pavement within the superelevation transition of such curves has a Profile Index of 9 inches per mile [142 mm/km] or less.

c. In addition to the above Profile Index requirements, paragraphs (1) and (2), ensure that the pavement riding surfaces have all deviations in excess of 0.3 inch [7.5 mm] in 25 feet [7.5 m] removed.

The Engineer will evaluate the pavement in 0.1 mile [0.1 km] consecutive sections. Grind all areas represented by individual high points having deviations in excess of 0.3 inch [7.5 mm] in 25 feet [7.5 m] or less until such points do not exceed 0.3 inch [7.5 mm].

After removing all individual deviations in excess of 0.3 inch [7.5 mm] in 25 feet [7.5 m], perform additional grinding as necessary to reduce the Profile Index to the requirements specified.

Do not perform pavement surface smoothness testing with a California Type Profilograph on bridges. Ensure that the pavement within 15 feet [4.5 m] of a bridge approach (or existing pavement which is being joined) complies with the testing requirements of a 10 foot [3.048 m] straightedge.

Visually inspect transverse joints and random cracks to ensure that the adjacent surfaces are in the same plane. Where misalignment of the planes of the surfaces on adjacent sides of the joints or cracks is in excess of 1/16 inch [1.5 mm], grind the pavement until the surfaces are flush.

352-5 Method of Measurement.

The quantity to be paid for will be the area, in square yards [square meters], completed and accepted.

352-6 Basis of Payment.

Price and payment will be full compensation for all work and materials specified in this Section, including furnishing all labor, materials, tools, equipment, testing, and incidentals and for doing all work involved in grinding the existing surface, removing residue, and cleaning the pavement, including necessary disposal of residue and furnishing any water or air used in cleaning the pavement.

Contract Unit Price adjustments will be made in accordance with the following schedule(s).

Non SI Units

Average Profile Index (inches/mile) per 0.1 mile Section		Contract Unit Price Adjustments
PI = 7 inches/mile	PI = 9 inches/mile	Percent of Pavement Unit Bid Price
PI # 3	PI # 5	103
3 < PI # 4	5 < PI # 6	102
4 < PI # 5	6 < PI # 7	101
5 < PI # 6	7 < PI # 8	100
6 < PI # 7	8 < PI # 9	99
PI = 7	PI = 9	98
PI > 7	PI > 9	Corrective work required

SI Units

Average Profile Index (mm/km) per 0.1 km Section		Contract Unit Price Adjustments
PI = 110 mm/km	PI = 140 mm/km	Percent of Pavement Unit Bid Price
PI # 45	PI # 80	103
45 < PI # 60	80 < PI # 95	102
60 < PI # 80	95 < PI # 110	101
80 < PI # 95	110 < PI # 125	100
95 < PI # 110	125 < PI # 140	99
PI = 110	PI = 140	98
PI > 110	PI > 140	Corrective work required

Pay (Price) Adjustments for Incentives/Disincentives will be based on the initial measured average Profile Index, prior to any corrective work.

The Unit Bid Adjusted Price will be computed using the planned thickness of cement concrete pavement. This Unit Bid Price will apply to the total area of the 0.1 mile [0.1-km] section for the lane width represented by the profilograms for the average Profile the average Profile Index.

Payment will be made under:

Item No. 352- 70- Grinding Concrete Pavement - per square yard.
Item No. 2352- 70- Grinding Concrete Pavement - per square meter.

SECTION 370

BRIDGE APPROACH EXPANSION JOINTS

370-1 Description.

Construct special expansion joints for concrete pavement near the bridge approach slabs that consist of a section of reinforced concrete subslab supporting the roadway concrete pavement, with a portion of the roadway pavement over the subslab interrupted by a galvanized sheet metal strip.

370-2 Materials.

Bar Reinforcement: Use bar reinforcing steel meeting the requirements of 931-1.1.

Concrete: For the expansion joint subslab, use Class I (Nonstructural) concrete meeting the requirements of Section 347.

Galvanized Sheet Metal: Use galvanized sheet metal meeting the requirements shown in the plans.

370-3 Construction Methods.

Construct the expansion joints in accordance with the applicable requirements of Sections 346, 347, 350, and 415 and as directed by the Engineer.

370-4 Method of Measurement.

The quantity to be paid for will be plan quantity, in feet [meters], calculated across the pavement at right angles to the centerline of the roadway pavement, completed and accepted.

370-5 Basis of Payment.

Price and payment will be full compensation for all work and materials specified in this Section or required for the expansion joint, including concrete subslab, sheet metal strip, reinforcing steel, and all additional excavation required.

Payment will be made under:

Item No. 370- 1- Bridge Approach Expansion Joint - per foot.
Item No. 2370- 1- Bridge Approach Expansion Joint - per meter.

STRUCTURES

SECTION 400

CONCRETE STRUCTURES

400-1 Description.

Construct concrete structures and other concrete members, with the exception of pavement and incidental concrete construction (which are specified in other Sections).

Refer to Section 450 for prestressed construction requirements additional to the requirements of this Section.

For precast concrete structures incorporating Microsilica, meet the requirements of Section 450 for finishing, curing, storage, shipping and erection.

400-2 Materials.

Meet the following requirements:

Concrete	Sections 346 and 347
Reinforcing Steel	Section 415
Curing Materials	*Section 925
Epoxy Bonding Compounds	Section 926
Joint Materials	Section 932
Bearing Pads	932-2
Self-Lubricating Bearing Plates	964-2
Copper Water Stops	964-4
Water	Section 923

* The Engineer will allow clean sand and sawdust for certain curing, when and as specified.

400-3 Depth of Footing.

Consider the elevations of the bottoms of footings, as shown in the plans, as approximate only. The Engineer may change dimensions or elevations of footings as necessary to secure a satisfactory foundation. If the elevation of a footing as shown in the plans is changed to a higher or lower elevation, the Engineer will not consider such change as a material change to the original Contract Documents, a waiver of any condition of the Contract, or an invalidation of any of the provisions of the Contract. If the excavation must be carried deeper than shown in the plans to obtain a satisfactory foundation, the Engineer will revise the plans in accordance with one of the following methods:

(a) The Engineer will keep the top of the footing at the elevation shown in the original plans and will increase the thickness to obtain a satisfactory foundation. The Engineer will follow this method when the change in bottom elevation of the footing is 12 inches [300 mm] or less. When this method is followed, place the reinforcing steel the same as if the footings, as shown in the original plans, were placed on a subfooting of plain concrete; make no alteration in the position of the reinforcing bars relative to the top of the footing.

(b) The Engineer will revise the plans and lower the footing, thereby increasing the height of stem, to obtain a satisfactory foundation. Generally, the Engineer will increase the thickness and width of footing over that shown in the original plans. If this method is followed, use the dimensions, sizes, and location of reinforcing steel shown in the revised plans. The Engineer will follow this method when the change in elevation of the bottom of footing exceeds 12 inches [300 mm].

The Engineer will determine which of the above methods to use.

400-4 Falsework.

400-4.1 Plans: At the Engineer's request, furnish detailed plans for falsework or centering to the Department. The Contractor is responsible for results obtained by using these plans.

400-4.2 Design and Erection: Design and construct all falsework to provide the necessary rigidity and to support the loads without appreciable settlement or deformation. Use screw jacks or hardwood wedges to take up any settlement in the framework, either before or during the placing of concrete. If any weakness develops and the centering shows undue settlement or distortion, stop the work, remove any masonry affected, and strengthen the falsework before resuming work. Support falsework which cannot be founded on a satisfactory footing on piling. Space, drive, and remove the piling in an approved manner.

400-4.3 Camber: Provide camber to correct for settlement and deflection of falsework. Give bridges permanent camber only when shown in the plans.

400-5 Forms.

400-5.1 General: Provide forms, either of wood or metal, that are as follows: (a) externally secured and braced where feasible; (b) substantial and unyielding; (c) of adequate strength to contain the concrete without bulging between supports and without apparent deviation from the neat lines, contours, and shapes shown in the plans. Design forms to withstand the additional forces of vibration without apparent deviation from the desired shape or position. Assemble forms to be mortartight. If using lumber forms, construct them of dressed wood of uniform thickness. Use form liners on wooden forms where Class 3 surface finish is specified. Construct assembled forms to render a concrete surface of smooth, uniform finish. Make provisions to remove forms without injury to concrete surfaces. Remove blocks and bracing with the forms, and do not leave any portion of the forms in the concrete. Use the same form system for a type of work throughout.

400-5.2 Inspection and Approval: Do not place concrete in a form until the form has been inspected and approved. Although the Engineer inspects and approves the forms, the Contractor is responsible for obtaining satisfactory concrete surfaces, free from warping, bulging, or other objectionable defects. Pay special attention to the ties and bracing. Where the forms appear to be insufficiently braced or unsatisfactorily built, stop and correct defects to the satisfaction of the Engineer.

400-5.3 Non-metallic Form Materials:

400-5.3.1 Lumber: For all surfaces, use lumber that is not less than : inch [19 mm] in thickness, dressed, and free of knot holes, loose knots, cracks, splits, warps, and other defects. Proportion the spacing of studs, joists, and wales to exclude warps and bulges and to produce true and accurate concrete surfaces. Only use structurally sound lumber.

400-5.3.2 Form Liners: Use form liners of durable, abrasion resistant materials that are unaffected by water. Use liners with a hard surface texture capable of rendering concrete surfaces of a smooth, uniform texture, without grain marks, patterns, or blemishes. Use form liner material of sufficient thickness to eliminate the reflection of irregularities, undesirable patterns, and marks from the forms to the surfaces. Replace liners as necessary to produce a consistent concrete surface texture. Use form liners in large sheets and with true, tight-fitted joints which are logically located. Obtain the Engineer's approval of the layout of sheets. Do not use liners which have been patched. Use liner material of the same stock throughout.

400-5.3.3 Plywood: The Contractor may use plywood of not less than ε inch [15.9 mm] in thickness manufactured with waterproof glue or protected with an approved impervious coating. Do not use pieces with bulged plies or ravelled, untrue edges.

400-5.4 Special Requirements:

400-5.4.1 Re-entrant Angles: Use chamfered forms for re-entrant angles, and use filleted forms for corners. Use chamfers and fillets that are : by : inch [19 by 19 mm] and are mill-dressed on all sides to uniform dimensions. The Contractor may use plastic or metal chamfers and fillets provided they perform satisfactorily in producing uniform, smooth concrete corner surfaces without honeycomb.

400-5.4.2 Handrails and Parapets: For a portion of handrail or parapet cast in place, carefully secure smooth and tight-fitting forms that can be held to line and grade and that can be removed without injury to the concrete. Use only moldings, panel work, and bevel strips that are straight and true, with neatly mitered joints, and provide corners in the finished work that are true, sharp, and clean-cut. Recheck the alignment of forms and the grade of top chamfer strips immediately after placing concrete in the forms.

400-5.4.3 End-bent Caps: Do not place forms for end-bent caps until the embankment has been constructed to within 12 inches [300 mm] of the bottom of the cap. Place a mass of embankment that is sufficient to produce the subsidence, displacement, and settlement which may result from the construction of the total embankment.

400-5.4.4 Footings: Where footing concrete can be placed in dry excavation, the Contractor may omit cribs, cofferdams, and forms, subject to compliance with the following limitations and conditions:

(a) Use this procedure only in locations not exposed to view from traveled roadways.

(b) Obtain required elevations shown in the plans.

(c) Obtain neat line dimensions shown in the plans.

(d) Fill the entire excavation with concrete to the required elevation of the top of the footing.

(e) The Engineer will determine the volume of footing concrete to be paid for from the neat line dimensions shown in the plans.

400-5.5 Form Alignment, Bracing, and Ties: Construct forms in such manner that they may be adequately secured for alignment, shape, and grade. Use bracing systems, ties, and anchorages that are substantial and sufficient to ensure against apparent deviation from shape, alignment, and grade. Do not drive nails into existing concrete. Do not use bracing systems, ties, and anchorages which unnecessarily deface or mark, or have an injurious or undesirable effect on surfaces that will be a part of the finished surface.

If metal ties and anchorages are to remain in the concrete, construct them so as to permit the removal of metal to at least 1 inch [25 mm] beneath the finished surface of concrete. Use accessories for metal ties and anchorages that allow the removal of metal to the prescribed depth while leaving the smallest possible repairable cavity.

When using wire ties, cut or bend them back from the finished surface of the concrete a minimum of 1 inch [25 mm]. Do not use internal ties of wire when forming surfaces that are exposed to view.

400-5.6 Preparation and Cleaning: Meet the following requirements for the condition of forms at the time of beginning concrete casting:

(a) Treat all forms with an approved form-release agent before placing concrete. Do not use material which adheres to or discolors the concrete.

(b) Clean forms of all concrete laitance from previous use and all dirt, sawdust, shavings, loose wire ties and other debris.

(c) Close and secure all inspection and cleanout holes.

400-5.7 Stay-In-Place Metal Forms:

400-5.7.1 General:

(a) Use of permanent stay-in-place metal forms: Permanent stay-in-place metal forms may be used in lieu of removable forms to form all concrete bridge deck slabs except on bridge superstructures classified as Extremely Aggressive, subject to the conditions, limitations, and requirements contained herein and stated in the plans. Use forms made of corrugated material of cellular or non-cellular construction.

Stay-in-place metal forms may be used to form the portion of the top slab which lies between the webs of individual steel box girders regardless of the environmental classification.

Prior to using stay-in-place forms, submit detailed plans for approval of the forming system, including method of support and attachment and method of protecting the supporting structural steel components from welding effects. Submit design calculations. Detail stay-in-place forms such that they in no way infringe upon the concrete outline of the slab shown on the plans. Use stay-in-place forms that provide and maintain the dimensions and configuration of the original slab in regards to thickness and slope.

Do not weld stay-in-place metal form supports and connections to structural steel components. Make attachments by permissible welds, bolts, clips, or other approved means. If metal form supports and connections are field welded in place, protect structural steel components from damage by using a shield to guard against weld splatter, weld overrun, arc strikes, or other damaging effects of the welding process. Upon completion of welding, rest the metal form support flush on the supporting steel component. Should any weld spatter, weld overrun, arc strike, or other effects of the welding process be evident or occur to the structural steel component, immediately stop in place welding of the metal form supports for the remainder of the work. In this event, weld all metal form supports off of the structure and erect the forms after prefabrication, or use an alternate approved method of attaching the form supports. Remove improper weldment, repair the supporting steel component for any improper welding technique, and perform all required verification and testing at no expense to the Department and to the satisfaction of the Engineer.

Do not use stay-in-place forms until the forming system has been approved by the Engineer. The Contractor is responsible for the performance of the stay-in-place forms.

(b) Structures designed, detailed, and dimensioned for the use of removable forms: Where stay-in-place metal forms are permitted, the Contractor is responsible and shall obtain the approval of the Engineer for the additional slab thickness, elevation changes, changes in design, etc. to accommodate the use of stay-in-place forms. The Engineer will compute pay quantities of the various components of the structure which are paid on a cubic yard [cubic meter] basis from the design dimensions shown on the plans with no allowance for changes in deflection or dimensions necessary to accommodate the stay-in-place forms or concrete to fill the form flutes. The Engineer will limit pay quantities of other Contract items that the Contractor increases to accommodate the use of stay-in-place forms to the quantity required for the original plan design.

Submit all changes in design details of bridge structural members that support stay-in-place forms, showing all revisions necessary to enable the supporting components to withstand the additional weight of the forms and the weight of the extra concrete required to fill the form flutes. Include with the design calculations a comparative analysis of the stresses in the supporting components as detailed on the Contract plans and as modified to support the forms. Use the identical method of analysis in each case, and do not allow the stresses in the modified components to exceed those of the component as detailed in the Contract plans. Include with the design the adjusted cambers for any changes in deflection over those shown on the original plans. Modify the beams to provide additional strength to compensate for the added dead loads imposed by the use of stay-in-place forms. Obtain the additional strength by adding strands to the prestressed beams or by adding steel material to increase the section modulus of steel girders. Substantiate the added strength by the comparative calculations. Do not use stay-in-place forms until the forming system and all necessary design revisions of supporting members have been approved by the Engineer.

(c) Structures designed, detailed, and dimensioned for the use of stay-in-place metal forms: Prior to using stay-in-place forms, submit detailed plans for approval of the forming system (including method of support and attachment) together with design calculations. Include an analysis of the actual unit weight of the proposed forming system over the projected plan area of the metal forms. If the weight thus calculated exceeds the weight allowance for stay-in-place metal forms and concrete required to fill the form flutes shown on the plans, then modify the supporting components to support the excess in weight as stipulated in 400-5.7.1(b).

(d) Painting of top flange: For all structures utilizing structural steel supporting components for which stay-in-place metal forms are to be used, paint the vertical sides of the top flange prior to installation of the stay-in-place forms in accordance with 560-7.9.

(e) Zinc coating of supports and connections: Apply a zinc paint coating in accordance with Section 562 to all welded areas of supports and to accessories cut from galvanized sheets, which are not embedded in concrete.

400-5.7.2 Materials: Fabricate permanent stay-in-place metal forms and supports from steel meeting the requirements of ASTM A 653 [ASTM A 653M], having a coating designation of G165 [Z500]. Do not use form materials that are less than 22 gauge [0.7925 mm] in thickness.

400-5.7.3 Design: Meet the following criteria for the design of permanent bridge deck forms:

(1) Design the forms on the basis of deadload of form, reinforcement, and plastic concrete plus 50 lb/ft^2 [2.4 kPa] for construction loads. Use a unit working stress in the steel sheet of not more than 0.725 of the specified minimum yield strength of the material furnished, but not to exceed 36,000 psi [250 MPa].

(2) Do not allow deflection under the weight of the forms, reinforcement, and plastic concrete to exceed 1/180 of the form span or 2 inch [13 mm], whichever is less, for form spans of 10 feet [3 m] or less, or 1/240 of the form span or : inch [19 mm], whichever is less, for form spans greater than 10 feet [3 m]. In all cases, do not use a loading that is less than 120 psf [5.75 kPa] total.

(3) Use a design span of the form equal to the clear span of the form plus 2 inches [50 mm]. Measure the span parallel to the form flutes.

(4) Compute physical design properties in accordance with requirements of the AISI Specifications for the Design of Cold Formed Steel Structural Members, latest published edition.

(5) For all reinforcement, maintain the design concrete cover required by the plans.

(6) Maintain the plan dimensions of both layers of primary deck reinforcement from the top surface of the concrete deck.

(7) Do not consider the permanent bridge deck form as lateral bracing for compression flanges of supporting structural members.

(8) Do not use permanent steel bridge deck forms in panels where longitudinal deck construction joints are located between stringers.

(9) Secure forms to the supporting members by means other than welding.

400-5.7.4 Construction: Install all forms in accordance with approved fabrication and erection plans.

Do not rest form sheets directly on the top of the stringer of floor beam flanges. Fasten sheets securely to form supports, and maintain a minimum bearing length of 1 inch [25 mm] at each end for forms. Place form supports in direct contact with the flange of the stringer or floor beam. Make all attachments for forms by bolts, clips, or other approved means.

For any permanent exposed steel where the galvanized coating has been damaged, thoroughly clean, wire brush, and paint it with two coats of galvanizing compound in accordance with 971-15 to the satisfaction of the Engineer. Do not touch up minor heat discoloration in areas of welds.

Locate transverse construction joints at the bottom of a flute, and field drill 3 inch [6 mm] weep holes at not less than 12 inches [300 mm] on center along the line of the joints.

400-5.7.5 Placing of Concrete: Vibrate concrete to avoid honeycomb and voids, especially at construction joints, expansions joints, and valleys and ends of form sheets. Use approved pouring sequences. Do not use calcium chloride or any other admixture containing chloride salts in the concrete.

400-5.7.6 Inspection: The Engineer will observe the Contractor's method of construction during all phases of the construction of the bridge deck slab, including the installation of the metal forms; location and fastening of the reinforcement; composition of concrete items; mixing procedures, concrete placement, and vibration; and finishing of the bridge deck. Should the Engineer determine that the procedures used during the placement of the concrete warrant inspection of the underside of the deck, remove at least one section of the forms in each span for this purpose. Do this as soon after placing the concrete as practicable in order to provide visual evidence that the concrete mix and the procedures are obtaining the desired results. Remove an additional section in any span if the Engineer determines that there has been any change in the concrete mix or in the procedures warranting additional inspection.

After the deck concrete has been in place for a minimum period of two days, test for soundness and bonding of the forms by sounding with a hammer as directed by the Engineer. If sounding discloses areas of doubtful soundness to the Engineer, remove the forms from such areas for visual inspection after the concrete has attained adequate strength. Remove permanent bridge deck forms at no expense to the Department.

At locations where sections of the forms have been removed, the Engineer will not require the Contractor to replace the forms. Repair the adjacent forms and supports to present a neat appearance and to ensure their satisfactory retention. As soon as the form is removed, the Engineer will examine the concrete surfaces for cavities, honeycombing, and other defects. If irregularities are found, and the Engineer determines that these irregularities do not justify rejection of the work, repair the concrete as directed, and provide a General Surface Finish in accordance with 400-15. If the Engineer determines that the concrete where the form is removed is unsatisfactory, remove additional forms as necessary to inspect and repair the slab, and modify the method of construction as required to obtain satisfactory concrete in the slab. Remove and replace all unsatisfactory concrete as directed at no expense to the Department.

If the method of construction and the results of the inspections as outlined above indicate that sound concrete has been obtained throughout the slabs, the amount of sounding and form removal may be reduced when approved.

Provide the facilities for the safe and convenient conduct of the inspection procedures.

400-5.8 Stay-In-Place Concrete Forms:

400-5.8.1 General: Permanent stay-in-place concrete forms may be used in lieu of removable forms to form concrete bridge deck slabs subject to the conditions contained herein. Neither concrete stay-in-place forms nor precast prestressed panels are permitted to construct a composite concrete deck.

When detailed plans for structures are dimensioned for the use of removable forms, provide additional slab thickness, elevation changes, changes in design, etc. to accommodate the use of stay-in-place forms, subject to the Engineer's approval. The Engineer will compute pay quantities of the various component members of the structure which are paid on a cubic yard [cubic meter] basis from the design dimensions shown on the plans with no allowance for changes in deflection and changes in dimensions necessary to accommodate the stay-in-place forms. The Engineer will limit pay quantities of other Contract items which are increased to accommodate the use of stay-in-place forms to the quantity required for the original plan design.

Prior to using stay-in-place forms, submit for approval detailed plans of the forming system. Indicate on the plans the form panel sizes, placing patterns, type of mastic or felt bearing material and type and method of caulking between panels. A panel section design as shown in the table below may be chosen or a design may be submitted for approval. If a design is submitted, design calculations shall also be submitted. Also, submit appropriate changes in design details of structural members supporting stay-in-place forms showing any revisions necessary to enable the supporting components to withstand the additional weight of the forms and perform equally as contemplated in the plans. Modify the beams to provide additional strength to compensate for the added dead loads imposed by the use of stay-in-place forms. Obtain this strength by adding additional strands to prestressed girders or increasing the section modulus for steel girders. Do not use stay-in-place forms until the forming system and any necessary design revisions of supporting structural members have been approved by the Engineer. The Department is not responsible for the performance of the stay-in-place forms by its approval.

TABLE OF PRESTRESSED FORM DESIGNS (NON SI UNITS)

Clear Span	Form Depth	AE≅	Maximum Strand Spacing
3'0"	2δ"	0	22.72"
4'0"	2δ"	0	12.72"
5'0"	2δ"	0	8.18"
6'0"	2δ"	0	5.68"
6'6"	2δ"	0	4.84"
6'7"	2ε"	χ"	6.76"
7'0"	2ε"	χ"	5.83"
8'0"	2ε"	χ"	4.46"
8'3"	2ε"	χ"	4.19"
8'4"	2φ"	3"	5.34"
9'0"	2φ≅	3"	4.43"
9'9"	2φ"	3"	3.70"
10'0"	3χ"	δ"	4.47"
10'6"	3χ"	δ"	4.25"
11'0"	3χ"	δ"	3.85"

NOTE: (a) Column "E" shows the required eccentricity to the centerline of the strand below the mid-depth of the panel.
(b) The form panel designs shown above require δ" diameter S.R. Strands loaded to 14,000 pounds each.

TABLE OF PRESTRESSED FORM DESIGNS (SI UNITS)

Clear Span	Form Depth	AE≅	Maximum Strand Spacing
0.91 m	60 mm	0	575 mm
1.22 m	60 mm	0	325 mm
1.52 m	60 mm	0	210 mm
1.83 m	60 mm	0	145 mm
1.99 m	60 mm	0	125 mm
2.01 m	70 mm	3 mm	170 mm
2.13 m	70 mm	3 mm	150 mm
2.44 m	70 mm	3 mm	115 mm
2.52 m	70 mm	3 mm	105 mm
2.54 m	75 mm	6 mm	135 mm
2.74 m	75 mm	6 mm	115 mm
2.97 m	75 mm	6 mm	95 mm
3.05 m	80 mm	10 mm	115 mm
3.20 m	80 mm	10 mm	110 mm
3.35 m	80 mm	10 mm	100 mm

NOTE: (a) Column "E" shows the required eccentricity to the centerline of the strand below the mid-depth of the panel.
(b) The form panel designs shown above require 9.5 mm diameter S.R. Strands loaded to 62 kN each.

400-5.8.2 Materials: Construct permanent concrete forms of prestressed concrete in accordance with Section 450. Use concrete having a 28-day minimum compressive strength of 5,000 psi [35 MPa]. Use stress steel with 250K [1.72 GPa], 270K [1.86 GPa], or LOK-Stress. For using all other metal reinforcement, meet the requirements of Section 931.

400-5.8.3 Design: Use the following criteria for the design of permanent bridge deck forms:

(1) Design the forms on the basis of deadload of form, reinforcement, and plastic concrete plus 50 psf [2.4 kPa] for construction loads. For the unit working stress of the concrete, meet the AASHTO design requirements.

(2) Deflection under the weight of the forms, reinforcement, and the plastic concrete shall not exceed 1/180 of the form span or 2 inch [13 mm], whichever is less. In all cases, do not use a loading that is less than 120 psf [5.75 kPa] total.

Base the permissible form camber on the actual deadload condition. Do not use camber to compensate for deflection in excess of the foregoing limits.

(3) Use a design span of the form equal to the clear span of the form between supports. Measure the span of concrete forms parallel to the centerline of the form panels.

(4) Compute physical design properties of concrete forms in accordance with current AASHTO design procedures.

(5) Ensure that all steel reinforcement contained in the cast-in-place concrete has the minimum cover shown on the plans or not less than 1 inch [25 mm], whichever is greater. Measure the minimum cover normal to the plane of the bottom of the cast-in-place concrete. For stay-in-place concrete forms with other than plane surfaces in contact with the cast-in-place concrete, such as regularly spaced geometrical shapes projecting above the plane of the bottom of the cast-in-place concrete, meet the following special requirements:

(a) Space geometrical shapes projecting above the bottom plane of the cast-in-place concrete used to provide support for reinforcement no closer than 3 feet [1.0 m] apart and of sufficient height to maintain the required concrete cover on the bottom mat of reinforcing steel.

(b) Construct all other geometrical shapes projecting above the plane of the bottom of the cast-in-place concrete to provide a minimum vertical clearance of : inch [19 mm] between the closest surface of the projections and the secondary longitudinal reinforcing steel in the deck slab.

(c) Do not allow a minimum horizontal distance from the surface of any transverse reinforcing steel to surfaces of the stay-in-place form of less than 12 inches [38 mm].

For all steel reinforcement for the stay-in-place form panels, provide a minimum of 1 inch [25 mm] concrete cover except that, for construction in a salt or other corrosive environment, provide a minimum of 12 inches [38 mm] concrete cover.

(6) Maintain the plan dimensions of both layers of primary deck reinforcement from the top surface of the concrete deck. Measure the minimum cover of the bottom mat of steel normal to the top of the precast concrete form panel.

(7) Do not consider the permanent bridge deck form as lateral bracing for compression flanges of supporting structural members.

(8) Do not use permanent concrete bridge deck forms in panels where longitudinal deck construction joints are located between stringers.

(9) Do not allow the maximum weight of the concrete form to exceed 40 lb/ft^2 [195 kg/m5] of form surface.

400-5.8.4 Construction: Install all forms in accordance with approved fabrication and erection plans.

For concrete forms, provide a minimum bearing length of at least 12 inches [38 mm] but not exceeding 22 inches [64 mm]. Support concrete forms on the beams or girders by continuous layers of an approved mastic or felt bearing material that will provide a mortar tight uniform bearing. Use a mastic or felt bearing material that has a minimum width of 1 inch [25 mm] and a maximum width of 12 inches [38 mm]. Seal joints between concrete form panels with caulking, tape, or other approved method.

400-5.8.5 Placing of Concrete: Place the concrete in accordance with the requirements of 400-5.7.5. Immediately prior to placing the slab concrete, saturate concrete stay-in-place form panels with water.

400-5.8.6 Inspection: Inspect the concrete in accordance with the requirements of 400-5.7.6.

After the deck concrete has been in place for a minimum period of two days, inspect the forms for cracks and excessive form deflection, and test for soundness and bonding of the forms by sounding with a hammer as directed by the Engineer. Remove, for visual inspection, form panels found to be cracked that show evidence of leakage and form panels which have a deflection greater than adjacent panels by 2 inch [13 mm] or more which show signs of leakage. If sounding discloses areas of doubtful soundness to the Engineer, remove the form panels from such areas for visual inspection after the concrete has attained adequate strength. Remove permanent bridge deck form panels at no expense to the Department.

At locations where sections of the forms have been removed, the Engineer will not require the forms to be replaced. Repair the adjacent forms and supports to present a neat appearance and to ensure their satisfactory retention. As soon as the form is removed, the Engineer will examine the concrete surfaces for cavities, honeycombing, and other defects. If irregularities are found, and the Engineer determines that these irregularities do not justify rejection of the work, repair the concrete as directed and provide a General Surface Finish in accordance with 400-15. If the concrete where the form is removed is unsatisfactory, as determined by the Engineer, additional forms shall be removed as necessary to inspect and repair the slab, and modify the methods of construction as required to obtain satisfactory concrete in the slab. Remove and replace all unsatisfactory concrete as directed at no expense to the Department.

If the methods of construction and the results of the inspections as outlined above indicate that the Contractor has obtained sound concrete throughout the slabs, the Contractor may moderate the amount of sounding and form removal, when approved.

Provide all facilities for the safe and convenient conduct of the inspection procedures.

400-6 Weep Holes.

Provide weep holes in all abutments, retaining walls, and culverts over 5 feet [1.5 m] in height. Provide weep holes that are at least 3 inches [75 mm] in diameter and not more than 10 feet [3 m] apart, but do not place any weep holes under the area to be occupied by the base or pavement. Place the outlet ends of the weep holes just above the ground line in front of abutments and retaining walls. In culverts, place weep holes approximately 6 inches [150 mm] above the top of the floor slab. Cover the inside ends of all weep holes with wire mesh and at least 2 ft^3 [0.05 m^3] of clean, broken stone or gravel, so placed as to allow free drainage but at the same time prevent the fill from washing out. From approximately 6 inches [150 mm] below the bottom of the inside ends of the weep holes, carry a column of clean, broken stone or gravel at least 1 ft^2 [0.1 m^2] up against the back of the wall to the surface of the original ground.

400-7 Placing Concrete.

400-7.1 Temperature Restrictions:

400-7.1.1 Concreting in Cold Weather: Do not place concrete when the temperature of the concrete at placement is below 45EF [7EC].

Meet the air temperature requirements for mixing and placing concrete in cold weather as specified in Sections 346 and 347. During the curing period, if NOAA predicts the ambient temperature to fall below 35EF [2EC] for 12 hours or more or to fall below 30EF [-1EC] for more than four hours, enclose the structure in such a way that the concrete and air within the enclosure can be kept above 60EF [16EC] for a period of three days after placing the concrete or until the concrete reaches a minimum compressive strength of 1500 psi [10 MPa].

Assume all risks connected with the placing and curing of concrete. Although the Engineer may give permission to place concrete, the Contractor is responsible for satisfactory results. If the placed concrete is determined to be unsatisfactory, remove, dispose of, and replace the concrete at no expense to the Department.

400-7.1.2 Concreting in Hot Weather: Meet the temperature requirements and special measures for mixing and placing concrete in hot weather as specified in Section 346.

When the temperature of the concrete as placed exceeds 75EF [24EC], incorporate in the concrete mix a water-reducing retarder or water reducer if allowed by Section 346.

Spray reinforcing steel and metal forms with cool fresh water just prior to placing the concrete in a method approved by the Engineer.

Assume all risks connected with the placing and curing of concrete. Although the Engineer may give permission to place concrete, the Contractor is responsible for satisfactory results. If the placed concrete is determined to be unsatisfactory, remove, dispose of, and replace the concrete at no expense to the Department.

400-7.2 Lighting Requirements: Provide adequate lighting for all concrete operations conducted at night. Obtain approval of the lighting system prior to starting the concrete operations.

400-7.3 Inspections before Placing Concrete: Do not place concrete until the depth and character of the foundation and the adequacy of the forms and falsework have been approved by the Engineer. Do not deposit any concrete until all reinforcement is in place and has been inspected and approved by the Engineer.

400-7.4 Exposure to Water: Do not expose concrete other than seal concrete in cofferdams to the action of water before final setting. Do not expose such concrete to the action of salt or brackish water for a period of seven days after placing the concrete. Protect the concrete during this period by keeping salt or brackish water pumped out of cofferdams.

400-7.5 General Requirements for Placing Concrete: Do not place any concrete prior to submitting an approved concrete placement plan as specified in Section 346. Deposit concrete as nearly as possible in its final position. Do not deposit large quantities at one point and then run or work it along the forms. Take special care to fill each part of the forms, to work coarse aggregate back from the face, and to force concrete under and around reinforcing bars without displacing them.

Use a method and manner of placing concrete that avoids the possibility of segregation or separation of aggregates. If the Engineer determines that the quality of concrete as it reaches its final position is unsatisfactory, remove it and discontinue or adjust the method of placing until the Engineer determines that the quality of the concrete as placed is satisfactory.

Use metal or metal-lined open troughs or chutes with no aluminum parts in contact with the concrete. Where steep slopes are required, use chutes that are equipped with baffles or are in short lengths that reverse the direction of movement. Where placing operations would involve dropping the concrete freely more than 5 feet [1.5 m], deposit it through pipes, troughs, or chutes of sheet metal or other approved material. Use troughs, chutes, or pipes with a combined length of more than 30 feet [10 m] only with the Department's authorization. Keep all troughs, chutes, and pipes clean and free from coatings of hardened concrete by thoroughly flushing them with water after each run or more often if necessary.

Place all foundation concrete against supporting material that is moist at the time of concrete placement. If additional water is required, uniformly apply it ahead of the concrete placement as directed by the Engineer. Do not place concrete on supporting material that is frozen. The Contractor may use a moisture barrier in lieu of controlling the foundation grade moisture when approved by the Engineer.

400-7.6 Placing Concrete by Belt Conveyor: Place concrete by means of a belt conveyor system with written Department authorization. Remove conveyor belt systems which produce unsatisfactory results before continuing operations. Take concrete samples for assurance testing at the discharge end of the belt conveyor system. Make available to the Engineer the necessary platform to provide a safe and suitable place for sampling and testing. Remove any concrete placed in an unsatisfactory manner at no expense to the Department before continuing operations.

Use conveyor belt systems that do not exceed a total length of 550 feet [170 m], measured from end to end of the total assembly. Arrange the belt assembly so that each section discharges into a vertical hopper arrangement to the next section. To keep segregation to a minimum, situate scrapers over the hopper of each section to remove mortar adhering to the belt and to deposit it into the hopper. Equip the discharge end of the conveyor belt system with a hopper and a chute or suitable deflectors to cause the concrete to drop vertically to the deposit area.

In order to avoid delays due to breakdowns, provide stand-by equipment with an alternate power source prior to the beginning of the placement.

After the beginning of the placement, direct the discharge from the belt conveyor so that the concrete always falls on freshly placed concrete.

400-7.7 Placing Concrete by Pumping: In general, use concrete pumping equipment that is suitable in kind and adequate in capacity for the work proposed. Use a pump discharge line that has a minimum diameter of 4 inches [100 mm]. Use a pump and discharge lines that are constructed so that no aluminum surfaces are in contact with the concrete being pumped. Operate the pump to produce a continuous stream of concrete, without air pockets. When using cement slurry or similar material to lubricate the discharge line when pumping begins, collect such material at the point of discharge. Dispose of the collected slurry in areas provided by the Contractor. Control the pump discharge locations so that the placement locations of the various lots of concrete represented by strength test cylinders can be identified in the event the test cylinders indicate deficient strength. When concrete is placed by pumping, take all test samples of concrete at the end of the discharge line, except in accordance with the provisions of the Standard Operating Procedures for Quality Control of Concrete.

400-7.8 Consolidation: Consolidate the concrete by continuous working with a suitable tool in an acceptable manner, or by vibrating as set forth in 400-7.11. When not using vibrators, thoroughly work and compact all thin-section work with a steel slicing rod. Spade all faces, and flush the mortar to the surface by continuously working with a concrete spading implement.

400-7.9 Obstructions: In cases where, because of obstructions, difficulty is encountered in puddling the concrete adjacent to the forms, bring the mortar content of the mix into contact with the interior surfaces by vibrating the forms. Produce the vibrations by striking the outside surfaces of the forms with wooden mallets or by other satisfactory means. In placing concrete around steel shapes place it only on one side of the shape until it flushes up over the bottom flange of the shape on the opposite side, after which place it on both sides to completion. After the concrete has taken its initial set, exercise care to avoid jarring the forms or placing any strain on the ends of projecting reinforcing bars.

400-7.10 Requirements for Successive Layers: Generally, place concrete in continuous horizontal layers, approximately 12 inches [300 mm] thick. To avoid obtaining a plane of separation between batches, do not allow the time before placing the next successive layer to exceed 20 minutes, unless the Engineer determines that adequate fluidity exists in the underlying layer. Generally, leave each layer of concrete unfinished to secure efficient bonding with the overlying layer. To minimize the visibility of joints on exposed faces, finish the top surface of the concrete immediately adjacent to the forms of the exposed face, smoothing with a plaster mason's trowel. Where required, use inset form work to eliminate featheredges and to obtain concrete layers with a minimum thickness of 6 inches [150 mm]. Conduct the operation of depositing and consolidating the concrete so as to form a dense, impervious mass of uniform texture with smooth faces on exposed surfaces. Remove, dispose of, and replace defective concrete as directed by the Engineer and at no expense to the Department.

400-7.11 Vibration of Concrete:

400-7.11.1 General: Consolidate all concrete except seal, culvert floors, steel pile jackets, and concrete for incidental construction by the use of mechanical vibrators.

400-7.11.2 Vibrators: Provide adequate vibrators on the project that are approved by the Engineer before beginning concrete work. Generally, provide vibrators of the internal type. For thin sections, where the forms are especially designed to resist vibration, the Contractor may use external vibrators. Use a vibrator with a minimum frequency of 4,500 impulses per minute with sufficient intensity and duration to cause complete consolidation of the concrete without causing segregation of the materials. For vibrating thin, heavily reinforced sections, use heads of such size to secure proper vibration of the concrete without disturbance of either the reinforcing steel or the forms.

400-7.11.3 Number of Vibrators Required: Use a sufficient number of vibrators to secure the compaction of each batch before the next batch is delivered, without delaying the delivery. In order to avoid delays due to breakdowns, provide at least one stand-by vibrator, with an appropriate power source.

400-7.11.4 Method of Vibration: Use vibrators to consolidate properly placed concrete. Do not use them to move concrete about in the forms. Insert the vibrators in the surface of concrete at points spaced to ensure uniform vibration of the entire mass of the concrete. Insert the vibrator at points that are no further apart than the radius over which the vibrator is visibly effective. Allow the vibrator to sink into the concrete by its own weight, and allow it to penetrate into the underlying layer sufficiently so that the two layers are thoroughly consolidated together. After thoroughly consolidating the concrete, withdraw the vibrator slowly to avoid formation of holes.

400-7.11.5 Hand Spading: When necessary in order to secure well-filled forms, free from aggregate pockets, honeycomb, bubbles, etc., spade the concrete by hand, along the surfaces of the forms and in all corners, following the vibration.

400-7.12 Columns: Place concrete in columns in one continuous operation for each lift as shown in the plans.

400-7.13 Slabs and Bridge Decks:

400-7.13.1 Bulkheads, Screed Rails, and Screeding Devices: Strike-off the concrete using an approved metal screed operating on rails or bulkheads. Use devices which do not contain aluminum parts. Prior to placing concrete, provide an approved screed capable of striking-off and screeding the surface of the slab or deck to the required shape. Set all necessary bulkheads and screed rails to the required grade. Use bulkheads, screed rails, and screeding devices that permit vertical profile adjustment to the grade, satisfactory for providing straight transverse slopes, differing transverse slopes broken as shown in the plans and/or tranversing slopes with changing grade along the longitudinal length of slab or deck. Locate the screed rails so the entire placement surface can be screeded to grade without using intermediate screed rails, unless approved otherwise by the Engineer.

Use a screed consisting of a truss or heavy beams that will retain it=s shape under all working conditions, and a set of rotating drums with a diameter sufficient to carry a 2 inch [50 mm] mortar roll in front of and parallel to the axis of the drums, while making an initial pass. Adjust the drums to prevent mortar buildup forming behind the trailing edges of the drums. As an alternate to the drum type screed, a mechanical screed with a metal strike-off may be used. Equip the mechanical screed with mechanical vibrators to provide continuous uniform vibration to the entire length unless otherwise authorized by the Engineer. Small and irregularly shaped areas may be screeded in a manner approved by the Engineer.

400-7.13.2 Screed Demonstration: Subsequent to the placement of all reinforcing steel and prior to placing any slab or deck concrete, demonstrate that the proposed equipment and methods can finish the concrete to the specified grades while maintaining the specified cover over the reinforcement. Provide the demonstration over the entire length and width of the spans to be placed. During the demonstration, load the screed support rails that are cantilevered beyond the fascia girders to simulate the concrete loading that will be placed on the rail support system during actual placement and screeding operations.

400-7.13.3 Screeding Operations: Perform concrete placement and screeding as independently controlled mechanical operations. Ensure that the traverse of the screed and forward movement of the screeding equipment are independent of the movement of concrete placement equipment.

Level the concrete in front of the screed as near to the finished grade as possible to prevent the screed from rising off the rail and forming uneven ridges behind the screed. Pass the screed over the slab or deck as many times as necessary to obtain a satisfactory surface.

Provide a concrete surface true to grade and crown, and free of irregularities. Do not add water to the concrete surface to assist in finishing operations unless specifically authorized by the Engineer. If the Engineer permits the addition of water, apply only a fog mist, above the concrete surface, by means of approved power driven spray equipment.

400-7.13.4 Placing Operations: Select an approved concrete design mix which ensures complete placement of all slab or deck concrete between construction joints before initial set begins in the plastic concrete. On placements of 50 yd^3 [40 m^3] or less, the minimum placement rate is 20 yd^3/h [15 m^3/h]. On placements of greater than 50 yd^3 [40 m^3], the minimum placement rate is 30 yd^3/h [23 m^3/h].

The Engineer will not permit slab or deck placements until an acceptable plan for meeting the minimum placement rate is approved.

400-7.13.5 Concrete Decks on Steel Spans: Where concrete decks are placed on steel spans, release the temporary supports under the bridge before placing any concrete.

400-7.13.6 Concrete Decks on T-Beams: For cast-in-place T-beam construction, cast the slabs and beams in one continuous operation. As an exception, where special shear anchorage or keys are provided for in the plans or approved by the Engineer, the beams and slabs may be constructed in successive placements.

400-7.13.7 Diaphragms: Place concrete diaphragms at least 48 hours before the bridge deck slabs are placed unless otherwise indicated in the plans.

400-7.13.8 Weather Protection: Provide an approved means of protecting unhardened concrete from rain. Position the protection system to shield the concrete from rain and running water. Provide a shield impervious to water over the slab or deck concrete, of sufficient size to protect all areas of slab or deck concrete subject to water damage, and include a means of intercepting and diverting water away from freshly placed concrete. Arrange the equipment so that the weather protection system can be erected over unhardened concrete. When there is a possibility of rain during concrete placement operations, place the weather protection system in stand-by readiness, capable of being deployed in a timely manner. Use the weather protection immediately when rain begins so that slab or deck concrete damage will not occur. Do not place concrete during rain.

Assume responsibility for damage to the slab or deck in the case of failure of the weather protection system.

Describe the weather protection materials and methods in the Contractor=s Level II Plan for Quality Control of Concrete.

400-7.14 Concrete Box Culverts: In general, place the base slab or footing of concrete box culverts, and allow them to set before constructing the remainder of the culvert. In this case, make suitable provision for longitudinal keys. Construct bottom slabs, footings, and apron walls as a monolith if practicable. Where transverse construction joints are necessary, place them at right angles to the culvert barrel, and make suitable provision for keys.

In the construction of box culverts having walls 6 feet [1.8 m] or less in height, the sidewalls and top slab may be constructed as a monolith or may place the concrete in the walls and allow it to set before placing the top slab concrete.

Where the height of the box culvert walls exceed 6 feet [1.8 m], place the walls, and allow the concrete to set at least 12 hours before placing the top slab concrete. In such cases, form keys in the sidewalls.

When casting the walls and top slabs of box culverts as a monolith, ensure that any necessary construction joints are vertical. Design all construction joints with formed keys. Provide keys that are beveled as shown in the plans or as directed, but do not allow the edge of the beveled material forming the key to be less than 12 inches [38 mm] from the edge of the concrete.

Construct each wingwall, if possible, as a monolith. Ensure that construction joints, where unavoidable, are horizontal and so located that no joints will be visible in the exposed face of the wing above the ground line.

Precast box culvert sections may be used in lieu of cast-in-place box culvert construction provided the provisions in Section 410 are satisfied.

400-8 Seals.

400-8.1 General: Wherever practicable, dewater all foundation excavations, and deposit the concrete in the dry as defined in 455-15.2. Where conditions are encountered which render it impracticable to dewater the foundation before placing concrete, the Engineer may authorize the construction of a concrete foundation seal of the required size. Then, dewater the foundation, and place the balance of the concrete in the dry.

When required to place seal concrete, the Contractor is responsible for the satisfactory performance of the seal in providing a watertight excavation for placing structural concrete. The Department will provide and pay for the seal concrete as an aid to the construction of the structure. Repair seal concrete as necessary to perform its required function at no expense to the Department.

400-8.2 Method of Placing: Carefully place concrete deposited under water in the space in which it is to remain by means of a tremie, a closed-bottom dump bucket of not less than 1 yd^3 [0.75 m^3] capacity, or other approved method. Do not disturb the concrete after depositing it. Deposit all seal concrete in one continuous placement. Do not place any concrete in running water, and ensure that all form work designed to retain concrete under water is watertight.

400-8.3 Use of Tremie: Use a tremie consisting of a tube having a minimum inside diameter of 10 inches [250 mm], constructed in sections having water-tight joints. Do not allow any aluminum parts to have contact with the concrete. Ensure that the discharge end is entirely seated at all times, and keep the tremie tube full to the bottom of the hopper. When dumping a batch into the hopper, keep the tremie slightly raised (but not out of the concrete at the bottom) until the batch discharges to the bottom of the hopper. Stop the flow by lowering the tremie. Support the tremie such as to permit the free movement of the discharge end over the entire top surface of the work and to permit its being lowered rapidly when necessary to choke off or retard the flow. Provide a continuous, uninterrupted flow until completing the work. Exercise special care to maintain still water at the point of deposit.

400-8.4 Use of Bottom-dump Bucket: When placing the concrete by means of a bottom-dump bucket, lower the bucket gradually and carefully until it rests upon the concrete already placed. Raise the bucket very slowly during the discharge travel, the intent being to maintain, as nearly as possible, still water at the point of discharge and to avoid agitating the mixture. Do not use aluminum buckets.

400-8.5 Time of Beginning Pumping: Do not commence pumping to dewater a sealed cofferdam until the seal has set sufficiently to withstand the hydrostatic pressure, and in no case earlier than 72 hours after placement of the concrete.

400-9 Construction Joints.

400-9.1 Location: Make construction joints only at locations shown in the plans or in the placement schedule, unless otherwise approved in writing. If not detailed in the plans or placement schedule, or in case of emergency, place construction joints as directed.

400-9.2 Provisions for Bond and Transmission of Shear: Use shear key reinforcement where necessary to transmit shear or to bond the two sections together.

400-9.3 Preparations of Surfaces: Before depositing new concrete on or against concrete which has hardened, re-tighten the forms. Roughen the surface of the hardened concrete in a manner that will not leave loosened particles, aggregate, or damaged concrete at the surface. Thoroughly clean the surface of foreign matter and laitance, and saturate it with water.

400-9.4 Placing Concrete: Continuously place concrete from joint to joint. Carefully finish the face edges of all joints which are exposed to view true to line and elevation.

400-9.5 Joints in Sea Water or Brackish Water: For concrete placed in sea water or brackish water, do not place any construction joints between points 2 feet [0.6 m] below extreme low tide and 4 feet [1.2 m] above extreme high tide.

400-9.6 Joints in Long Box Culverts: For long concrete box culverts, vertical construction joints may be placed at a spacing not less than 30 feet [9 m]. When using transverse construction joints, ensure that longitudinal reinforcing steel is continuous through the joint and that the joint is vertical.

400-9.7 Joints in Concrete Bridge Decks: When the plans provide an option for or require joints in concrete decks to be made with a saw cut, make the cut in accordance with plan details and no later than the day following concrete placement.

400-10 Expansion Joints.

400-10.1 General: After meeting the smoothness criteria in 400-15, construct expansion joints to permit absolute freedom of movement. Carefully remove all loose or thin shells of mortar likely to cause a spall with movement at a joint from all expansion joints as soon as possible.

400-10.2 Sealed Joints: Fill expansion joints with a preformed joint filler. Cut the filler to conform to the cross-section of the structure, and furnish it in as few pieces as practicable, using only a single piece in each curb section. Do not use small pieces that would tend to come loose. Prepare joints to be sealed and apply the sealer in accordance with approved manufacturer's directions.

400-10.3 Joint System Installation: After receiving the Engineer=s acceptance of the bridge deck and approach slab smoothness, install the joint following the manufacturers instructions, on a profile tangent between the ends of the deck and/or approach slab to within a +0 and -χ inch [+0 and -3.0 mm] variation as determined by string line parallel to the centerline of the structure at maximum 3 foot [1.0 m] intervals along the joint.

400-11 Contact and Bearing Surfaces.

400-11.1 Separation of Surfaces: In general, separate all contact surfaces between superstructure and substructure or end walls and between adjacent superstructure sections by a layer of 55 lb [25 kg] roofing felt.

400-11.2 Finishing of Bearing Surfaces: Pay special attention to bearing areas supporting shoes, bearing pads, or the ends of beams or slabs. In general, float-finish such areas, and grind them to true planes with carborundum. If precast, they may be cast against true metal surfaces. Check all such areas for accuracy with a steel straightedge prior to the setting of shoes, bearing pads or superstructure elements.

400-11.3 Beam and Deck Slab Units: Do not allow the bearing plate or bearing area plane of precast concrete beam and deck slab units, including prestressed units, to deviate from a true plane by more than χ inch [3 mm] when both bearing areas of a unit are tested on a level plane. Provide a bearing plate or bearing area that also proves to be a true plane when tested in all directions of the plane surface with a steel straightedge. In the event that a 100% true plane is not achieved, the Engineer will accept a surface having not less than 80% of its area in a true plane provided the deviations from such true plane are evenly distributed. Remove minor convex projections by grinding with an abrasive stone. The Engineer will accept minor depressions, provided that they amount to not more than 20% of the bearing area, are evenly distributed over the entire bearing area, and are not deeper than χ inch [3 mm].

400-11.4 Bearing Pads: Use bearing pads for seating bridge shoes, ends of beams, and slabs of the types specified or required in the plans.

Furnish and install Composite Neoprene Pads as detailed in the plans. Place neoprene pads, where specified or required, directly on masonry surfaces finished in accordance with the requirements of this Article. Ensure that pads, bearing areas of bridge seats, and metal bearing plates are thoroughly cleaned and free from oil, grease, and other foreign materials.

Exercise care in fabrication of related metal parts to avoid producing conditions detrimental to the performance of the pads, such as uneven bearing, excessive bulging, etc.

400-12 Anchor Bolts and Dowels.

Set anchor bolts and dowels as specified in 460-30.

Galvanize all anchor bolts as specified in 460-30.

400-13 Epoxy Bonding Compounds.

Where epoxy bonding compounds for bonding concrete are specified or required, apply the epoxy bonding materials only to clean, dry, structurally sound concrete surfaces. Provide surface preparation, application, and curing of epoxy bonding compound in strict accordance with the manufacturer's recommendations for each particular application. Use an epoxy bonding compound listed on the Department=s Qualified Products List.

400-14 Removal of Forms.

Use the table below as the criterion for minimum time or compressive strength required before removal of forms or supports.

When using the time period criterion, include in the time period all days except days in which the temperature falls below 40EF [4EC].

Use the specified 28-day minimum compressive strength value as stated in 346-3.1 for each Class of Concrete utilized.

Location of Concrete Placement	Minimum Time for Form Removal for any Strength Concrete	Minimum (%) of 28-day Compressive Strength for Form Removal
(1) Centering under girders		
(a) Class II (Bridge Deck)	12 days	75
(b) Class III	12 days	70
(c) Class IV	12 days	60
(d) Class V	12 days	50
(2) Deck slabs, top slabs of culverts and bottom of caps, forms under sidewalks, and safety curb overhangs extending more than 2 feet [0.6 m]		
(a) Class II (Bridge Deck)	seven days*	75*
(b) Class II (Other than Bridge Deck)	seven days	75
(c) Class III	seven days	70
(d) Class IV	seven days	60
(e) Class V	seven days	50
(3) Walls, piers, columns, sides of beams and other vertical surfaces	24 hours**	50**
(4) Front face form of curbs	6 hours	70

* Reference 400-16.1.1 for alternate criteria.

**Do not place additional load on the section until 70% of the specified 28-day concrete strength is attained. Also, refer to 400-7.4.

When using the percent of required strength, cast test cylinders from representative concrete for compressive strength determination.

Provide the Engineer with a minimum of three cylinder breaks, established at different curing times and concrete strength, so he can develop a curve relating curing time to concrete strength. Cure such test cylinders as nearly as practical in the same manner as the concrete in the corresponding structural component, and test them in accordance with FM 1-T 022 and FM 1-T 023. Perform casting, curing, and testing at no expense to the Department and under the observation of the Engineer. When approved by the Engineer, the Contractor may use test results certified by a testing laboratory approved by the Department as a basis for form removal. When concrete strength tests indicate a compressive strength equal to or greater than the percentage of specified strength shown in the table above, the Contractor may remove the forms. Curing periods so established may be used so long as the ambient temperature is equal to or greater than the temperature existing during the curing of the test cylinders. When the temperature falls 15EF [8EC] or more below the ambient temperature existing during the test cylinder curing period, repeat the test procedure outlined above, and establish a different curing period for the different ambient temperature.

Do not remove forms at any time without the consent of the Engineer. Even when the Engineer provides consent to remove the forms, the Contractor is responsible for the work.

400-15 Finishing Concrete.

400-15.1 General Surface Finish (Required for All Surfaces): After placing and consolidating the concrete, strike-off all exposed surfaces to the lines and grades indicated in the plans in a manner that will leave a surface of uniform texture free of undesirable surface irregularities, cavities, and other defects. Cut back metal ties supporting reinforcement, conduit, and other appurtenances a minimum of 1 inch [25 mm] from finished surface. After removing excess mortar and concrete and while the concrete is still in a workable state, carefully tool all construction and expansion joints. Leave joint filler exposed for its full length with clean edges. Ensure that finished work in addition to that specified above is compatible and complementary to the class of surface finish required.

Immediately after removing forms from any exposed concrete surface, remove all fins and irregular projections flush with the surface. Clean, saturate with water, and carefully point with mortar all holes, material tie cavities, honeycomb, chips, and spalls.

In the event unsatisfactory surfaces are obtained, repair these surfaces by methods approved by the Engineer or the affected concrete will be rejected. Repair any surface or remove rejected concrete at no expense to the Department.

For pointing, use mortar that is a blended mixture of cement and fine aggregates, mixed in the same proportions used for these components in the class of concrete being finished and composed of materials from the same source as used in the class of concrete being placed. To prevent shrinkage, allow the mortar to take its initial set, then rework and apply it without adding water. Carefully roughen and clean cavities to be filled with mortar to provide a mechanical bond. Exercise care during the roughening process to prevent additional defacement and damage to the formed surface.

400-15.2 Surface Finishes:

400-15.2.1 General: In addition to the general surface work specified for all exposed concrete surfaces, the Engineer may require one of the classes of surface finish listed below. For all such exposed surfaces, begin finish work for the applicable class specified, along with the general finish work, immediately after removal of the forms. In order to further ensure the required quality of the finish, remove forms no later than the minimum time specified for the forms to remain in place. Satisfactorily repair finished concrete surfaces which are subsequently disfigured or discolored at no expense to the Department.

Provide the required class of surface finish for the various items of structural concrete as shown in the plans.

400-15.2.2 Class 1 Surface Finish: As soon as the pointing has sufficiently set, thoroughly saturate the exposed surfaces with water, and rub them with a medium coarse carborundum stone. Continue rubbing until the surface has been ground to a paste and remove all form marks, irregularities, and projections. In this process, do not introduce any additive material other than water. After the rubbing has produced a smooth surface of uniform color, allow the material which has been ground to a paste to reset under proper curing conditions. Subsequently, as a second operation, re-saturate the concrete surfaces with water, and thoroughly rub them with a fine carborundum stone. Continue this rubbing until the surface has a smooth, fine grain texture of uniform color.

The Contractor may substitute a Class 5 applied finish coating in accordance with 400-15.2.6 as an alternate surface finish on all areas where Class 1 surface finish is specified.

400-15.2.3 Class 2 Surface Finish: As soon as pointing has sufficiently set, thoroughly saturate the exposed concrete surfaces with water and rub them with a medium coarse carborundum stone. Continue rubbing until the surface has been ground to a paste and remove all form marks, irregularities, and projections. In this process, do not introduce any additive material other than water.

After rubbing has produced a smooth surface finish, of uniform color, carefully brush the material which has been ground to a paste to a uniform texture, and allow it to reset under proper curing conditions. Carefully protect these surfaces from disfigurement and discoloration during subsequent construction operations.

400-15.2.4 Class 3 Surface Finish: Where this surface finish is specified, use metal forms or timber forms with a form liner. Where specified or required on the plans, use No. 89 coarse aggregate for concrete.

After concrete has been placed in the forms and compacted, finish all exposed surfaces which are not contained by the forms to produce a surface texture as nearly equal to that produced by the form as practicable. Generally, finish unformed surfaces to a smooth, dense surface with a steel trowel.

Perform all work, including general surface finish work, in a manner that will preserve the same surface texture and color produced by the form. Pointed areas may be rubbed with a dry carborundum stone.

400-15.2.5 Class 4 Floor Finish:

400-15.2.5.1 General: Apply a Class 4 finish on bridge decks and concrete approach slabs. On Short Bridges (bridges and approach slabs having a combined length less than or equal to 300 feet [100 m]), meet the finish and smoothness requirements of 400-15.2.5.2 and 400-15.2.5.3. On Long Bridges (bridges and approach slabs having a combined length greater than 300 feet [100 m]), meet the finish and smoothness requirements of 400-15.2.5.2 and 400-15.2.5.4. After meeting the curing requirements of 400-16 and the smoothness requirements, herein, groove the bridge deck and approach slab. Do not install expansion joints, except open joints, until the smoothness criteria has been met and accepted by the Engineer.

Meet the finish and smoothness requirements of 400-15.2.5.2 and 400-15.2.5.3 for all bridge widenings unless shown otherwise in the Contract Documents.

400-15.2.5.2 Plastic Finish and Surface Finish: After screeding is completed, check the surface of the plastic concrete with a 10 foot [3.048 m] straightedge, positioning and half-lapping the straightedge parallel to the centerline to cover the entire surface. Immediately correct deficiencies of more than χ inch [3 mm], measured as an ordinate between the surface and the straightedge.

Finish the concrete surface to a uniform texture using a burlap drag, fine bristle broom or float. Finish the deck to a smooth surface having a sandy texture without blemishes, marks or scratches deeper than 1/16 inch [1.6 mm]. Decks to be planed will not require a sandy texture, and blemishes, marks or scratches may be up to 3/16 inch [5 mm] in depth. All other finish requirements will apply.

400-15.2.5.3 Smoothness Requirements for Short Bridges (including approach slabs): Perform a final straightedge check with a 10 foot [3.048 m] straightedge, positioning and half-lapping the straightedge parallel to the centerline, approximately 5 feet [1.5 m] apart to cover the entire surface. Correct all irregularities greater than 3/16 inch [5 mm] measured as an ordinate to the straightedge, by grinding. Perform grinding by the abrasive method using hand or power tools or by machine, to leave a smooth surface within a χ inch [3 mm] tolerance.

400-15.2.5.4 Smoothness Evaluation, Bridges greater than 300 feet [100 m] in length (including approach slabs): Provide a smoothness evaluation of the completed bridge deck and concrete approach slab riding surfaces by a computerized Cox California-type profilograph in accordance with the criteria herein and FM 5-558. Furnish this evaluation through an independent provider approved by the Engineer, using equipment calibrated by the Engineer. The riding surfaces subject to this evaluation include all traffic lanes, all full width acceleration and deceleration lanes, and lanes planned for future use, on both the bridge deck and concrete approach slabs. For areas outside the traffic lanes, perform testing and meet the smoothness requirements for short bridges.

Prior to initial profilograph testing and grooving, complete work on the bridge deck, except for expansion joint installations. Throughly clean and clear the bridge deck and approach slab area to be evaluated for smoothness of all obstructions and provide the smoothness evaluation. Ensure that no radio transmissions or other activities that might disrupt the automated profilograph equipment are allowed during the evaluation.

Average the Profile Index Value for the bridge deck, including the concrete approach slabs, for the left and right wheel path of each lane. The maximum allowable Profile Index Value for acceptable smoothness is 10 inches per mile [158 mm per kilometer] utilizing the 0.2 inch [5 mm] blanking band. Apply this criteria to each 300 feet [100 m] of each lane. Additionally, correct individual bumps or depressions exceeding a cutoff height of 0.3 inch [7.6 mm] from a chord of 25 feet [7.620 m] (see ASTM E-1274) on the profilograph trace and ensure that the surface meets a 3 inch in 10 feet [6 mm in 3.048 m] straightedge check made transversely across the deck and approach slabs as determined necessary by the Engineer. Provide at least one profilograph test per bridge deck and approach slabs. A single test will occur only when the initial profilograph results satisfy all acceptance criteria. Provide additional profilograph testing as necessary following longitudinal planing and any other actions taken to improve smoothness, until a profile meeting the acceptance criteria is obtained.

For bridges that do not pass the profilograph smoothness criteria given above, longitudinally plane the entire bridge deck and concrete approach slab surfaces using a self-propelled grinding machine with gang mounted diamond saw cutting blades specifically designed for such work. Use a machine with a minimum wheel base length of 15 feet [4.57 m], constructed and operated in such manner that it does not cause strain or damage to the deck surface, excessive ravels, aggregate fractures or spalling. The equipment shall be approved by the Engineer. Perform longitudinal planing parallel to the roadway centerline, and provide a consistent, textured surface that will meet or exceed the profilograph smoothness criteria. Clean the surface of all slurry/debris generated during this work concurrently with operation of the machine. Control the work to limit surface removal by all passes of the longitudinal planing equipment and any other grinding to a total maximum depth of 2 inch [13 mm].

After planing, reevaluate the pavement smoothness using the profilograph testing described above. Perform additional retesting with the same equipment if further corrective measures are necessary.

400-15.2.5.5 Grooving: After the concrete surface profile has been accepted by the Engineer, and prior to opening the bridge to traffic, groove the bridge deck and approach slabs perpendicular to the centerline of the structure. Cut grooves into the hardened concrete using a mechanical saw device which will leave grooves nominally χ inch [3 mm] wide and 3/16 inch [5 mm] deep. Space the grooves apart in random spacing center of grooves in the following sequence: : inch [20 mm], 1χ inch [30 mm], ε inch [15 mm], 1 inch [25 mm], ε inch [15 mm], 1χ inch [30 mm], : inch [20 mm] in 6 inch [150 mm] repetitions across the width to be grooved in one pass of the mechanical saw device. One 6 inch [150 mm] sequence may be adjusted by 3 sequence increments to accommodate various cutting head widths provided the general pattern is carried out. The tolerance for the width of the grooves is +1/16 to - 0 inch [+1.6 to - 0 mm] and the tolerance for the depth of grooves is ∀1/16 inch [∀1.6 mm]. The tolerance for the spacing of the grooves is ∀1/16 inch [∀1.6 mm].

Cut grooves continuously across the deck or approach slab to within 18 inches [450 mm] of gutter lines at barrier rail, curb line and median divider. At skewed metal expansion joints in bridge deck surfaces, adjust groove cutting by using narrow width cutting heads so that all grooves of the bridge deck surface or approach slab surface end within 6 inches [150 mm], measured normal to centerline of the joint, leaving no ungrooved surface adjacent to each side of the joint greater than 6 inches [150 mm] in width. Ensure that the minimum distance to the first groove, measured normal from the edge of the concrete joint or from the junction between the concrete and the metal leg of the armored joint angle, is 1 inch [25 mm]. Produce grooves that are continuous across construction joints or other joints in the concrete surface less than 2 inch [13 mm] wide. Apply the same procedure described above where the gutter lines at barrier rails, curb lines and median dividers are not parallel to the centerline of the bridge to maintain the 18 inches [450 mm] maximum dimension from the grooves to the gutter line. Cut grooves continuously across formed concrete joints.

400-15.2.6 Class 5 Applied Finish Coating:

400-15.2.6.1 General: Place an applied finish coating upon all concrete surfaces where the plans indicate Class 5 Applied Finish Coating. Apply the finish coating after completion of the general surface work specified for all exposed concrete surfaces. Select an Applied Finish Coating from the Departments Qualified Products List.

400-15.2.6.2 Material: For the coating material, use a commercial product designed specifically for this purpose. Use only coating material that is manufactured by one manufacturer and delivered to the job site in sealed containers bearing the manufacturer's original labels. Make available a copy of the manufacturer's printed instructions to the Engineer.

Use a coating material that, in the finished state, is capable of accommodating the thermal and elastic expansion ranges of the substrate without cracking.

400-15.2.6.3 Surface Preparation: Prepare the surface prior to the application of an applied finish coating by providing surface finish in accordance with the requirements of 400-15.1. The Engineer will not require air pockets that are 3 inch [6 mm] or less in width and depth to be grouted prior to application of the finish coating. Fill air pockets larger than 3 inch [6 mm] in width and depth with a grout composed of one part portland cement, two parts screened and washed sand graded to pass the 16 mesh [1.18 mm] sieve with not more than 5% retained on the 30 mesh [600 μm] sieve, and sufficient water to produce a thick liquid mix. As an alternate, a grout composed of the same materials used for the applied finish coating may be used. Apply the grout by filling the air pockets using burlap pads, float sponges, or other acceptable methods. As soon as the grout has taken its initial set, brush the surface to remove all loose grout, leaving the surface smooth and free of any air holes. Ensure that the surface to be coated is free from efflorescence, flaking coatings, dirt, oil, and other substances deleterious to the applied finish coating. Prior to application of the finish coating, prepare the surfaces in accordance with the manufacturer's recommendations, and ensure that they are in a condition consistent with the manufacturer's requirements.

400-15.2.6.4 Application: Apply the finish coating in a manner recommended by the manufacturer. When applying the finish coating by spraying, supply heavy duty spray equipment capable of maintaining a constant pressure necessary for proper application. Mix, apply, and cure all coating materials in accordance with the manufacturer's printed instructions. Apply the finished coating at a rate of 50 ∀ 10 ft^2/gal [1.25 ∀ 0.25 m^2/L].

400-15.2.6.5 Finished Product: Produce a texture of the completed finish coat that is generally similar to that of rubbed concrete. Ensure that the completed finished coating is tightly bonded to the structure and presents a uniform appearance and texture. If necessary, apply additional coats to produce the desired surface texture and uniformity.

Upon failure to adhere positively to the structure without chipping, flaking, or peeling, or to attain the desired surface appearance, remove coatings entirely from the structure, and reapply the finish coating after surface preparation until achieving the desired finished product. Do not allow the average thickness of the completed finish coating to exceed χ inch [3 mm].

400-15.2.6.6 Color: Use a color for the applied finish coating that is similar to Federal Color Standard No. 595B, Table VIII, Shade No. 36622 or as specified in the plans.

400-15.2.6.7 Material Tests and Certification: Before any portion of any shipment of finish coating is applied on the project, furnish the Engineer with a certificate from the manufacturer attesting that the commercial product furnished conforms to the same formula as that previously subjected to the tests specified below and approved. Attach copies of the current test reports to the certificate. The Engineer will not accept any test report for tests made more than four years prior to shipment to the project.

Ensure that all testing is performed by a qualified commercial testing laboratory acceptable to the Department.

The Contractor is responsible for the cost of testing necessary to provide material certification.

Prior to use of the applied finish coating on any structure, meet the requirements of the tests listed below:

(a) Freeze-Thaw Tests: Subject the applied finish coating to Freeze-Thaw Cycle Tests as follows:

(1) Cast and cure three concrete specimens, not less than 4 by 6 by 6 inches [102 by 152 by 152 mm], of the mix design for the structure. Moist cure the specimens for 14 days with a drying period in room air at 60 to 80EF [16 to 27EC] for 24 hours before coating the specimens with the applied finish.

Take caution that there is no excessive oil on specimen forms. Apply the finish coating to the sides of specimens (brush permitted) at a spreading rate of 50 ∀ 10 ft^2/gal [1.25 ∀ 0.25 m^2/L]. Cure cementitious coatings at room temperature and 50% relative humidity for 24 hours, at room temperature and 90% relative humidity for 48 hours, and at room temperature and 50% relative humidity for four days for a total cure of seven days. Cure other coatings at room temperature for 48 hours. After the completion of curing:

(2) Immerse in water at room temperature (60 to 80EF [16 to 27EC]) for three hours; remove and:

(3) Place in cold storage at -15E F [-26EC] for one hour; remove and;

(4) Thaw at room temperature (60 to 80EF [16 to 27EC]) for one hour.

(5) Repeat Steps three and four to complete a total of 50 cycles. At the end of 50 cycles Freeze-Thaw Test, verify that the specimens show no visible defects.

(b) Accelerated Weathering: Subject the applied finish coating to a 5000-hour exposure test in Twin-Carbon-Arc-Weather-ometer, ASTM G 23, Type D, at an operating temperature of 145EF [63EC]. Perform this test at

20-minute cycles consisting of 17 minutes of light and three minutes of water spray plus light. At the end of said exposure test, verify that the exposed samples show no chipping, flaking, or peeling. Prepare the panels for this test by applying the coating at a spreading rate of 50 ∀ 10 ft^2/gal [1.25 ∀ 0.25 m^2/L] to both sides and edges of panels cut from asbestos cement shingles conforming to Federal Specification SS-S-346, Type I. Use curing time as in (a).

(c) Fungus Growth Resistance: Ensure that the applied finish coating to be used passes a fungus resistance test as described by Federal Specification TT-P-29G with a minimum incubation period of 21 days where no growth is indicated after the test.

(d) Abrasion Resistance: Ensure that the applied finish coating to be used passes the 3000 L sand abrasion test, Federal Test Method Standard 141A Method 6191 Abrasion Resistance - Falling Sand.

Prepare the specimens for this test by applying the coating to a cleaned steel panel at a spreading rate of 50 ∀ 10 ft^2/gal [1.25 ∀ 0.25 m^2/L]. Cure at room temperature for 21 days.

(e) Impact Resistance: Apply the coating to a concrete panel prepared in accordance with Federal Test Method Standard 141A, Method 2051 at a spreading rate of 50 ∀ 10 ft^2/gal [1.25 ∀ 0.25 m^2/L], and allow it to cure for 21 days at room temperature. Then, run the test using the Gardner Mandrel Impact Tester and its method, applying an impact load of 24 inch-pounds [2.7 N≅m]. Verify that the coating shows no chipping under this impact load.

(f) Salt-Spray Resistance Test: Coat a concrete specimen with the applied finish coating at a rate of 50 ft^2/gal ∀ 10% [1.25 m^2/L ∀ 10%], and cure it for 21 days at room temperature.

Using ASTM B 117 test method, expose the coated specimen to a 5% salt solution for 300 hours where the atmospheric temperature is maintained at 90 ∀ 2EF [32 ∀ 1EC]. At the end of 300 hours of exposure, verify that the coating shows no ill effects, loss of adhesion or deterioration.

(g) Flexibility Test: Coat a sheet metal specimen with the applied finish coating at a rate of 50 ∀ 10 ft^2/gal [1.25 ∀ 0.25 m^2/L]. Bend the coated specimen 180 degrees over a 1 inch [25 mm] round mandrel. After bending, verify that the coating shows no breaking.

Supply a service record showing that the finish coating material has a satisfactory service record for a period of not less than five years prior to the date of submission of the service record and that the finish coating has shown satisfactory service characteristics without peeling, chipping, flaking, or nonuniform change in texture or color. Name a specific structure for the specific product for the service record.

In addition to the above, ensure that the manufacturer submits, for each batch of material used, the following product analysis data:

(a) Weight per gallon [liter].
(b) Viscosity [Consistency] (Krebs Units).
(c) Weight percent pigment.
(d) Weight percent vehicle solids.
(e) Infra-red spectra of vehicle solution.

400-15.2.7 Final Straightedging for Surfaces to Receive Asphaltic

Concrete Surface: Test the slab surfaces of poured-in-place floors which are to be surfaced with an asphaltic concrete wearing course for trueness with a 10 foot [3.048 m] straightedge, as specified above. As an exception, correct only irregularities of more than 3 inch [6 mm] measured as an ordinate (either above or below the general contour of the surface). The Engineer will not require belting or brooming of slabs that are to be surfaced with an asphaltic concrete wearing course. For curing, meet the requirements specified for other floor slabs.

400-15.2.8 Finishing Bridge Sidewalks: Provide bridge sidewalks, that are not finished in accordance with the requirements of Section 522, a Class 4 finish.

400-16 Curing Concrete.

400-16.1 General:

400-16.1.1 Methods and Curing Time: For surfaces other than bridge deck slabs on which forms are kept continuously in place, without loosening, for a period of 72 hours or more, the Engineer will not require further curing. For form removal from bridge deck slabs, meet the requirements of 400-14 or the following:

Bottom forms may be removed for bridge deck slabs after the concrete has attained at least 75% of the minimum 28-day strength as specified in 346-3.1 and a minimum curing time of 72 hours has occurred with the forms kept continuously in place, without loosening. Determine the concrete strength by procedure described in 400-14. Then, apply membrane curing compound in accordance with 400-16.1.2 no later than a two hour time period after form removal.

400-16.1.2 Curing Methods: For surfaces other than bridge deck slabs, continuous-moisture curing, steam curing, membrane curing compound, or an impervious covering for any concrete parts may be used. Mix membrane curing compound with a mechanically operated mixer immediately prior to each use to provide uniform consistency. Apply curing compound in accordance with the manufacturer's recommendations, subject to the rate of application specified herein. If curing compound is to be applied by spraying, use a compressor driven sprayer of sufficient size to provide uniform spray at the nozzle. Keep all nozzles clean, and ensure that they provide uniform mist. The Engineer will require standby equipment in case of mechanical failure. The Engineer will allow hand-held pump-up sprayers for standby equipment. However, do not use the hand held pump-up sprayers except in case of mechanical failure or for applying compound on Class I Concrete (non-pavement). If these requirements are not met, the Engineer will suspend further concrete placements until proper control is re-established. Apply membrane curing compound at a rate of at least one gallon to every 200 ft^2 [1 liter to every 5 m^2] of exposed surface to be cured. Provide a membrane curing compound and impervious covering that is continuous, flexible, and without defects and that retains the required moisture in the concrete.

Keep cover materials used in continuous moisture curing methods continuously wet for a period of 72 hours.

400-16.2 Curing Bridge Deck Slabs: Apply Type 2 membrane curing compound as specified in 925-2 to the exposed surfaces of slabs which are not formed immediately after finishing the concrete. The Engineer will not require further application of curing compound prior to placing the curing blankets.

Place curing blankets on all exposed surfaces which are not formed. Place them as soon as possible without affecting the surface texture. Place the curing blankets as approved by the Engineer, overlapping sufficiently to form an effective moisture seal. Before using curing blankets, mend tears, splits, or other damage that makes them unsuitable. Discard curing blankets that are not mendable. Use curing blankets consisting of polyethylene-coated blankets or quilted blankets of cotton, burlap, or other suitable water absorbent material weighing not less than 10 oz per yard, 40 inches wide [0.3 kg/m^2].

Ensure that polyethylene used for coating blankets is white opaque and has a minimum thickness of 0.004 inch [0.1 mm]. Ensure that it is securely bonded to the blanket material so that there will be no separation of the materials during handling and curing of the concrete. Use polyethylene coated blankets that have a maximum moisture loss of 0.11 lb/ft^2 [0.55 kg/m^2].

Wet all curing blankets immediately after satisfactorily placing them and maintain them in a saturated condition throughout the seven day curing period. Supply a sufficient quantity of fresh water at the job site for wetting the blankets.

Where a bridge deck slab is to be subjected to walking, wheeling, or other approved construction traffic within the seven day curing period, protect the curing blankets and the slab surface from damage by placing wooden sheeting, plywood or other approved protective material in the travel areas.

When the ends of the curing blankets are rolled back to permit screeding of adjacent bridge deck slabs, keep the exposed surfaces wet by spraying water throughout the period of exposure.

The Engineer will not consider surfaces of parapets, sidewalk, end post, and horizontal and vertical faces of curbs to be a part of the bridge deck slab, and the Contractor shall cure the surfaces as specified in 400-16.1.2.

400-16.3 Curing Construction Joints: Cure construction joints for 72 hours by leaving the form in place without loosening or by continuous-moisture curing. The Continuous-moisture curing of construction joint areas may be accomplished by: covering the joints with at least three layers of burlap or other water absorbent material and maintaining the same in a moist condition; covering the joints with a 12 inch [38 mm] deep layer of sand or sawdust and maintaining the same in a moist condition; or sealing the areas beneath with an impervious layer of plastic material and maintaining the sealed condition.

Cure construction joint areas by continuous-moisture curing or by leaving the form in place. Construction joint areas include, but are not limited to, those areas: at the top of footings; in pier columns; in bascule piers below the trunion elevation; and in pier crash walls and pier struts. As an exception to this requirement, construction joint surface areas may be cured where projecting reinforcing steel or other interferences cause continuous-moisture or form curing to be impractical for 72 hours with a clear membrane curing compound as specified in 400-16.1.2. Construction joint surface areas include, but are not limited to, those areas: beneath a barrier wall; at the tops of diaphragms; between the backwall and the wingwall of bent caps; in drainage inlets, manholes, and junction boxes; between curtain walls of bent and pier caps; in non-reinforced pipe endwalls; and between pedestals and the top of footings for signs and highmast lighting.

400-17 Protection of Concrete.

400-17.1 Opening to Traffic: Close concrete bridge floor and culverts to traffic for a period of at least 14 days after placing and for such additional times as deemed advisable. In the operation of placing, the Contractor may wheel concrete across previously poured slabs after they have set for 24 hours, provided plank runways are used to keep the loads over the beams.

400-17.2 Storing Materials on Bridge Slabs: Do not store heavy equipment or material, other than light forms or tools, on concrete bridge slabs until 14 days after they have been poured. For all stockpiles, tools, and equipment stored on bridge slabs at any time, obtain prior approval by the Department, and the Engineer will require any such stored materials or equipment to be dispersed in order to avoid overloading any structural part.

400-17.3 Time of Placing Superstructure: In the case of piers or bents with concrete caps, do not place the weight of the superstructure or of beams on the caps until they have reached the ages required in the following table:

Superstructure	Seven days
Beams	Three days

400-17.4 Alternate Procedure: As an alternate procedure, in lieu of the time delay periods set forth in 400-17.1 and 400-17.3, test beams may be cast from representative concrete and cure them identically with the concrete in the corresponding structural component. Test the test beams in accordance with FM 1-T 023 and FM 1-T 097. When the test results indicate a flexural strength of 550 psi [3.8 MPa] or more, concrete bridge floors and culverts may be opened to traffic and the superstructure and beams placed on caps.

400-18 Precast Planks, Slabs, and Girders.

400-18.1 General: Where so shown in the Contract Documents, the Contractor may construct concrete planks, slabs, girders, and other structural elements by precasting. In general, use a method that consists of casting structural elements in a casting yard, curing as specified in 400-16, transporting them to the site of the work, installing them on previously prepared supports and, where so shown in the plans, joining them with poured-in-place slabs or keys. Handle and install precast prestressed members as specified in Section 450.

400-18.2 Casting: Cast precast elements on unyielding beds or pallets. Use special care in casting the bearing surfaces on both the elements and their foundations in order that these surfaces shall coincide when installing the elements. Check bearing surfaces on casting beds with a level and a straightedge prior to the casting. Similarly check corresponding surfaces on the foundations during finishing operations.

400-18.3 Poured-in-Place Keys: Where precast elements are to be joined with poured-in-place keys, carefully align the elements prior to pouring the keys.

400-18.4 Surface Finish: Finish the surface as specified in 400-15, except that where precast slabs and poured-in-place keys form the riding surface, give the entire surface a broomed finish.

400-18.5 Moving, Placing, and Opening to Traffic: Reinforced precast members may be moved from casting beds, placed in the structure, and opened to traffic at the ages shown in the following table:

Handling from casting beds to storage areas	7 days
Placing in structure	14 days
Opening to traffic:	
Precast elements	14 days
Cast-in-place slabs over precast girders	14 days
Cast-in-place keys joining precast slabs	7 days

As an alternate procedure, in lieu of the time delay periods set forth above, test beams may be cast from representative concrete, and cure them identically with the concrete in the corresponding structural component. Test the test beams in accordance with FM 1-T 023 and FM 1-T 097. When the test results indicate a flexural strength of 550 psi [3.8 MPa], or more, any of the operations listed above may proceed without completing the corresponding time delay period.

400-18.6 Setting Prestressed Slabs: Before permitting construction equipment on the bridge to erect slab units, submit sketches showing axle loads and spacing and a description of the intended method of setting slab units to the Engineer for approval. Do not use axle loads, spacing, and methods of setting which produce stresses in the slab units greater than the allowable stress.

400-18.7 Protection of Precast Elements: The Contractor is responsible for the safety of precast elements during all stages of construction. The Engineer will reject any precast elements that become cracked, broken, seriously spalled, or structurally impaired. Remove rejected precast elements from the work at no expense to the Department.

400-18.8 Form Material: Form material used to form hollow cores may be left in place. Ensure that the form material is neutral with respect to the generating of products harmful to the physical and structural properties of the concrete. The Contractor is responsible for any detrimental effects resulting from the presence of the form material within the precast element.

400-19 Cleaning and Coating Concrete Surfaces.

Water blast and coat existing concrete surfaces as shown in the plans. Use water blast equipment producing a minimum working pressure of 750 psi [5 Mpa] with a gauge at or near the nozzle to confirm the working pressure. Apply a Class 5 Applied Finish Coating unless otherwise directed in the plans.

400-20 Approach Slabs.

Construct approach slabs at the bridge ends in accordance with the applicable requirements of Section 350 using Class II (Bridge Deck) concrete. Place the reinforcement as specified in 350-7 and Section 415.

The approach slab may be opened to traffic, vehicular or construction equipment, 14 days after concrete placement or after the prescribed curing period has elapsed and the concrete has attained the required 28 day cylinder strength.

400-21 Classification of Cracks in Concrete Structures to be Sealed.

Cracks are classified as structural and nonstructural. Do not seal or repair structural cracks without having a repair procedure approved in advance by the Engineer. Seal nonstructural cracks in accordance with the criteria listed in Table I below. Structural cracks are those which are induced by external forces which produce internal stresses exceeding the tensile strength of the concrete, commonly referred to as working cracks, and those caused by overloads. Nonstructural cracks are those which appear as a result of atmospheric effects and localized constraint effects, commonly called shrinkage cracks. In any case, the Engineer will determine the classification of cracks.

Table I

Criteria for Sealing Nonstructural Cracks During Construction

Environment (*4)	Crack Width	Location (*2)	Treatment (*3) (*1)
Extremely Aggressive	Less than 0.006 in. [0.15 mm]	Substructure and Superstructure	Coat with penetrant sealer
	Greater than 0.006 in. [0.15 mm] and less than 0.012 in. [0.30 mm]	Substructure including Superstructure less than 18 feet [5.5 m] above existing ground or high water elevation	Epoxy injection
		Superstructure including Substructure more than 18 feet [5.5 m] above existing ground or high water elevation	Coat with penetrant sealer
	Greater than 0.012 in. [0.30 mm] and less than 0.025 in. [0.60 mm]	Substructure and Superstructure	Epoxy injection
Moderately Aggressive	Less than 0.006 in. [0.15 mm]	Substructure and Superstructure	No treatment
	Greater than 0.006 in. [0.15 mm] and less than 0.012 in. [0.30 mm]	Substructure including Superstructure less than 18 ft [5.5 m] above existing ground or high water elevation	Coat with penetrant sealer
		Superstructure including Substructure more than 18 ft [5.5 m] above existing ground	No treatment

		or high water elevation	
	Greater than 0.012 in. [0.30 mm] and less than 0.025 in. [0.60 mm]	Substructure and Superstructure	Coat with penetrant sealer
Slightly Aggressive	Less than 0.025 in. [0.60 mm]	All locations	No treatment

Notes: (*1) Cracks greater than 0.025 inch [0.60 mm] require individual investigation. Report these cracks to the Engineer for initiation of an investigation.

(*2) When the substructure crack elevation is 18 feet [5.5 m] above the high water elevation or ground level, use the same method of treatment as the superstructure for that environment.

(*3) (a) Perform epoxy injection of cracks in accordance with Section 411. Apply penetrant sealers in accordance with Section 413. Select materials used for sealing and for epoxy injection from the Department's Qualified Products List.

(b) Use penetrant sealers to repair cracks that are compatible with previously applied materials.

(c) Use sealers to repair riding surfaces that are designated for that purpose.

(d) The Contractor may also repair riding surfaces of bridge decks with a methacrylate sealer for crack widths greater than 0.006 inch [0.15 mm] in extremely aggressive environments.

(e) Clean for epoxy injection in compliance with Section 411. Clean for penetrant sealer application in compliance with Section 413.

(f) Recoat cracks which reopen after the initial application of penetrant sealer with penetrant sealer.

(*4) Investigate cracks which occur underwater prior to treatment.

Seal cracks determined by the Engineer to be excessive due to inadequate curing effort or inadequate construction practice at no expense to the Department. Seal all other cracks occurring in concrete in accordance with the above and Sections 411 and 413. When such work is authorized by the Engineer, the Department will pay for the work under the appropriate pay items contained in Sections 411 and 413.

Prepare the surface, clean the surface, and apply the sealant in accordance with the sealant material manufacturer's recommendations.

400-22 Method of Measurement.

400-22.1 General: The quantities of concrete to be paid for will be the volume, in cubic yards [cubic meters], of each of the various classes shown in the plans, in place, completed and accepted. The quantity of Traffic Railing Barrier and Pedestrian/Bicycle Parapet to be paid for will be the length, in feet [meters], completed and accepted. The quantity of precast anchor beams to be paid for will be the number in place and accepted. The quantity of bridge floor grooving to be paid for will be the area, in square yards [square meters] of bridge deck and approach slab, completed and accepted.

Except for concrete barriers, parapets and precast anchor beams, for any item of work constructed under this Section and for which measurement for payment is not to be made by the volume of concrete, measurement and payment for such work will be as specified in the Section under which the work is specified in detail.

No separate payment will be made for obtaining the required concrete finish.

400-22.2 Calculation of Volume of Concrete:

400-22.2.1 Dimensions: The quantity will be computed by the plan dimensions of the concrete, within the neat lines shown in the plans, except that no deduction will be made for weep holes, floor drains, or encroachment of inlets and pipes in box culverts, and no chamfers, scorings, fillets, or radii 12 in^2 [970 mm^2] or less in cross-sectional area will be taken into account.

400-22.2.2 Pay Quantity: The quantity to be paid for will be the original plan quantity, measured as provided in 400-22.2.1, except that where the plans call for an estimated quantity of miscellaneous concrete for contingent use, the contingent concrete will be measured as the actual quantity in place and accepted.

400-22.2.3 Items not Included in Measurement for Payment: No measurements or other allowances will be made for work or material for forms, falsework, cofferdams, pumping, bracing, expansion-joint material, etc. The volume of all materials embedded in the concrete, such as structural steel, pile heads, etc., except reinforcing steel, will be deducted when computing the volume of concrete to be paid for. For each foot [meter] of timber pile embedded, 0.8 ft^3 [0.074 m^3] of concrete will be deducted. The cost of furnishing and placing dowel bars shall be included in the Contract unit price for the concrete.

400-22.2.4 Deck Girders and Beam Spans: In computing the volume of concrete in deck girders and beam spans, the thickness of the slab will be taken as the nominal thickness shown on the drawings and the width will be taken as the horizontal distance measured across the roadway. The volume of haunches over beams will be included in the volume to be paid for.

400-22.2.5 Stay-in-Place Metal Forms: When using stay-in-place metal forms to form the slab of deck girder and beam spans, the volume of concrete will be computed in accordance with the provisions of 400-20.2.4 except that the thickness of the slab over the projected plan area of the stay-in-place metal forms will be taken as the thickness shown on the drawings above the top surface of the forms. The concrete required to fill the form flutes will not be included in the volume of concrete thus computed.

400-22.3 Traffic Railing Barrier and Pedestrian/Bicycle Parapets: The quantity will be computed by the plan quantity including the transitional sections and end sections where shown on the plans and including the volume occupied by expansion or open joints, not in excess of 1 inch [25 mm] in width.

400-22.4 Bridge Floor Grooving: The quantity will be computed by measurement of the area bounded by the gutter lines (at barrier rails, curbs and median dividers) and the beginning and end of the bridge or the end of approach slabs, whichever is applicable.

400-22.5 Composite Neoprene Pads: The quantity to be paid for will be the original plan quantity, computed using the dimensions of the pads shown in the plans.

400-22.6 Cleaning and Coating Concrete Surfaces: The quantity to be paid for will be the plan quantity in square feet [square meters] for the areas shown in the plans.

400-23 Basis of Payment.

400-23.1 Concrete:

400-23.1.1 General: Price and payment will be full compensation for each of the various classes of concrete shown in the proposal.

400-23.1.2 Concrete Placed below Plan Depth: Authorized concrete placed in seal or footings 5 feet [1.5 m] or less below the elevation of bottom of seal or footing as shown in the plans will be paid for at the Contract price set forth in the proposal under the pay items for substructure concrete.

Authorized concrete used in seal (or in the substructure where no seal is used) at a depth greater than 5 feet [1.5 m] below the bottom of seal or footing as shown in the plans will be paid for as Unforeseeable Work.

Such payment will be full compensation for the cofferdam construction, for excavation, and for all other expenses caused by the lowering of the footings.

400-23.1.3 Seal Concrete Required but Not Shown in Plans: When seal concrete is required as provided in 400-8 and there is no seal concrete shown in the plans, it will be paid for as Unforeseeable Work.

400-23.2 Traffic Railing Barrier and Pedestrian/Bicycle Parapets: The quantity, as determined in 400-22.3, will be paid for at the Contract unit price per foot [meter] for Traffic Railing Barrier or Pedestrian/Bicycle Parapets. Price and payment will include the furnishing and placing all concrete and reinforcing steel contained in the railing/parapet.

400-23.3 Precast Anchor Beams: Price and payment will be full compensation for the beams, including all reinforcing steel and materials necessary to complete the beams in place and accepted.

No separate prices will be allowed for the various types of anchor beams.

400-23.4 Reinforcing Steel: Reinforcing steel will be measured and paid for as provided in Section 415, except that no separate payment will be made for the fabric reinforcement used in concrete jackets on steel piles or reinforcement contained in barriers, traffic separators or parapets. Where so indicated in the plans, the Department will not separately pay for reinforcing steel used in incidental concrete work, but the cost of such reinforcement shall be included in the Contract unit price for the concrete.

400-23.5 Bridge Floor Grooving: Price and payment will be full compensation for all grinding, grooving, equipment, labor, and material required to complete the work in an acceptable manner.

400-23.6 Composite Neoprene Pads: Price and payment will be full compensation for all work and materials required to complete installation of the pads.

400-23.7 Cleaning and Coating Concrete Surfaces: Price and payment will be full compensation for all work and materials required. The cost of coating new concrete will not be paid for separately, but will be included in the cost of the item to which it is applied.

400-23.8 General: The above prices and payments will be full compensation for all work specified in this Section, including all forms, falsework, joints, weep holes, drains, pipes, conduits, bearing pads, setting anchor bolts and dowels, surface finish, and cleaning up, as shown in the plans or as directed. Where the plans call for water stops, include the cost of the water stops in the Contract unit price for the concrete.

Unless payment is provided under a separate item in the proposal, the above prices and payments will also include all clearing and grubbing; removal of existing structures; excavation, as provided in Section 125; and expansion joint angles and bolts.

The Department will not change the rate of payment for the various classes of concrete in which steel may be used due to the addition or reduction of reinforcing steel.

The Department will not make an allowance for cofferdams, pumping, bracing, or other materials or equipment not becoming a part of the finished structure. The Department will not pay for concrete placed outside the neat lines as shown in the plans.

When using stay-in-place metal forms to form bridge floors, the forms, concrete required to fill the form flutes, attachments, supports, shoring, accessories, and all miscellaneous items or work required to install the forms shall be included in the Contract unit price of the superstructure concrete.

400-23.9 Payment Items: Payment will be made under:

Item No. 400- 1- Class I Concrete - per cubic yard.
Item No. 2400- 1- Class I Concrete - per cubic meter.
Item No. 400- 2- Class II Concrete - per cubic yard.
Item No. 2400- 2- Class II Concrete - per cubic meter.
Item No. 400- 3- Class III Concrete - per cubic yard.
Item No. 2400- 3- Class III Concrete - per cubic meter.
Item No. 400- 4- Class IV Concrete - per cubic yard.
Item No. 2400- 4- Class IV Concrete - per cubic meter.
Item No. 400- 6- Precast Anchor Beams - each.
Item No. 2400- 6- Precast Anchor Beams - each.
Item No. 400- 7- Bridge Floor Grooving - per square yard.
Item No. 2400- 7- Bridge Floor Grooving - per square meter.
Item No. 400-143- Cleaning and Coating Concrete Surfaces - per square foot.
Item No. 2400-143- Cleaning and Coating Concrete Surfaces - per square meter.
Item No. 400-147- Composite Neoprene Pads - per cubic foot.
Item No. 2400-147- Composite Neoprene Pads - per cubic meter.
Item No. 400-148- Traffic Railing - per foot.
Item No. 2400-148- Traffic Railing - per meter.
Item No. 400-160- Pedestrian/Bicycle Parapet - per foot.
Item No. 2400-160- Pedestrian/Bicycle Parapet - per meter.

SECTION 407

THREE-SIDED PRECAST CULVERT

407-1 Description.

Design and construct a three-sided precast culvert as an alternative to the structure shown in the plans.

407-2 Materials.

Meet the following requirements:

Shop Drawings 5-1
Portland Cement Concrete..Section 346
Reinforcing Steel ....Section 415
Riprap ....Section 530
Non-Shrink Grout..Section 934
Filter Fabric ....Section 985

407-3 Limitations on Use.

Do not use three-sided precast culverts at locations with an Extremely or Moderately Aggressive Environmental classification. Also, do not use a three-sided precast culvert to extend the inlets of existing multi-cell culverts due to the potential for clogging with debris.

407-4 Design Requirements.

Provide a design that complies with the requirements of the AASHTO Standard Specifications for Highway Bridges and the Structures Design Guidelines, current at the time of letting. Use a design load of HS-25 [MS-22.5]. In addition, ensure that a hydraulic analysis and scour evaluation is completed, signed, and sealed by the Specialty Engineer, and submitted to the Engineer. Line the channel between footings with either a cast-in-place reinforced concrete slab with a toe wall at the inlet and outlet end of the structure, a blanket of rubble riprap with a minimum thickness of 18 inches [450 mm], or similar treatment. Use a concrete slab with a minimum thickness of 6 inches [15 mm] and with toe walls that have a minimum depth of 30 inches [750 mm]. Use lining designed to withstand the hydraulic forces and extend the lining beyond the ends of the structure a minimum of 10 feet [3 m].

Ensure that the bottom of spread footings are a minimum of 30 inches [750 mm] below the bottom of the channel lining.

407-5 Dimensional Tolerances.

Meet the following plan dimension tolerances:

Internal dimensions .... ∀0.5 inch [∀13 mm]
Haunch radius...∀1 inch [∀25 mm
Slab and wall thickness ....-1/4 inch, +1/2 inch [-6 mm, +13 mm]
Laying lengths of two opposite surfaces
of a precast unit.. ∀1 inch [∀25 mm]
Underrun in length of a section .... 1 inch [25 mm]

Reinforcing steel areas greater than specified in the shop drawings will be acceptable.

407-6 Joints.

Produce the precast units with keyways at the adjoining surfaces or with butt joints between adjacent units. In the keyways, use a non-shrinking grout listed on the Qualified Products List. Design and construct the adjoining surfaces so that when placed together, they make a continuous line of units with a smooth interior free of appreciable irregularities within the tolerance permitted. Seal all joints between precast units with a bituminous seal and cover with a strip of filter fabric adhered to the precast unit. Ensure that the filter fabric strip is a minimum of 24 inches [600 mm] wide and meets the requirements of Section 985. Obtain the Engineer's approval of the adhesive used. The Contractor may use an alternate joint sealant using a low modulus silicone sealant if approved on the shop drawings. Exercise care during backfilling to prevent damage to the filter fabric.

Construct headwalls, wingwalls, and other special features in place or as detailed on the shop drawings. Leave sufficient steel exposed in end units for connection of endwalls and cast-in-place sections.

407-7 Handling.

Use handling devices or holes in each unit for the purpose of handling and laying. Remove the handling devices and fill all holes with non-shrink grout after erection, as approved by the Engineer.

407-8 Marking.

Clearly mark the following information on the interior of each precast unit by indention, water proof paint, or other approved method: span, rise, skew angle, date of manufacture, name or trademark of manufacturer, and design earth cover.

407-9 Construction Requirements.

Prior to constructing the footing, prepare the bearing soil in accordance with Section 455. If a precast concrete footing is used, prepare a 4 inch [100 mm] thick layer of compacted granular material to a minimum width of 12 inches [300 mm] outside the footing width. Accomplish all footing construction in the dry as defined in 455-15.2. Use dewatering devices that are capable of maintaining a stable as well as surface dry trench bottom.

Form a 3 inch [75 mm] deep key in the top surface of the footing 4 inches [100 mm] wider than the wall thickness. Ensure that footings reach a compressive strength of 3,000 psi [20 MPa] before placing precast units.

Place the units as shown in the shop drawings. Carefully set the structure to the true line and grade. Set the units in a bed of mortar placed in the keyway in the top of the footing. Fill the keyway with mortar, and float the mortar flush with the top of the footing or use shims between the footer and culvert during setting, then inject grout under the culvert walls.

Carefully place backfill against the filter fabric and bituminous seal to avoid damage to the material. Use mechanical tampers or approved compacting equipment to compact all backfill and embankment immediately adjacent to each side of the structure. Place the backfill within 4 feet [1.2 m] of each side of the structure in lifts of 8 inches [200 mm] or less (loose depth). Do not operate heavy compaction equipment within 4 feet [1.2 m] of the structure. Ensure that the backfill elevation differential between both sides of the structure does not exceed 24 inches [600 mm]. Carry backfill in front of wingwalls to ground lines shown in the plans.

407-10 Basis of Payment.

Payment for the alternative three-sided precast culvert will be at the price bid for the sum of the items included in the structure shown in the design plans.

Price and payment will be full compensation for all work and materials specified in this Section necessary to complete the structure, including dewatering, excavation, channel excavation, channel lining, backfilling, and other miscellaneous items.

SECTION 410

PRECAST CONCRETE BOX CULVERT

410-1 Description.

Construct precast concrete box culverts. Submit details of special units, modifications, and required devices for approval to the Engineer prior to manufacturing.

410-2 Materials.

Meet the requirements of AASHTO M 259 [AASHTO M 259M] for installations with cover greater than 2 feet [0.6 m] and AASHTO M 273 [AASHTO M 273M] for installations with less than 2 feet [0.6 m] of cover. The plans will note the appropriate table for the AASHTO specification to be used. Design the precast box culvert section for the same live load, hydraulic opening, fill height, and reinforcing steel cover as the plan details using the section dimensions shown in the appropriate tables in the AASHTO specifications. Alternatively, in lieu of a redesign, design the precast box culvert section identical to plan details including reinforcing steel quantity, grade and cover, concrete class, and slab and wall thicknesses. Ensure that a Specialty Engineer performs any redesign of the box culvert and signs and seals the plans. When used with headwalls and other special features, provide special precast end sections having exposed reinforcement for tying headwall reinforcing steel. The Engineer will not allow field cutting of the sections for the purpose of exposing reinforcement.

410-3 Trench, Foundation, Laying, and Backfill.

For the methods of construction of trench and foundation, and for laying and backfilling, meet the requirements specified in Section 430, and the following:

Lay all precast box culvert sections on a dry, unyielding foundation. Provide dewatering devices capable of maintaining a stable as well as surface dry trench bottom. Provide bedding that consists of a minimum 6 inch [150 mm] depth of coarse concrete sand or other suitable granular material placed below the culvert to a minimum width of 12 inches [300 mm] outside the exterior walls of the culvert. Set grade forms 12 inches [300 mm] outside each exterior wall of the box culvert. Uniformly compact this material as required in 120-9.3, and then grade off using the forms. Set the grade forms approximately χ to 3 inch [3 to 6 mm] above the theoretical grade line to allow for soil compression. Adjust this distance to yield the proper grade, but do not use in lieu of the proper compaction of the granular bedding material. Remove the forms after placing the precast box culvert section. When required by the plans, provide other special bedding. Obtain the Engineer's approval of the method of controlling line and grade during culvert installation. Use a method that allows rapid checking of the previously laid sections. Maintain line and grade on sections previously set. The Engineer will consider sections which do not retain the plan line (within 0.10 foot [30 mm]) or grade (within 0.10 foot [30 mm]) during laying of subsequent sections as not having been laid to line and grade. Take up and relay sections not to line and grade without additional compensation. Begin backfilling only after the Engineer determines that the culvert sections are to line and grade and will not be affected by subsequent laying procedures. Seal holes provided for lifting or joint restraint by plugging using a non-shrinking mortar in accordance with 450-11.2, and properly cure to ensure a sound and watertight plug.

410-4 Joints.

Make field joints for precast concrete box culvert sections with a butyl rubber based preformed plastic gasket material or as detailed in the plans. For culverts to be laid with joints made from preformed plastic gasket material, meet the requirements outlined in 430-7.3, and the following:

Furnish to the Engineer a written recommendation of the size (cross-sectional area) of gasket material which will create a watertight seal. Ensure that this amount is the minimum quantity of gasket material used.

In addition, completely wrap the outside of each joint with either a woven or non-woven filter fabric. Use fabric having a minimum width of 2 feet [0.6 m] and secure the fabric tightly against the box culvert section with metal strapping. The Contractor may use other methods which, in the opinion of the Engineer, would hold the fabric securely against the wall of the culvert until the Contractor places and compacts the backfill. When specified in the plans, secure the joint by a suitable device capable of holding the sections to line and grade as well as fully home. Remove these devices after placing and compacting sufficient backfill to secure the sections.

Construct headwalls and other special features in place, leaving a sufficient length of steel exposed for connection to endwalls or cast-in-place sections.

410-5 Method of Measurement.

The quantity to be paid for will be the length, in feet [meters], installed in place, completed and accepted, measured along the centerline of the structure, from end to end with proper deduction in length for cast-in-place headwalls or other cast-in-place sections. As an exception to the deduction in length requirement, short cast-in-place sections which are used in lieu of standard field joints as specified in 410-4 will not be deducted. Measurement for multiple barrel precast box culvert installations will be the total of measurements along each barrel.

410-6 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section, including the cost of the special bedding material and its placement, graded forms, sealing hoses, preformed plastic gasket material, filter fabric material, attachment of the filter fabric, and restraining devices when required. The price will also include all excavation except the volume included in the items for the grading work specified for separate payment in Section 125.

Cast-in-place transitions and headwalls will be paid for under the pay items for concrete (culverts) and reinforcing steel (roadway).

As an exception to the above, when precast construction of a concrete box culvert is substituted for cast-in-place construction, payment will be made for concrete and steel at the Contract unit prices. Prices and payments will be full compensation for all work specified herein. The quantities to be paid for will be those quantities which would be paid for if cast-in-place construction was utilized.

Payment will be made under:

Item No. 410- 70- Precast Concrete Box Culvert - per foot.
Item No. 2410- 70- Precast Concrete Box Culvert - per meter.

SECTION 411

EPOXY INJECTION OF CRACKS

IN CONCRETE STRUCTURES

411-1 Description.

Inject epoxy into cracks in portland cement concrete.

411-2 Materials.

Meet the requirements of Section 926 and as follows:

Use Type E compound epoxy for injection.

Use Type F-1 compound epoxy for sealing crack surfaces in preparation for injection.

Use epoxy materials on the Qualified Products List.

411-3 Equipment.

For the equipment used to inject the epoxy, meet the recommendations of the epoxy injection material manufacturer and the following requirements:

(1) Use equipment that has the capacity to automatically proportion the material components within the mix ratio tolerances set by the epoxy materials manufacturer.

(2) Use equipment that has the capacity to automatically mix the epoxy component materials within the pump and injection apparatus. The Engineer will not allow batch mixing.

(3) Use equipment that has the capacity to inject the epoxy resin under controlled variable pressures up to 200 psi [1.4 MPa], with a pressure gauge mounted at or near the nozzle to indicate the actual working pressure.

411-4 Injection Personnel Qualifications.

Employ personnel trained in performing injection work similar to that required for the project to carry out the epoxy injection of cracks in concrete. Provide an on-site supervisor for the epoxy injection work who is qualified by one of the following methods:

(1) Certified by the manufacturer of the epoxy injection material as having the necessary competence to accomplish the epoxy injection work in a satisfactory and safe manner in compliance with these Specifications.

(2) He can furnish documented evidence that he has a minimum of three years experience of on-site supervision of similar epoxy injection work and a list of five contracts in which similar epoxy injection was acceptably completed. Ensure that the listed experience in on-site supervision and completed contracts contains the project name and location, names of contracting parties, the owner's name, brief description of the work, and dates of completion of the epoxy injection work.

Furnish written evidence showing personnel training and the on-site supervisor's qualification to the Department prior to beginning any epoxy injection work.

411-5 Crack Surface Preparation and Cleaning Requirements.

Clean the area surrounding the cracks of all deteriorated concrete, efflorescence and other contaminants detrimental to the adhesion of the surface sealing epoxy compound. Clean the interiors of the cracks with air under sufficient pressure to remove loose materials entrapped within the crack including efflorescence.

411-6 Sealing Cracks for Epoxy Injection.

After cleaning, drill injection port holes using a swivel drill chuck and hollow drill bits, including a vacuum attachment which will remove dust and debris generated during drilling. Determine the spacing of the injection port holes by the size of the crack and the depth of the crack in the concrete substrate. Generally, space the injection ports from 4 to 8 inches [100 to 200 mm] apart. Determine the actual spacing of injection ports by field trials. Drill the holes to a minimum depth of ε inch [16 mm], exercising care in aligning the hole along the plane of the crack so that the hole follows the crack for the full ε inch [16 mm] depth.

Insert the injection ports in the drilled holes approximately 2 inch [13 mm], allowing for a small reservoir below the injection port.

After cleaning the cracks and drilling the injection port holes, seal the crack surface and the injection ports with suitable epoxy.

411-7 Epoxy Injection.

Inject the epoxy in accordance with the epoxy manufacturer's instructions. Determine the actual injection procedures and pressures in field trials, based on crack widths and depth into the substrate and sufficiency of the results.

411-8 Cleaning After Epoxy Injection.

Clean concrete surface areas of excess epoxy materials and injection ports after completing the epoxy injection work. Clean in a manner which will not damage the concrete by scraping, light sand blasting, grinding, use of solvents, or any other appropriate method approved by the Engineer. Clean excess materials so that no epoxy material or injection ports extend beyond the plane surface of the concrete.

411-9 Acceptance.

Drill three cores located in each day's work as directed by the Engineer. Take drilled core samples containing representative crack sizes. The Engineer will accept the epoxy injection work represented by the core samples when the core samples indicate that 90% of the crack void greater than 0.006 inch [0.15 mm] wide is filled with epoxy resin and the concrete of the core sample is bonded through the crack into a unit.

Reinject epoxy injection work which does not satisfy the acceptance criteria, and correct it as necessary at no expense to the Department. Install additional injection ports as required to achieve satisfactory reinjection of epoxy resin.

After the epoxy injection work is completed and accepted, fill the core holes with an epoxy mortar consisting of one part by volume epoxy injection resin and four parts by volume clean, dry sand. Supply the sand in moisture proof bags. Do not use previously opened bags of sand for making epoxy mortar. The Contractor may use one part by volume epoxy material for sealing with one part by volume clean, dry sand in lieu of the above.

411-10 Method of Measurement.

411-10.1 Epoxy Material. The quantity to be paid will be the volume, in gallons [liters], authorized, injected, and accepted.

411-10.2 Inject and Seal Crack. The quantity to be paid will be the length, in feet [meters], authorized and accepted, measured along the approximate centerline of the sealed crack.

411-11 Basis of Payment.

411-11.1 Epoxy Material. Price and payment will be full compensation for all work specified in this Section, including furnishing the epoxy material, and miscellaneous related costs, storage, handling, etc.

411-11.2 Inject and Seal Crack. Price and payment will constitute full compensation for furnishing all labor, equipment, incidentals and materials (except epoxy), for cleaning and sealing the crack, and all labor and equipment for injecting the crack.

411-11.3 Payment Items. Payment will be made under:

Item No. 400-134- Epoxy Material - per gallon.
Item No. 2400-134- Epoxy Material - per liter.
Item No. 400-135- Inject and Seal Crack - per foot.
Item No. 2400-135- Inject and Seal Crack - per meter.

SECTION 413

SEALING CONCRETE STRUCTURE SURFACES

413-1 Description.

Perform surface preparation and application of a penetrant sealer to all exposed concrete surfaces as the project plans designate in accordance with the manufacturer's recommendations and these Specifications.

413-2 Materials.

For penetrant sealer, use a silane/siloxane sealer listed on the Qualified Products List as a "High Performance Penetrant Sealer".

Penetrant sealers are qualified in accordance with FM 5-522 and have time-to-failure of not less than 50 days.

413-3 Surface Preparation.

413-3.1 General: Prepare concrete surfaces to receive a penetrant sealer in accordance with these Specifications dependent on whether the surfaces are of recently cast concrete (new construction) or of existing concrete.

413-3.2 Surface Preparation for New Construction: Remove substances such as dust, grime, dirt, curing compounds, form oil, debris, etc. by water blasting, light sandblasting, wire brushing, or other methods acceptable to the Engineer, all in accordance with the penetrant sealer manufacturer's recommendations. When using cleaning methods other than water blasting, wash the cleaned surfaces with water meeting the requirements of Section 923, as a final cleaning operation.

413-3.3 Surface Preparation for Existing Concrete:

413-3.3.1 General: Remove substances such as dust, grime, dirt, stains, mineral deposits, oil, bituminous materials, debris, and all other deleterious material by using water blasting equipment of sufficient operating capacity and pressure, all in accordance with the penetrant sealer manufacturer's recommendations.

413-3.3.2 Cleaning Equipment: Use approved water blasting equipment to clean existing concrete surfaces. Use water blasting equipment which is specifically manufactured to clean concrete surfaces. Use equipment that has a minimum rated nozzle capacity of 6,000 psi [40 MPa] using the spray head proposed for use in the work.

413-3.3.3 Water for Blasting: Use water meeting the requirements of Section 923.

413-3.3.4 Concrete Surface Cleaning Operation: During the cleaning operation, exercise sufficient care to minimize the removal of the concrete matrix. Furnish hand tools, power girders, and other similar equipment to remove materials which cannot be removed by water blasting without abrading the concrete matrix beyond acceptable limits. Wash concrete surfaces cleaned by methods other than water blasting with water blasting equipment as the final cleaning operation.

Limit the duration of water blasting to provide a light abraded surface. Do not allow surface abrasion to exceed 0.016 inch [0.4 mm]. The Engineer will not require further cleaning of stains still apparent after abrading to a depth of 0.016 inch [0.4 mm]. Avoid exposure of coarse aggregate by water blasting.

Reclean cleaned concrete surfaces which become contaminated before applying the penetrant sealer at no expense to the Department prior to applying the penetrant sealer.

413-4 Application of Sealant Materials.

413-4.1 General: Apply the penetrant sealer only to surfaces which have been prepared in accordance with these Specifications and approved by the Engineer. For application of the penetrant sealer, meet these Specifications and the penetrant sealer manufacturer's recommendations.

Prior to application of any penetrant sealer, cure concrete for a minimum of 21 days.

Coordinate the application of the penetrant sealer so that concrete surfaces prepared to receive penetrant sealer are sealed with the penetrant sealer within ten days after completion of the surface preparation and prior to contamination of the prepared surfaces.

413-4.2 Application Equipment: Apply the penetrant sealer using any suitable air or airless sprayer with an operating pressure of approximately 20 psi [140 kPa].

413-4.3 Application Limitations: Apply the penetrant sealer material only when the ambient air temperature is between 50 and 90E F [10 and 32EC]. Apply the penetrant sealer only to concrete surfaces which have dried a minimum of 48 hours after water last contacted the concrete surfaces. Do not apply the penetrant sealer when winds are blowing 25 mph [40 km/h] or more, during rainfall, or when water spray or mist is present.

413-4.4 Application: Apply the penetrant sealer only to concrete surfaces that have been prepared in accordance with the requirements and limitations set forth in these Specifications. Determine the actual coverage rate in square feet per gallon [square meters per liter] on the basis of field trials. Conduct a field trial to determine coverage rate at the beginning of any penetrant sealer application operation. Conduct additional confirmation field trials at a frequency of once for every 5,000 ft^2 [465 m^2] applied, production day of application, or when the character of the work changes, whichever is sooner. For each field trial, determine the optimum coverage rate for 500 ft^2 [46 m^2] of surface area. Maintain the penetrant sealer application rate between 155 and 225 ft^2 covered per gallon [4 and 5.5 m^2 covered per liter] of penetrant sealer used. Apply the penetrant sealer in a uniform manner without puddling and skips. Redistribute any penetrant sealer which is applied and subsequently puddles in low areas over the concrete surfaces by use of a squeegee.

Generally, begin the application of the penetrant at the lowest elevation and proceed upward toward higher elevations.

Maintain operating pressures in the sprayers used for application of the penetrant sealer material sufficiently low so that atomization or misting of the material does not occur.

413-5 Control of Materials.

413-5.1 Packaging and Identification: Deliver the penetrant sealer to the project in the unopened, sealed containers with the manufacturer's label identifying the product and with numbered seals intact. Ensure that each container is clearly marked by the manufacturer with the following information:

a. Manufacturer's name and address.
b. Product name.
c. Date of manufacture.
d. Expiration date.
e. LOT identification number.
f. Container serial number.

413-5.2 Manufacturer's Certification: Submit a notarized certification from the sealant manufacturer attesting that the material delivered to the project is of identical composition and manufacture as the material that was previously submitted to the Department for pre-approval. Submit such certification for each LOT of material delivered to the project. In each certification, identify the serial numbers of the containers certified.

413-5.3 Materials Sampling for Tests: The Engineer may require samples from each LOT or container of materials delivered to the project or from containers at the point of use. When samples are required, furnish samples in accordance with the Engineer's instructions. The Engineer may use these samples to ascertain authenticity of the materials delivered or to determine continued compliance with the acceptance test performance requirements outlined in FM 5-522 and 926-16.

413-5.4 Storage of Materials: Store materials delivered to the job site in original unopened containers within an appropriate storage facility. Use a storage facility that provides protection from the elements, and safe and secure storage of the materials.

413-5.5 Unused Material in Opened Containers: Do not return unused material in opened containers to storage for later use. The Contractor may either apply such material to appropriate areas on concrete surfaces or remove and dispose of it at locations off site that the Contractor provides.

413-6 Acceptance.

The Engineer may accept penetrant sealer application when the Engineer determines that the Contractor has properly cleaned all surface areas to be sealed and has applied the penetrant sealer within the required rates of application.

413-7 Method of Measurement.

Prestressed precast items designated in the plans to be sealed will not be measured for separate payment. The Contractor shall include the cost of cleaning, sealing, and applying Penetrant Sealer with the prestressed precast items being sealed. When separate payments for other areas are specified, the quantities to be paid for will be (1) the volume, in gallons [liters], of Penetrant Sealer as determined by use of the field measured area satisfactorily sealed divided by the approved application rate, and (2) the area, in square feet [square meters], of Cleaning and Sealing Concrete Surfaces as determined by field measurement, completed and accepted.

413-8 Basis of Payment.

Prices and payments will be full compensation for all work specified in this Section, including cleaning, applying penetrant, and furnishing penetrant required to satisfactorily clean and seal the areas designated.

No additional compensation will be made for areas which must be resealed due to Contractor error.

Payment will be made under:

Item No. 400-149- Penetrant Sealer - per gallon.
Item No. 2400-149- Penetrant Sealer - per liter.
Item No. 400-154- Cleaning and Sealing Concrete Surfaces - per square foot.
Item No. 2400-154- Cleaning and Sealing Concrete Surfaces - per square meter.

SECTION 415

REINFORCING STEEL

415-1 Description.

Furnish and place in concrete masonry reinforcing steel of the quality, type, size, and quantity designated.

415-2 Materials.

Meet the following requirements:

Bar Reinforcement 931-1.1
Fabric Reinforcement 931-1.2

415-3 Protection of Material.

Store steel reinforcement above the surface of the ground, upon platforms, skids, or other supports, and protect it as far as practicable from mechanical injury and surface deterioration caused by exposure to conditions producing rust. When placing steel reinforcement in the work, ensure that the steel reinforcement is free from loose rust, scale, dirt, paint, oil, and other foreign material.

415-4 Bending, Splicing, and Cutting.

Fabricate reinforcing bars as prescribed in the CRSI Manual of Standard Practice. Bend the reinforcement cold to the shapes indicated in the plans. Perform bending in the shop before shipment, and not in the field.

Do not hot bend or straighten, weld, or thermal cut reinforcing steel unless otherwise specified in the Contract Documents.

415-5 Placing and Fastening.

415-5.1 Bar Spacing - General: Except as otherwise specified herein, ensure that each bar is within 1 inch [25 mm] of the plan position.

415-5.2 Mortar Blocks for Spacing: Use precast mortar blocks to space and support the reinforcing steel. Use blocks composed of one part of cement to two parts of concrete sand that have wires cast into them for fastening to the steel. Moist-cure the blocks for at least three days.

415-5.3 Wire for Tying: For tying reinforcing steel, use soft pliable wire, that readily bends and twists without breaking and that provides a tie of sufficient strength to hold the reinforcing steel in its proper position.

415-5.4 Splices: Where splices are authorized, rigidly clamp the bars or tie them in a manner meeting the Engineer's approval. Use the splice length as shown on the plans. The Contractor may submit additional splices the Specialty Engineer recommends for approval prior to use.

Do not use welded splices except as specifically authorized by the Engineer and, when authorized, meet the requirements of AWS D 1.4 "Structural Welding Code - Reinforcing Steel".

415-5.5 Footings:

415-5.5.1 Supports: In general, support the footing mat steel with mortar blocks having dimensions not greater than 4 by 4 inches [100 by 100 mm] by plan clearance. Fasten mortar blocks to the steel using the cast-in wires. The Engineer may approve other proposed means of support.

415-5.5.2 Tolerances: Place footing mat steel within 2 inch [13 mm] vertically from the plan bottom clearance and within 1 inch [25 mm] from the plan side clearance.

415-5.5.3 Tying: Tie footing mat steel with a double-strand single tie at all intersections on the periphery and at alternate intersections within the mat.

415-5.6 Dowel Bars for Columns and Walls:

415-5.6.1 Supports and Positioning: Position dowel bars projecting into columns and walls so as to allow splicing of the column bars or vertical wall bars to the dowels and to tie the dowel bars in their plan position. Support the dowel bars by a rigid template constructed across the top of the footing, and attach them to the template in such manner that placing the concrete does not disturb their position. Set the supports prior to the pouring of the concrete in the footings, and do not push dowel bars into the wet concrete after placing the footing concrete.

415-5.6.2 Tolerances: Place the dowels within 2 inch [13 mm] of their plan position and with a side clearance tolerance not exceeding 3 inch [6 mm].

415-5.7 Verticals and Hoops for Columns:

415-5.7.1 Spacing-off from Side Forms: Space-off column steel from the side forms by mortar blocks of dimensions not exceeding 2 by 2 inches [50 by 50 mm] by clearance dimension. Securely fasten each block to the reinforcing.

415-5.7.2 Tolerances and Clearance:

(a) Column Verticals: Place column verticals within 2 inch [13 mm] of their plan position. Ensure that the side form clearance is within 3 inch [6 mm] of the specified clearance.

(b) Column Hoops: Place every hoop within 1 inch [25 mm] of the plan position for the specific hoop, with no accumulation of such tolerance caused by the spacing between any two hoops. Ensure that side form clearance for any hoop is within 2 inch [13 mm] of its specified clearance.

415-5.7.3 Tying: Tie the column hoops to the column verticals at each intersection, by a cross tie or "figure 8" tie.

415-5.8 Wall Steel (Not Including Dowel Bars):

415-5.8.1 Supports: Space-off wall steel from the side forms by mortar blocks of dimensions not greater than 2 by 2 inches [50 by 50 mm] by clearance dimensions. Fix the spacing between wall mats by means satisfactory to the Engineer.

415-5.8.2 Tolerance: Except where it is necessary in order to clear a fixture, place each bar within 1 inch [25 mm] of its specified position. In any case, ensure that the number of bars in any affected unit is as specified, and place the remainder of the bars (not thus affected) within the specified 1 inch [25 mm] tolerance.

415-5.8.3 Tying: Tie wall steel with a cross tie or "figure 8" tie. On the periphery, tie the steel at each intersection. Within the mat, tie the steel at every third intersection, except that where the wall is of such size that it is necessary that workmen use the reinforcing as a ladder, the Engineer may require tying at every other intersection, or at every intersection, as he deems necessary.

415-5.9 Beams and Caps:

415-5.9.1 Supports: Maintain bottom clearances by approved heavy beam bolsters. Support additional layers of main longitudinal steel from the lower layers by heavy upper-beam bolsters, placed directly over low supports.

Begin the spacing of beam bolsters at not more than 2 feet [0.6 m] from the end of the beams or caps and space the additionally required bolsters at not more than 4 feet [1.2 m].

Use mortar blocks, having dimensions not greater than 2 by 2 inches [50 by 50 mm] by specified clearance, fastened to the steel by the cast-in wires, for spacing the upper main longitudinal steel below the top bars. Maintain the side clearance by mortar blocks, having dimensions not greater than 2 by 2 inches [50 by 50 mm] by required clearance, fastened to the reinforcing steel by the cast-in wires.

415-5.9.2 Tolerances: Place the main longitudinal steel so as to provide a bottom and top clearance within 3 inch [6 mm] of the plan vertical dimensions for all layers. Space the steel from side forms within 2 inch [13 mm] of the specified spacing.

Space and tie the stirrups within 1 inch [25 mm] of the plan position for each individual stirrup, and do not allow the tolerance to accumulate.

415-5.9.3 Tying: Tie all intersecting bars with a double-strand single tie.

415-5.10 Deck Slabs:

415-5.10.1 Supports:

(a) Bottom Mats: In general, support the bottom mats of steel by one row of slab bolsters placed 6 inches [150 mm] from the edge of the slab and by two rows down each panel between beams. Do not allow the spacing between rows to exceed 4 feet [1.2 m], measured center to center.

As an exception, when deemed satisfactory by the Engineer, the Contractor may use mortar blocks in lieu of slab bolsters. Use blocks 2 by 2 inches [50 by 50 mm] by clearance dimensions. Space mortar blocks 4 feet [1.2 m] on center as a maximum. If at any time, however, the Engineer judges that the mortar blocks do not provide the proper support, he may require using slab bolsters.

(b) Top Mats: Support the top mats of steel by either continuous high chairs or individual high chairs. Support continuous high chairs along both sides of each beam and approximately 6 inches [150 mm] back from the edge of the beam. Place the outside row of high chairs 6 inches [150 mm] from the edge of the slab. If using individual high chairs, space them transversely, as specified for the continuous high chair, and do not allow the longitudinal spacing to be greater than 4 feet [1.2 m].

As an alternate to the above, on prestress beam construction, the Contractor may support the top mat of steel on the shear connectors bent to the proper elevation with one line of high chairs centered between the beams.

(c) Truss Bars: Support truss bars at each end of the top bends by continuous high chairs or by individual high chairs spaced longitudinally at not more than 4 feet [1.2 m].

415-5.10.2 Tolerances: Ensure that top and bottom clearances are within 3 inch [6 mm] from those shown on the plans.

Ensure that end and bottom clearances are within 3 inch [6 mm] from those shown on the plans.

Ensure that end and edge clearances are within 3 inch [6 mm] of the clearance specified.

Place curb bars within 3 inch [6 mm] in any direction of the plan position.

415-5.10.3 Tying: Tie all steel in each layer with a double-strand single tie at every intersection on the periphery and at every third intersection in the interior area. If encountering difficulty in maintaining the reinforcing steel in position during the placing of concrete, tie additional intersections as necessary to hold the reinforcing steel secure.

415-5.11 Box Culverts:

415-5.11.1 Supports:

(a) Bottom Slabs: In the bottom slabs of box culverts, provide supports for single-mat steel and for bottom-mat steel, including placement and spacing, as specified for footing mat steel in 415-5.5. In addition, where the plans call for more than one mat of steel in the bottom slab of the culvert, support the top mat away from the bottom mat, either by upper beam bolsters or by other means satisfactory to the Engineer.

(b) Walls: Place, space and support the steel in walls of box culverts in accordance with the requirements of 415-5.8.

(c) Top Slabs: In the top slabs of box culverts, support the bottom mats of steel by a row of slab bolsters 12 inches [300 mm] from the inside face of the walls and with additional rows of bolsters at spacings not exceeding 4 feet [1.2 m], center to center. As an exception, unless the Engineer deems the use of the slab bolsters as necessary to obtain proper support, the Contractor may use mortar blocks as the supporting device. Use blocks of dimensions not greater than 2 by 2 inches [50 by 50 mm] by the required clearance, with spacings not exceeding 4 feet [1.2 m] in any direction. Fasten blocks to the reinforcing steel by the cast-in wires.

(d) Truss Bars: Support truss bars as specified in 415-5.10.1 (c).

415-5.11.2 Tolerances: Use tolerances in placing the steel in box culvert slabs as specified for deck slabs in 415-5.10.2. Use tolerances for placing steel in walls as specified in 415-5.8.2.

415-5.11.3 Tying: Tie steel in box culverts as specified for deck slabs in 415-5.10.3.

415-5.12 Cleaning: Before placing any concrete, clean all mortar from the reinforcement.

415-5.13 Metal Chairs and Bolsters:

415-5.13.1 General: Provide reinforcing steel bar supports manufactured in accordance with all requirements of the CRSI Manual of Standard Practice. Use chairs and bolsters of adequate strength to withstand a 300 pound [1.3 kN] concentrated load without permanent deformation or breakage, with the deformation under a 300 pound [1.3 kN] load being less than 5% of the support height.

Ensure that no more than 5% of the reinforcing steel bar supports exhibit unsatisfactory performance, breakage, or permanent deformation during rebar tying and/or concrete placement operations. If a bar support does not achieve this level of performance, reduce the average spacing between bar supports by 15%, or remove that product from use on the job.

Ensure that bar supports, both chair and bolster, do not move during concrete placing operations. To prevent movement, tie supports to the reinforcing steel.

When using bar supports on corrugated metal stay-in-place forms, use supports specifically designed for the form being used.

415-5.13.2 Metal Chairs and Bolsters: For metal bar supports in contact with steel stay-in-place forms and metal bar supports in contact with boundary surfaces of concrete to be cast, provide supports constructed with molded plastic legs or plastic protected steel legs. Do not allow any portion of the bar support other than the molded plastic leg or plastic protected portion of the steel leg to be closer than 2 inch [13 mm] from the boundary surface of concrete to be cast.

Certify that all metal bar supports meet the following requirements:

(1) That they are manufactured from cold drawn steel wire in accordance with the wire sizes and geometrical dimensions shown in the CRSI Manual of Standard Practice, Chapter 3, Table II.

(2) That the plastic used for protection of the steel legs has a thickness of 3/32 inch [2.5 mm] or greater at points of contact with the form work.

Provide plastic protection by a dipping operation, by adding premolded plastic tips to the legs of the support or by molding plastic to the top wire of the support. Ensure that the plastic material used for protection of steel legs does not chip, crack, deform, or peel under ordinary job conditions. Provide molded plastic legs that have sufficient strength to carry the weight of the supported reinforcing steel in its required position without deformation and relaxation under job conditions.

415-5.13.3 Recycled Plastic Chairs and Bolsters: In addition to the physical properties specified in Section 972, mold plastic rebar supports in a configuration which does not restrict concrete flow and consolidation around and under the rebar support.

Do not use continuous legs or rails on surfaces of concrete.

Meet the requirements of Section 972 for all recycled plastic products.

Due to the wide range of applications and heights, ensure that the manufacturer additionally certifies that he has examined the particular application and that his product is recommended for that stated use for that specific project.

Provide each individual bar support with an identification number unique to the particular model permanently marked on the surface as included in the Qualified Products List. The Contractor may use a patent number or manufacturer's model number as the identification number.

415-6 Welded Deformed Steel Wire Fabric Reinforcement.

415-6.1 General: The Contractor may substitute welded deformed steel wire fabric reinforcement for deformed bar reinforcement when approved on shop drawings. Propose substitutions of welded deformed steel wire fabric in a manner that provides a cross-sectional area per foot [meter] of welded deformed steel wire fabric equal to that provided on the plans for deformed bar reinforcement. Orient the deformed wires of welded deformed steel wire fabric reinforcement in the same position as bar reinforcement detailed in the plans. The Contractor may use smooth or deformed cross wires of welded deformed steel wire reinforcement. Use a cross wire size that is a minimum of 35% or more of the area of the deformed wire.

Provide welded steel wire fabric reinforcement as shown in the plans.

415-6.2 Design: When welded deformed steel wire fabric reinforcement is substituted for deformed bar reinforcement, ensure that the development length, splices, shear reinforcement, and distribution meet the requirements of the AASHTO Standard Specifications for Highway Bridges.

415-7 Method of Measurement.

415-7.1 General: The quantity to be paid for will be the computed weight, in pounds [kilograms], of reinforcing steel entering into the completed structure or item of work and accepted. The quantity will not include the reinforcing steel in any item of work for which the basis of payment includes the steel reinforcement. No separate payment will be made for reinforcing steel in pipe endwalls. No deduction will be made from reinforcing steel quantities for encroachment of inlets and pipes in box culverts. The lengths to be used in the calculation will be the detailed lengths of bars as shown in the plans. The quantity to be paid for will be the original plan quantity, determined as provided above.

415-7.2 Unit Weights of Bars: The unit weights used will be CRSI Standard Reinforcing Steel Bar Weights.

415-7.3 Fabric Reinforcement: Where fabric reinforcement is to be paid for by weight, the quantity to be paid for will be the product of the area, in square feet [square meters], of the fabric actually incorporated in the structure and accepted, by the manufacturer's standard weight per square foot [square meter].

When welded deformed steel wire fabric reinforcement is substituted for deformed bar reinforcement, the quantity to be paid for will be the quantity which would be paid for if bar reinforcement as detailed in the plans were utilized, based on plan quantity.

415-8 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section, including all welding, all clips, spacers, ties, etc., and wire or other material used for fastening the reinforcement in place.

In case short bars are permitted for use when full length bars might reasonably be required, the weight paid for will be only that which would be obtained if full length bars were used, with no allowance for lap.

Payment will be made under:

Item No. 415- 1- Reinforcing Steel - per pound.
Item No. 2415- 1- Reinforcing Steel - per kilogram.

SECTION 416

INSTALLING ADHESIVE-BONDED ANCHORS AND DOWELS

FOR STRUCTURAL APPLICATIONS

416-1 Description.

Prepare and install adhesive bonded anchors and dowels in hardened concrete as indicated in the Contract plans, as directed by the Engineer, and in accordance with the manufacturer=s instructions and this Section.

Anchors and dowels in this Section are intended for use in structural applications where designated on the Contract plans.

416-2 Materials.

Use adhesive bonding material systems which meet the requirements of Section 937, and are included on the Qualified Products List.

416-2.1 Storage of Materials: Store materials delivered to the job-site in the original unopened containers within an appropriate facility capable of maintaining storage conditions consistent with the manufacturer=s recommendations.

416-3 Equipment.

Ensure that the equipment used to install adhesive-bonded anchors and dowels is in conformance with the recommendations of the manufacturer.

416-4 Preparing of Concrete Members.

Ensure that concrete members receiving adhesive-bonded anchors or dowels are structurally sound and free of cracks in the vicinity of the anchor or dowel to be installed. Unless other equipment is recommended by the adhesive manufacturer, drill holes to the diameter required by the manufacturer, but as a minimum, not less than 105% nor more than 150% of the diameter of the steel bar anchor, using a rotary hammer drill and bit.

Clean and prepare drilled holes in accordance with the manufacturer=s recommendations, but as a minimum, use compressed air to remove loose particles from drilling, brush inside surface to free loose particles trapped in pores, then use compressed air again to remove the remaining loose particles. Use a non-metallic bristle brush and avoid over-brushing to prevent polishing the inside surface of the drilled hole.

416-5 Installing of Anchors or Dowels.

Install anchors or dowels in accordance with the details shown on the plans and the manufacturer=s instructions, with particular attention to requirements and/or limitations due to anchor position, dampness, ambient temperature, and curing.

Use adequate quantities of the adhesive bonding material to fill the drilled hole to within 1/4 inch [5 mm] of the concrete surface measured after placement of the steel bar or anchor.

416-6 Acceptance.

The Engineer will base acceptance of adhesive-bonded anchors and dowels on determining that the material requirements of Section 937, the installation requirements of this Section, and the placement requirements of the plans have been met. The Engineer may also require testing of installed anchors and dowels.

416-7 Basis of Payment.

The work specified in this Section will not be paid for directly, but will be considered as incidental work.

SECTION 425

INLETS, MANHOLES, AND JUNCTION BOXES

425-1 Description.

Construct drop inlets, manholes, junction boxes, shoulder gutter inlets, and yard drains from reinforced concrete. Brick masonry may be used if the structure is circular and constructed in place. Furnish and install the necessary metal frames and gratings. Also, adjust those structures shown in the plans to be adjusted or which are required to be adjusted for the satisfactory completion of the work.

425-2 Composition and Proportioning.

425-2.1 Concrete: Use Class I concrete, as specified in Sections 346 and 347.

425-2.2 Mortar: For brick masonry, make the mortar by mixing one part portland cement to three parts sand. Miami Oolitic rock screenings may be substituted for the sand, provided the screenings meet the requirements of 902-5.2.3 except for gradation requirements. Use materials passing the No. 8 [2.36 mm] sieve that are uniformly graded from coarse to fine. Hydrated lime may be added to the mortar in an amount not to exceed 10% of the amount of cement.

Masonry cement may be used in lieu of the above-specified mortar provided it is delivered in packages properly identified by brand name of manufacturer, net weight of package, and whether it is Type 1 or Type 2, and further provided that it has not been in storage for a period greater than six months. Do not use hydrated lime with masonry cement.

425-3 Materials.

425-3.1 General: Meet the following requirements:

Sand (for mortar)	902-3.2
Portland Cement	Section 921
Hydrated Lime	Section 922
Water	Section 923
Reinforcing Steel	931-1.1 and 415-3
Inlet and Outlet Pipe	Sections 941, 943, 945 and 946
Brick and Concrete Masonry Units	Section 949
Castings for Frames and Gratings	962-8

425-3.2 Gratings: Use gratings and frames fabricated from structural steel galvanized in accordance with the requirements of ASTM A 123, or painted, meeting the requirements of 971-8. Use the Qualified Products List to determine the number of dip coats to apply and the thickness of each coat. Apply a black finish coat (Color No. 17038, Federal Standard 595A). Prior to painting, clean the steel in accordance with the Steel Structures Painting Council Surface Preparation

Specifications, SSPC-SP2 or SSPC-SP7. All paint may be applied in the shop, by dipping, provided that the first coat application is thoroughly dry before applying the second coat. Do not follow the requirements of this Subarticle when using ASTM A 588 steel.

425-4 Forms.

Design and construct wood or metal forms so that they may be removed without injuring the concrete. Build forms true to line and grade and brace them in a substantial and unyielding manner. Obtain the Engineer's approval before filling them with concrete.

425-5 Precast Inlets, Manholes, and Junction Boxes.

Precast inlets, manholes and junction boxes, designed and fabricated in accordance with the plans, may be substituted for cast-in-place units.

Smooth welded wire fabric may be substituted for deformed re-bar or welded deformed wire reinforcement in non-circular precast drainage structures provided the following requirements are met:

1. The smooth welded wire fabric complies with ASTM A 185.

2. Substitution of equal areas of smooth wire fabric for the reinforcing steel and provided the width and length of the unit is four times the width of the spacing of the cross wires.

3. Wire is continuous around the box and spliced at a quarter point of one side with an overlap of not less than the spacing of the cross wires plus 2 inches [50 mm].

425-6 Construction Methods.

425-6.1 Excavation: Excavate as specified in Section 125.

Where unsuitable material for foundations is encountered, excavate the unsuitable material and backfill with suitable material prior to constructing or setting inlets, manholes and junction boxes.

As an option to the above and with the Engineer's approval, the Contractor may carry the walls down to a depth required for a satisfactory foundation, backfill to 8 inches [200 mm] below the flowline with clean sand and cast a non-reinforced 8 inch [200 mm] floor.

425-6.2 Placing and Curing Concrete: Place the concrete in the forms, to the depth shown in the plans, and thoroughly vibrate it. After the concrete has hardened sufficiently, cover it with suitable material and keep it moist for a period of three days. Finish the traffic surface in accordance with 522-7.2, or with a simulated broom finish approved by the Engineer.

425-6.3 Setting Manhole Castings: After curing the concrete as specified above, set the frame of the casting in a full mortar bed composed of one part portland cement to two parts of fine aggregate.

425-6.4 Reinforcing Steel: Follow the construction methods for the steel reinforcement as specified in Section 415.

425-6.5 Laying Brick: Saturate all brick with water before laying. Bond the brick thoroughly into the mortar using the shovejoint method to lay the brick. Arrange headers and stretchers so as to bond the mass thoroughly. Finish the joints properly as the work progresses and ensure that they are not less than 3 inch [6 mm] or more than : inch [19 mm] in thickness. Do not use spalls or bats except for shaping around irregular openings or when unavoidable at corners.

425-6.6 Placing Pipe: Construct inlet and outlet pipes of the same size and kind as the connecting pipe shown in the plans. Extend the pipes through the walls for a distance beyond the outside surface sufficient for the intended connections, and construct the concrete around them neatly to prevent leakage along their outer surface. Keep the inlet and outlet pipes flush with the inside of the wall. Resilient connectors as specified in 942-3 may be used in lieu of a masonry seal.

425-6.7 Backfilling: Backfill as specified in Section 125, meeting the specific requirements for backfilling and compaction around inlets, manholes, and junction boxes detailed in 125-8.1 and 125-8.2. However, for outfall lines beyond the sidewalk or future sidewalk area, where no vehicular traffic will pass over the pipe, inlets, manholes, and junction boxes, compact backfill as required in 125-8.3.

425-6.8 Adjusting Existing Structures: Cut down or extend existing manholes, catch basins, inlets, valve boxes, monument boxes, etc., within the limits of the proposed work, to meet the finished grade of the proposed pavement, or if outside of the proposed pavement area, to the finished grade designated on the plans for such structures. Use materials and construction methods which meet the requirements specified above to cut down or extend the existing structures.

The Contractor may extend manholes needing to be raised using adjustable extension rings of the type which do not require the removal of the existing manhole frame. Use an extension device that provides positive locking action and permits adjustment in height as well as diameter and meets the approval of the Engineer.

425-7 Method of Measurement.

The quantities to be paid for will be (1) the number of inlets, manholes, junction boxes, and yard drains, completed and accepted; and (2) the number of structures of these types (including also valve boxes and monument boxes) satisfactorily adjusted.

425-8 Basis of Payment.

425-8.1 New Structures: Price and payment will be full compensation for furnishing all materials and completing all work described herein or shown in the plans, including all clearing and grubbing outside the limits of clearing and grubbing as shown in the plans, all excavation except the volume included in the measurement designated to be paid for under the items for the grading work on the project, all backfilling around the structures, the disposal of surplus material, and the furnishing and placing of all gratings, frames, covers, and any other necessary fittings.

425-8.2 Adjusted Structures: When an item of payment for adjusting manholes, valve boxes, inlets, or monument boxes is provided in the proposal, price and payment will be full compensation for the number of such structures designated to be paid for under such separate items, and which are satisfactorily adjusted, at the Contract unit prices each for Adjusting Inlets, Adjusting Manholes, Adjusting Valve Boxes and Adjusting Monument Boxes.

For any of such types of these structures required to be adjusted but for which no separate item of payment is shown in the proposal for the specific type, payment will be made under the item of Adjusting Miscellaneous Structures.

425-8.3 Payment Items: Payment will be made under:

Item No. 425- 1- Inlets - each.
Item No. 2425- 1- Inlets - each.
Item No. 425- 2- Manholes - each.
Item No. 2425- 2- Manholes - each.
Item No. 425- 3- Junction Boxes - each.
Item No. 2425- 3- Junction Boxes - each.
Item No. 425- 4- Adjusting Inlets - each.
Item No. 2425- 4- Adjusting Inlets - each.
Item No. 425- 5- Adjusting Manholes - each.
Item No. 2425- 5- Adjusting Manholes - each.
Item No. 425- 6- Adjusting Valve Boxes - each.
Item No. 2425- 6- Adjusting Valve Boxes - each.
Item No. 425- 7- Adjusting Monument Boxes - each.
Item No. 2425- 7- Adjusting Monument Boxes - each.
Item No. 425- 8- Adjusting Miscellaneous Structures - each.
Item No. 2425- 8- Adjusting Miscellaneous Structures - each.
Item No. 425- 9- Shoulder Gutter Inlets - each.
Item No. 2425- 9- Shoulder Gutter Inlets - each.
Item No. 425- 10- Yard Drains - each.
Item No. 2425- 10- Yard Drains - each.

SECTION 430

PIPE CULVERTS AND STORM SEWERS

430-1 Description.

Furnish and install drainage pipe and mitered end sections at the locations called for. Also, furnish and construct such joints and connections to existing pipes, catch basins, inlets, manholes, walls, etc., as may be required to complete the work.

Construct structural plate pipe culverts, underdrains, or roof drains; under Sections 435, 440, and 445, respectively.

430-2 Materials.

430-2.1 Pipe: Meet the following requirements:

Concrete Pipe..Section 941
Round Rubber Gaskets ....Section 942
Corrugated Steel Pipe and Pipe Arch................................Section 943
Corrugated Aluminum Pipe and Pipe Arch ....Section 945
Cast Iron Pipe ....Section 946
Corrugated Polyethylene Pipe ....Section 948
Polyvinyl Chloride (PVC) Pipe ....Section 948

Do not use bituminized-fiber pipe.

430-2.2 Joint Materials: Use joint materials as specified in 430-7 through 430-11 for the particular type of pipe and conditions of usage as specified.

430-2.3 Mortar: Use mortar composed of one part portland cement and two parts of clean, sharp sand, for sealing joints in concrete and cast iron pipe, to which mixture the Contractor may add hydrated lime in an amount not to exceed 15% of the cement content. The Contractor need not test the cement, the hydrated lime, or the sand used in the mortar in accordance with Section 346, provided the cement and the hydrated lime are products of the type and quality appropriate for this work as determined by the Engineer, and the sand is a clean commercial sand approved by the Engineer. Use mortar within 30 minutes after its preparation.

430-3 Type of Pipe to Be Used.

The type or types of pipe to be used will be designated in the plans with the following exception:

Use either concrete pipe (at least Class I), corrugated steel pipe, corrugated aluminum pipe, corrugated polyethylene pipe or PVC pipe, for side drains.

430-4 Laying Pipe.

430-4.1 General: Lay all pipe, true to the lines and grades given, with hubs upgrade and tongue end fully entered into the hub. When pipe with quadrant reinforcement, or circular pipe with elliptical reinforcement, is used, install the pipe in a position such that the manufacturer's marks designating "top" and "bottom" of the pipe are not more than five degrees from the vertical plane through the longitudinal axis of the pipe. Take up and relay any pipe that is not in true alignment or which shows any settlement after laying at no additional expense to the Department.

Repair lift holes, if present, by use of a hand-placed, stiff, non-shrink, 1-to-1 mortar of cement and fine sand, after first washing out the hole with water. Completely fill the void created by the lift hole with mortar. Cover the repaired area with a 24 by 24 inch [600 by 600 mm] piece of filter fabric secured to the pipe. Use a Class D filter fabric meeting the requirements shown on Roadway and Traffic Standard Index 199.

Secure the filter fabric to the pipe using a method that holds the fabric in place until the backfill is placed and compacted. Use a grout mixtures, mastics, or strapping devices to secure the fabric to the pipe.

Test plastic and metal pipe larger than 36 inches [900 mm] in diameter to verify that pipe deflection does not exceed 5%. Provide test and testing equipment at no additional expense to the Department. Obtain the Engineer's approval for all testing devices and test methods. The Engineer will supervise the test.

The following minimum joint performance standards apply:

Pipe Application	Minimum Standard
Cross Drains	Soil-tight
Storm Drains	Soil-tight
Gutter Drain	Water-tight
Side Drains	Soil-tight

430-4.2 Trench Excavation: Excavate the trench for pipe culverts and storm sewers as specified in Section 125.

430-4.3 Foundation: Provide a suitable foundation, where the foundation material is of inadequate supporting value, as determined by the Engineer. Remove the unsuitable material and replace it with suitable material, as specified in 125-8. Where in the Engineer's opinion, the removal and replacement of unsuitable material is not practicable, he may direct alternates in the design of the pipe line, as required to provide adequate support. Minor changes in the grade or alignment will not be considered as an adequate basis for extra compensation.

Do not lay pipe on blocks or timbers, or on other unyielding material, except where the use of such devices is called for in the plans.

430-4.4 Backfilling: Backfill around the pipe as specified in 125-8 unless specific backfilling procedures are described in the Contract Documents.

430-4.5 Plugging Pipe: When shown in the plans, seal the ends of the pipe culverts with a masonry plug a minimum of 8 inches [200 mm] in thickness, or by an approved prefabricated pipe plug listed on the Qualified Products List. Install the prefabricated pipe plug in accordance with the manufacturer's instructions.

430-4.6 End Treatment: Place an end treatment at each cross drain, side drain, or storm sewer pipe end as shown in the plans. Refer to the Roadway and Traffic Design Standards for types of end treatment details.

As an exception to the above, when concrete mitered end sections are permitted, the Contractor may use reinforced concrete U-endwalls, if shop drawings are submitted to the Engineer for approval prior to use.

Provide end treatments for corrugated polyethylene pipe and PVC pipe as specified in 948-2.3 and 948-3, respectively, or as detailed in the plans.

430-4.7 Metal Pipe Protection: Apply a bituminous coating to the surface area of the pipe within and 12 inches [300 mm] beyond the concrete or mortar seal prior to sealing, to protect corrugated steel or aluminum pipe embedded in a concrete structure, such as an inlet, manhole, junction box, endwall, or concrete jacket.

Ensure that the surface preparation, application methods (dry film thickness and conditions during application), and equipment used are in accordance with the coating manufacturers' published specifications.

Obtain the Engineer=s approval of the coating products used .

430-5 Removing and Relaying Existing Pipe.

430-5.1 Removal: If the plans indicate that existing pipe is to remain the property of the Department, collect and stack along the right-of-way all existing pipe or pipe arch so indicated in the plans to be removed, or that does not conform to the lines and grades of the proposed work and that is not to be relaid, as directed by the Engineer. Take care to prevent damage to salvageable pipe during removal and stacking operations.

430-5.2 Relaying: Where so shown in the plans, collect and clean existing culvert pipe, then relay it in the same manner as specified for new culvert pipe. Where necessary, straighten existing metal pipe or pipe arch before it is relaid.

430-6 Placing Pipe Under Railroad.

430-6.1 General: Construct pipe culverts under railroad tracks in accordance with the requirements of the railroad company.

Perform all the shoring under the tracks, and sheeting and bracing of the trench, required by the railroad company or deemed necessary by the Engineer in order to ensure safe and uninterrupted movement of the railroad equipment, at no expense to the Department.

430-6.2 Requirements of the Railroad Company: Install pipe using methods required by the railroad company and shown in the Contract Documents.

When the general method of installation required by the railroad company is indicated in the plans, do not alter such method, or any other specific details of the installation which might be indicated in the plans, without receiving approval or direction from the railroad, followed by written approval from the Engineer.

430-6.3 Notification to Railroad Company: Notify the railroad company and the Engineer at least ten days prior to the date on which pipe is to be placed under the railroad tracks.

430-6.4 Placing Pipe by Jacking: Obtain the Engineer's and the railroad company's approval of the details of the jacking method to be used, when placing pipe through the railroad embankment, before the work is started.

430-6.5 Use of Tunnel Liner: When the railroad company requires that a tunnel liner be used for placing the pipe in lieu of the jacking method, the Department will pay for the tunnel liner material separately in cases where the Contract Documents do not require the use of a tunnel liner. For these cases the Department will reimburse the Contractor for the actual cost of the liner, delivered at the site. The Department will base such cost on a liner having the minimum gage acceptable to the railroad.

430-7 Specific Requirements for Concrete Pipe.

430-7.1 Sealing Joints:

430-7.1.1 Round Concrete Pipe Other than Side Drain: Seal the pipe joints with round rubber or profile gaskets. When round rubber gaskets are used, meet the requirements of 941-1.5. Ensure that the gasket and the surface of the pipe joint, including the gasket recess, are clean and free from grit, dirt and other foreign matter, at the time the joints are made. In order to facilitate closure of the joint, application of an approved vegetable soap lubricant immediately prior to closing of the joint will be permitted. Prelubricated gaskets may be used in lieu of a vegetable soap lubricant when the lubricating material is certified to be inert with respect to the rubber material.

Seal pipe joints with a profile rubber gasket meeting the requirements of 942-4 for joints designed in accordance with the requirements of 941-1.6.

Furnish and install a filter fabric jacket around the first joint of all round concrete pipe entering or leaving a drainage structure.

Use a filter fabric jacket consisting of a piece of woven or non-woven filter fabric which provides an Apparent Opening Size (AOS) of a No. 70 to No. 100 sieve [150 to 212 μm], 24 inches [600 mm] in width and a length sufficient to provide a minimum overlap of 24 inches [600 mm]. Secure the filter fabric jacket against the outside of the pipe by steel or plastic strapping or by other methods approved by the Engineer.

430-7.1.2 Side Drain Pipe: For all concrete pipe which does not have rubber-gasket joints, thoroughly wet the joints before the inside mortar is placed. Before succeeding sections of the pipe are laid, fill the lower half of the joint portion of the pipe in place on the inside with cement mortar, and wipe the upper half of the tongue portion of the next joint with cement mortar, both in sufficient thickness to bring the inner surface of the abutting pipe flush and even, when the pipe is laid. After the pipe is laid, wipe and finish smooth the inside of the joint. Form a mortar bead not less than : inch [20 mm] thick completely around the outside of the joint.

430-7.2 Laying Requirements for Concrete Pipe with Rubber Gasket Joints: Lay the pipe to the line and grade shown in the plans within the following tolerances. Do not allow departure from and return to plan alignment and grade to exceed 1/16 inch per foot [5 mm per meter] of nominal pipe length, with a total of not more than 1 inch [25 mm] departure from theoretical line and grade. In addition, do not allow the gap between sections of pipe to exceed ε inch for pipe diameters of 12 inches through 18 inches [16 mm for pipe diameters of 300 through 450 mm], ϕ inch for pipe diameters of 24 through 66 inches [25 mm for pipe diameters of 600 mm through 1.7 m], and 1 inch for pipe diameters 72 inches and larger [25 mm for pipe diameters 1.8 m and larger]. Where minor imperfections in the manufacture of the pipe create an apparent gap in excess of the tabulated gap, the Engineer will accept the joint provided that the imperfection does not exceed α the circumference of the pipe, and the rubber gasket is 3 inch [6 mm] or more past the pipe joint entrance taper. Where concrete pipes are outside of these tolerances, replace them at no expense to the Department. Do not apply mortar, joint compound, or other filler to the gap which would restrict the flexibility of the joint.

Place and compact backfill material consisting of crushed stone/gravel or soils required in 125-8.

430-7.3 Field Joints for Elliptical Concrete Pipe: Use either a preformed plastic gasket material or a profile rubber gasket to make a field joint.

430-7.3.1 Plastic Gasket: Meet the following requirements when field joints are made from preformed plastic gasket material:

430-7.3.1.1 General: Install field joints in accordance with the manufacturer's instructions and the following:

430-7.3.1.2 Material: Meet the requirements of 942-2.

430-7.3.1.3 Joint Design: Ensure that the pipe manufacturer furnishes the Engineer with details regarding configuration of the joint and the amount of gasket material required to effect a satisfactory seal. Do not brush or wipe joint surfaces which are to be in contact with the gasket material with a cement slurry. Fill minor voids with cement slurry.

430-7.3.1.4 Primer: Apply a primer of the type recommended by the manufacturer of the gasket material to all joint surfaces which are to be in contact with the gasket material, prior to application of the gasket material. Thoroughly clean and dry the surface to be primed.

430-7.3.1.5 Application of Gasket: Apply gasket material to form a continuous gasket around the entire circumference of the leading edge of the tongue and the groove joint, in accordance with the detail shown on the Roadway and Traffic Design Standards, Index No. 280. Do not remove the paper wrapper on the exterior surface of the gasket material until immediately prior to joining of sections. Apply plastic gasket material only to surfaces which are dry. When the atmospheric temperature is below 60E F [15EC], either store plastic joint seal gaskets in an area above 70EF [20EC], or artificially warm the gaskets to 70EF [20EC] in a manner satisfactory to the Engineer.

430-7.3.1.6 Installation of Pipe: Remove and reposition or replace any displaced or contaminated gasket as directed by the Engineer. Install the pipe in a dry trench. Carefully shape the bottom of the trench to minimize the need for realignment of sections of pipe after they are placed in the trench. Hold to a minimum any realignment of a joint after the gaskets come into contact. Prior to joining the pipes, fill the entire joint with gasket material and ensure that when the pipes are joined there is evidence of squeeze-out of gasket material for the entire internal and external circumference of the joint. Trim excess material on the interior of the pipe to provide a smooth interior surface. If a joint is defective, remove the leading section of pipe and reseal the joint.

430-7.3.1.7 Filter Fabric: Completely wrap the outside of each joint with either a woven or non-woven filter fabric which provides an AOS of a No. 70 to No. 100 sieve [150 to 212 μm], a minimum of 24 inches [600 mm] in width and a length sufficient to provide a minimum overlap of 24 inches [600 mm]. Secure filter fabric against the outside of the pipe by steel or plastic strapping or by other methods approved by the Engineer.

430-7.3.2 Rubber Gasket: Meet the following requirements when field joints are made with profile rubber gaskets:

430-7.3.2.1 General: Install field joints in accordance with the manufacturer's instructions and the following:

430-7.3.2.2 Material: Meet the requirements of 942-4.

430-7.3.2.3 Joint Design: Ensure that the pipe manufacturer furnishes the Engineer with details regarding configuration of the joint and gasket required to effect a satisfactory seal. Do not apply mortar, joint compound, or other filler which would restrict the flexibility of the gasket joint.

430-7.3.2.4 Filter Fabric: Meet the requirements of 430-7.3.1.7.

430-7.4 Requirements for Concrete Radius Pipe:

430-7.4.1 Design: Construct concrete radius pipe in segments not longer than 4 feet [1.2 m] (along the pipe centerline), except where another length is called for in the Contract Documents. Join each segment using round rubber gaskets. Ensure that the pipe manufacturer submits details of the proposed joint, segment length and shape for approval by the Engineer, prior to manufacture.

430-7.4.2 Pre-Assembly: Ensure that the manufacturer pre-assembles the entire radius section in his yard, in the presence of the Engineer, to ensure a proper fit for all parts. At the option of the manufacturer, the Contractor may assemble the pipe without gaskets. Consecutively number the joints on both the interior and exterior surfaces of each joint, and make match marks showing proper position of joints. Install the pipe at the project site in the same order as pre-assembly.

430-8 Specific Requirements for Corrugated Steel Pipe.

430-8.1 Field Joints:

430-8.1.1 General: Make a field joint with locking bands, as specified in Article 9 of AASHTO M 36.

When existing pipe to be extended is helically fabricated, make a field joint between the existing pipe and the new pipe using one of the following methods:

(1) Cut the new pipe to remove one of the re-rolled annular end sections required in 943-1, or fabricate the pipe so that the re-rolled annular section is fabricated only on 1 end. Use either a spiral (helical) band with a gasket or a flat band with gaskets as required by 430-8.1.2 (2) to join the pipe sections. Omit the gasket when a helical band is used on side drains.

(2) The Contractor may construct a concrete jacket as shown on the Roadway and Traffic Design Standards, Index No. 280 , provided that the minimum cover required by the Roadway and Traffic Design Standards, Index No. 205 can be obtained.

430-8.1.2 Cross Drain, Storm Sewer, and Gutter Drains: Where corrugated steel pipe is used as cross drain, storm sewer, or gutter drain, for the above specified banded joints, use a rubber or neoprene gasket of a design shown to secure the joint performance specified.

Use a gasket of one of the following dimensions:

(1) For annular joints with 2 inch [13 mm] depth corrugation: either a single gasket a minimum of 7 inches by δ inch [175 by 9.5 mm] or two gaskets a minimum of 32 inches by δ inch [90 by 9.5 mm]; and for annular joints with 1 inch [25 mm] depth corrugations: either a single gasket a minimum of 7 inches by ϕ inch [175 by 25 mm] or two gaskets a minimum of 32 inches by ϕ inch [90 by 25 mm].

(2) For helical joints with 2 inch [13 mm] depth corrugation: either a single gasket a minimum of 5 inches by 1 inch [125 by 25 mm] or two gaskets a minimum of 32 inches by 1 inch [90 by 25 mm]; and for helical joints with 1 inch [25 mm] depth corrugations: either a single gasket a minimum of 5 inches by 12 inches [125 by 40 mm] or two gaskets a minimum of 32 inches by 12 inches [90 by 40 mm].

(3) Such other gasket designs as may be approved by the Engineer.

If, in lieu of a single gasket spanning the joint, two gaskets are used, place these individual gaskets approximately 2 inches [50 mm] from each pipe end at the joint. When two gaskets are used, seal the overlapping area on the coupling band between the gaskets consistent with the joint performance specified. The Contractor may tuck a strip of preformed gasket material over the bottom lip of the band for this purpose. Use coupling bands that provide a minimum circumferential overlap of 3 inches [75 mm]. As the end connections on the coupling band are tightened, ensure that there is no local bending of the band or the connection. Use precurved coupling bands on pipe diameters of 24 inches [600 mm] or less.

Use flat gaskets meeting the requirements of ASTM D 1056, designation 2C2 or 2B3. In placing flat gaskets on pipe prior to placing the coupling band, do not stretch the gasket more than 15% of its original circumference. Use circular gaskets meeting the requirements of ASTM C 361 [ASTM C 361M]. Do not stretch the circular gasket more than 20% of its original circumference in placing the gasket on pipe. Use preformed plastic gasket material meeting the composition requirements of 942-2.2.

Apply an approved vegetable soap lubricant, as specified for concrete pipe in 430-7.1.1.

The minimum joint performance standards specified in 430-4.1 apply.

430-8.1.3 Alternate Joint: In lieu of the above-specified combination of locking bands and flat gaskets, the Contractor may make field joints for these pipe installations by the following combinations:

(a) Use the metal bands as specified in Article 9 of AASHTO M 36M that are at least 102 inches [265 mm] wide and consist of a flat central section with a corrugated section near each end, designed to match the annular corrugation in the pipe with which they are to be used. Connect the bands in a manner approved by the Engineer, with a suitable fastening device such as the use of two galvanized 2 inch [M12] diameter bolts through a galvanized bar and galvanized strap, suitably welded to the band. Use a strap that is the same gage as the band.

Where helically corrugated pipe is to be jointed by this alternate combination, ensure that at least the last two corrugations of each pipe section are annular, and designed such that the band will engage each pipe end with the next-to-outside annular corrugation.

(b) For these bands, use a rubber gasket with a circular cross-section of the "O-ring" type conforming to ASTM C 361 [ASTM C 361M]. Use gaskets having the following cross-sectional diameter for the given size of pipe:

Non-SI Units

Pipe Size	Gasket Diameter
12 inches through 36 inches (with 2 inch depth corrugations)	$1^{3}/_{16}$ inch
42 inches through 96 inches (with 2 inch depth corrugations)	ϕ inch
36 inches through 120 inches (with 1 inch depth corrugations)	1δ inches

SI Units

Pipe Size	Gasket Diameter
300 through 900 mm (with 13 mm depth corrugations)	20 mm
1,000 through 2,400 mm (with 13 mm depth corrugations)	22 mm
900 through 3,000 mm (with 25 mm depth corrugations)	35 mm

Use preformed gasket material to seal the overlapping area on the coupling band between gaskets.

(c) Use channel band couplers in helical pipe with ends which have been reformed and flanged specifically to receive these bands. Use channel band couplers that are of a two piece design, are fabricated from galvanized steel stock conforming to AASHTO M 36, have 2 by 2 by 3/16 inch [51 by 51 by 4.8 mm] angles fastened to the band ends to allow for proper tightening, and meet the following:

Non SI Units

Band Thickness	Pipe Wall Thickness
0.079 inch	0.109 inch or lighter
0.109 inch	0.138 inch or heavier
: inch wide	0.109 inch or lighter
1 inch wide	0.138 inch or heavier

SI Units

Band Thickness	Pipe Wall Thickness
2.01 mm	2.77 mm or lighter
2.77 mm	3.51 mm or heavier
19 mm	2.77 mm or lighter
25 mm	3.51 mm or heavier

Furnish 22 inch [M12 diameter] connection bolts with each band, that conform to ASTM A 307, Grade A and are electroplated in accordance with ASTM B 633.

Use a gasket with the joint that is a hydrocarbon blend of butyl rubber meeting the chemical composition and physical properties of 942-2.2. Use a δ by : inch [9.5 by 19 mm] gasket for pipe fabricated from 0.109 inch [2.77 mm] or lighter material and a δ by 1 inch [9.5 by 25 mm] gasket for pipe fabricated from 0.138 inch [3.51 mm] and heavier material.

The Contractor may use a flange band coupler without the gasket for all applications other than cross drain, storm sewer and gutter drain.

Do not use the flange band coupler to join dissimilar types of pipe.

The Contractor may join reformed flanged helical pipe to existing annular or reformed pipe having annular ends. On non-gasketed installations, use either an annular band or an alternate joint described in 430-8.1.3. On gasketed installations, use an annular band, minimum of fivecorrugations in width, in conjunction with two O-ring gaskets as specified in 430-8.1.3. Use mastic material to seal the area of band overlap.

430-8.2 Laying and Shape Requirements for Corrugated Steel Pipe: Install pipe using either a trench or open ditch procedure. Place and compact backfill material consisting of crushed stone/gravel or soils as required in 125-8.

Upon completion of the project, and just prior to acceptance by the Department, clean coated corrugated steel pipe and inspect it for breaks, corrosion or other damage to the coating or to the pipe itself, and make necessary repairs. When the pipe is laid, ensure that the interior is reasonably uniform and as near circular as is practical.

Ensure that the vertical diameter is not less than 100%, or more than 105%, of the nominal diameter, and the horizontal diameter is not less than 95%, or more than 100%, of the nominal diameter.

Make all measurements for the above dimensions at the surface of the coating, at the point of smallest diameter on the corrugations.

430-9 Field Joints for Aluminum Pipe.

430-9.1 General: Make a field joint with bands fabricated of the same alloy as the culvert sheeting and meet the requirements of AASHTO M 196M.

430-9.2 Aluminum Cross Drains, Storm Sewers, and Gutter Drains: For aluminum pipe (for circular and helical corrugations), meet the requirements as specified above for corrugated steel pipe, except for the material in the bands and band connections for the alternate combination of joint materials, use the same alloy as the culvert sheeting.

430-10 Joints for Cast Iron Pipe.

Meet the requirements of 430-7.1.2 for mortaring and wetting inside the joints, as specified for concrete side drain pipe without rubber gaskets.

430-11 Specific Requirements for Corrugated Polyethylene Pipe (12 to 36 inches) [(300 to 900 mm)] and Polyvinyl Chloride (PVC) Pipe (12 to 48 inches) [(300 to 1,200 mm)].

430-11.1 Field Joints: Ensure that split couplings, twist couplings or gasketed joints are used to seal side drain. Use gasketed joints, wrapped with filter fabric meeting the requirements of a Type D-3 fabric as specified on Roadway and Traffic Standard Index 199, to seal cross drain and storm drain. Use gaskets meeting the requirements of 941-1.5. Ensure that the pipe manufacturer provides a joint design approved by the Engineer prior to use.

430-11.2 Installation Requirements Including Trenching, Foundation and Backfilling Operations: Do not use any corrugated polyethylene or PVC pipe when fill heights exceed 10 feet [3 m], when minimum cover is less than that shown on the Roadway and Traffic Design Standards, Index No. 205, or when extra base is required as shown on Roadway and Traffic Design Standards, Index No. 205.

When pipe is laid, ensure that the interior is reasonably uniform and as nearly circular as practical. Check structure shape regularly during backfilling to verify acceptability of the construction method used. Do not allow pipe to deflect more than 5% in any direction.

Place and compact backfill material as required in 125-8 under, around and a minimum of 12 inches [300 mm] above the pipe.

430-12 Method of Measurement.

430-12.1 New Pipe: The quantities of storm drain pipe, storm drain trench, and cross drain pipe to be paid for will be plan quantity, in place and accepted. The plan quantity will be measured from the inside wall of the structure as shown on the plans, along the centerline of the pipe.

The quantities of side drain pipe and gutter drain pipe to be paid for will be the net length of pipe measured in place, completed and accepted.

430-12.2 Relaid Pipe: The quantity to be paid for (including relaid pipe arch) will be the net length of pipe, measured in place after relaying, completed and accepted.

430-12.3 Mitered End Section: The quantity to be paid for will be the number completed and accepted.

430-13 Basis of Payment.

430-13.1 General: Prices and payments will be full compensation for all work specified in this Section, including all excavation except the volume included in the items for the grading work on the project, and except for other items specified for separate payment in Section 125; all backfilling material and compaction; disposal of surplus material; and all clearing and grubbing outside of the required limits of clearing and grubbing as shown in the plans.

430-13.2 New Pipe: Price and payment will be full compensation for all work and materials for constructing pipe culvert of the kinds and sizes shown in the proposal, including the optional kinds specified as being permissible under the items of Cross Drain Pipe, Side Drain Pipe and Storm Drain Pipe Culvert.

430-13.3 Relaid Pipe: Price and payment will be full compensation for all work, including hauling the pipe to the new location as necessary, any cleaning necessary and, for metal pipe, any straightening, etc., which might be required.

430-13.4 Removing Existing Pipe: When existing pipe is removed and replaced with new pipe approximately at the same location, and clearing and grubbing is not designated to be paid for in the particular area, the cost of excavating and removing the old pipe and of its disposal will be included in the Contract unit price for the new pipe in place.

430-13.5 Replacing Pavement: The cost of restoring pavement, curb, sidewalk, etc., removed only for the purpose of constructing pipe culvert, as specified in 125-9, will be included in the Contract unit price for the pipe culvert, unless designated specifically to be paid for under other items.

430-13.6 Plugging Pipes: The cost of plugging pipes, where so shown in the plans, will be included in the Contract unit price for the pipe culvert.

430-13.7 Flared End Sections: Price and payment will be full compensation for all work and materials required.

430-13.8 Mitered End Sections: Price and payment will be full compensation for all pipe, grates when required, fasteners, reinforcing, connectors, anchors, concrete, sealants, jackets and coupling bands, and all work required.

430-13.9 Railroad Requirements: Where pipe culvert is constructed under railroad tracks, the Contract unit price for the pipe culvert will include the costs of any jacking operations and the operation of placing the pipe by use of a tunnel liner, (except as specified for unanticipated tunnel liner, in 430-6.5, where reimbursement is to be made for such unanticipated liner), and all other work necessary to meet the requirements of the railroad company, excluding the costs of watchman or flagman services provided by the railroad company, except as provided below.

The Department will reimburse the Contractor for the actual costs of any trestle bridge work which is performed by the railroad's forces, as billed to him by the railroad, less the value of any salvage materials derived therefrom, whether such salvage materials are retained by the railroad company or by the Contractor. When the work of shoring and bracing is to be performed by the railroad, such fact will be stipulated in the Contract Documents and the Contractor will be required to pay to the railroad the amount of such costs, which amount will be reimbursed to him by the Department. The Contract unit price for the pipe culvert shall include the costs of all other work of shoring and bracing.

430-13.10 Payment Items: Payment will be made under:

Item No. 430- 1- Concrete Pipe Culvert - per foot.
Item No. 2430- 1- Concrete Pipe Culvert - per meter.
Item No. 430- 2- Corrugated Steel Pipe Culvert - per foot.
Item No. 2430- 2- Corrugated Steel Pipe Culvert - per meter.
Item No. 430- 3- Bituminous Coated Corrugated Steel Pipe Culvert - per foot.
Item No. 2430- 3- Bituminous Coated Corrugated Steel Pipe Culvert - per meter.
Item No. 430- 4- Bituminous Coated and Paved Corrugated Steel Pipe Culvert - per foot.
Item No. 2430- 4- Bituminous Coated and Paved Corrugated Steel Pipe Culvert - per meter.
Item No. 430- 5- Corrugated Steel Pipe Arch Culvert - per foot.
Item No. 2430- 5- Corrugated Steel Pipe Arch Culvert - per meter.
Item No. 430- 6- Bituminous Coated Steel Pipe Arch Culvert - per foot.
Item No. 2430- 6- Bituminous Coated Steel Pipe Arch Culvert - per meter.
Item No. 430- 7- Bituminous Coated and Paved Steel Pipe Arch Culvert - per foot.
Item No. 2430- 7- Bituminous Coated and Paved Steel Pipe Arch Culvert - per meter.
Item No. 430- 8- Corrugated Aluminum Pipe Culvert - per foot.
Item No. 2430- 8- Corrugated Aluminum Pipe Culvert - per meter.
Item No. 430- 9- Bituminous Coated Corrugated Aluminum Pipe Culvert - per foot.
Item No. 2430- 9- Bituminous Coated Corrugated Aluminum Pipe Culvert - per meter.
Item No. 430-10- Bituminous Coated and Paved Corrugated Aluminum Pipe Culvert - per foot.
Item No. 2430-10- Bituminous Coated and Paved Corrugated Aluminum Pipe Culvert - per meter.
Item No. 430-11- Corrugated Aluminum Pipe Arch Culvert - per foot.
Item No. 2430-11- Corrugated Aluminum Pipe Arch Culvert - per meter.
Item No. 430-12- Aluminized Corrugated Steel Pipe Culvert - per foot.
Item No. 2430-12- Aluminized Corrugated Steel Pipe Culvert - per meter.
Item No. 430-14- Elliptical Concrete Pipe Culvert - per foot.
Item No. 2430-14- Elliptical Concrete Pipe Culvert - per meter.
Item No. 430-17- Pipe Culvert Optional Material - per foot.
Item No. 2430-17- Pipe Culvert Optional Material - per meter.
Item No. 430-96- Polyvinyl Chloride Pipe Culvert - per foot.
Item No. 2430-96- Polyvinyl Chloride Pipe Culvert - per meter.
Item No. 430-98- Mitered End Section - each.
Item No. 2430-98- Mitered End Section - each.
Item No. 430-99- Polyethylene Pipe Culvert - per foot.
Item No. 2430-99- Polyethylene Pipe Culvert - per meter.
Item No. 430-150- Cast Iron Pipe Culvert - per foot.
Item No. 2430-150- Cast Iron Pipe Culvert - per meter.

Item No. 430-190- Relay Existing Pipe - per foot.
Item No. 2430-190- Relay Existing Pipe - per meter.
Item No. 430-200- Flared End Sections - each.
Item No. 2430-200- Flared End Sections - each.
Item No. 430-610- U-Endwall With Grate - each.
Item No. 2430-610- U-Endwall With Grate - each.

SECTION 431

PIPE LINER

431-1 Description.

Rehabilitate pipelines, where indicated in the plans, by using any one of the materials listed below and in strict accordance with the manufacturer's recommendations.

431-2 Materials.

431-2.1 General: Furnish certification that materials incorporated meet with the requirements of this Section.

431-2.2 Flexible Polyester Felt Liner: Use lining materials made from a polyester fiber felt tubing, lined on one side with polyurethane and fully impregnated with a liquid, thermosetting resin in accordance with the manufacturer's recommendations and meeting the requirements of ASTM D 638 and ASTM D 790.

When directed by the Engineer, prior to the installation of the lining material, furnish written guarantee that materials meet the aforementioned requirements.

431-2.3 HDPE Pipe Liner: Use a pipe liner that consists of either high density profile wall polyethylene pipe manufactured in accordance with ASTM F 894, or a high density solid wall polyethylene pipe manufactured in accordance with ASTM D 714 with an SDR of 21. Use polyethylene liners with a minimum pipe stiffness of 46 psi [320 kPa] when tested in accordance with ASTM D 2417, equivalent to an SDR of 21 in solid wall HDPE pipe. Use polyethylene material, HDB rated with a PPI material designation of PE 3408 and a material classification of Type III C5 P34 with a cell classification per ASTM D 3350 of 345434C.

431-2.4 Corrugated HDPE Pipe Liner: Use a pipe liner that consists of corrugated polyethylene pipe meeting the requirements of 948-2.3.

431-2.5 PVC Pipe Liner: Use a pipe liner that consists of polyvinyl chloride corrugated pipe with a smooth interior meeting the requirements of ASTM F 949, having a minimum pipe stiffness of 46 psi [320 kPa] when tested in accordance with ASTM D 2412. Use pipe and fittings homogeneous throughout and free from visible cracks, holes, foreign inclusions, or other injurious defects. Use pipe made of PVC compounds having a cell classification of 12454B as defined in ASTM D 1784.

431-3 Installation.

431-3.1 General: Size the pipe liner to allow approximately 10% clearance between the host pipe and the liner OD. Unless otherwise approved by the Engineer, use a liner that will maintain flows equal to 100% or greater of the original culvert or pipe. Fill the void or annular space between the HDPE liner and the host pipe for a minimum of one pipe diameter or other distance as directed by the Engineer with a non-shrink hydraulic grout, meeting the requirements of Section 934. If the plans or Engineer so directs, grout the entire annular space. In this case, use a wet slurry grout and take care to keep pressures low to prevent collapse of the pipe liner.

431-3.2 Flexible Polyester Felt Liner: Install the pipe liner in strict accordance with the manufacturer's recommendations and as specified in the plans.

431-3.3 HDPE Pipe Liner: Install the pipe liner in strict accordance with the manufacturer's recommendations and as specified in the plans, with the following additional requirements.

Join HDPE pipe by the butt or heat fusion method in accordance with ASTM D 2657, or ensure that the HDPE pipe has a positive mechanical joint in which the outside diameter and inside diameter joint surfaces are substantially flush with the pipe outside diameter and inside diameter. Provide a joint capable of being pulled, winched or pushed into the host pipeline without joint separation.

431-3.4 Corrugated HDPE Pipe liner: Install the pipe liner in strict accordance with the manufacturer=s recommendations and as specified in the plans, with the following additional requirements.

When the HDPE pipe is joined, the connection at the joint shall not reduce the interior diameter while maintaining a constant outside diameter. The assembled joint shall meet the performance requirements of ASTM D 3212. The elastomeric sealing gasket shall meet the requirements of ASTM F 477. Each joint must be capable of being pulled, winched or pushed into the host pipeline without joint separation.

431-3.5 PVC Pipe Liner: Install the pipe liner in strict accordance with the manufacturer=s recommendations and as specified in the plans, with the following additional requirements.

PVC pipe shall be connected with a PVC coupling utilizing elastomeric sealing gaskets. When joined, the coupling shall not reduce the interior diameter while maintaining a constant outside diameter. The assembled joint shall meet the performance requirements of ASTM D 3212. Elastomeric seals (gaskets) shall meet the requirements of ASTM F 477. Each joint must be capable of being pulled, winched or pushed into the host pipeline without joint separation.

431-4 Method of Measurement.

The quantity to be paid for will be the plan quantity, in feet [meters], of existing pipe measured from manhole to manhole along the centerline of the pipe, or from culvert end to culvert end along the centerline of the pipe, lined, installed, completed and accepted.

431-5 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section, including all materials, tests, equipment, labor, repairs, and incidental items necessary for satisfactorily performing the work.

Payment will be made under:

Item No. 431- 70- Pipe Liner - per foot.
Item No. 2431- 70- Pipe Liner - per meter.

SECTION 435

STRUCTURAL PLATE PIPE AND PIPE ARCH CULVERTS

435-1 Description.

Construct structural plate pipe and pipe arch culverts.

435-2 Materials.

Meet the requirements of Section 944 for steel and Section 945 for aluminum.

When the plans call for bituminous coated pipe or pipe arch, meet the coating requirements of 944-4.

When other types of coating material are shown in the plans, use a coating that consists of at least two coats of the specified material, applied at the job site. Apply the coating by brush or by spray.

435-3 Trench, Foundation, Laying, and Backfill.

Perform this work as specified in Section 430, and as follows.

Provide a foundation for the bottom plates that is of uniform density and carefully shaped to fit the lower plate of the pipe or pipe arch. Thoroughly tamp the backfill material against the remaining plates.

435-4 Assembly.

Assemble the plates to form the pipe or pipe arch structure in accordance with the diagram furnished by the manufacturer. Connect the plates by bolting tightly in all bolt holes provided.

435-5 Method of Measurement.

The quantities to be paid for will be the plan quantity, in feet [meters], of pipe or pipe arch, installed in place, completed and accepted. The quantity will be measured along the centerline of the structure from end to end of metal for full section structures, from average end to end at top and bottom for beveled-end structures.

435-6 Basis of Payment.

Prices and payments will be full compensation for all work specified in this Section, including all materials, backfilling, and disposal of surplus material and all excavation except the volume included in the items for grading work and for other items specified for payment in Section 125.

Payment will be made under:

Item No. 435 - Structural Plate Pipe Culvert - per foot.
Item No. 2435 - Structural Plate Pipe Culvert - per meter.

SECTION 440

UNDERDRAINS

440-1 Description.

Construct underdrains, underdrain cleanout structures, underdrain inspection boxes and underdrain outlet pipes. Use any one of the types of pipe listed in 440-2, unless a particular type is specifically required. Use only perforated pipe, and do not use open joints.

440-2 Materials.

Meet the following requirements:

Filter Aggregate	902-4
Concrete Pipe	941-3
Corrugated Steel Pipe	Section 943
Corrugated Aluminum Pipe	945-1
Clay Pipe	947-2
Polyvinyl-Chloride	948-1
Corrugated Polyethylene Pipe	948-2
Filter Fabric Sock	948-3
Geotextile Fabrics	Section 985

Use bitumized-fiber pipe only when called for in the Contract Documents.

440-3 Excavating Trench.

Excavate the trench carefully, to the depth required to permit the pipe to be laid to the grade required, and to the dimensions shown in the plans.

440-4 Laying Pipe.

440-4.1 General: Bed the pipe firmly on the bottom of the trench, with the perforations down and joints securely made.

440-4.2 Corrugated Steel Pipe - Protection of Coating: Handle corrugated steel pipe in such a way that the zinc coating will not be bruised or broken. Do not use pipe showing bruises or breakage of the zinc coating.

440-4.3 Protection of Drain Inlet: Protect the influent end of the pipe in a manner which will prevent any soil from entering the drain.

440-4.4 Lateral Connections: Make lateral connections with prefabricated wyes, tees, elbows, etc., as required.

440-4.5 Underdrain Inspection Box: Construct underdrain inspection boxes in accordance with the Roadway and Traffic Design Standard Index Number 245 and the plans.

440-4.6 Underdrain Cleanout Structures: Construct underdrain cleanout structures of in-line wye fittings and stub for access where called for in the plans.

440-5 Placing Filter Material and Backfilling.

440-5.1 Placing Material: After laying the pipe and obtaining the Engineer's approval, backfill the trench with filter material to the lines shown on the plans.

440-5.2 Compaction of Filter Material and Protection of Pipe: Place and compact the filter material around the pipe and for the full width of the trench, in layers not exceeding 6 inches [150 mm] in thickness. Take special care to avoid displacement or damage to the pipe.

440-5.3 Backfill above Filter Material: For all types of pipe, backfill the portion of the trench above the filter material with suitable pervious material. Place and compact the material in layers not exceeding 4 inches [100 mm] in thickness.

440-6 Method of Measurement.

The quantities to be paid for will be the length, in feet [meters], of underdrain, which includes underdrain cleanout structures, measured in place, along the centerline and gradient of the underdrain, completed and accepted. The quantities to be paid for will be the length, in feet [meters], of outlet pipe measured in place, along the centerline and gradient of the outlet pipe, completed and accepted. The quantity of underdrain inspection boxes to be paid for will be the number completed and accepted.

440-7 Basis of Payment.

Price and payment will be full compensation for all the work, including all materials and all excavation except the volume included in the items for the grading work.

Payment will be made under:

Item No. 440- 1- Underdrains - per foot.
Item No. 2440- 1- Underdrains - per meter.
Item No. 440- 70- Underdrain Inspection Box - each.
Item No. 2440- 70- Underdrain Inspection Box - each.
Item No. 440- 73- Underdrain Outlet Pipe - per foot.
Item No. 2440- 73- Underdrain Outlet Pipe - per meter.

SECTION 441

EDGEDRAIN MAT (GEOCOMPOSITE DRAIN)

441-1 Description.

Construct an edgedrain mat using a geocomposite drain (prefabricated drainage unit) at locations shown in the plans or as directed by the Engineer.

441-2 Materials.

441-2.1 General: Furnish manufacturer's certification that all materials proposed for use meet the requirements as specified.

Include with the certification test results from an approved independent testing laboratory for each material property as specified. Submit the certification and test results to the Engineer at least 30 days prior to using materials on any project. Include two specimens, each 12 by 12 inches [300 by 300 mm], of the geocomposite drain with the submission. However, the Engineer may inspect, test, or reject all materials at any time.

As specified by the manufacturer, use geocomposite drains that include all necessary fittings and materials to make splices along the drain and connections from the drain to the outlet piping. Use fittings and connections that are of sufficient strength to withstand construction handling and permanent loading and that meet the approval of the Engineer in any and all cases. Ensure that the geocomposite drain is a product included on the Qualified Products List.

441-2.2 Drainage Core: The drainage core is the interior element of the geocomposite drain, which is encased in filter fabric.

Use a drainage core that is a flexible, rectangular, hollow mat fabricated from a polyolefin and is strong enough to resist the vertical and lateral pressures induced by installation and subsequent soil and traffic loadings. Use a design that allows entry of water from all sides of the core and provides open continuous channels, both horizontally and vertically, for water to flow without restriction.

Property	Test Method	Requirements
Water Absorption	ASTM D 570	0.05% Maximum at 24 hours
Fungus Resistance	ASTM G 21	No Growth

441-2.3 Filter Fabric: The filter fabric is the exterior element of the geocomposite drain, which completely encases the supporting drainage core. For cores having a waffle and/or column type structure, bond the filter fabric to the cores projections. For cores having an over-elongated tube type structure, tightly stretch the filter fabric around the core.

Use a filter fabric that is a non-woven needle punched polyolefin geotextile fabric, free of chemical treatment or coating which alters its physical properties. All fabric minimum strengths shown are minimum average roll requirements in the weakest principal direction, using sampling procedures specified in ASTM D 4354.

Non SI Units

Property	Test Methods	Requirements
Permeability*	ASTM D 4491	K = 0.20 cm/sec. minimum
AOS (Apparent Opening Size)	ASTM D 4751 (U.S. Std. Sieve)	50-100
Grab Tensile Strength	ASTM D 4632	90 lbs., minimum
Puncture Strength	ASTM D 3787 Modified**	45 lbs., minimum
Trapezoidal Tear Strength	ASTM D 4533	45 lbs., minimum

Mullen Burst Strength	ASTM D 3786	150 psi, minimum
Elongation	ASTM D 4632	35%, minimum
Seam Strength	ASTM D 4595 (wide-width strip method)	80 lbs., minimum
Fabric Weight	ASTM D 3773	4.0 oz/yd^2 minimum
Ultraviolet (UV) Resistance	ASTM D 4355 (UV exposure 500 hrs.)	80% Strength retained, minimum
Fungus Resistance	ASTM G 21	No Growth

* Any drain's filter fabric that is overlapped and glued and/or bonded on the pavement side is the critical permeability section. Test a section of filter fabric with the same characteristics, i.e., as fabricated and installed, to ensure that the overlapped section complies with the specified requirements. When the drain's filter fabric is not overlapped on the pavement side, the Contractor may test a normal thickness of the filter fabric to determine its acceptability.
**(steel ball replaced with a $^{5}/_{16}$O diameter solid steel cylinder with a flat tip chamfered at $^{1}/_{32}$O H 45 degrees, centered within the ring clamp.)

SI Units

Property	Test Method	Requirements
Permeability*	ASTM D 4491	2 mm/s, minimum
AOS	ASTM D 4751	150 - 300 µm
Grab Tensile Strength	ASTM D 4632	400 N, minimum
Puncture Strength	ASTM D 3787 Modified**	200 N, minimum
Trapezoidal Tear Strength	ASTM D 4533	200 N, minimum
Mullen Burst Strength	ASTM D 3786	1,035 kPa, minimum
Elongation	ASTM D 4632	35%, minimum
Seam Strength	ASTM D 4595 (wide width strip method)	14 kN/m, minimum
Fabric Weight	ASTM D 3773, ASTM D 3774, ASTM D 3775, ASTM D 3776, ASTM D 3882, ASTM D 3883	0.14 kg/m^2, minimum
Ultraviolet (UV) Resistance	ASTM D 4355 (UV exposure 500 hours)	80% Strength retained, minimum
Fungus Resistance	ASTM G 21	No Growth

* Any drain's filter fabric that is overlapped and glued and/or bonded on the pavement side is the critical permeability section. Test a section of filter fabric with the same characteristics, i.e., as fabricated and installed, to ensure that the overlapped section complies with the specified requirements. When the drain's filter fabric is not overlapped on the pavement side,

the Contractor may test a normal thickness of the filter fabric to determine its acceptability.
** Steel ball replaced with a 8 mm diameter solid steel cylinder with a flat tip chamfered at 1 mm by 45 degrees, centered within the ring clamp.

441-2.4 Geocomposite Drain: The geocomposite drain is a prefabricated drainage unit consisting of a supporting drainage core and a filter fabric envelope which completely encases the core and itself.

Once completely fabricated, ensure that the drain's thickness is no less than : inch [19 mm] with a width or depth as shown in the plans. Sufficiently bond the filter fabric to the core as specified in order to prevent the fabric from sagging into the core and impeding the water flow due to installation and subsequent soil and traffic loadings, to provide acceptable peel strength, and to facilitate continuous installation of the drain using an approved trenching machine.

Non SI Units

Property	Test Method	Requirements
Compressive Strength (20% Maximum Deformation)	ASTM D 1621 (12 x 12 inch specimen)	50 psi, minimum
Peel Strength* (Bonding Fabric to Fabric, Bonding Fabric to Projection, Bonding Fabric to Core)	ASTM D 903	35 lbs/ft of width, minimum
In-Plane Flow (Cross-sectional Area; Hydraulic Transmissivity)	ASTM D 4716** (24 inch long specimen, minimum)	15 gal/minute/ft of width, minimum

* Test peel strength for all three conditions. Use test specimens that are both flexible (filter fabric) when testing bonding fabric to fabric, and flexible to rigid (filter fabric to core) when testing bonding fabric to projection or core. Bond specimens to each other using typical assembly conditions for a drain completely fabricated and installed. Thickness of the rigid (core) material is the normal core thickness, prior to the filter fabric encasement, and is an exception to the limiting 1/8 inch thickness of test materials specified in the test method.
**Test to be conducted at a gradient of 0.1 and a normal pressure of 10 psi for not less than 100 hours.

SI Units

Property	Test Method	Requirements
Compressive Strength (20% Maximum Deformation)	ASTM D 1621 (300 by 300 mm specimen)	345 kPa, minimum
Peel Strength* (Bonding Fabric to Fabric, Bonding Fabric to Projection, Bonding Fabric to Core)	ASTM D 903	0.05 kg/mm of width, minimum

In-Plane Flow (Cross-sectional Area; Hydraulic Transmissivity)	ASTM D 4716** (600 mm long specimen, minimum)	0.003 $m^3/(s{\cong}m)$ of width, minimum

* Test peel strength for all three conditions. Use test specimens that are both flexible (filter fabric) when testing bonding fabric to fabric, and flexible to rigid (filter fabric to core) when testing bonding fabric to projection or core. Bond specimens to each other using typical assembly conditions for a drain completely fabricated and installed. Thickness of the rigid (core) material is the normal core thickness, prior to the filter fabric encasement, and is an exception to the limiting 3 mm thickness of test materials specified in the test method.
**Test to be conducted at a gradient of 0.1 and a normal pressure of 70 kPa for not less than 100 hours.

(a) Use waffle and/or column drains that provide at least 65% unobstructed inflow opening on the pavement side and at least 12% unobstructed inflow opening on the shoulder side. If a multi-channel core separates the flow into two sections, use only the in-plane flow rate of the pavement side facing channel in determining acceptability. The Contractor may consider a multi-channel core as a single channel if it provides at least 10% unobstructed crossing opening between channels.

(b) Use over-elongated drains that provide at least 12% unobstructed inflow opening on either the pavement or the shoulder side.

Ensure that the drain's material and manufacture are appropriate to facilitate swift, continuous machine-installation using conventional trenching equipment.

441-2.5 Outlet Pipe: For pipe materials for outlets, use any of those specified in 440-2 except that there shall be no perforations. Use outlet pipes 4 inches [100 mm] in diameter as specified on Roadway and Traffic Design Standards, Index No. 287 (edgedrain requirements).

441-3 Installation Methods.

Prior to commencing installation of the geocomposite drain, submit the proposed installation method, noting any deviation from the manufacturer's recommendations to the Engineer. Propose an installation method that reflects adequate measures to safeguard the drain's filter fabric from clogging, minimizing any likely sources of contamination. Upon review of the proposed installation plan, the Engineer may request the Contractor to have a manufacturer's representative present on the project during the installation of the drain at no expense to the Department.

Install geocomposite drains with approved trenching equipment which will cause only a minimal disturbance to the pavement structure and subbase. Design a trencher installation boot to ensure that the drain maintains its flat flow plane after placement and compaction of backfill materials. Throughout each section of drain, use trenching equipment that provides an exposed edge of pavement free of any sand, clay, soil, or other foreign material which hinders inflow and/or prevents direct contact between the drain and the pavement structure. If the Contractor fails to comply with these requirements, the Engineer may restrict the installation of additional sections of drain until the Contractor has made appropriate equipment adjustments or obtained other equipment able to comply with this requirement.

Install the drain as shown in the plans, recommended by the manufacturer, specified herein, and approved by the Engineer. Place the drain in a trench immediately adjacent to the roadway pavement edge. If projections protrude from only one side of the drain, place it such that the projections are in contact with the pavement side of the trench. For over-elongated tube drains, place it such that the drain is in contact with the shoulder side of the trench. Since trench depths shown in the plans are approximate, the Engineer may adjust them. Provide a trench a minimum of 4 inches [100 mm] and a maximum of 5 inches [125 mm] in width.

For over-elongated tube drains, backfill meeting the requirements of 902-4. Otherwise, use materials generated from the trenching operation or material as required by the plans for backfill. Only use rock or coarse aggregate material passing a : inch [19.0 mm] sieve. Perform the backfilling operation in uncompacted lifts, no greater than 8 inches [200 mm].

Due to the specified trench width limitations, compact the embankment with vibratory compactors having a maximum compaction force of 5,000 pounds [22 kN] (Construction Industry Manufacturers Association rating) or to a degree acceptable to the Engineer. Achieve a minimum density of 90% of the maximum density as determined by AASHTO T 99, Method A or as estimated by the Engineer based on his experience with the backfill material used. Obtain the Engineer's approval of other compaction type equipment.

Excavate the trench, place the drain, and place the first backfill lift in a single continuous operation. Provide compaction equipment, tension in drain, and boot clearance that are compatible with the trencher speed in order to ensure adequate density of the backfill.

Install outlet fittings and outlet pipes concurrently with the installation of the geocomposite drains. Provide positive drainage within 24 to 48 hours of beginning trenching for installation of a given section of drain. If the Contractor fails to comply with this requirement, the Engineer may restrict the installation of additional sections of drains until such time as the Contractor completes appropriate outlet installations.

Install all fittings and material in such a way as to preclude soil intrusion into the drainage mat core or outlet piping, and to provide continuity of the drainage flow.

Either connect the open end of outlet pipes into a drainage structure or terminate them by the use of a concrete apron. Use geocomposite drain outlets and outlet pipe aprons meeting the same requirements used on draincrete edgedrains, which are shown on Roadway and Traffic Design Standards, Index No. 287. Refer to the plans for any significant difference or exception.

Excavate, restore, and sod the disturbed areas at the outlet ends without blocking the proposed drainage. At the time of the Engineer's inspection and project acceptance, ensure that all outlet pipes and concrete aprons are clear of earth material, vegetation, and other debris.

Leave the backfilled and compacted trench in condition ready to receive a capping of Type S asphaltic concrete, or a capping meeting the requirements as shown on the plans.

Do not leave any trench greater than 2 inches [50 mm] in depth open overnight. Barricade trenches at all times.

441-4 Method of Measurement.

The quantities to be paid for will be the length, in feet [meters], completed and accepted. The quantity will be measured in place along the centerline of the edgedrain and outlet pipe.

441-5 Basis of Payment.

441-5.1 Edgedrain Mat: Price and payment will be full compensation for removal of existing shoulder pavement, trench excavation, disposal of excess materials, fittings, splices, and connections, select backfill material, and barricades necessary for edgedrain mat construction.

441-5.2 Edgedrain Mat Outlet Pipe: Price and payment will be full compensation for removal of existing shoulder pavement, trench excavation, pipe and fittings, standard aprons (for details on concrete, sodding, and other details see Roadway and Traffic Design Standards, Index No. 286), galvanized hardware cloth (rodent screens), grouting around and stubbing into existing or proposed inlets and drainage structures or paved ditches; restoration of ditch pavement, backfill in place, and disposal of excess materials.

441-5.3 Separate Payment: Separate payment will be made for the following work:

(1) Non-standard concrete apron, which will be paid for at the Contract unit price per cubic yard [cubic meter] for Class I Concrete (miscellaneous);

(2) Non-standard sodding, which will be paid for at Contract unit price per square yard [square meter] for sodding;

(3) Shoulder pavement, which will be paid for at the Contract unit price per ton [metric ton] for Type S Asphaltic Concrete;

(4) Tack coat, which will be paid for at the Contract unit price per gallon [liter] for Bituminous Material (Tack Coat); and

(5) Shoulder joint seal, which will be paid for at the Contract unit price per foot [meter] for Shoulder Joint Seal.

441-5.4 Payment Items: Payment will be made under:

Item No. 441- 74- Edgedrain Mat - per foot.
Item No. 2441- 74- Edgedrain Mat - per meter.
Item No. 441- 75- Edgedrain Mat Outlet Pipe - per foot.
Item No. 2441- 75- Edgedrain Mat Outlet Pipe - per meter.

SECTION 443

FRENCH DRAINS

443-1 Description.

Construct French Drains, utilizing one of the authorized types of pipe, with coarse aggregate, or ballast rock when specified, and filter fabric.

443-2 Materials.

443-2.1 Pipe: Unless a particular type is specified in the plans, pipe furnished may be any of the following types:

(1) Concrete Pipe (Bell & Spigot): Slotted or perforated concrete pipe may be used. Meet the requirements of 941 for concrete pipe. Use the class of pipe specified on the Roadway and Traffic Design Standards, Index No. 205. Do not use gaskets. Fully insert the spigot in the bell, and bring home. Conform to Roadway and Traffic Design Standards, Index No. 285 for slotted pipe. Use perforated pipe having perforations equally located 360 degrees around the pipe. Use pipe having not less than 30 round perforations, δ inch each, per square foot [320 round perforations, 10 mm each, per square meter] of inside pipe surface. Extend perforations to within 6 inches [150 mm] of the bell or spigot area. The Engineer will permit other perforations not less than 5/16 inch [8 mm] nor more than δ inch [10 mm] in the least dimension if they provide an opening area not less than 3.31 in^2/ft^2 [23,000 mm^2/m^2] of pipe surface.

(2) Corrugated Aluminum Alloy Culvert Perforated Pipe: Meet the requirements of Section 945. Use perforated pipe having perforations equally located 360 degrees around the pipe. Locate perforations either on the inside crests or on the neutral axis of all corrugations except that perforations are not required within 4 inches [100 mm] of each end of each length of pipe or in a corrugation where seams are located.

Provide pipe having not less than 30 round perforations, δ inch each, per square foot [320 round perforations, 10 mm each, per square meter] of pipe surface. The Engineer will permit other perforations not less than 5/16 inch [8 mm] nor more than δ inch [10 mm] in the least dimension if they provide an opening area not less than 3.31 in^2/ft^2 [23,000 mm^2/m^2] of pipe surface.

(3) Corrugated Steel Perforated Pipe: Meet the requirements of Section 943. Space the perforations and meet the requirements as specified in (2) above.

(4) Bituminous Coated Corrugated Steel Perforated Pipe: Meet the requirements of Section 943. Space the perforations and meet the requirements as specified in (2) above. Place the perforations prior to the bituminous coating. The Engineer will accept the minimum opening of not less than 3.31 in^2/ft^2 [23,000 mm^2/m^2] of pipe if 50% of the opening area is maintained after coating.

(5) Corrugated Polyethylene Pipe: Meet the requirements of 948-2.3. Space the perforations and meet the requirements as specified in (2) above.

(6) Polyvinyl Chloride (PVC) Pipe: Meet the requirements of 948-3. Space the perforations and meet the requirements as specified in (2) above.

443-2.2 Coarse Aggregate: Meet the requirements of 901-1.4 for No. 4 stone.

443-2.3 Select Fill: Use select fill, unless otherwise called for, consisting of well-graded limerock or limerock and sand fill. Sand, or fill having a high proportion of sand, will not be accepted as select fill. Prior to placing select fill, obtain the Engineer=s approval.

443-3 Excavating Trench.

Excavate the trench in accordance with Section 125 unless specific trench excavation procedures are described in the plans.

Carefully excavate the trench to such depths as required to permit the filter fabric, coarse aggregate and the pipe to be placed in accordance with the details shown on the plans.

443-4 Laying Pipe.

Lay all pipe conforming with the lines and grades specified in the plans and in accordance with these Specifications. Unless otherwise specified in the plans, set the pipe with a 36 inch [0.9 m] minimum cover and a maximum cover of 66 inches [1.7 m].

443-5 Placing Coarse Aggregate and Backfilling.

After the pipe placement has been approved, carefully place the coarse aggregate or ballast rock, without disturbing the pipe, around and over the pipe to a depth shown on the plans. Then fold the filter fabric over the coarse aggregate or ballast rock as shown on the plans, and fill the portion of the trench above the coarse aggregate with select fill material placed in layers not to exceed 6 inch [150 mm] compacted thickness.

443-6 Method of Measurement.

The quantity of French Drains to be paid for under this Section will be the length in feet [meters], measured in place, completed and accepted or paid for separately under the several related pay items as specified on Roadway and Traffic Design Standards, Index No. 285 for French Drains with a significantly different cross-section.

443-7 Basis of Payment.

The quantities determined as provided above will be paid for at either (1) the Contract unit price per foot [meter] for French Drains or (2) separately under the several related pay items as defined in 443-6. Such prices and payments will be full compensation for all the work specified in this Section and will include all materials and all excavation, and will also include sheeting or shoring, if required, the disposal of surplus material, pavement restoration, backfilling and tamping, but will not include payment for items paid for elsewhere in the specifications.

Payment shall be made under:

Item No. 430- 72- Slotted or Perforated Pipe Culvert - per foot.
Item No. 2430- 72- Slotted or Perforated Pipe Culvert - per meter.
Item No. 443- 70- French Drains - per foot.
Item No. 2443- 70- French Drains - per meter.
Item No. 443- 71- Ballast Rock - per cubic yard.
Item No. 2443- 71- Ballast Rock - per cubic meter.
Item No. 514- 71- Plastic Filter Fabric - per square yard.
Item No. 2514- 71- Plastic Filter Fabric - per square meter.

SECTION 445

ROOF DRAINS

445-1 Description.

445-1.1 Scope of Work: Construct pipe drains for the discharge from buildings alongside the project that extend from the right-of-way or easement limit under the sidewalk and to the face of the curb. Locate the intake of the drain to adequately collect the runoff.

445-1.2 Where Required: Perform this work on all projects where constructing curb and gutter adjacent to built-up areas, although the work usually is not specifically shown in the plans. Provide all building areas which will discharge an undue amount of surface water onto the project with such drains.

445-2 Materials.

445-2.1 Pipe: Use any cast iron pipe available commercially that is, in general, 4 inches [100 mm] in diameter.

445-2.2 Joint Materials: Use joint materials as specified in Section 430.

445-3 Construction Methods.

Perform construction methods as specified in Section 430.

445-4 Method of Measurement.

The quantity to be paid for will be the length, in feet [meters], of pipe for roof drains in place, completed and accepted. The quantity will be measured along the centerline of the pipe, from end to end of the installed pipe.

445-5 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section, including all materials, excavation, and backfill required.

Payment will be made under:

Item No. 445- 1- Cast Iron Pipe for Roof Drain - per foot.
Item No. 2445- 1- Cast Iron Pipe for Roof Drain - per meter.

SECTION 446

EDGEDRAIN (DRAINCRETE)

446-1 Description.

Construct Edgedrain (Draincrete), and Edgedrain Outlet Pipe as shown in the plans and Roadway and Traffic Design Standards, Index No. 287. Use any one of the types of pipe listed in 446-2, unless a particular type is specifically required within the Contract Documents. Use only perforated pipe, and do not use open joints.

446-2 Materials.

Meet the following requirements:

Portland Cement Concrete - Class I (Nonstructural)	Section 347*
Coarse Aggregate	Section 901
Portland Cement	Section 921
Water	Section 923
Polyvinyl-Chloride Pipe	Section 948
Polyethylene Pipe	Section 948

Filter Fabric ....Section 985

*For Draincrete, the concrete requirements of Section 347 are modified as follows:

Use Type I or II portland cement (no fly ash or other pozzolans permitted).

Composition:

Grade of coarse aggregate (stone)........................... # 57, # 67 or # 89
Maximum Water/Cement ratio 0.38
Minimum cement factor............ 385 lb/yd^3 [228 kg/m^3] of Draincrete
Maximum Slump Range .... Not Applicable
Fine Aggregate...None
Admixtures...None

Do not use materials which contain hardened lumps, crusts, or frozen matter, or are contaminated with dissimilar material.

446-3 Control of Quality.

446-3.1 Concrete Design Mix: Submit the proposed design mix prior to production, on the "Concrete Mix Design" form, for the Engineer=s approval. Use only draincrete design mixes having prior approval of the Engineer. Do not change the design mix component materials except as per 446-3.2.

Furnish sufficient material of each component to the Engineer, for verification of the proposed mix design by the State Materials Office. Meet the unit weight requirements as determined in accordance with FM 5-530, and the drain rate in accordance with FM 5-570. Also, provide one of the following with the design mix submittal:

(1) Evidence from three sets of production data, either from Department acceptance tests or independently verifiable commercial mixes, that draincrete produced in accordance with the proposed design mix meets the requirements of this Section.

(2) Test data from a single trial batch of 0.10 yd^3 [0.10 m^3] minimum is required, which demonstrates that the draincrete produced using the proposed mix, designated ingredients, and designated water-cement ratio meets the requirements of this Section.

446-3.2 Batch Adjustment - Materials: Meet the theoretical yield requirements of the approved mix design. Inform the Engineer of any adjustments to the approved mix design. Note any batch adjustments and record the actual quantities incorporated into the mix, on the concrete ADelivery Ticket/Certification≅ form.

446-3.3 Delivery Certification: Furnish to the Engineer a complete "Delivery Ticket/Certification" form with each batch of draincrete prior to unloading at the site.

446-4 Construction.

446-4.1 Excavating Trench: Meet the requirements of Section 440.

446-4.2 Laying Pipe: Meet the requirements of Section 440.

446-4.3 Placement of Draincrete: Obtain the Engineer's approval before placing the draincrete. Deliver the draincrete to the site of placement in a freshly mixed unhardened state. Deposit draincrete in the form or trench by a method approved by the Engineer, to ensure uniform distribution. Do not use vibrators.

Avoid displacement or damage to the pipe or filter fabric.

446-5 Sampling and Testing.

446-5.1 General: The Engineer will take random samples of the draincrete at the point of placement in accordance with FM 5-570 to determine the drain rate. A minimum of two test cylinders will be made for each LOT. A LOT represents one day=s production of each mix design.

446-5.2 Acceptance of Hardened Draincrete: Meet the minimum drain rate of 6 oz/second [185 ml/second]. Draincrete not meeting the drain rate requirement will be rejected.

Remove, and replace all rejected draincrete at no cost to the Department.

446-6 Method of Measurement.

The quantity of Edgedrain (Draincrete) to be paid for will be the length, in feet [meters], measured in place, along the centerline and gradient of the Edgedrain (Draincrete), completed and accepted. The quantity of Edgedrain Outlet Pipe to be paid for will be the length, in feet [meters], measured in place along the centerline and gradient of the outlet pipe, completed and accepted.

446-7 Basis of Payment.

Price and payment will be full compensation for all work, including all materials, excavation, equipment, labor and incidentals necessary to complete the work.

Payment will be made under:

Item No. 441- 1- Edgedrain (Draincrete) - per foot.
Item No. 2441- 1- Edgedrain (Draincrete) - per meter.
Item No. 441- 71- Edgedrain Outlet Pipe - per foot.
Item No. 2441- 71- Edgedrain Outlet Pipe - per meter.

SECTION 450

PRESTRESSED CONSTRUCTION

450-1 Description.

Fabricate, store, transport, and erect precast prestressed concrete members prestressed by the pretensioning method. The requirements of Section 346, Section 400, Section 415, Section B460, and Division III, together with other applicable Sections of the specifications covering specific construction items, also apply, except as modified herein.

450-2 Pretensioned Precast Prestressed Concrete.

450-2.1 General: Pretensioned precast prestressed concrete members are members prestressed by the pretensioning method. In this method, steel components are stressed and anchored; the concrete for the member is then cast and cured, and finally the stress in the steel components is released from the anchorages to the concrete through bond, after the concrete has attained its specified release strength. When members are prestressed by a combination of pretensioning and posttensioning, meet the applicable requirements of this Section for all the activities related to the fabrication of such members.

450-2.2 Quality Control/Quality Assurance Program:

450-2.2.1 General: The quality control/quality assurance program for precast prestressed concrete members is composed of the quality control activities performed by the Contractor and the quality assurance activities performed by the Department.

Control the quality of fabrication of precast prestressed concrete members in accordance with the requirements described herein, under the monitoring of the Department. Develop a Quality Control Plan (QCP), and obtain the Engineer's approval of it prior to commencement of any work.

450-2.2.2 Definitions: The quality control/quality assurance program is defined by the following:

Quality Control (QC): The activities performed by the Contractor to ensure that materials, methods, techniques, personnel, procedures and processes utilized during fabrication of precast prestressed concrete members are within the required limits.

Quality Assurance (QA): The activities performed by the Engineer to ensure that the quality and acceptability of the precast prestressed concrete members are in accordance with this Section and the Contract Documents.

Independent Assurance (IA): The activities performed by the Engineer, the Federal Highway Administration, or any other local or state agency, who do not normally have direct responsibility for quality assurance. IA sampling and testing and IA procedures are normally used to determine reliability of QC and QA sampling and testing, and to evaluate fulfillment of QC and QA activities.

450-2.2.3 Contractor's Quality Control: Develop and implement a QCP with the objective of verifying that all materials and workmanship incorporated into the precast prestressed concrete members conform with the level of quality required by this Section. The Contractor's QCP shall also verify that the fabrication processes are controlled to ensure that the finished member conforms to the physical characteristics and dimensions called for by the plans and this Section. Provide the QCP with sufficient detail to enable the Department to determine the adequacy of the plan. Include with the plan a management statement of dedication to quality and to the QCP. Include with the plan a schedule of frequencies of the sampling, testing, inspection, and documentation that the Contractor shall perform. As a minimum, the QCP shall address items listed below. Submit the plan in writing to the Engineer for approval prior to beginning fabrication. Submit modifications to the QCP for approval in the same manner.

Obtain the Engineer's approval of a QCP for each project. The Engineer will extend approval of the QCP on a project by project basis upon written request from the Contractor for all continuing work at a specific prestressed concrete plant, provided the materials, methods, techniques, procedures, processes and personnel qualifications utilized during fabrication of precast prestressed concrete members remain the same.

QCP General Format:

(1) General Information

- Company Name, Address and Location
- Plant Number, Address and Location (if different from above)
- Plant Organizational Chart
- Plant Personnel and Experience
  - General Manager
  - Production Manager
  - Plant Engineer
  - Quality Control Manager
  - Quality Control Inspectors and Technicians
  - Stressing Foreman/Yard Superintendent
- Statement of Management Commitment to Quality Control
- Department Approval of Plant

(2) Materials

- Description of Testing Facilities to be Utilized for Materials Testing
- Site Plan Detailing Material Storage and Handling Facilities
- Sampling and Testing Frequencies of the Following Materials:
  - Concrete (In accordance with 450-2.5.7)
  - Miscellaneous Materials

Procedure for verifying that steel products received are represented by certified test reports and that the material meets specification requirements.

(3) Inspection

- Responsibility for Inspection Operations
- Inspection of Pre-placement Operations
  - Control of Dimensions and Tolerances
  - Stressing Bed and Formwork
  - Positioning of Embedded Items
  - Size and Position of Reinforcing Steel and Welded Wire Fabric
  - Size, Position, and Condition of Prestressing Steel and/or Posttensioning Ducts
  - Stressing Operations
  - Inspection of Concrete Operations
  - Proportioning and Mixing of Concrete
  - Handling, Placing, and Consolidation of Concrete
  - Concrete Finishing
  - Concrete Curing
- Inspection of Postplacement Operations
  - Detensioning and Stripping of Forms
  - Dimensional and Alignment Tolerances
  - Handling, Storage, Transportation
  - Member Identification
  - Repairs
  - Resolution of Non-Complying Issues
  - Concrete Sealing

(4) Procedures

- Proposed Method of Duct Support

Temperature Changes

Procedure for adjusting stressing force for temperature differential

Procedure for heating, covering, insulating or housing concrete work during cold weather after casting and prior to detensioning

Procedure for protection of exposed strands between stressing headers or anchorages

Proposed location of thermocouples

Detensioning Procedures

Non-complying Members

Procedure for identification, evaluation and disposition of deficiencies

Repair methods and materials

QCP Review/Revision

Procedure to periodically address and correct repetitive noncompliance issues

(5) Acceptance and Certification of Members

Producers Stamp Configuration

Certification Statement

(6) Documentation

Material Acceptance

Pre-placement Inspection

Stressing

Placement Operation

Postplacement Inspection

Deficiencies

Repairs

450-2.2.4 Department's Quality Assurance: The Department will perform inspections, sampling, and testing to ensure the quality and acceptability of the materials, methods, techniques, procedures and processes being utilized by the Contractor in the fabrication of precast prestressed concrete members. For this purpose, the Engineer will perform periodic assurance inspections, sampling and testing during, but not limited to, any of the following stages of fabrication:

(a) Prior to Tensioning
(b) During Tensioning
(c) Prior to Concrete Placement
(d) During Concrete Placement and Curing
(e) Prior to Detensioning
(f) During Detensioning
(g) After Detensioning
(h) Storage
(i) Prior to Shipment

The Department's Quality Assurance Program is reflected in the Department's Manual for Quality Assurance of Precast Prestressed Concrete Members.

450-2.2.5 Independent Assurance: In addition to quality assurance inspection, sampling and testing, the Department may perform independent assurance inspection, sampling and testing to provide independent monitoring of the fabrication process and the QC and QA activities. The Department may perform independent assurance activities during, but not limited to, the stages of fabrication of precast prestressed members identified in 450-2.2.4. Results of the independent assurance inspections, sampling and testing will not constitute a basis for determining the acceptability of precast prestressed concrete members but will assist in the evaluation of the Contractor's quality control.

450-2.3 Prestressed Plant:

450-2.3.1 General: Initial Acceptance of a precast prestressed concrete plant will require approval of a QCP in accordance with 450-2.2.3 and compliance with 450-2.3.2, 450-2.3.3 and 450-2.3.4 below. A plant that fails to comply with these requirements will not be acceptable to produce precast prestressed concrete members for Department projects. A plant is defined as an independent operating facility capable of performing all the operations necessary to fabricate precast prestressed concrete members.

450-2.3.2 Approval: Obtain the Engineer's approval of the precast prestressed concrete plant prior to producing precast prestressed concrete members. Apply, in writing, to the Department for approval of the prestressed concrete plant. Apply with the Department's District Materials Office for the District in which the plant is located. For out-of-state prestressed concrete plants, submit the application to the District Materials Office for the District in which the construction project is located.

The approval status of any prestressed concrete plant may be a provisional approval reflecting only passing an initial inspection by the Department, or a complete approval.

The approval process is intended to evaluate the plant's capability for fabricating quality members in accordance with established standards through a series of inspections, which include an initial in-depth inspection and subsequent unannounced spot inspections of the plant.

Obtain the Department's approval of a plant for each project. The Department will extend approval of the plant on a project-by-project basis upon written request from the Contractor for continuing work provided the plant has produced members for Department projects within one year prior to the request.

450-2.3.3 Plant Staff Organization and Qualifications: The plant's organization shall include, as a minimum, a full-time production manager and a full-time quality control manager at each plant. The plant shall have on staff a Specialty Engineer, or have on retainer a Specialty Engineer. The plant engineer may serve as the quality control manager, unless the plant engineer has direct responsibilities for production. If the plant engineer has duties directly related to production, another Specialty Engineer must be available for consultation by QC personnel relative to QC issues. The quality control manager shall report to the top management of the plant through a path independent of production.

Ensure that the plant has sufficient qualified production personnel with prestressed concrete fabrication experience who are responsible for the complete fabrication process, storage and shipment of the members. Include with the QCP the work experience and qualifications of key plant production personnel and QC personnel such as the production manager, stressing foreman, yard supervisor, and quality control manager.

The quality control manager shall be a registered professional engineer or shall have at least five years of related experience and have a Prestressed Concrete Institute (PCI) Technician/Inspector Level II certification. A quality control inspector shall have, as a minimum, a PCI Technician/Inspector Level II certification. These requirements may be met by alternate experience and certification considered to be equivalent by the Engineer.

450-2.3.4 Measuring and Testing Equipment: Use a laboratory with the equipment necessary to perform required testing. Provide measuring and testing equipment meeting the applicable standards of the specifications. Have the measuring and testing equipment on-site prior to its need and in working condition. Provide a number of units adequate to meet the production and testing schedule included in the QCP. Have available reserve equipment to replace equipment used in daily production in the event of breakdown. Use reserve equipment of the same type as the equipment being used.

450-2.4 Disapproval of Precast Prestressed Concrete Plants:

450-2.4.1 Department's Conditional Status: Take immediate and positive actions as applicable to resolve deficiencies in fabrication that result in failure to meet the Contract Documents. Submit a written proposal to the Engineer explaining how deficiencies noted by the Department will be resolved. Correct any specification compliance deficiency detected by the QCP prior to fabrication. Resolve any deficiency detected after fabrication in accordance with 450-2.6.12. Failure to correct deficiencies in a timely manner or continued production of members with noted deficiencies will be justification for disapproval of the plant.

Periodically address repeating noncomplying issues with plant production personnel and require resolution of the issues through better production control. Include such procedure in the QCP.

Any plant which fails to maintain compliance with this Section and the Contract, as evaluated by the Department, may be placed in a conditional approval status for a period of time which will depend on the nature of the deficiency and the corrective action required. A plant may remain in a conditional approval status for a maximum period of six months. The plant will be removed from conditional approval status by the Department after the deficiencies are satisfactorily resolved. If the deficiencies are not resolved, meet the requirements of 450-2.4.2. Approval of a plant that is in a conditional approval status will not be extended for a new project.

450-2.4.2 Debarment: Failure to maintain the Department's approval status will result in the debarment of the plant. Also, failure to take positive action to resolve deficiencies found by the Department's quality assurance activities will result in the debarment of the plant. Plants that have been debarred will not be allowed to fabricate any members for Department work. Members that have been fabricated prior to debarment of a precast prestressed concrete plant shall be subject to review by the Department for compliance with this Section and the Contract, before shipment to the project site.

The Department will remove debarment status upon satisfactory resolution of deficiencies that caused the debarment.

450-2.4.3 Contract Time Extensions and Claims: Contract Time extension requests and claims for extra compensation will not be considered by the Department for the time and expense for the Contractor to resolve deficiencies or to retain another acceptable precast prestressed concrete producer when a plant is placed on a conditional or debarred status.

450-2.5 Materials:

450-2.5.1 Concrete: Use concrete as specified in Section 346 and the Contract Documents.

Use concrete produced in central mix plants approved in accordance with Section 346, unless otherwise permitted by this Section. Ready mix concrete produced in ready mix plants approved in accordance with Section 346 may be used if the following criteria are met:

Concrete is delivered to the placement site within a maximum of 20 minutes after the initial mixing.

When the concrete is produced in a central mix plant and malfunctions occur, concrete from any other local Department approved plant (either central mix or ready-mixed) is used to complete any ongoing concrete placement of the entire bed line being cast without restrictions on delivery time as stated above. Concrete placement in other bed lines is not resumed until repairs to the central mix plant have been completed or approval to use another approved central mix plant or to continue using a ready mix plant has been obtained from the Department.

450-2.5.2 Prestressing Steel: Use steel strands meeting the requirements of 933-1. Do not use strands from more than one source in any individual prestressed element.

Use steel bars meeting the requirements of 933-2. Use steel wires meeting the requirements of 933-3.

The shipping package for prestressing steel shall be clearly marked stating that the package contains high-strength prestressing steel and indicating the care to be used in handling.

450-2.5.3 Strand Chucks and Splice Chucks: Use strand chucks capable of anchoring stressing loads positively with a minimum of differential slippage and that are designed for the size of strand used. Length of grips and configurations of serrations shall be such as to ensure against strand failure within the grips.

Splice chucks used to transmit the prestressing force from one partial length prestressing tendon to another shall develop at least 90% of the minimum specified ultimate tensile strength of the prestressing steel.

450-2.5.4 Reinforcing Steel: Use steel reinforcement meeting the requirements of 931-1.1, except as otherwise provided in the plans or this Section.

Use welded deformed steel wire fabric for concrete reinforcement meeting the requirements of 931-1.2.

450-2.5.5 Accessories: Use bearing assemblies meeting the requirements of Section 962. Use bearing assemblies coated in accordance with 962-7.

Use inserts that consist of miscellaneous items such as anchor bolts, threaded anchorages, conduits, pipes, wiring, built-in fixtures, and lifting devices. Use inserts meeting the requirements shown on the plans or as approved by the Engineer.

Do not use aluminum inserts.

For duct enclosures embedded in the concrete for prestressing steel, meet the requirements of Section B460.

Use sheathing (debonding material) that is tubular non-slit, high-density polyethylene or polyprophylene with a minimum wall thickness of 0.025 inch [0.6 mm], and that has an inside diameter exceeding the maximum outside diameter of the pretensioning strand by 0.025 inch [0.6 mm] to 0.14 inch [3.5 mm].

To seal sheathing tubes, use a commercial adhesive sealant labeled as 100% silicone.

Use void forms of a type for which service adequacy has been demonstrated. Use void forms that have sufficient strength to provide stability during handling and placing and to withstand hydrostatic pressures and other forces imposed upon them during concrete placement. Use form material that is neutral with respect to the generation of products harmful to the physical and structural properties of the concrete. Assume responsibility for any detrimental effects resulting from the presence of the form material within the member. Positively vent all voids to the outside of the member.

Use lubricated rollers with bronze bushings or roller bearings for hold-up points, and low-friction, free-turning rollers for hold-down points for restraining devices for deflecting draped tendons. Use devices of sufficient rigidity and that have adequate support so that the position of the strand will remain unchanged under the induced load. Do not allow the devices to induce friction to the tendons to the point of preventing attainment of the required jacking force and elongation.

The steel spirals for reinforcing in concrete piling may be manufactured from stock meeting the requirements of any grade of reinforcing steel, as shown in ASTM A 615 [ASTM A 615M], or hard-drawn wire.

450-2.5.6 Miscellaneous Materials: Use membrane curing compound for curing concrete that meets the requirements of 925-2. Use membrane curing compounds that are compatible with coatings or other materials to be applied to the surfaces.

For epoxy resin compounds applied to Portland Cement Concrete, meet the requirements of Section 926.

For curing blankets, use light colored polyethylene-coated blankets; quilted blankets of cotton, burlap, or other suitable water absorbent material weighing not less than 10 oz/yd per 40 inches width [0.3 kg/m^2]; or insulated blankets.

Use burlap meeting the requirements of 925-1.

For penetrant sealers used on concrete, meet the requirements of Section 413. Use a sealer that is compatible with other materials to be applied to the concrete surface.

450-2.5.7 Material Acceptance and Testing:

(a) Concrete:

(1) Contractor Sampling and Testing: Assume the responsibility of QC sampling and testing for concrete, and have the work performed by the quality control inspectors. The quality control inspectors shall perform the sampling and testing of plastic concrete after delivery to the casting site.

Verify the water/cement ratio of concrete deliveries for compliance with requirements. For each design mix, sample and test the concrete for slump, air content, temperature and compressive strength, in accordance with the following, as a minimum for all concrete classes:

For Compressive Strength: Every 50 yd^3 [40 m^3] or part thereof.

For Air Content, Slump and Temperature: Every 50 yd^3 [40 m^3] or part thereof or at intervals not exceeding one hour.

Check the temperature, slump and air content of plastic concrete on the initial load of each placement operation for verification of acceptance criteria.

If the initial concrete temperature is less than the maximum permitted placement temperature by more than 5EF [3EC], monitor and record the concrete temperature at one hour time intervals for subsequent loads. During placement when concrete temperature is within 5EF [3EC] of the maximum specified placement temperature, check every second load for compliance.

Do not proceed with the concrete placement operation until the concrete complies with specification requirements for plastic concrete. Reject noncomplying loads which cannot be adjusted to meet the specification requirements.

(2) Acceptance Sampling and Testing: The Department will perform acceptance sampling and testing of concrete in accordance with Section 346.

(b) Reinforcing Steel and Welded Wire Fabric: Identify all reinforcing steel and welded wire fabric by LOTs. A LOT of reinforcing steel or welded wire fabric is a shipment of material that is from the same manufacturer and heat. A shipment of material is defined as a single vehicle load of material delivered to the plant. Obtain, and provide to the Department, a certified mill analysis and physical properties report showing compliance with 450-2.5.4 for each LOT of material received. Verify that the report represents the steel received and that the steel meets Contract Documents.

Assign a LOT number to each shipment of reinforcing steel or welded wire fabric received, and tag in a manner such that each LOT can be accurately identified at the plant or job site. Obtain records identifying assigned LOT numbers with the heat of the material represented. Reject all unidentified reinforcing steel or welded wire fabric received at the plant or job site. Reject any material that cannot be positively identified prior to use.

The Department will perform acceptance sampling and testing of reinforcing steel and of welded wire fabric.

If members are cast using material from a LOT that does not meet the above requirements, the Engineer may evaluate such members in accordance with 450-2.6.12.1 and 450-2.6.12.5. Reject the remainder of the material from the same LOT.

(c) Prestressing Steel for Pretensioning: Identify all prestressing steel by LOTs. A LOT of prestressing steel is a shipment of material of the same size and production grade from the same manufacturer. A shipment of material is defined as a single vehicle load of material delivered to the plant. Obtain and provide to the Department for each LOT of material received, certified test values for specified material properties together with a representative load-elongation curve and the modulus of elasticity value based upon strand nominal area. Provide and support by records maintained by the strand manufacturer, production tolerances applied in selection of the reported strand modulus Verify that documents provided represent the shipment and that the steel meets Contract Documents.

Assign each shipment of prestressing steel received by the

Contractor a LOT number and tag each in such a manner that each LOT can be accurately identified. Maintain complete records for each LOT identifying the material and its properties. Reject all unidentified prestressing steel received at the plant or job site. Reject any materials that can not be positively identified prior to use.

The Department will perform acceptance sampling and testing of prestressing steel. The Department will select two samples, 7 feet [2 m] long, from each LOT of material received, for testing. One of the samples shall be tested; the remaining sample, properly identified and tagged, will be stored for future testing in the event of loss or failure of the first sample to meet minimum requirements. If the first sample fails to meet the requirements specified, the second sample will be tested. If both samples fail to meet specified requirements, the heat or LOT of material will be rejected. If one sample fails and one sample meets the material requirements, additional tests may be performed by the Engineer to confirm material acceptability. Tests will be performed to determine compliance with ASTM A 416.

If members are cast using material from a LOT that does not meet the above requirements, the Engineer may evaluate such members in accordance with 450-2.6.12.1 and 450-2.6.12.5. Reject the remainder of the material from the same LOT.

(d) Strand Chucks and Splice Chucks: Acceptance of strand chucks and splice chucks will be based on certified test results obtained by the Contractor showing compliance with 450-2.5.3.

(e) Steel Accessories: Acceptance of steel accessories will be based on certified test results obtained by the Contractor. Use accessory materials for prestressed concrete meeting the requirements of Section 933. Do not use steel accessories which have not been pre-approved by the Department until certified copies of pre-qualification tests which demonstrates satisfactory performance are obtained. Perform additional tests when deemed necessary by the Engineer or when required by the plans.

(f) Ducts: Obtain material certifications for duct material certifying that the material meets the Contract Documents.

(g) Miscellaneous Materials: Acceptance of miscellaneous materials shall be based on certifications by the Contractor that the materials are adequate to function as intended. Do not use miscellaneous materials which have not been pre-approved by the Department until certified copies of pre-qualification tests which demonstrate satisfactory performance are obtained. Perform additional tests when deemed necessary by the Engineer or when required by the plans.

450-2.6 Construction:

450-2.6.1 Shop Drawings: Plans for prestressed members will designate the prestressing to be done by the pretensioning, posttensioning or combined methods. Plans for all precast prestressed concrete members will be detailed for at least one of these methods.

Furnish information necessary to fabricate or erect precast prestressed concrete members that is not included in the plans furnished by the Department or this specification When submission of shop drawings is required, meet the requirements of 5-1 and any additional plan requirements.

When the design plans contain all the information necessary for fabrication of a pretensioned member, a formal shop drawing submittal is not required. Shop drawings will be required for members which are posttentioned or partially posttentioned. In order to fabricate precast pretensioned concrete members under this provision, all detailed and specified materials, dimensions, component types and sizes and methods of stressing and detensioning must be in strict accordance with the plans and this Section.

In lieu of formal shop drawings, furnish one copy of the following to the Engineer for information only:

(a) A copy of the Framing Plan with member designations for all superstructure components.

(b) Strand detensioning schedule.

(c) Tensioning and elongation calculations.

If the Contractor desires to use materials or methods that differ in any respect from those shown in the plans and described in this Section, he shall submit full plan details and specifications. In order for any alternate materials or methods to be considered, they will be required to comply fully with the intent of the following:

(a) The provisions of these Specifications.

(b) The AASHTO Standard Specifications for Highway Bridges, edition with interims as referenced in plans.

(c) The provisions of the Department's "Structures Design Guidelines".

(d) Design criteria and notes on the plans.

(e) The recommendations of the material manufacturer.

(f) Any materials change proposed by the Contractor and approved by the Engineer.

The Engineer will be the sole judge as to the adequacy and propriety of any variation of materials or methods, and the right is specifically reserved to the Engineer to reject any alternate details or designs based upon the use of materials or methods which are not fully equivalent in all respects to those shown in the plans and described in this Section.

450-2.6.2 Inspection:

450-2.6.2.1 General: Perform QC inspections of all phases of work. The inspection frequency and depth shall be sufficient to ensure that all materials and workmanship incorporated into the work meet the Contract Documents and that the fabrication processes are controlled to ensure that the finished product conforms to the physical characteristics and dimensions required by the Contract. The quality control manager shall be responsible for inspection operations. The quality control manager shall have an adequate number of quality control inspectors to ensure review of all materials and fabrication processes. A review of the information obtained through QC inspections shall be discussed on a weekly basis with production personnel to identify fabrication areas that may need strengthening or modifying, or equipment that needs to be repaired or replaced.

Appendix VI in the Department's Manual for Quality Assurance for Precast Prestressed Concrete Members contains guidelines for inspecting precast prestressed concrete member fabrication. These guidelines may be used by the Contractor in developing the QCP inspection requirements.

450-2.6.2.2 Preplacement Operations: The quality control inspector shall routinely review the work operations performed to prepare a casting bed for concrete placement. Prior to concrete placement, the quality control inspector shall review the completed bed to verify all specification requirements have been met. Notify the quality control inspector far enough in advance of concrete placement to give the inspector sufficient time to make a review of the casting bed. Routinely inspect items in 450-2.6.3 through 450-2.6.8 as the work is being performed and again prior to concrete placement.

450-2.6.2.3 Concrete Operations: The quality control inspector shall perform an inspection during concrete placement for precast prestressed concrete members, including the concrete curing. Items in 450-2.6.9 shall be inspected during concrete operations.

450-2.6.2.4 Postplacement Operations: The quality control inspector shall review all work operations and the prestressed member subsequent to concrete placement. Inspect the items in 450-2.6.10 and 450-2.6.11 during the postplacement operations. Also, inspect the member for conformance with 450-2.7.

450-2.6.2.5 Noncomplying Prestressed Members: When a member is damaged or when a determination is made by the quality control manager that a precast prestressed concrete member does not meet the requirements of this Section, he shall notify the Department's inspector for examination and determination of which course of action is appropriate in accordance with 450-2.6.12.

450-2.6.2.6 Member Certification: The quality control inspector shall make a final inspection of completed members within two weeks prior to shipment to verify that all specification requirements have been met. After the QC personnel have verified that all Contract Document requirements have been met and all necessary repairs have been satisfactorily completed, the QC manager shall stamp each member at the plant. The stamp shall be specifically designed for the plant and used only by the QC manager or inspectors under his direction. The configuration of the stamp shall be shown in the QC plan.

Monthly or with each request for payment, submit a certification that includes the following or similar wording:

"The undersigned being a responsible official of (plant name) certifies that the precast prestressed members listed herein have been produced under strict quality control and meet the Contract requirements for the applicable project."

Include a positive identification on the certification and the members to connect the certification with particular members. The certification shall be signed by an official of the plant that is in a position above the production manager and QC manager.

450-2.6.3 Forms:

450-2.6.3.1 Materials: Use metal side and bottom forms, unless otherwise specified in the Contract Documents. For members with special shapes such as corner sheet piles, wood forms may be used. Slab units and sheet piles may be cast on concrete surfaces finished to meet the requirements of 450-2.6.3.3.

For all beam members, use side forms designed to be removed without damaging the top flange of the beam. Remove the forms horizontally away from the beam by a method that prevents any contact of the form with the top flange after release of the form. Do not subject the top flange to any vertical force at any time. Include the form details and method of removal in the QCP for the project.

For end headers and inside forms, other materials capable of resisting the pressure from the concrete may be used. Use end headers so designed that they can be placed and maintained in correct position between the side forms. Hold the headers in place with devices capable of being removed or loosened after the concrete has attained its initial set allowing free form expansion during curing methods that involve heat. Use end headers with openings conforming to the prestressing steel pattern to permit passage of the prestressing steel. Locate the openings accurately within χ inch [3 mm] of planned location of prestressing steel elements.

Construct circular openings for strands a maximum of 3 inch [5 mm] larger than the nominal strand diameter. Construct square or rectangular openings a maximum of 3 inch [5 mm] larger, horizontally and vertically, than the nominal strand diameter. Ensure that all headers are mortar tight.

450-2.6.3.2 Supports: Use forms of sufficient thickness, with adequate external bracing and stiffeners, that are anchored to withstand the forces due to placement and vibration of concrete. Ensure that joints in forms are mortar tight. Support bottom forms on concrete pallets with metal stiffeners, wales, shims, etc. Do not use timber elements between the bottom metal form and concrete pallets.

450-2.6.3.3 Alignment: Make and maintain during their use, forms and centering true to the shapes and dimensions for the member being produced. Plumb, align, and secure forms for each member in position before each reuse.

Apply the following tolerances to form alignment and pallets or beds used in prestressed construction:

(1) Horizontal Alignment (horizontal deviation of side forms either side of a vertical plane within the length of a member) .... χ inch [3 mm]

(2) Vertical Alignment (vertical deviation of the bed or pallet from a horizontal plane within the length of a member) .... χ inch [3 mm]

(3) Offset Between Adjacent Form Sections .... χ inch [3 mm]

450-2.6.3.4 End Header Locations: When the ambient temperature is expected to be below 55EF [13EC] between the time of stressing and detensioning and the members and exposed strands between the stressing anchorages are not protected, maintain a minimum free length of stressed strand as specified herein between the end header and the stressing anchorage at each end of a bed line. Allow a 20 foot [6 m] minimum free length of stressed strand for stress relieved strand and 25 feet [7.5 m] for low-relaxation strand. When cold weather concrete conditions as specified in 450-2.6.9.1(1) are in effect, protect all exposed strands between stressing anchorages regardless of length. When the members and strands between stressing anchorages are protected, provide protection adequate to maintain the ambient temperature of the air around the members and strand above 55EF [13EC] until the members are detensioned. Do not allow the end header to be closer than 5 feet [1.5 m] to the stressing anchorage.

Provide a minimum of 18 inches [450 mm] of exposed strands between adjacent ends of all members except 24 inch [600 mm] square and smaller piles. Provide a minimum of 6 inches [150 mm] of exposed strands between adjacent ends of 24 inch [600 mm] square and smaller piles.

450-2.6.3.5 Surface Conditions: Use clean, rust free form surfaces against which concrete is to be cast. Before each reuse, inspect forms and, if necessary, recondition them.

450-2.6.3.6 Form Ties: For form ties that will remain in the concrete, use either the threaded type or the snap-off type, so that no form wires or metal pieces will be left within 2 inches [50 mm] of the surface of the finished concrete.

450-2.6.3.7 Corners, Angles and Joints: Chamfer, miter, or round corners and angles exposed in the final structure. Use a chamfer, miter, or radius of the rounding of : inch [20 mm], unless otherwise specified or shown on the plans. Provide mortar tight joints between panel forms, and smooth within the alignment tolerances. Minimize offsets between adjacent form sections.

450-2.6.3.8 Form Release Materials: Treat the facing of all forms with form oil or other bond breaking coating prior to placing concrete, unless previous applications of form release coatings are still effective. Do not apply form surface coatings to the bottom form prior to placing the prestressing steel, unless the form coating materials are of a type, and in such a condition, that they will not contaminate the prestressing steel.

450-2.6.4 Protection and Placement of Prestressing Steel:

450-2.6.4.1 Protection of Prestressing Steel: Maintain and store prestressing steel above the ground surface on platforms, skids, or other supports, to prevent contamination from below, and protect them from mechanical injury. Do not use any packaging or wrapping material that retains moisture at the bottom of the reel. Clean contaminated prestressing steel before use or otherwise reject it.

Handle prestressing steel carefully to prevent nicks or kinks and do not expose it to temperatures greater than 200EF [90EC] at any time. Do not use arc welding equipment, including welding electrode lines, within 2 feet [0.5 m] of prestressing steel. Do not perform any welding on forms that have been set in place after the prestressing steel is placed in the bed. Reject prestressing steel that has sustained any physical damage at any time.

Protect prestressing steel for posttensioning operations in accordance with Section B460.

450-2.6.4.2 Placing Prestressing Steel: Use care during placement of prestressing steel to avoid physical damage and contamination. Reject damaged strands. Restore contaminated strands to its original condition prior to concrete placement.

Inspect the prestressing steel for broken wires and other damage after placement into the bed. Do not use prestressing steel containing nicks, kinks, or former chuck grip marks, unless such points will be located outside the members. Do not reuse prestressing steel that has been stressed in a draped position. Do not use steel showing evidence of scale formation or which has become pitted. Remove and replace any damaged prestressing steel in the bed before the stressing operation begins.

450-2.6.4.3 Cleanliness of Prestressing Steel: After stressing operations are complete, inspect the prestressing steel for any evidence of contamination. Use steel that is free of deleterious materials such as grease, oil, wax, dirt, paint (except that used for marking identification) or other similar contaminants. Remove any contaminants detected from the steel before proceeding with fabrication activities.

Rust on prestressing steel which can be removed by light rubbing is acceptable. Streaks or spots which may remain after rust removal are acceptable if no pitting is present.

450-2.6.4.4 Debonded Strands: For debonded prestressing steel, extend the tubular debonding material (sheathing) through the header and tape and tie it at the terminus within the member to prevent intrusion of cement paste during the casting operation.

450-2.6.5 Stressing Equipment: Use stressing equipment meeting the requirements of (a), (b), or (e) below. In addition, calibrate all stressing equipment in accordance with (c) below.

(a) For the stressing equipment, use a hydraulic jacking system that is adjustable to automatically apply and sustain a predetermined load together with a pressure transducer built into the hydraulic system. Connect such transducer to a digital readout and printer which shall provide an instantaneous readout and record of the applied load in pounds [kilonewtons]. Use a jacking system with the capacity to induce the required load. Use jacking equipment with pressure bypass valves that allow pulling to a predetermined load which can be held while elongation checks are made. Base the use of this system on demonstrated accuracy and repeatability verified through comparison with loads indicated by either an independent load cell or proving ring.

Continued use of the equipment will be contingent upon the satisfactory performance of the equipment in service as determined under the requirements of (d) below.

(b) For stressing equipment, use a hydraulic jacking system as described in (a) above with a load cell built directly into the hydraulic jack and connected to the digital readout and printer instead of the pressure transducer. Continued use of the equipment will be contingent upon the satisfactory performance of the equipment in service as determined under the requirements of (d) below.

(c) Prior to their use, calibrate all jacking systems. Repeat calibration at intervals not exceeding 12 months. Recalibration during the intervals may be required by the Engineer as described hereinafter. Calibrate and recalibrate by one of the following methods:

(1) By a qualified calibration agency. A listing of such agencies is available at the Department's Materials Office in Gainesville.

(2) Under the supervision of a Specialty Engineer.

Calibrate gages, jacks and pumps as a system in the same manner they are used in tensioning operations with the cylinder extension in the approximate position that it will be in actual use at final jacking force. Calibrations should cover the load ranges that will be used during production. A certified calibration curve shall accompany each tensioning system. Load readings can be used directly if the calibration determines a reading is within 1.5% tolerance of actual load. Calibration of load cells or proving rings used to calibrate jacking systems shall be on compression testing equipment that has been checked by the National Bureau of Standards within the preceding 24-month period.

If, while work is in progress, any jack or gage appears to be giving erratic results, or if the jack force and elongation do not compare within specified limits and differences cannot be justified, recalibrate the equipment. Also recalibrate the equipment after internal jacking system repairs or when gage and jacking units are switched.

Calibrate or recalibrate in accordance with ASTM E 4 and ASTM E 74. After calibration or recalibration has been completed, prepare a certificate and have it signed by the person in responsible charge of the verifications as outlined in ASTM E 4 and ASTM E 74.

(d) Verify the accuracy of the jacking and recording system a minimum of once each week during stressing operations by either an independently calibrated load cell or a proving ring. The load reading from the recording system shall agree within 1.5% of the load indicated by the load cell or proving ring.

(e) For multiple strand stressing, apply the stressing equipment requirements of Section B460.

450-2.6.6 Stressing Operations:

450-2.6.6.1 General: The stressing operations shall consist of the application of the final load required by the plans and adjusted for abutment rotation, bed shortening, anchorage header movement, anchor set, slippage, live end seating and any other element as applicable for the type of bed and anchorage being used. Also, adjust the final load required by the plans when the temperature differential between the ambient temperature at time of stressing and the expected concrete temperature at time of placement is greater than 25EF [14EC]. Increase the load 0.5% for each 5EF [3EC] increment between the ambient temperature at time of stressing and the expected concrete temperature at time of placing. When the expected concrete temperature at time of placing is below the ambient temperature at time of stressing, make no adjustment to the final load. Do not allow the stress in the prestressing steel to exceed the stress allowed by the AASHTO Standard Specifications for Highway Bridges.

Compensation for temperature differential and abutment rotation are not required for self-stressing beds. However, adjust the final load for the effects of bed shortening due to the load from all the strands.

If the placement of concrete is delayed for more than seven calendar days after the completion of the stressing operation, check and adjust the final strand load as necessary prior to the placement of concrete.

The stressing methods, in general, consist of stressing to the loads indicated by the jacking system, or stressing to the required load while monitoring the elongation of the prestressing steel.

Accomplish stressing by either single strand stressing or multiple strand stressing, and ensure that it is symmetrical about the vertical axis of the member.

450-2.6.6.2 Single Straight Strand Stressing: When single straight strand stressing is used, tension the prestressing steel until the required final load is attained. The loads indicated by the jacking system shall control the tensioning process. Two stage stressing, consisting of an initial load and final load, may be used. The initial load, if used, shall be between 5% and 25% of the final load.

450-2.6.6.3 Multiple Straight Strand Stressing: Bring each strand to be stressed in a group individually to an initial uniform tension prior to being given its full tensioning. The amount of the initial load will be influenced by the length of the casting bed and the size of strands in the group to be tensioned. The minimum initial tensioning load shall be 5% of the required final load. Increase the magnitude of this load if deemed necessary but do not allow it to exceed 25% of the required final load. Then stress the strands by multiple strand stressing to final load by pulling to elongation and checking against the jack load. Allow the required elongation to control the tensioning. The actual jack load shall agree within 5% of the computed elongation converted to load.

For uniform application of load to strands, the face of anchorage at final load must be in a plane parallel to its position under initial load. Verify this by measurement of movement on opposite sides of the anchorage and check its plumb position before and after application of the final load. During stressing, allow the anchorage to move without restraint.

450-2.6.6.4 Draped Strand Stressing: Tension draped strands by either of the following methods:

(1) Partial Stressing and Subsequent Strains: This method applies when the strands are tensioned through a combination of applied jack loads and strand uplift. To verify the final force, place a load cell between the stressing anchorage and anchor chucks at the dead end on at least two draped strands. Other methods as approved by the Engineer may be used to verify the final force in the dead end. Bring the partially draped strand to an initial tension using a force in the range of 5% to 25% of the required final stressing force. After application of the initial force, establish reference marks for measuring elongation.

Then apply a precalculated jacking force and measure elongations on a minimum of four strands. The average measured elongation shall agree within 5% of the theoretical elongation for strand force measured by jack load, or the factors contributing to the difference shall be identified and corrected prior to proceeding. Allow the load indicated by the jacking system to control the tensioning for the precalculated load.

Obtain the required final force by raising the strand simultaneously at all pickup points or in an approved sequence as shown on the shop drawings. On each different bed setup, after deflecting the strands to their final position, check the final force at the dead end of the bed. If the load is below the required stressing force by more than 5%, adjust it to the final load.

(2) Final Stressing in Draped Position: When the final stressing is performed in the draped position, apply the tensioning load in two increments with the tendons being held in their draped positions. To verify the final force, place a load cell between the stressing anchorage and anchor chucks at the dead end on at least two draped strands. Other methods as approved by the Engineer may be used to verify the final force in the dead end. Bring each strand to an initial tension of 5% to 25% of the final load prior to the application of the required final load.

After application of the initial load, establish reference marks for measuring elongation. Then stress the strands to final load and measure the elongation. Allow the load indicated by the jacking system to control the tensioning for the initial and final loads.

The measured elongation shall agree within 5% of the theoretical elongation for the strand force measured by jack load, or the factors contributing to the difference shall be identified and corrected prior to proceeding.

When the jacking is performed at one end of the bed, check the applied load on two strands at the other end of the bed. If the load on the end opposite the jacking end is below the required value by more than 5%, adjust the load to the required final load.

450-2.6.6.5 Wire Breakage: Limit wire breakage to 2% of the total area of the strands in any member and verify that breakage is not indicative of a more extensive distress condition, otherwise reject all stranding. Replace individual strands with more than one wire failure.

450-2.6.6.6 Strand Chucks and Splice Chucks: Use chucks as complete units and clean, inspect, and lubricate them between each use. Take care to avoid improper fit and seating of wedges on the strands. Use wedges and housing that are compatible and made for the specific type and size of steel being used.

Do not use wedges that become worn, cracked, deformed, or that allow slippage in excess of δ inch [10 mm]. Use components from the same manufacturer to make up chucks and to provide proper wedge fit.

The Engineer will allow one patented splice per strand subject to the following:

(1) Splices are located outside the concrete members (except for precast piling where up to two splices are permitted to be used in each pile, so long as they are not located in the same plane).

(2) Strands which are being spliced have the "lay" or "twist" in the same direction.

450-2.6.6.7 Position of Prestressing Steel: Position prestressing steel as shown in the plans within the tolerances allowed in 450-2.7. Fix the required vertical and horizontal position of each prestressing strand at the ends of each member and at intervals within each member not exceeding 30 feet [9 m]. Use the method of fixing the prestressing steel shown in the QCP. When blocks are to be used for supporting prestressing steel, use those cast from concrete of the same mix design as used in the prestressed member. Stagger the location of blocks with an offset of 12 inches [300 mm] or greater and do not stack them.

450-2.6.7 Reinforcing Steel: Except as provided below, meet the requirements of Section 415 for all reinforcing steel work:

(a) Protection of Reinforcing Steel: Store steel reinforcement above the surface of the ground, upon platforms, skids or other supports, and protect it as far as practical from mechanical injury and surface deterioration caused by exposure to conditions producing rust. When placed in the work, reinforcing steel shall be free from loose rust, scale, dirt, paint, oil, grease, and any other foreign material.

(b) Bending: Unless otherwise shown on the plans, Fabricate reinforcing bars as prescribed in the Manual of Standard Practice, published by the CRSI. Bend the reinforcement cold to the shapes indicated in the plans and in accordance with 415-4.

(c) Placing and Tying: Tie and/or support in position all reinforcing steel in each member with other reinforcing steel in a manner that will accurately position the steel throughout the fabrication process. Use types of ties and methods of tying recommended by the CRSI, including lacing. When concrete blocks are used for supporting reinforcing steel, use those that meet the requirements of 450-2.6.6.7. Do not tie reinforcing steel to debonded prestressing steel within the limits of the sheathing material.

Tie or lace beam stirrup bars at a minimum of three points. Tie reinforcing steel, other than stirrup bars in beam ends, as a minimum, at every other intersection. Either tie or lace spiral wire in piling at all four corners in the 1 inch [25 mm] pitch area, at the top corners and bottom center in the 3 inch [75 mm] pitch area, and at the top corners in the center area. Tie the bottom center in the pile center area as necessary to maintain concrete cover. Bend all tie wires away from the form surface to provide maximum concrete cover.

Provide not less than the specified cover for all steel minus 3 inch [6 mm].

(d) Welding Reinforcing Steel: When shown on the plans, weld reinforcing steel in accordance with the requirements of AWS Structural Welding Code D 1.4. Do not weld in the prestressing bed.

450-2.6.8 Placing Other Embedded Material:

450-2.6.8.1 Posttensioning Anchorages: Install anchorages for posttensioning tendons in accordance with Section B460.

450-2.6.8.2 Inserts and Lifting Devices: Locate inserts and lifting devices in accordance with the tolerances listed in 450-2.7.2.

450-2.6.8.3 Bearing Assemblies: Set bearing assemblies designed to transmit reaction forces to the concrete in the position shown in the plans.

Place bearing plate assemblies or shoes which are to be cast in a member within appropriate tolerances as provided in 450-2.7.2. Check the assemblies for position after stripping from the forms.

450-2.6.8.4 Void Forms: Securely support and tie in position void forms to avoid displacement throughout concrete placement and consolidation operations.

Vent voids as shown in the plans or shop drawings.

450-2.6.9 Concrete Operations:

450-2.6.9.1 Temperature Restrictions:

(1) Cold Weather Concrete: When the temperature of the surrounding air is expected to be below 40EF [4EC] within 24 hours after placing concrete, the temperature of the plastic concrete as placed shall be 55EF [13EC] or greater. Maintain the temperature of the concrete after placement above 55EF [13EC] until the prestressing steel is detensioned. Make arrangements for heating, covering, insulating or housing the concrete work in advance of placement and maintain the required temperature without injury due to concentration of heat. Do not use direct fired heaters during the first 24 hours after concrete placement, unless actions are taken to prevent exposure of the concrete to exhaust gases which contain carbon dioxide. Continuously monitor the temperature of the concrete or the ambient air around the member until the member is detensioned. Monitor by the use of thermocouples located in the member cross-section or temperature recording devices located under the enclosure. Provide one thermocouple or temperature recording device for each 200 feet [60 m] of bed length or part thereof. Locate the thermocouples within the member's cross-section as shown in the QCP or as approved by the Engineer. Record the temperature determined by each thermocouple or temperature recording device. If the temperature of the ambient air

is monitored, maintain the air temperature above 60EF [15EC] to ensure that the concrete temperature is above 55EF [13EC].

(2) Hot Weather Concrete: For temperature requirements and special measures for mixing concrete in hot weather comply with Section 346.

Spray the exterior of steel forms with water just prior to placing the concrete when the hot weather concreting special measures are in effect.

450-2.6.9.2 Placing Concrete:

(1) General: Check forms, reinforcing steel, prestressing steel, posttensioning ducts, vent pipes, anchorages, duct supports and other embedded items for compliance with the Contract Documents prior to placing concrete. Place concrete in accordance with 400-7, except as modified by this Section.

For concrete operations conducted at night, provide enough lighting to allow visual inspection of the interior of the forms during the complete concrete placement operation.

Convey concrete by the use of buckets, conveyors, pumps, troughs, or other equipment specifically designed for concrete conveyance, provided the placement method consistently produces quality concrete with no segregation or separation of the mix. Locate the concrete conveyance equipment within 12 inches [300 mm] of the top of the forms or surface of the concrete to minimize the free fall of the concrete.

Multiple placements may be used within a bedline, provided compliance with 450-2.6.11.1 is maintained.

(2) Requirements for Successive Layers: Place concrete in prestressed members in accordance with (aa) through (ee) below, unless concrete with a High Range Water Reducer (HRWR) is used. When HRWR concrete is used, place the concrete in accordance with the following, or as approved in the QCP or as approved in writing by the Engineer.

(aa) Type II and Double Tee Beams, Piling and Precast Slab Units (Except Voided Piling and Slabs): Place concrete in one or more layers or lifts. If more than one layer is used for double tee beams, end the first layer such that the top of the concrete is slightly below the bottom of the flange.

(bb) Type III and Type IV Beams and Voided Units (Slabs and Piling): Place concrete in a minimum of two horizontal layers. The thickness of the first layer shall be such that the top of the concrete is just above the top of the bottom flange. In voided units, end the first layer slightly above the middle height of the void. Fill the form by the last layer.

(cc) Type V and Type VI Beams: Place concrete in a minimum of three horizontal layers. The thickness of the first layer shall be such that the top of the concrete is slightly above the top of the bottom flange. The thickness of the second layer shall be such that the top of the concrete is slightly above the bottom of the top flange. Fill the beam forms by the last layer.

(dd) Bulb Tee Beams: Place concrete in one continuous lift beginning in the end block zone and progressing to the other end. Do not allow the progression of the concrete placement to proceed until previously placed concrete has been properly consolidated, and the rate of advancement equals the ability to fill the forms. In progression of the placement, deposit concrete within the forms on the surface of previously placed concrete; avoid placement directly on posttensioning ducts to the maximum extent possible.

(ee) Time Between Successive Placements of Concrete: In any progressive concrete placement operation, do not allow the time between successive placements onto previously placed concrete to exceed 20 minutes, unless the initial set of previously placed concrete has not yet occurred, as evidenced by the continued effective use of vibration.

(3) Protection of Concrete from Weather: Have protection materials available before the concrete placement begins to cover the members in the event of rain during the placement of concrete. Protection materials may be tarps, curing blankets, or other impervious material that will not puncture when placed over protruding reinforcing steel and/or form elements. Include the method and materials for protection in the QCP.

450-2.6.9.3 Vibration of Concrete: Internal and external vibration will be required as necessary to produce uniformly dense concrete. Use both internal and external vibration for all prestressed beams, except beams with posttensioning ducts. For beams with posttensioning ducts, use internal vibration in the end block sections; use external vibration throughout the beam length. For beams cast using HRWR concrete, only external vibration is required.

Design external form vibrators for the specific use. Design forms used in conjunction with external vibration and build them to effectively transmit vibration to the concrete mass. Mount and operate form vibrators in compliance with the vibrator manufacturer's written recommendations, a copy of which shall be on file at the prestress plant. Secure vibrators to the form mounts by positive locking devices so that maximum vibration is transmitted into the form. Modify or replace external form vibrator systems which are demonstrated to be ineffective. Operate vibrators at each mount location for the time necessary for complete concrete consolidation. Do not allow progressive points of vibration to exceed twice the visually effective radius of vibration. Keep forms equipped with external vibrators clean, and free of any buildup of hardened concrete.

Have internal vibrators available before concrete placement is started. Use an internal vibrator with a head of such size that proper vibration of the concrete will be secured without causing movement of the prestressing steel or reinforcing steel. The vibrating frequency range shall be 8,000 to 15,000 impulses per minute. Have one standby internal vibrator available on-site. Insert the vibrator in the concrete at points spaced to ensure uniform vibration of the entire mass of the concrete. Do not allow points of insertions to be further apart than the radius over which the vibrator is visibly effective. Allow the vibrator to sink into the concrete by its own weight and allow it to penetrate into the underlying layers sufficiently so that the two layers are thoroughly consolidated together. After the concrete is thoroughly consolidated, slowly withdraw the vibrator to avoid formation of holes.

450-2.6.9.4 Inspection of Posttensioning Ducts: After concrete placement and consolidation in a prestressed member are complete, check all posttensioning ducts shall clear them of any obstructions. Check all ducts in accordance with Section B460.

450-2.6.9.5 Finishing:

(1) Beams: Roughfloat the top surface of the beam and then scrub it transversely with a coarse brush or metal tine to produce a roughened surface for bonding.

Unless otherwise specified, Apply a Class 3 surface finish to the external surfaces of prestressed beams in accordance with Section 400.

(2) Piling: Apply a general surface finish to the prestressed pile surface as specified in Section 400. Miter or round the top corners with an edging tool of similar corner radius as in the pile forms. Surfaces exposed during casting shall have a steel trowel finish.

When concrete incorporating microsilica is used, screed and finish with a continuous water fog maintained above the concrete. Do not apply the fog directly toward the concrete. The Contractor may apply a monomolecular finishing aid approved by the Engineer in accordance with the manufacturer's recommendation.

(3) Slabs and Double Tees: When the plans show the top surface of prestress slab or double tee units to be the riding surface, apply a Class 4 floor finish in accordance with Section 400.

When the plans show the surface to be overlaid with asphalt or concrete, roughfloat the top surface and then scrub it transversely with a coarse brush to remove all laitance and to produce a roughened surface for bonding.

Unless otherwise specified, apply a Class 3 surface finish to other exposed surfaces in accordance with Section 400.

When concrete incorporating microsilica is used, maintain a continuous water fog above the concrete during the screeding and the finishing operations. Do not apply the fog directly toward the concrete. A monomolecular finishing aid approved by the Engineer may be applied in accordance with the manufacturer=s recommendation.

450-2.6.9.6 Curing:

(1) Methods: After the finishing operations have been completed and as soon as the concrete has hardened sufficiently to permit the application of curing material without marring the exposed surface, cover the exposed surfaces of all prestressed concrete members by one of the following procedures or other alternate curing methods. Alternate curing methods and details proposed by the Contractor shall be included in the QCP or otherwise approved by the Engineer. Base alternate curing methods upon a demonstrated ability to retain surface moisture of the concrete and to control curing temperatures within acceptable limits. Control any curing method that induces heat into the concrete, other than accelerated curing, so that the maximum air temperature within the enclosure is below 130EF [55EC] during the curing period. Discontinue use of any alternate curing method other than those included herein upon any indication of noncompliance with this Specification.

(aa) Continuous Moisture: Place burlap on the surface and keep it continuously saturated for the curing period by means of soil soakers, leaking pipes, or automatic sprinklers. Do not apply moisture manually. If side forms are removed during the curing period, extend the burlap to completely shield the sides of the members.

(bb) Membrane Curing Compound: White-pigmented membrane curing compound may be used for the top surface. Apply the compound in a single-coat, continuous operation, at a uniform coverage of at least 1 gal/200 ft^2 [0.2 L/m^2] or as recommended by the manufacturer. Allow surfaces covered by the membrane curing compound to remain undisturbed for the curing period. Recoat any cracks, checks or other defects in the membrane seal which are detected during the curing period within one hour. If side forms are loosened during the curing period, remove them at that time and immediately coat the formed surfaces with a clear membrane curing compound and maintain the surface seal for the remainder of the curing period. Do not apply membrane curing compound to surfaces of concrete members to which other concrete is to be bonded, unless areas to which concrete is to be bonded are sandblasted until all traces of membrane curing compound are removed.

(cc) Curing Blankets: Curing blankets may be used for curing the top surfaces of members so long as the members' side forms remain in place. Do not use curing blankets which have been torn or punctured. Securely fasten edges to provide as tight a seal as practical. Should the system fail to maintain a moist condition on the concrete surface, discontinue it. Allow curing blankets to remain in place for the curing period.

(dd) Accelerated Cure:

(i) General: For accelerated curing of the concrete, use low-pressure steam curing, radiant heat curing or continuous moisture and heat curing. If accelerated curing is completed before the curing period has elapsed, continue curing for the remaining part of the curing period in accordance with one of the curing methods above, unless conditions in 450-2.6.9.6(2) are met.

If accelerated curing is used, furnish temperature recording devices that will provide accurate, continuous, and permanent records of the time and temperature relationship throughout the entire curing period. Provide one such recording thermometer or each 200 feet [60 m] of bed length or part thereof. Initially calibrate recording thermometers and recalibrate them at least annually.

When the ambient air temperature is above 50EF [10EC], allow the member to remain undisturbed in the ambient air for a two to four hour preheating period to allow initial set to occur. If the ambient air temperature is below 50EF [10EC], apply heat during the preheating period to hold the air surrounding the member at a temperature of 50 to 90EF [10 to 32EC]. When admixtures are used in the concrete mix, the preheating period may be increased up to six hours to the time it takes the concrete to attain its initial set. The time of initial set may be determined by AASHTO T 197.

To prevent moisture loss on exposed surfaces during the preheating period, cover members as soon as possible after casting or keep the exposed surfaces wet by fog spray or wet blankets.

During application of the heat, do not allow the temperature rise within the enclosure to exceed 40EF/hr [22EC/hr]. Do not allow the curing temperature throughout the enclosure to exceed 160EF [71EC]. Maintain the curing temperature within a temperature range of 130 to 160EF [54 to 71EC] until the concrete has reached the required release strength.

Use enclosures for heat curing that allow free circulation of heat about the member and that are constructed to contain the heat with a minimum moisture loss. The use of tarpaulins or similar flexible covers may be used provided they are kept in good repair and secured in such a manner to prevent the loss of heat and moisture. Use enclosures that cover the entire bed from stressing abutment to stressing abutment, including all exposed stranding.

(ii) Low-Pressure Steam: The steam shall be in a saturated condition. Do not allow steam jets to impinge directly on the concrete, test cylinders, or forms. Cover control cylinders to prevent moisture loss and place them in a location where the temperature is representative of the average temperature of the enclosure.

(iii) Curing with Radiant Heat: Apply radiant heat by means of pipe circulating steam, hot oil or hot water, or by electric heating elements. To prevent moisture loss during curing, keep the exposed surfaces wet by fog spray or wet blankets.

(iv) Continuous Moisture and Heat: This method consists of heating the casting beds in combination with the continuous moisture method described above.

Do not allow the heating elements to come in direct contact with the concrete or the forms. Distribute sources of heat in a manner that will prevent localized high temperatures above 160EF [71EC]. The initial covering of burlap and the continuous application of moisture shall be as described in 450-2.6.9.6(1). An auxiliary cover in addition to the burlap for retention of the heat will be required over the entire casting bed. Support this cover a sufficient distance above the member being cured to allow circulation of the heat.

(2) Curing Requirements for Microsilica Concrete: When concrete incorporating microsilica is used, begin curing of the concrete immediately after the finishing operation is complete. Keep a film of water on the surface by fogging until curing blankets are in place.

Apply burlap curing blankets as soon as the concrete surface can be covered without marring. Place the curing blankets overlapping sufficiently so that an effective moisture seal is formed.

Saturate curing blankets with potable water immediately upon placement. Apply additional potable water under the curing blankets by using soaker hoses or other approved methods (manual application not allowed). Keep the concrete surface and curing blankets wet throughout the curing period. Provide continuous moist curing of all exposed surfaces for a minimum period of seven days, and do not interrupt the initial seven day moist curing period except as specified in 450-2.8.2. Apply these requirements to all surfaces exposed to air during any portion of the initial seven day curing period. Terminate the moist curing period in the late afternoon or as otherwise approved in the QCP.

Immediately after completion of the seven day moist curing and the removal of the curing blankets, mix and apply a water impervious membrane curing compound meeting the requirements of 925-2 in two independent coats applied in opposing directions (90E to each other) to all surfaces in accordance with the manufacturer's recommendations, subject to the rate of application specified herein. The rate of application of membrane curing compound for each coat shall be at least 1 gal/300 ft^2 [0.14 L/m^2] for each coat of exposed surface to be cured. Color each coat differently in order to facilitate application at the prescribed coverage. Use white for the top coat. Color the first coat to present a high contrast to the white top coat. Do not allow the concrete to dry prior to curing compound application under any circumstances.

Allow surfaces covered by the membrane curing compound to remain undisturbed for a period of 28 days after casting. Recoat any cracks, checks or other defects in the membrane seal which are detected during the curing period within 30 minutes. If forms are removed during the curing period, immediately coat the surfaces from which the forms are removed with the curing compound and maintain the surface seal for the remainder of the 28-day curing period.

Remove curing compounds applied to surfaces of concrete members to which other concrete is to be bonded by sandblasting after the 28-day curing period is complete and prior to bonding the additional concrete. Water blasting with potable water may be used as an alternate to sandblasting. The minimum nozzle pressure for water blasting is 10,000 psi [70 MPa].

(3) Length of Curing Period: Cure prestressed members not incorporating microsilica in accordance with 450-2.6.9.6(1) for at least 72 hours. Alternatively, except for members used in substructures or superstructures whose environment has been designated on the plans as extremely aggressive, curing may be terminated when the average compressive strength of cylinders kept adjacent to the member and cured by the same methods, has reached 70% of the required 28-day strength or 100% of the release strength, whichever is greater.

450-2.6.10 Form Removal: Do not remove forms sooner than six hours after casting and not until the concrete strength is sufficient to avoid structural damage. For AASHTO Type V, Type VI, and Bulb Tee beams, do not remove the forms supporting the top flange concrete sooner than 12 hours after casting except when the release strength has been reached.

450-2.6.11 Detensioning:

450-2.6.11.1 General: The required concrete strength at which the prestressing force may be transferred to the concrete in a member shall be a minimum of 4,000 psi [28 MPa], unless specified otherwise in the plans. Verify the release strength by compressive strength cylinder breaks or other approved means no later than 24 hours after casting and every 24 hours thereafter until release strength is obtained. For members cured using accelerated curing, release the prestressing force immediately after terminating curing. For members cured using methods other than accelerated curing release the prestressing force within 24 hours of verifying release strength by compressive strength cylinder breaks or other approved strength gain monitoring system, unless the required time for release occurs on a weekend or holiday. Detension members cured using methods other than accelerated curing but which induce heat into the member before a concrete temperature drop of more than 60EF [33EC] occurs. When the required time for release occurs on a weekend or holiday, cover the members and exposed strand with curing blankets or other similar materials, or detension the members. Detension the members immediately on the first workday after the weekend or holiday. Cure concrete cylinders used for strength tests in the same manner and location as the prestressed concrete members. Make concrete cylinders in accordance with the Department's test methods.

450-2.6.11.2 Method of Stress Transfer: In all detensioning operations, keep the prestressing forces nearly symmetrical about the vertical axis of the member and apply them in a manner that will minimize sudden shock or loading. Remove or loosen forms, ties, inserts, or other devices that would restrict longitudinal movement of the members along the bed. Remove hold-downs of draped strand profiles at the appropriate time for the specific member.

Release hold-downs for members with draped strands prior to releasing the stresses at the anchorages, unless the hold downs are free to move longitudinally. If the latter is the case, the hold-downs may be released subsequent to release of the anchorage stress.

Cut dormant strands in top of beams prior to releasing any fully tensioned strands. Release fully bonded strands next, followed progressively by strands having the minimum length of tubular sheathing through to those strands having the maximum length of tubular sheathing. The Contractor may propose alternative detensioning patterns to suit his particular operation. The method of the stress transfer to be used by the Contractor shall be specified either in the QCP, the construction submittal, or the shop drawings to be submitted in accordance with 450-2.2.2 and 450-2.6.1, respectively.

Transfer prestressing forces to the concrete by either single strand release or multiple strand release, as follows:

(1) Single Strand Detensioning: Detension the strand by using a low-oxygen flame, and in accordance with a pattern and schedule provided in the approved shop drawings, or QCP. Heat with a low-oxygen flame played along the strand for a minimum of 5 inches [125 mm]. Heat strands in such a manner that the failure of the first wire in each strand will occur after the torch has been applied for a minimum of five seconds.

Release unsymmetrically stressed members simultaneously and symmetrically about the vertical axis at both ends of the bed and all intermediate points between members to minimize sliding of members. Release symmetrically stressed members simultaneously and symmetrically about the vertical axis at both ends of the bed and at intermediate points between members not greater than 150 feet [45 m] apart. Do not cut the strands quickly, but heat them until the metal gradually loses its strength, in order for release of the strands to occur gradually.

(2) Multiple Strand Detensioning: In this method, detension all the strands simultaneously by hydraulic dejacking. The total force is taken from the header by the jack, then released gradually. Do not allow the overstress required to loosen the anchoring devices at the header to exceed the force in the strand by 5%. After detensioning, strands at all points may be cut progressively from one end of the bed to the other using equipment and methods described in (1) above.

450-2.6.11.3 Trimming Strands: Upon completion of the detensioning operation, cut the exposed strands to required length, using an oxygen flame or mechanical cutting device. On piles, use only mechanical cutting, unless specifications require strand to be burned below the pile surface. Do not use electric arc welders. Unless otherwise specified, allow all strands to protrude 2.5 ∀ 0.5 inches [65 ∀ 15 mm] beyond the end of the member, except cut strands for piling back to be flush with or below the concrete surface. Seal openings between strand and sheathing for debonded strands with either an epoxy or silicone sealant within 48 hours of detensioning.

450-2.6.12 Noncomplying Prestressed Members:

450-2.6.12.1 General: When a precast prestressed concrete member does not comply with the requirements of this Section or is damaged, use the following provisions for evaluating and disposing of deficiencies. Apply these provisions in all cases which clearly fall under the circumstances described. Consider situations not covered by these specific circumstances on their individual merits. Consider and apply the following where practical.

The Engineer will examine all deficiencies to determine the applicable provisions and requirements of this Article and which course of action is appropriate. If the Engineer determines that a deficiency is repairable within the terms of this Article, appropriate repairs may be executed immediately. If the Engineer determines that a deficiency requires an engineering evaluation and disposition, the Contractor may submit a repair proposal to the Department in accordance with 450-2.6.12.5. Make all repairs which require a repair proposal under the observation of and to the satisfaction of the Engineer.

The disposition of deficiencies and repair methods provided herein shall at no time, and under no circumstances, be used as an excuse for or applied in such a manner so as to relieve the Contractor of his responsibility for QC in accordance with 450-2.2.3. The number and type of deficiencies evaluated under this specification will, however, be used in evaluating the Contractor's quality control.

In addition, the Department will require a credit on any member with deficiencies attributable to the Contractor which is evaluated in accordance with 450-2.6.12.5 and is accepted for use in the structure.

Bear the costs of repairs and any actions taken to rectify deficiencies at no expense to the Department.

450-2.6.12.2 Surface Deficiencies: Surface deficiencies are defined below. Regardless of the types of deficiencies, when the total surface area of all deficiencies within a single member exceeds 1% of the product of the member's length times its depth, the member shall require engineering evaluation and disposition in accordance with 450-2.6.12.5.

(1) Bughole: A bughole is a form surface air pocket void with an area up to 3.0 in^2 [2000 mm^2] and a depth up to 1.5 inches [40 mm]. Treat any air pocket void with a dimension exceeding either of these dimensions as a honeycomb. The Engineer will not require the Contractor to repair any bughole with a depth less than 0.25 inch [5 mm] and less than 0.75 inch [20 mm] in diameter, unless otherwise indicated in the plans or specifications. Consider all other bugholes cosmetic and repair them in accordance with 450-2.6.12.4(1).

(2) Spall: A spall is a depression resulting when a fragment is detached from a large mass by a blow, action of weather, by pressure or by

expansion within the larger mass.

A cosmetic spall is a circular or oval depression not greater than 1.0 inch [25 mm] in depth nor greater than 3.0 in^2 [2,000 mm^2] in area, and shall be repaired in accordance with 450-2.6.12.4(1).

A minor spall is a spall no larger than 1.0 ft^2 [0.1 m^2] and no deeper than 1.5 inches [40 mm]. Repair minor spalls in accordance with 450-2.6.12.4(3).

A major spall is a spall which is deeper than 1.5 inches [40 mm] regardless of the surface area, or a shallower spall with a surface area greater than 1.0 ft^2 [0.1 m^2]. A major spall shall require engineering evaluation and disposition in accordance with 450-2.6.12.5.

(3) Chip: A chip is the local breaking of the corners or edges of the concrete with the resulting void containing angular surfaces.

Cosmetic chips are chips where the sum of the two lateral dimensions perpendicular to the length does not exceed 2.0 inches [50 mm]. Regardless of length, it is not necessary to repair cosmetic chips except for visually exposed surfaces which may require repair in accordance with 450-2.6.12.4(4).

Minor chips are chips where the sum of the two lateral dimensions perpendicular to the length exceeds 2.0 inches [50 mm], but does not exceed 4.0 inches [100 mm], and with a length of no more than 12.0 inches [300 mm]. Repair minor chips in accordance with 450-2.6.12.4(4).

Major chips are any chips larger than minor chips. Major chips shall require engineering evaluation and disposition in accordance with 450-2.6.12.5.

(4) Surface Porosity: Surface porosity is the localized porosity of a formed surface due to medium scaling. Medium scaling is defined as the loss of surface mortar up to δ inch [10 mm] in depth and exposure of concrete aggregate. Repair surface porosity with a surface area greater than 1.0 ft^2 [0.1 m^2] in accordance with 450-2.6.12.4(2) below. Repair surface porosity with an area less than 1.0 ft^2 [0.1 m^2] in accordance with 450-2.6.12.4(1).

(5) Honeycombing: Honeycombing is voids in the concrete, loss of fines or other material from between the aggregate particles, the inclusion of air pockets between aggregate particles, or larger volumes of lost material. Remove honeycombing in its entirety to sound concrete prior to establishing the classification of the defect.

Minor honeycombing is a void no deeper than 1.5 inches [40 mm] to the sound concrete and no larger than 1.0 ft^2 [0.1 m^2] in area that results after the removal of unsound material. Repair minor honeycombing in accordance with 450-2.6.12.4(5).

Major honeycombing is a void deeper than 1.5 inches [40 mm] to the sound concrete regardless of the surface area, or shallower but with a surface area greater than 1.0 ft^2 [0.1 m^2] that results after the removal of unsound material. Major honeycombing shall require engineering evaluation and disposition in accordance with 450-2.6.12.5.

(6) Formed Surface Misshapening: Formed surface misshapening is the visual and measurable deficiency or excess of material from the specified tolerance on any surface of a member.

(a) Pile Ends: Make square pile ends which are outside this Section=s tolerances by grinding in accordance with 450-2.6.12.4(6), or any other means of removal as approved by the Engineer. Reshape the chamfer if more than 3 inch [5 mm] from the cast pile end is removed and such removal affects the chamfer dimension.

(b) Pile Chamfers: Reshape chamfers outside of this Section=s tolerances to within the tolerances in accordance with 450-2.6.12.4(6) below.

(c) Other Surfaces: Any deficiency exceeding the plan dimensions for size, length, squareness, designated skew, plumbness, and the like by up to twice the specified plus (+) tolerance may be corrected by grinding to within the allowable tolerance in accordance with 450-2.6.12.4(6). Any deficiency exceeding the specified minus (-) tolerance or twice the specified plus (+) tolerance shall require an engineering evaluation and disposition in accordance with 450-2.6.12.5.

(7) Bearing Areas: Consider the bearing area to extend from the end of the member to 3 inches [75 mm] beyond the edge of the bearing contact area for the full member width. Treat minor defects in the bearing area in accordance with 400-11.

450-2.6.12.3 Cracks: A crack is the separation of a member or portion thereof which may appear before or after detensioning and may or may not cause separation throughout the member thickness or depth. Identify cracks by the classifications and locations described below and subject them to the disposition required by the identified crack. Regardless of the classifications and locations of cracks within any single member, if the total surface length of all cracks on any and all surfaces exceeds α of the member's length, the member shall require engineering evaluation and disposition in accordance with 450-2.6.12.5. Establish crack sizes subsequent to release of all pretensioning forces.

The Engineer will reject any pile that is cracked to the point that a transverse or longitudinal crack extends through the pile, shows failure of the concrete as indicated by spalling of concrete on the main body of the pile adjacent to the crack, or which in the opinion of the Engineer will not withstand driving stresses. Occasional hairline surface cracking caused by shrinkage or tensile stress in the concrete from handling will not be cause for rejection.

(1) Classification of Cracks: Regardless of cause and for the purposes of this specification, cracks in prestressed components, excluding piling, will be identified according to their surface appearance in accordance with the following classifications:

Cosmetic Cracks: Cosmetic cracks are any cracks which are less than 0.006 inch [0.15 mm] wide and are in structurally non-critical locations on the member. Treat cosmetic cracks after detensioning in accordance with Section 400 and Section 413.

Minor Cracks: Minor cracks are any cracks which are between 0.006 and 0.012 inch [0.15 and 0.30 mm] wide, inclusive, and are in structurally non-critical locations on members. Repair minor cracks after detensioning in accordance with Section 400, and Section 411 or Section 413.

Major Cracks: Major cracks are any cracks of any width which are located in structurally critical locations on members or cracks in structurally non-critical locations which are greater than 0.012 inch [0.30 mm] wide. Major cracks require an engineering evaluation and disposition in accordance with 450-2.6.12.5.

Cracks in the Riding Surface: Repair cracks in the top surface of components which will become the riding surface (with no overlays) in accordance with Section 400, and Section 411 or Section 413 regardless of the classification of the crack identified in accordance with this Specification.

(2) Locations of Cracks: Regardless of cause and for the purposes of this specification, cracks will be identified as occurring in either structurally critical or structurally non-critical locations in accordance with the following criteria and conditions:

Structurally Critical Locations: Structurally critical locations of cracks are any locations in which a crack would tend to open under stresses occurring at any time during the service life of the structure, or which may reduce the ultimate capacity or fatigue life of the member. Specifically, structurally critical locations of cracks are any locations in a member not defined and included in (3) below as structurally non-critical. Cracks in structurally critical locations shall require engineering evaluation and disposition in accordance with 450-2.6.12.5.

Structurally Non-critical Locations: Structurally non-critical locations of cracks are defined by the position within a member's length, the position within a member's depth, and the orientation of the crack.

(3) Structurally Non-critical Locations of Cracks by Member Type are:

(aa) Piles: Surface cracks in any direction and of a length not exceeding twice the width of the pile.

(bb) Simple Span Prestressed Beams:

End zones (within a distance of twice the depth of the member from the end): One horizontal crack at either or both ends in the top flange and web of the member, not in the plane of nor intersecting any row of prestressing strands, and extending from the end of the member for a length not to exceed 2 the member's depth.

Mid-span region (between end zones) before detensioning: Vertical cracks extending through the top flange and web of the member.

Any Location: Horizontal crack at the interface of the web and top flange which is not longer than the member's depth.

(cc) Simple Span Double Tees:

End zones (within a distance of twice the depth of the member from the end): One horizontal crack at either or both ends and in the top flange of the member, not in the plane of nor intersecting any row of prestressing strands, and extending from the end of the member for a length not to exceed half the member's depth.

Mid-span Region (between end zones) before detensioning: Vertical cracks extending through the top flange and not exceeding half the web depth of the member.

Any Location: Horizontal crack at the interface of the web and top flange which is not longer than the member's depth.

(dd) Pretensioned I Beams Containing Longitudinal

Posttensioning Ducts:

End zones (within a distance of twice the depth of the beam from the end): Vertical cracks in the bottom half of the beam within an end zone with no posttensioning anchorages and where the posttensioning ducts are located in the top of the beam at the location of a permanent substructure support.

Mid-span Region (between quarter points): Vertical cracks in the web and top flange of the beam provided the beam is to be supported at each end in its final position in the structure.

Horizontal cracks not longer than the beam's depth and only at the interface of the web and top flange provided the beam is to be supported at each end in its final position in the structure.

(ee) Simple Span Prestressed Slab Units:

End Zones (within a distance of twice the depth of the member from the end): One horizontal crack at either or both ends in the top 2 of the member, which is not in the plane of nor intersecting any row of prestressing strands, and extending from the end of the member for a length not to exceed half the member's depth.

Mid-span Region (between end zones) before detensioning: Vertical cracks in the top half of the member.

Any Location (after detensioning): Vertical cracks in the top half of the member.

450-2.6.12.4 Repair Methods and Materials: For minor defects repaired in accordance with the requirements herein, the Engineer will not require a repair proposal and review. Proceed with the defect repair upon completing the "Noncomplying Prestressed Precast Concrete Component Data Sheet" (FDOT Form No. 700-030-010) and receiving signature verification by the Engineer indicating the information on the form is correct. If the Contractor elects to propose an alternate repair method, submit a proposal in conformance with 450-2.6.12.5. Prior to repair, prepare the surface of the repair area by removing all laitance, loose material, form oil, curing compound, and any other deleterious matter. Complete all repairs, other than repairs to cracks and surface grinding, within three working days of discovery. The three working day period for the completion of repairs may be extended if authorized by the Engineer. Cure repaired surfaces for the full curing time required for concrete as specified in 450-2.6.9(f). Repaired surfaces shall have a surface texture, finish and color which matches the appearance of the unaffected surrounding area of the member.

(1) Cosmetic Surface Filling: Repair areas to be filled by filling with a mortar mix consisting by volume of one part cement, 2.5 parts sand that will pass a No.16 [1.18 mm] sieve, and only sufficient water to produce a dry but workable mix consistency compatible with the repair required.

(2) Surface Restoration: Maintain the surface continuously wet for a minimum of three hours prior to application of repair material. Repair areas to be restored with a mortar mix consisting by volume of one part cement, 2.5 parts sand that will pass a No. 16 [1.18 mm] sieve, and sufficient water to produce a viscous slurry mix.

(3) Cutting and Filling: Carefully cut all feathered edges of the area to be repaired back perpendicular to (or slightly undercut from) the surface to the

depth of sound concrete or to a minimum depth of 2 inch [15 mm], whichever is deeper. Coat the prepared surface with an approved epoxy bonding agent applied in accordance with the manufacturer's recommendations. Fill the cutout area with an approved high-strength, non-metallic, non-shrink grout mixed and applied in accordance with the manufacturer's recommendations. Firmly consolidate the grout mix in the cutout area.

(4) Restoration of Surfaces and Edges: When reinforcing steel, prestressing strand, inserts or weldments are exposed, remove concrete from around the items to provide a 1 inch [25 mm] clearance all around. Form surfaces and edges to the original dimensions and shape of the member. Coat the prepared surface with an approved epoxy bonding agent applied in accordance with the manufacturer's recommendations. Restore surfaces and edges with an approved high-strength, non-metallic, non-shrink grout mixed and applied in accordance with the manufacturer's recommendations. Firmly consolidate the grout mix in the area to be repaired.

(5) Removal and Restoration of Unsound Concrete: Carefully cut the area of unsound concrete to be repaired back perpendicular to (or slightly undercut from) the surface and to the depth of sound concrete or to a minimum depth of 1 inch [25 mm], whichever is deeper. When reinforcing steel, prestressing strand, inserts or weldments are exposed, remove the concrete from around the items to provide a 1 inch [25 mm] clearance all around. Coat the prepared surface with an approved epoxy bonding agent applied in accordance with the manufacturer's recommendations and then filled with an approved high-strength, non-metallic, non-shrink grout mixed and applied in accordance with the manufacturer's recommendations. Firmly consolidate the grout mix in the area to be repaired. Restore surfaces and edges to the original dimensions and shape of the member.

(6) Surface Grinding: Grind off misshaped formed surfaces with an abrasive stone with the following limitations and requirements:

Apply two coats of an approved penetrant sealant to any surfaces which are not subsequently encased in concrete immediately after grinding has been accepted.

Do not apply a penetrant sealer to any surfaces to be subsequently encased in concrete.

(7) Treatment of Cracks: Treat cracks in accordance with Section 400, and Section 411 or Section 413.

450-2.6.12.5 Submittal of Proposal to Accept or Repair Structural Deficiencies: When notified that a member is deficient and, thereby, unacceptable to the Department, the Contractor may propose repairs to the member either in the casting yard, or at the project site when such deficiencies are discovered at the project site. If the Contractor proposes to repair the member, it must be restored to provide its required design capacity and perform its intended function in the structure in order to be considered for acceptance by the Department. Proposals must include an evaluation of the member's relative ability to perform its intended function in the structure and its durability relative to other acceptable, similar members. Submit the proposal in writing to the Engineer as outlined below. Do not ship members which require repairs from the casting yard which require repairs to the project site until such repairs are complete and the Department has determined the member to be acceptable.

If the proposal is accepted by the Department, all Department costs associated with review of the proposal, including the cost of any and all engineering evaluation and/or testing services required, will be borne entirely by the Contractor, but not to exceed 15% of the member value based on unit bid prices.

Prepare the proposal to consist of the following information:

(1) A cover letter prepared on the Contractor's letterhead describing the member and addressed to the Engineer.

(2) Completed "Noncomplying Prestressed Precast Concrete Component Data Sheet" (FDOT Form No. 700-030-010) countersigned by the Department's inspector indicating his agreement with the described defect or noncompliance feature.

(3) A structural and durability evaluation of the member.

(4) A proposed credit to the contract proportionate to the member's deficiency. The credit is in addition to the cost for review and evaluation of the proposal.

(5) Any other supportive information, pictures, sketches, etc. The description of the proposed repair and/or the structural and durability evaluation of the member must be prepared by or under the direct supervision of a Specialty Engineer and must bear his signature and seal.

Include in the proposed credit consideration of the Department's added costs which may include but are not necessarily limited to reinspection, testing, reduced durability, or increased maintenance cost.

The Engineer will review and evaluate the Contractor's proposal and will notify the Contractor of its disposition. The Engineer's review of the Contractor's proposal does not amend or delete code requirements, unless such changes are specifically brought to the Engineer's attention and accepted by the Engineer.

The Engineer's acceptance of a proposal does not relieve the Contractor of his responsibility to provide members that are structurally adequate to resist the loads specified in the contract drawings and that maintain the intended aesthetic, durability and maintenance aspects of the member.

The Engineer will not accept repaired members unless repairs are made as proposed or described, the resulting repairs are sound in all aspects, and the repairs are aesthetically acceptable.

Replace a rejected member with a member meeting the requirements of the Contract Documents at no additional expense to the Department.

450-2.6.12.6 Repairs Prior to Approval: If repairs to precast members are initiated in advance of Department approval of the repair procedures, materials, etc., for deficiencies that require evaluation in accordance with this Section, the affected member will only be considered for acceptability and use when the following conditions have been satisfied:

(1) Prior to beginning the repairs, prepare and deliver to the Engineer a repair proposal in accordance with the requirements of 450-2.6.12.5.

(2) All repair materials must be selected from the Department's qualified product list or otherwise be subsequently evaluated, tested by the Contractor as required by the Department, and/or approved by the Department for the specific use made of the material.

(3) Perform repairs under the observation of the Engineer.

It shall be clearly understood that such actions taken by the Contractor are entirely at his own risk. It is intended that repairs shall be made only after the proposed methods have been accepted to ensure that the proposal will not be modified or rejected, and the work will be accepted if the repair proves to be adequate.

450-2.7 Dimensional Tolerances:

450-2.7.1 General: Apply all tolerances with respect to the theoretical positions and dimensions shown in the plans.

The tolerances listed in 450-2.7.2 represent the total allowable tolerance that will be accepted in the finished product. Do not accumulate tolerances allowed in other manufacturing sequences to supersede any individual tolerance. Do not apply tolerances shown for the overall dimensions of a member in a manner that will cause the tolerances shown for positions of reinforcing and prestressing steel to be violated whether the position of the steel is considered with respect to the centerlines of the member or to the surfaces of the member as a reference.

450-2.7.2 Tolerances: Apply the following tolerances during and after the fabrication of prestressed members:

Non SI Units

(a) All Prestressed Members: Allowable reduced concrete cover for reinforcing steel shall be 3 inch from cover shown, unless shown as Aminimum cover≅ on plans.

The tolerance on all miscellaneous shapings including, but not necessarily limited to, chamfers, miters, bevels, keys, tapers, radii, holes, inserts, blockouts, shall be ∀χ inch of the control dimension of the shape or ∀χ inch, whichever is greater.

(b) Piling (voided and solid):

Length (after detensioning)	-1 inch, +3 inches
Width or Diameter	∀ 3 inch
Sweep-variation from straight line parallel to centerline of member, measured after removal from forms and before shipping	∀ χ inch per 10 feet, up to 1 inch maximum
Position of Strands	∀ 3 inch
Void Position:	
Longitudinal	∀ 2 inches
Transverse	∀ 2 inch
Vertical	∀ 2 inch
Holes for cable ties	∀ 1 inch
Position of Handling Devices	∀ 6 inches
Variation from Specified End Squareness or Skew	∀χ in/ft, ∀ 3 inch maximum
Local Smoothness of Any Surface	∀3 inch per 10 feet
Longitudinal Pitch or Spacing of Spiral, for spacing	

Non SI Units

(x) of:	
x<3 inches	∀ 3 inch
3#x#9 inches	∀ 2 inch
x>9 inches	∀ : inch
Pile Chamfers:	
3 inch dimension	+0 inch, -2 inch
: inch dimension	+2 inch, -3 inch
(c) Sheet Piling:	
Length (after detensioning)	-1 inch, +3 inches
Width	∀δ inch
Thickness	∀3 inch
Position of Strands	∀3 inch
Position of Handling Devices	∀6 inches
Variation from Specified End Squareness or Skew (measured along the width of the sheet pile)	∀χ in/ft, ∀2 inch maximum
Local Smoothness of Any Surface	∀3 inch per 10 feet
Longitudinal Spacing of Stirrups	∀3/4 inch
(d) Double Tees:	
Length (measured prior to detensioning)	∀1 inch
Width (Overall)	∀3 inch
Depth	+2 inch, -3 inch
Stem Width	∀χ inch
Flange Thickness	∀3 inch
Distance Between Stems	∀3 inch
Centerline of Stem to Edge of Top Flange	∀3 inch
Variation from Specified Flange Squareness or Skew:	
Horizontal	∀χ in/ft of width, ∀1/2 inch maximum
Variation from Specified End Squareness or Skew:	
Vertical depth (x):	
x>24 inches	∀χ in/ft of depth of double tee; ∀2 inch maximum
x#24 inches	∀3 inch
Sweep- variation from straight line parallel to centerline of member, measured immediately after storing	χ inch per 10 feet, 1 inch maximum
Differential Camber between Adjacent Members of the Same Design	2 inch
Position of Strands:	
Individual	∀3 inch
Bundled	∀2 inch

Non SI Units

Position from Design Location of Deflection Points for Deflected Strands	∀6 inches
Position of Blockouts	∀1 inch
Size of Blockouts	∀2 inch
Position of Plates	∀1 inch
Position of Bearing Plates	∀2 inch
Tipping and Flushness of Plates and Bearing Plates, longitudinal and transverse over the width and/or length of the plate	∀χ inch
Position of Sleeves Cast in Stems, in both horizontal and vertical plane	∀1 inch
Position of Inserts for Structural Connections	∀2 inch
Position of Handling Devices; Parallel to Length	∀6 inches
Local Smoothness of any Surface:	
Top of Deck Surface, longitudinal and transverse	3/16 inch in 10 feet
Non Deck Surfaces	3 inch in 10 feet
Horizontal Position of Transverse Tendon Duct:	
Inside the member	∀2 inch
At faces of the member	∀3 inch
Vertical Position of Transverse Tendon Duct	
Inside the member	∀3 inch
At faces of the member	∀χ inch
Position of Stirrup Bars (Longitudinal Spacing)	∀1 inch
(e) Slab Units:	
Length, measured prior to detensioning	∀1 inch
Width	∀3 inch
Depth	∀3 inch
Blockout Location	∀1 inch
Variation from Specified End Squareness or Skew, horizontal and vertical	∀2 inch
Sweep- variation from straight line parallel to centerline of member, measured immediately after storing, for member length (x):	
x<40 feet	3 inch
40#x# 60 feet	δ inch
x>60 feet	2 inch
Position of Strands	∀3 inch
Position of Plates	∀1 inch
Local Smoothness:	
Top of Deck Surface, longitudinal and transverse	3/16 inch in 10 feet
Non Deck Surfaces	3 inch in 10 feet
Position of Stirrup Bars (longitudinal spacing)	∀1 inch

Non SI Units

Position of Transverse Posttensioning Ducts:	
Vertical:	
Inside the member	∀3 inch
At faces of the member	∀χ inch
Horizontal:	
Inside the member	∀2 inch
At faces of the member	∀3 inch
Differential Camber between Adjacent Members of the Same Design	2 inch
(f) I-Beams/Bulb Tee Beams:	
Length, to be measured prior to detensioning	∀1 inch
Width (Flanges)	+δ inch, -3 inch
Depth (Overall)	+2 inch, -3 inch
Depth (Flanges)	∀3 inch
Width (Web)	+δ inch, -3 inch
Sweep- variation from straight line connecting similar points of beam ends:	
After release and before removing from bed	χ inch per 10 feet beam length, 1.5 inches maximum.
In storage and after placement in the structure	χ inch per 10 feet beam length, 1.5 inches maximum.
Variation from Specified End Squareness or Skew:	
Horizontal	∀3 inch
Vertical	∀χ in/ft of beam depth
Position of Strands	∀3 inch
Position from Location of Deflection Points for Deflected Strands Shown in the Shop Drawing	∀6 inches
Position of Bearing Plates- horizontal, measured from end of beam	∀2 inch
Tipping and Flushness of Bearing Plates, longitudinal and transverse over the width and/or length of the plate	χ inch
Position of Posttensioning Duct:	
Vertical:	∀3 inch
Horizontal:	∀2 inch
Position of Inserts for Structural Connections	∀2 inch
Position of Handling Devices - Parallel to Length	∀6 inches
Position of Stirrups:	
Longitudinal Spacing:	
for spacing # 6 inches	∀1 inch
for spacing > 6 inches	∀2 inches

Non SI Units

End Stirrup Bars, from end of beam	not more than 2 inches
Transverse Horizontal Spacing, out to out	∀3 inch
Projection Above Top	∀: inch
Local Smoothness, any surface (does not apply to top surface left rough)	3 inch in 10 feet
Position of Strand Sheathing:	∀2 inches
Tilt of the Vertical Axis of a Beam End from True Vertical Due to Deviation of Blocking from Horizontal, measured in storage. (Tilt is the right or left incline of the beam end vertical axis as viewed when facing the beam end.)	3 in/ft of height (not to exceed 1 inch)

SI Units

(a) All Prestressed Members: Allowable reduced concrete cover for reinforcing steel shall be 5 mm from cover shown, unless shown as Aminimum cover≅ on plans.

The tolerance on all miscellaneous shapings including, but not necessarily limited to, chamfers, miters, bevels, keys, tapers, radii, holes, inserts, blockouts, shall be ∀3 mm of the control dimension of the shape or ∀3 mm, whichever is greater.

(b) Piling (voided and solid):

Length (after detensioning)	-25 mm, +75 mm
Width or Diameter	∀ 5 mm
Sweep-variation from straight line parallel to centerline of member, measured after removal from forms and before shipping	1 mm/m, up to 25 mm maximum
Position of Strands	∀ 5 mm
Void Position:	
Longitudinal	∀50 mm
Transverse	∀15 mm
Vertical	∀15 mm
Holes for cable ties	∀25 mm
Position of Handling Devices	∀150 mm
Variation from Specified End Squareness or Skew	∀10 mm/m, ∀ 5 mm maximum
Local Smoothness of Any Surface	∀2 mm/m
Longitudinal Pitch or Spacing of Spiral, for spacing (x) of:	
x<75 mm	∀5 mm
75#x#225 mm	∀15 mm
x>225 mm	∀20 mm
Pile Chamfers:	

SI Units

75 mm dimension	+0 mm, -15 mm
20 mm dimension	+15 mm, -5 mm
(c) Sheet Piling:	
Length (after detensioning)	-25 mm, +75 mm
Width	∀10 mm
Thickness	∀5 mm
Position of Strands	∀5 mm
Position of Handling Devices	∀150 mm
Variation from Specified End Squareness or Skew (measured along the width of the sheet pile)	∀10 mm/m, ∀15 mm maximum
Local Smoothness of Any Surface	∀2 mm/mm
Longitudinal Spacing of Stirrups	∀20 mm
(d) Double Tees:	
Length (measured prior to detensioning)	∀25 mm
Width (Overall)	∀5 mm
Depth	+15 mm, -5 mm
Stem Width	∀ 3 mm
Flange Thickness	∀5 mm
Distance Between Stems	∀5 mm
Centerline of Stem to Edge of Top Flange	∀5 mm
Variation from Specified Flange Squareness or Skew:	
Horizontal	∀10 mm/m of width, ∀15 mm maximum
Variation from Specified End Squareness or Skew:	
Vertical depth (x):	
x>600 mm	∀10 mm/m of depth of double tee; ∀15 mm maximum
x#600 mm	∀5 mm
Sweep- variation from straight line parallel to centerline of member, measured immediately after storing	1 mm/m, 25 mm maximum
Differential Camber between Adjacent Members of the Same Design	15 mm
Position of Strands:	
Individual	∀5 mm
Bundled	∀15 mm
Position from Design Location of Deflection Points for Deflected Strands	∀150 mm
Position of Blockouts	∀25 mm
Size of Blockouts	∀ 15 mm
Position of Plates	∀ 25 mm
Position of Bearing Plates	∀ 15 mm

SI Units

Tipping and Flushness of Plates and Bearing Plates, longitudinal and transverse over the width and/or length of the plate	∀ 3 mm
Position of Sleeves Cast in Stems, in both horizontal and vertical plane	∀25 mm
Position of Inserts for Structural Connections	∀15 mm
Position of Handling Devices; Parallel to Length	∀150 mm
Local Smoothness of any Surface:	
Top of Deck Surface, longitudinal and transverse	1.5 mm/m
Non Deck Surfaces	2 mm/m
Horizontal Position of Transverse Tendon Duct:	
Inside the member	∀15 mm
At faces of the member	∀5 mm
Vertical Position of Transverse Tendon Duct:	
Inside the member	∀5 mm
At faces of the member	∀3 mm
Position of Stirrup Bars (Longitudinal Spacing)	∀25 mm
(e) Slab Units:	
Length, measured prior to detensioning	∀25 mm
Width	∀5 mm
Depth	∀5 mm
Blockout Location	∀25 mm
Variation from Specified End Squareness or Skew, horizontal and vertical	∀15 mm
Sweep- variation from straight line parallel to centerline of member, measured immediately after storing, for member length (x):	
x<12 m	5 mm
12#x#18 m	10 mm
x>18 m	15 mm
Position of Strands	∀5 mm
Position of Plates	∀25 mm
Local Smoothness:	
Top of Deck Surface, longitudinal and transverse	1.5 mm/m
Non Deck Surfaces	2 mm/m
Position of Stirrup Bars (longitudinal spacing)	∀25 mm
Position of Transverse Posttensioning Ducts:	
Vertical:	
Inside the member	∀5 mm
At faces of the member	∀3 mm
Horizontal:	
Inside the member	∀15 mm

SI Units

At faces of the member	∀5 mm
Differential Camber between Adjacent Members of the Same Design	15 mm
(f) I-Beams/Bulb Tee Beams:	
Length, to be measured prior to detensioning	∀25 mm
Width (Flanges)	+10 mm, -5 mm
Depth (Overall)	+15 mm, -5 mm
Depth (Flanges)	∀5 mm
Width (Web)	+10 mm, -5 mm
Sweep- variation from straight line connecting similar points of beam ends:	
After release and before removing from bed	1 mm/m beam length, 40 mm maximum.
In storage and after placement in the structure	1 mm/m beam length, 40 mm maximum.
Variation from Specified End Squareness or Skew:	
Horizontal	∀5 mm
Vertical	∀10 mm/m of beam depth
Position of Strands	∀5 mm
Position from Location of Deflection Points for Deflected Strands Shown in the Shop Drawing	∀150 mm
Position of Bearing Plates- horizontal, measured from end of beam	∀15 mm
Tipping and Flushness of Bearing Plates, longitudinal and transverse over the width and/or length of the plate	3 mm
Position of Posttensioning Duct:	
Vertical:	∀5 mm
Horizontal:	∀15 mm
Position of Inserts for Structural Connections	∀15 mm
Position of Handling Devices - Parallel to Length	∀150 mm
Position of Stirrups:	
Longitudinal Spacing:	
for spacing # 150 mm	∀25 mm
for spacing > 150 mm	∀50 mm
End Stirrup Bars, from end of beam	not more than 50 mm
Transverse Horizontal Spacing, out to out	∀5 mm
Projection Above Top	∀20 mm
Local Smoothness, any surface (does not apply to top surface left rough)	2 mm/m
Position of Strand Sheathing	∀50 mm
Tilt of the Vertical Axis of a Beam End from True	20 mm/m of height

SI Units	
Vertical Due to Deviation of Blocking from Horizontal, measured in storage. (Tilt is the right or left incline of the beam end vertical axis as viewed when facing the beam end.)	(not to exceed 25 mm)

450-2.8 Handling and Storage:

450-2.8.1 Handling: All members may be handled after transfer of the prestress force except members that are prestressed by a combination of pretensioning and posttensioning. For the latter, do not handle the members before they are sufficiently prestressed to sustain all forces and bending moments due to handling. Exercise care in handling to prevent damage to members. Lift and move the members so as to minimize stresses due to sudden changes in momentum. Pick up members only at points designated as pickup points as shown on the contract plans or shop drawings. Maintain all members in an upright position at all times.

Evaluate the temporary stresses and stability of beams with a length-depth ratio greater than 20 during handling. The temporary stresses induced into the members during handling shall be within the acceptable stresses at release listed in the Department's Structures Design Guidelines. Take appropriate action to increase the stability of members during handling when the factor of safety against lateral buckling instability is below 2.0. Include the expected fabrication tolerance for sweep in the analysis. The analysis procedure provided by the Prestressed Concrete Institute or similar procedures may be used for the stability evaluation.

Verify lifting devices for capacity in lifting and handling members, taking into account various positions during handling. Keep multiple component lifting devices matched to avoid non-compatible use. When a member has multiple lifting devices, use lifting equipment (slings, pulleys, etc.) capable of distributing the load at each device uniformly to maintain the stability of the member. When the lifting devices are grouped in multiples at one location, align them for equal lifting.

Take appropriate steps to prevent the occurrence of cracking. When cracking occurs during handling and transportation, revise handling and transporting equipment and procedures as necessary to prevent cracking for subsequent members.

450-2.8.2 Storage: Store precast prestressed beams, double tees and slab units on only two points of support located within 18 inches [450 mm] of the end of the member. Support skewed beams, double tees or slab units within 18 inches [450 mm] of the end of the full member section. Support other members on an adequate number of supports so as to keep stresses in the members within the allowable stresses at release listed in the Department's Structures Design Guidelines. Locate multiple supports (more than 2) within 2 inch [15 mm] of a horizontal plane through the top surface of the supports.

All supports shall be level and on adequate foundation material that will prevent shifting or differential settlement which may cause twisting or rotation of members. Immediately pick up members in storage that have rotated or twisted and adjust the supports to provide level and uniform support for the member.

Support prestressed members that are stacked by dunnage placed across the full width of each bearing point and aligned vertically over lower supports. Do not use stored members as a storage area for either shorter or longer members or heavy equipment.

Where feasible, base the selection of storage sites, storage conditions and orientation upon consideration of minimizing the thermal and time-dependent creep and shrinkage effects on the camber and/or sweep of the precast pretensioned members.

When concrete incorporating microsilica is used, continuous application of water during the initial seven day moist curing period may be interrupted for a maximum of one hour to allow relocation of precast or prestressed elements within the manufacturing facility.

Check the sweep and camber of beams monthly for conformance with 450-2.7.2(f). If the camber exceeds by 1 inch [25 mm] the design camber shown in the plans, take appropriate actions in accordance with 400-7.13.1 to accommodate the member in the structure. If the sweep exceeds the tolerance specified, take immediate measures to bring the sweep of the member back to within tolerance. Special storage conditions for the purpose of removing excessive sweep shall not be restricted by requirements of this Subarticle nor contained in 450-2.7.2(f). If the sweep of the member exceeds the tolerance specified and can not be removed, the disposition of the member shall be in accordance with 450-2.6.12.1 and 450-2.6.12.5.

450-2.9 Shipping: Do not ship precast prestressed members prior to the concrete attaining the required 28-day strength. Do not ship members until accepted and stamped by the Contractor and the Department. The Contractor's stamp shall mean that the member was fabricated in conformance with the Contractor's QCP, the contract, and this Section. The Department's stamp shall mean that the Engineer has reviewed the Contractor's documentation for each member and determined it to be complete, and that a visual inspection of the completed member(s) found only those defects noted on the shipping documents.

When concrete incorporating microsilica is used, allow precast or prestressed concrete elements to remain at the manufacturing location until the initial seven day moist curing is complete. Upon completion of the seven day moist cure, application of the double coating of curing compound, and attaining the required strength, elements may be shipped and stored at the job site until the 28-day curing period has been accomplished.

Evaluate the temporary stresses and stability of all members during shipping and locate supports in such a manner as to maintain stresses within acceptable levels. Include impact loadings in the evaluation. Consider the actual route that will be used for transporting the member and consider any special conditions, such as sharp curvature, high superelevation, uneven roadways, that will cause leaning, rotation, twisting, or impact loadings, in any evaluation of shipping methods. Especially evaluate the lateral stability of beams with a length-depth ratio greater than 20 for transporting. Temporary stresses induced into the members during shipping shall be within the acceptable stresses at release listed in the Department's Structures Design Guidelines.

450-2.10 Erection: Erect precast prestressed members without damage. Meet the handling and storage requirements of 450-2.8 for field operations.

Adequately brace members to resist wind forces and weight of forms and other temporary loads, especially those eccentric to the vertical axis of the members, during all stages of erection. Prior to casting diaphragms and the deck slab, do not allow the horizontal alignment of prestressed concrete beams to deviate from a straight line connecting similar points of beam ends by more than χ inch per 10 feet [1 mm/m] or 2 inch [15 mm], whichever is the least.

When concrete containing microsilica is used, precast or prestressed elements must be at least 28 days old before installation is allowed.

450-2.11 Documentation: To establish evidence of proper fabrication and quality of precast prestressed concrete members, maintain a system of records in each plant which will provide full information regarding the testing of materials, tensioning, concrete proportioning, placing and curing, and disposition of members. Include in the recordkeeping for the work specified in this specification deficiencies found from inspection and testing and the disposition of deficiencies. Keep certified test reports for materials incorporated into the production of precast prestressed concrete members, including certified physical properties reports on file. Also keep reports of tests performed on file.

Items for which certifications and/or test reports are required shall include, but are not limited to prestressing steel, reinforcing steel, concrete materials and/or concrete, curing materials and embedded items. Maintain the printout for the stressing operations and ensure they reflect the identification of the bed and members fabricated.

Include in the QCP the method and format proposed to be used for documenting necessary information. Forms as developed by the Department, the Prestressed Concrete Institute or other source may be used to document inspection and testing. Sample forms are included in Appendix VII of the Department's Manual for Quality Assurance of Precast Prestressed Concrete Members.

Maintain records until all the precast prestressed members for a project have been fabricated. Then submit the records to the Engineer. Records shall be available for inspection at any time by the Engineer and the Federal Highway Administration.

450-2.12 Measurement and Payment:

450-2.12.1 General: The work specified in this Section will be measured and paid for as shown below for the particular item involved.

Precast prestressed concrete members are acceptable to the Department for full payment when all requirements of the contract have been met. No partial payments will be made for precast prestressed concrete members until the 28-day strength requirement, along with other applicable specification requirements, have been met.

The method of payment below will be full compensation for all work and materials specified in this Section, or as otherwise required for the complete item being constructed, transported to and placed into its permanent position in the structure. Such payment will be full compensation for steel reinforcement, pretensioning steel, embedded ducts and posttensioning anchorage hardware, for posttensioning as specified, and other materials as required to fabricate the member.

450-2.12.2 Prestressed Piling (All Piling): Payment will be made at the Contract unit price per foot [meter] for the particular type of piling, measured and paid for as specified in Section 455, including the provisions for cutoffs and splices.

450-2.12.3 Prestressed Beams: Payment will be made at the Contract unit price per foot [meter] for Prestressed Beams, complete in place and accepted. Final pay lengths will be plan quantity based on casting lengths, as detailed on the plans, subject to the provisions of 9-3.2.

450-2.12.4 Prestressed Slab Units: Payment will be made at the Contract unit price per foot [meter] for the units, complete in place and accepted. Final pay lengths will be plan quantity based on casting lengths, as detailed in the plans, subject to the provisions of 9-3.2.

450-2.13 Method of Payment: Payment for the items in 450-2.12 will be made under the following:

Item No. 450- 1- Prestressed Beams - per foot.
Item No. 2450- 1- Prestressed Beams - per meter.
Item No. 450- 2- Prestressed Slab Units - per foot.
Item No. 2450- 2- Prestressed Slab Units - per meter.

SECTION 451

PRESTRESSED SOIL ANCHORS

451-1 Description.

Construct prestressed soil anchors consisting of a high strength steel tendon anchored to the retaining wall on one end and to the soil on the other end through a bulb of pressure injected portland cement concrete grout. Test each anchor by prestressing to the load indicated in the Contract Documents before locking off to the retaining wall.

Select the prestressed soil anchor type and the installation method, and determine the bond length and anchor diameter. Assume responsibility for installing prestressed soil anchors that develop the load-carrying capacity indicated on the plans in accordance with 451-7.

Provide corrosion protection for permanent prestressed soil anchors. The Engineer will not require corrosion protection for temporary prestressed soil anchors. Protect anchor tendons from corrosion as shown on the plans in accordance with 451-8.

451-2 Definitions.

(a) Anchorage Devices: The anchor head wedges or nuts which grip the prestressing steel.

(b) Bearing Plate: The steel plate which distributes the prestressed soil anchor force to the structure.

(c) Bond Length: The length of the prestressed soil anchor which is bonded to the ground and transmits the tensile force to the soil or rock. For a compression prestressed soil anchor, the bond length will be different from the tendon bond length.

(d) Design Load: The maximum anticipated load that will be applied to the prestressed soil anchor during its service life after completing stressing and testing. The design load includes appropriate load factors to ensure that the overall structure has adequate strength for its intended use.

(e) Fine-grained Soils: Soils with at least 50% of the material smaller than the No. 200 [75 μm] sieve size.

(f) Tendon: The complete anchor assembly, excluding grout, consisting of anchorage and prestressing steel with sheathing and coating when required.

(g) Coupling: The means by which the prestressing force may be transmitted from one partial-length of prestressing tendon to another.

(h) Sheathing: Enclosure around the prestressing steel to avoid temporary or permanent bond between the prestressing steel and the surrounding grout or to provide corrosion protection.

(i) Coating: Material used to protect against corrosion or lubricate the prestressing steel.

(j) Anchor Grout: Portland cement grout that is injected into the anchor hole to provide anchorage at the bond length of the tendon.

(k) Proof Load: Temporary prestressing load in an anchor at a force level greater than its design load for testing purposes.

(l) Transfer (Lock-Off) Load: Prestressing force in an anchor after proof loading immediately after the force has been transferred from the jack to the stressing anchorage.

(m) Stressing Anchorage: That portion of assembly not within the earth fill.

(n) Alignment Load: A nominal load maintained on a performance tested anchor when the anchor is unloaded. This load is left in the anchor to keep the testing equipment positioned.

(o) Performance Test: Incremental test loading and unloading of a prestressed anchor recording the movement of the tendon at each increment.

(p) Proof Test: Incremental loading of a prestressed anchor recording the movement of the tendon at each increment.

(q) Creep Test: A test to determine the movement of the tendon at constant load during a certain period of time.

(r) Lift-Off Reading: A check made to determine that the actual transfer load is within 5% of the desired transfer load. This check is made immediately after transferring the load to the stressing anchorage.

(s) Residual Movement: The non-elastic (non-recoverable) movement of an anchor measured during a performance test.

(t) Elastic Movement: The recoverable movement of an anchor measured during a performance test.

(u) Prestressed Soil Anchor: A system, referred to as a tieback or a ground anchor, used to transfer tensile loads to soil or rock. A prestressed soil anchor includes all prestressing steel, anchorage devices, bearing plates, grout, coatings, corrosion protection, sheathings and couplers if used.

(v) Minimum Specified Ultimate Tensile Strength: The minimum breaking strength of the prestressing steel as defined by the specified standard.

(w) Tendon Bond Length: The length of the tendon which is bonded to the anchor grout.

(x) Total Anchor Length: The unbonded length plus the tendon bond length.

(y) Unbonded Length (Stressing Length): The length of the tendon which is not bonded to the grout and free to elongate during stressing. The grout surrounding the unbonded length is a void filler and provides corrosion protection.

451-3 Qualifications.

The Contractor or subcontractor performing the work described in this Section shall have installed prestressed soil anchors for a minimum of five years. At the preconstruction conference, the Contractor shall submit a list containing at least five projects, completed within the last five years, where the Contractor has installed prestressed soil anchors. Include a brief description of each project and a reference for each project listed. As a minimum, include with the reference an individual's name and current phone number.

Prior to the start of work, the Contractor shall submit a list identifying his engineer, drill operators, and on-site supervisors who will be assigned to the project. Include in the list a summary of each individual's experience.

Assign a Specialty Engineer to supervise the work with at least five years of experience in the design and construction of permanently-anchored structures. Do not use consultants or manufacturers' representatives in order to meet the requirements of this Section. Provide drill operators and on-site supervisors that have a minimum of one year experience installing permanent prestressed soil anchors with the Contractor's organization.

The Engineer will approve or reject the Contractor's qualifications and staff within 15 working days after receipt of the submission. Do not start work on any prestressed soil anchor wall system or order materials until receiving approval of the these qualifications. The Engineer may suspend the prestressed soil anchor work if the Contractor or subcontractor substitutes unqualified personnel for approved personnel during construction. If work is suspended due to the substitution of unqualified personnel, the Contractor is fully liable for additional costs resulting from the suspension of work and the Department will not allow any adjustment in Contract Time resulting from the suspension of work.

451-4 Materials.

451-4.1 General: Meet the following requirements:

Concrete ....Section 346
Prestressed Construction ....Section 450
Structural Steel and Miscellaneous Metals..............................Section 460

451-4.2 Prestressing Steel: Use prestressed soil anchor tendons fabricated from single or multiple elements of one of the following prestressing steels:

(a) Steel bars meeting the requirements of AASHTO M 275.

(b) Seven-wire, low-relaxation strands meeting the requirements of AASHTO M 203.

(c) "Compact" 7-wire, low-relaxation strands meeting the requirements of ASTM A 779.

451-4.3 Anchorage Covers (not applicable for temporary anchors): Use exposed anchorage covers fabricated from steel or ductile cast iron with a minimum thickness of 0.10 inch [2.5 mm]. Ensure that the cover is securely attached to the anchorage device or bearing plate. If the cover is to be grease filled, then ensure that the cover forms a permanent watertight enclosure for the anchorage device.

451-4.4 Anchorage Devices: Use anchorage devices capable of developing 95%

of the minimum specified ultimate tensile strength of the prestressing steel tendon. Use anchorage devices that meet the static strength requirements of Section 3.1.6(1) and Section 3.1.8(1) of the Post Tensioning Institute "Guide Specification for Post-tensioning Materials". Use couplers for tendon sections capable of developing 95% of the minimum specified ultimate tensile strength.

451-4.5 Cement Grout: Use grout for anchorage consisting of a pumpable mixture of Type I, II, or III portland cement meeting the requirements of AASHTO M 85, sand, water, and admixtures. The Contractor may use admixtures which control bleed, improve flowability, reduce water content, and retard set in the grout subject to the approval of the Engineer. The Contractor may only add expansive admixtures to the grout used for filling sealed encapsulations, trumpets, and anchorage covers. Do not use accelerators. Use admixtures compatible with the prestressing steels and mixed in accordance with the manufacturer's recommendations.

Do not perform strength testing as system performance will be measured by proof-testing each anchor. The Department may require grout cube testing if the Contractor uses admixtures or irregularities occur in anchor testing. Use grout that attains a minimum cube strength of 3,400 psi [24 MPa] within seven days.

451-4.6 Bearing Plate: Use bearing plates fabricated from steel meeting the requirements of AASHTO M 183 or AASHTO M 222.

451-4.7 Bondbreaker: Use bondbreaker fabricated from a smooth plastic tube or pipe having the following properties:

(a) Resistant to chemical attack from aggressive environments, grout, or grease;

(b) Resistant to aging by ultra-violent light;

(c) Fabricated from material non-detrimental to the tendon;

(d) Capable of withstanding abrasion, impact, and bending during handling and installation;

(e) Enable the tendon to elongate during testing and stressing; and

(f) Allow the tendon to remain unbonded after lock-off.

451-4.8 Centralizers: Use centralizers fabricated from plastic, steel, or material which is nondetrimental to the prestressing steel. Do not use wood. Ensure that the centralizer is able to support the tendon in the drill hole, and position the tendon so a minimum of 0.5 inch [12.5 mm] of grout cover is provided over the tendon bond length. In addition, locate the upper centralizer a maximum of 5 feet [1.5 m] from the top of the tendon bond length, and locate the lower centralizer a maximum of 12 inches [300 mm] from the bottom of the tendon bond length. The Engineer will not require centralizers on pressure injected tendons if the Contractor installs the anchor in coarse grained soils using grouting pressures greater than 150 psi [1.0 MPa]. The Engineer will not require centralizers if the Contractor installs the anchors and grouts them through a hollow stem auger and maintains the hole full of stiff grout (slump less than 9 inches [225 mm]) during extraction of the auger.

451-4.9 Corrosion Inhibiting Grease (not applicable for temporary anchors): For corrosion inhibiting grease, meet the requirements of Section 3.2.5 of the Post Tensioning Institute Specification for Unbonded Single Strand Tendons.

451-4.10 Heat Shrinkable Tubes: Use heat shrinkable tubes fabricated from a radiation cross-linked polyolefin tube internally coated with an adhesive sealant.

Prior to shrinking, ensure that the tube has a nominal wall thickness of 24 mils [600 µm]. Ensure that the adhesive sealant inside the tube has a nominal thickness of 20 mils [500 µm].

451-4.11 Sheath (not applicable for temporary anchors): Use a sheath as part of the corrosion protection system for the unbonded length portion of the tendon fabricated from one of the following:

(a) A polyethylene tube pulled or pushed over the prestressing steel. Use polyethylene Type II, III, or IV as defined by ASTM D 1248 or approved equal, with a minimum wall thickness of 60 ∀ 10 mils [1,500 ∀ 250 µm].

(b) A hot-melt extruded polypropylene tube. Use polypropylene cell classification PP 210 B5554211 as defined by ASTM D 4101 or approved equal, with a minimum wall thickness of 60 ∀ 10 mils [1,500 ∀ 250 µm].

(c) A hot-melt extruded polyethylene tube. Use polyethylene high density Type III as defined by ASTM D 3350 and ASTM D 1248 (or approved equal), with a minimum wall thickness of 60 ∀ 10 mils [1,500 ∀ 250 µm].

(d) Steel tubing meeting the requirements of ASTM A 500, with a minimum wall thickness of 0.20 inch [5 mm].

(e) Steel pipe meeting the requirements of ASTM A 53, Schedule 40 minimum.

(f) Plastic pipe meeting the requirements of ASTM D 1785, Schedule 40 minimum.

(g) A corrugated tube meeting the requirement of the tendon bond length encapsulation.

451-4.12 Spacers: Use spacers to separate elements of a multi-element tendon and which permit grout to flow freely up the drill hole. Use spacers fabricated from plastic, steel, or material which is nondetrimental to the prestressing steel. Do not use wood. The Contractor may use a combination centralizer-spacer.

451-4.13 Tendon Bond Length Encapsulations (not applicable for temporary anchors): When the Contract Drawings require the tendon bond length to be encapsulated to provide additional corrosion protection, use encapsulation fabricated from one of the following:

(a) High density corrugated polyethylene tubing meeting the requirements of AASHTO M 252, with a minimum wall thickness of 30 mils [750 µm].

(b) Deformed steel tubing or pipes with a minimum wall thickness of 25 mils [600 µm].

(c) Corrugated, PVC tubes manufactured from rigid PVC compounds meeting the requirements of ASTM D 1784, Class 13464-B.

451-4.14 Trumpet (not applicable for temporary anchors): Use a trumpet to provide a transition from the anchorage to the unbonded length corrosion protection fabricated from a steel pipe or tube meeting the requirements of ASTM A 53 for pipe or ASTM A 500 for tubing. Use a trumpet that has a minimum wall thickness of 0.125 inch [3.175 mm] for diameters up to 4 inches [100 mm] and 0.20 inch [5 mm] for larger diameters.

451-4.15 Water: Use potable water for mixing grout.

451-4.16 Grout Tube: Use a grout tube fabricated from a high density polyethylene tube, or a PVC pipe, or a steel pipe with a 0.5 inch [12.5 mm] minimum I.D.

451-5 Tendon Fabrication.

Provide tendons that are either shop or field fabricated. Fabricate the tendon as shown on the approved Shop Drawings.

Ensure that tendons are free of dirt, rust, or any other deleterious substance. Degrease the bond length.

Handle and protect tendons, prior to installation, in a manner to avoid corrosion and physical damage. The Engineer will consider damage such as abrasion kinks, welds and weld splatters, cuts, and nicks which impair the proper performance of the tendon cause for rejection.

Sheath tendons in the stressing length to prevent contact of the anchor tendon with the drill hole wall. The Contractor may use sheathing that consists of tubes surrounding individual tendon elements or a single tube surrounding the elements altogether.

The Contractor may use sheathing material of either steel, plastic, or any other material nondetrimental to the high strength prestressing steel. The Contractor may use tape to prevent grout from entering under the sheath on individually sheathed elements.

Select the type of tendon to be used. Size the tendon so the design load does not exceed 60% of the minimum specified ultimate tensile strength of the tendon. In addition, size the tendon so the maximum test load does not exceed 80% of the minimum specified ultimate tensile strength of the tendon.

Assume responsibility for determining the bond length necessary to develop the design load indicated on the plans or the Shop Drawings. Use a minimum bond length of 10 feet [3 m] in rock and 15 feet [4.5 m] in soil. Ensure that the minimum tendon bond length is 10 feet [3 m].

451-6 Installation.

451-6.1 General:

451-6.1.1 Drilling: Core drilling, rotary drilling, percussion drilling, auger drilling, or driven casing may be used. At the ground surface, locate the drill hole within 12 inches [300 mm] of the location shown on the plans or the approved Shop Drawings. Locate the drill hole so that the longitudinal axis of the drill hole and the longitudinal axis of the tendon are parallel. In particular, do not drill the prestressed soil anchor hole in a location that requires the tendon to be bent in order to connect the bearing plate to the supported structure. At the point of entry, install the prestressed soil anchor within ∀3 degrees of the inclination from horizontal shown on the plans or the approved Shop Drawings. At the point of entry, make the horizontal angle formed by the prestressed soil anchor and the structure to within ∀3 degrees of a line drawn perpendicular to the plane of the structure unless otherwise shown on the plans or approved Shop Drawings. Do not allow the prestressed soil anchors to extend beyond the right-of-way or easement limits shown on the plans.

451-6.1.2 Tendon Insertion: Insert the tendon into the drill hole to the desired depth . When the tendon cannot be completely inserted, remove the tendon from the drill hole, and then clean or redrill the hole to permit insertion. Do not drive or force partially inserted tendons into the hole.

451-6.1.3 Installation of Trumpet and Anchorage: When corrosion protection is required, extend that portion of the corrosion protection surrounding the unbonded length of the tendon, up beyond the bottom seal of the trumpet or 12 inches [300 mm] into the trumpet if no trumpet seal is provided. If the protection does not extend beyond the seal or sufficiently far enough into the trumpet, extend the corrosion protection, or lengthen the trumpet.

When required, ensure that the corrosion protection surrounding the unbonded length of the tendon does not contact the bearing plate or the anchor head during testing and stressing. If the protection is too long, trim the corrosion protection to prevent contact.

Place the bearing plate and anchor head so the axis of the tendon is perpendicular to the bearing plate within ∀3 degrees and the axis of the tendon passes through the center of the bearing plate.

If using grout protected tendons, electrically isolate the bearing plate, anchor head, and trumpet from the surrounding concrete, soldier pile, or any metallic element embedded in the structure.

Completely fill the trumpet with corrosion inhibiting grease or grout. Trumpet grease may be placed any time during construction. Place trumpet grout after the prestressed soil anchor has been tested and stressed. Demonstrate to the Engineer that the procedures selected for placement of either grease or grout will produce a completely filled trumpet.

For permanent soil anchors, cover all anchorages permanently exposed to the atmosphere with a corrosion inhibiting grease-filled or grout-filled cover. Demonstrate to the Engineer that the procedures selected for placement of either grease or grout will produce a completely filled cover. If the plans require restressable anchorages, use corrosion inhibiting grease to fill the anchorage cover.

451-6.2 Anchor Grouting: Provide grouting equipment that produces a grout free of lumps and undispersed cement. Use a positive displacement grout pump equipped with a pressure gauge to monitor grout pressures. Ensure that the pressure gauge is capable of measuring pressures of at least 150 psi [1.0 MPa] or twice the actual grout pressures used, whichever is greater. Size the grouting equipment to enable the grout to be pumped in one continuous operation. Ensure that the mixer is capable of continuously agitating the grout.

Inject the grout from the lowest point of the drill hole. Grout may be pumped through grout tubes, casing, hollow-stem-augers, or drill rods. The grout may be placed before or after insertion of the tendon. Record the quantity of the grout and the grout pressures. Control the grout pressures and grout takes to prevent excessive heave or fracturing.

Except where indicated below, the grout may be placed above the top of the bond length at the same time as the bond length grout but may not be placed under pressure. Ensure that the grout at the top of the drill hole does not contact the back of the structure or the bottom of the trumpet.

If the prestressed soil anchor is installed in a fine-grained soil using drill holes larger than 6 inches [150 mm] in diameter, place the grout above the top of the bond length after testing and stressing the prestressed soil anchor. The Engineer will allow the entire drill hole to be grouted at the same time if it can be demonstrated that the particular prestressed soil anchor system does not derive a significant portion of its load-carrying capacity from the soil above the bond length portion of the prestressed soil anchor.

If using grout protected tendons for prestressed soil anchors anchored in rock, use pressure grouting techniques. For pressure grouting, seal the drill hole, and inject grout until a 50 psi [350 kPa] grout pressure (measured at the top of the drill hole) can be maintained on the grout for five minutes.

Upon completion of grouting, the grout tube may remain in the hole, but it must be filled with grout.

After grouting, do not load the tendon for at least three days.

Record the following data concerning the grouting operation:

(a) Type of mixer
(b) Water/cement ratio
(c) Types of additives (if any)
(d) Grout pressure
(e) Type of cement
(f) Strength test samples (if any)
(g) Volume of first and second stage grout

451-7 Prestressed Soil Anchor Testing and Stressing.

451-7.1 Criteria for Performing a Performance Test: Test each prestressed soil anchor. Perform performance tests as follows:

(a) on the first two soil anchors installed on the project prior to the grouting of any additional soil anchors. The purpose of these initial tests is to verify the Contractor's installation procedures as well as the design loads.

(b) as shown on the plans.

(c) on 10% of the prestressed soil anchors or a minimum of three, whichever is greater.

Perform creep testing as follows:

(a) as shown on the plan.
(b) on 5% of the prestressed soil anchors.

The Engineer will select the prestressed soil anchors to be performance tested and those to be creep tested and, at his discretion, may increase or decrease the number of tests.

Perform proof tests on all prestressed soil anchors, not subjected to a performance test or a creep test. Record the results of each test on forms approved by the Engineer, such as the testing forms provided in the appendix of the AASHTO/AGC/ARTBA Joint Committee Task Force 27 Report. Submit a separate form for each test. Submit the test results to the Engineer on a weekly basis within one week of testing. Do not apply a load greater than 10% of the design load to the prestressed soil anchor prior to testing. For the maximum test load, do not exceed 80% of the minimum specified ultimate tensile strength of the tendon. Simultaneously apply the test load to the entire tendon. Do not perform stressing of single elements of multi-element tendons.

Provide testing equipment that consists of:

(a) a dial gauge or vernier scale capable of measuring to 0.001 inch [25 μm] to measure the ground anchor movement. Use a movement-measuring device that has a minimum travel equal to the theoretical elastic elongation of the total anchor length at the maximum test load and that has adequate travel so the prestressed soil anchor movement can be measured without resetting the device.

(b) a hydraulic jack and pump to apply the test load. Use the jack, with a minimum ram travel of not less than the theoretical elastic elongation of the total anchor length at the maximum test load, and a calibrated pressure gauge, graduated in 100 psi [690 kPa] increments or less, to measure the applied load. Ensure that the jack and pressure gauge are calibrated by an independent firm as a unit and that the calibration is performed within 45 working days of the date submitted. Obtain the Engineer's approval of the calibration before testing commences.

(c) Keep a calibrated reference pressure gauge at the site in possession of the Engineer. Ensure that the reference gauge is calibrated with the test jack and pressure gauge.

(d) Provide an electrical resistance load cell and readout to be used when performing a creep test.

(e) Place the stressing equipment over the prestressed soil anchor tendon in such a manner that the jack, bearing plates, load cells and stressing anchorage are axially aligned with the tendon and the tendon is centered within the equipment.

451-7.2 Criteria for Performing a Performance Test and a Proof Test: Raise the load from one increment to another immediately after recording the prestressed soil anchor movement. Measure and record the prestressed soil anchor movement to the nearest 0.001 inch [25 μm] with respect to an independent fixed reference point at the alignment load and at each increment of load. Monitor the load with a pressure gauge. At load increments other than the maximum test load, hold the load just long enough to obtain the movement reading.

Hold the maximum test load in a proof test for at least ten minutes. Repump the jack as necessary in order to maintain a constant load. Start the load-hold period as soon as the maximum test load is applied, and measure and record the prestressed soil anchor movement, with respect to an independent fixed reference, at 1, 2, 3, 4, 5, 6, and 10 minutes. If the prestressed soil anchor movement between one minute and ten minutes exceeds 0.04 inch [1 mm], hold the maximum test load for an additional 50 minutes. If extending the load-hold, record the prestressed soil anchor movements at 15 minutes, 20, 25, 30, 45 and 60 minutes.

451-7.2.1 Performance Test: Place the reference pressure gauge in series with the pressure gauge during each performance test. If the load determined by the reference pressure gauge and the load determined by the pressure gauge differ by more than 10%, recalibrate the jack, pressure gauge, and reference pressure gauge at no expense to the Department.

Perform the performance test by incrementally loading and unloading the prestressed soil anchor in accordance with the following schedule:

Performance Test Schedule

Load	Load
AL	AL
0.25DL*	0.25DL
AL	0.50DL
0.25DL	0.75DL

Performance Test Schedule

Load	Load
0.50DL*	1.00DL
AL	1.20DL*
0.25DL	AL
0.50DL	0.25DL
0.75DL*	0.50DL
AL	0.75DL
0.25DL	1.00DL
0.50DL	1.20DL
0.75DL	1.33DL*
1.00DL*	Reduce to lock-off load

AL - is the alignment load.
DL - is the prestressed soil anchor design load.

Plot the prestressed soil anchor movement versus load for each load increment marked with an asterisk (*) in the performance test schedule, and plot the residual movement of the tendon at each alignment load versus the highest previously applied load.

451-7.2.2 Proof Test: Perform the proof test by incrementally loading the prestressed soil anchor in accordance with the following schedule:

Proof Test Schedule

Load	Load
AL	1.00DL
0.25DL	1.20DL
0.50DL	1.33DL
0.75DL	Reduce to lock-off load

Compare the proof test results to the performance test results. If there is any significant variation from the performance test results, perform a performance test on the next anchor.

Plot the prestressed soil anchor movement versus load for each load increment in the proof test.

451-7.3 Criteria for Performing a Creep Test: Perform the creep test by incrementally loading and unloading the prestressed soil anchor in accordance with the performance test schedule given above. At the end of each loading cycle, hold the load constant for the observation period indicated in the creep test schedule below. Use the following times for reading and recording the prestressed soil anchor movement during each observation period: 1, 2, 3, 4, 5, 6, 10, 15, 20, 25, 30, 45, 60, 75, 90, 100, 120, 150, 180, 210, 240, 270, and 300 minutes as appropriate. Start each load-hold period as soon as applying the test load. In a creep test, use the pressure gauge and reference pressure gauge to measure the applied load, and use the load cell to monitor small changes in load during a constant load-hold period. Repump the jack as necessary in order to maintain a constant load.

Plot the prestressed soil anchor movement and the residual movement measured in a creep test as described for the performance test above, and plot the creep movement for each load-hold as a function of the logarithm of time.

Creep Test Schedule

Load	Observation Period (minutes.)
AL	
0.25DL	10
0.50DL	30
0.75DL	30
1.00DL	45
1.20AL	60
1.33DL	300

451-7.4 Lock-Off: Upon satisfactory completion of all testing, reduce the load to the lock-off load, and transfer the load to the anchorage device. Use a lock-off load that is 80% of the prestressed soil anchor design load. The Contractor may completely unload the prestressed soil anchor prior to lock-off. After transferring the load and prior to removing the jack, take a lift-off reading. Use a lift-off reading that is within 10% of the specified lock-off load. If the load is not within 10% of the specified lock-off load, reset the anchorage, and take another lift-off reading. Repeat this process until obtaining the desired lock-off load.

451-7.5 Cutting of Tendon Protrusions: After an anchor has been accepted by the Engineer, saw cut the portion of the anchor tendon extending beyond the anchorage. Take care not to damage the tendon or the tendon anchorage.

451-7.6 Prestressed Soil Anchor Load Test Acceptance Criteria: The Engineer will accept a performance or proof-tested prestressed soil anchor with a ten minute load hold if the:

(a) prestressed soil anchor carries the maximum test load with less than 0.04 inch [1 mm] of movement between one minute and ten minutes; and

(b) total movement at the maximum test load exceeds 80% of the theoretical elastic elongation of the unbonded length.

The Engineer will accept a performance or proof-tested prestressed soil anchor with a 60 minute load hold if the:

(a) prestressed soil anchor carries the maximum test load with a creep rate that does not exceed 0.08 inch/log cycle of time [2 mm/log cycle of time]; and

(b) total movement at the maximum test load exceeds 80% of the theoretical elastic elongation of the unbonded length.

The Engineer will accept a creep tested prestressed soil anchor if the:

(a) prestressed soil anchor carries the maximum test load with a creep rate that does not exceed 0.08 inch/log cycle of time [2 mm/log cycle of time]; and

(b) total movement at the maximum test load exceeds 80% of the theoretical elastic elongation of the unbonded length.

If the total movement of the prestressed soil anchors at the maximum test load does not exceed 80% of the theoretical elastic elongation of the unbonded length, replace the prestressed soil anchor at no cost to the Department.

Incorporate prestressed soil anchors which have a creep rate greater than 0.08 inch/log cycle of time [2 mm/log cycle of time] in the finished work at a load equal to one-half its failure load. The failure load is the load carried by the prestressed soil anchor after the load has been allowed to stabilize for ten minutes.

When a prestressed soil anchor does not satisfy the load test acceptance criteria, the Contractor may modify the design and/or the construction procedures. These modifications may include, but are not limited to, installing replacement prestressed soil anchors, reducing the design load by increasing the number of prestressed soil anchors, modifying the installation methods, increasing the bond length or changing the prestressed soil anchor type. Obtain the Engineer's approval prior to making any modification which requires changes to the structure. Perform any modifications at no additional cost to the Department. The Department will not allow additional Contract Time for modifications. The Engineer will not allow retesting of the failed prestressed soil anchor.

451-8 Corrosion Protection (not applicable for temporary anchors).

451-8.1 General: Protect prestressed soil anchors against corrosion using materials and procedures described herein. The following materials may be used independently or in various combinations:

(a) Portland cement grout.
(b) Plastic pipe or tubing.
(c) Steel pipe or tubing.
(d) Greases specially compounded for post-tensioning.
(e) Bitumens.
(f) Heat shrinkable polyethylene tubing.

Use corrosion protection materials with properties that are not detrimental to the prestressing steel and that prevent the intrusion of corrosive environments. Use coating materials that also have the following properties:

(a) Free from cracks and not brittle or fluid over the entire anticipated range of temperature.
(b) Chemically stable for the life of the tendon.
(c) Nonreactive with the surrounding materials such as concrete, tendons, or sheathing.
(d) Corrosion-inhibiting.
(e) Impervious to moisture.

When acidic water can enter the bore hole during the period subsequent to the drilling and flushing operation and prior to tendon insertion and grouting, introduce chemical additives for neutralizing purposes. A minimum pH of 9.0 is generally considered acceptable when the prestressing steel is in contact with this water. During prolonged periods, monitor the pH at regular intervals, and add additional neutralization as required. Concentrated sodium hydroxide and calcium hydroxide have proven effective for this purpose.

451-8.2 Protection Systems:

451-8.2.1 Bond Length:

(a) When the plans require grout protected prestressed soil anchor tendons, meet the following requirements:

1. Provide corrosion protection of the tendon bond length by the

cement grout cover.

2. Use spacers along the tendon bond length of multi-element tendons to separate each of the individual elements of the tendon so the prestressing steel will bond to the grout. Position spacers so their center to center spacing does not exceed 10 feet [3 m]. In addition, locate the upper spacer a maximum of 5 feet [1.5 m] from the top of the tendon bond length, and locate the lower spacer a maximum of 5 feet [1.5 m] from the bottom of the tendon bond length.

3. Use centralizers to ensure a minimum of 0.5 inch [12.5 mm] of grout cover over the tendon bond length. Position centralizers so their center to center spacing does not exceed 10 feet [3 m]. In addition, locate the upper centralizer a maximum of 5 feet [1.5 m] from the top of the tendon bond length, and locate the lower centralizer a maximum of 12 inches [300 mm] from the bottom of the tendon bond length.

4. The Engineer will not require centralizers on pressure-injected prestressed soil anchor tendons if the prestressed soil anchor is installed in coarse-grained soils using grouting pressures greater than 150 psi [1.0 MPa].

5. The Engineer will not require centralizers on hollow-stem-augured prestressed soil anchor tendons if the prestressed soil anchor is grouted through the auger and the hole is maintained full of a stiff grout, (9 inch [225 mm] slump or less) during extraction of the auger.

(b) When the plans require the tendon bond length to be encapsulated:

1. Protect the tendon bond length portion of the tendon against corrosion by encapsulating the tendon in a grout-filled corrugated plastic or deformed steel tube. Grout the tendon inside the encapsulation prior to inserting the tendon in the drill hole or after the tendon has been placed in the drill hole. Mix expansive admixtures with the encapsulation grout if the tendon is grouted inside the encapsulation prior to inserting it in the drill hole. Centralize the tendon within the tendon bond length encapsulation with a minimum of 0.10 inch [2.5 mm] of grout cover. Use spacers along the tendon bond length of multi-element tendons to separate the elements of the tendon so the prestressing steel will bond to the encapsulation grout.

2. Use centralizers to provide a minimum of 0.5 inch [12.5 mm] of grout cover over the tendon bond length encapsulation. Position centralizers so their center to center spacing does not exceed 10 feet [3 m]. In addition, locate the upper centralizer a maximum of 5 feet [1.5 m] from the top of the tendon bond length, and locate the lower centralizer a maximum of 12 inches [300 mm] from the bottom of the tendon bond length.

3. The Engineer will not require centralizers on encapsulated, pressure-injected prestressed soil anchor tendons if the prestressed soil anchor is installed in coarse-grained soils using grouting pressures greater than 150 psi [1.0 MPa].

4. The Engineer will not require centralizers on encapsulated, hollow-stem-augured prestressed soil anchor tendons if the prestressed soil anchor is grouted through the auger and the hole is maintained full of a stiff grout (9 inch [225 mm] slump or less) during extraction of the auger.

451-8.2.2 Unbonded Length: For the minimum unbonded length of the tendon, use 15 feet [4.5 m] or as indicated on the plans or the approved Shop

Drawings, whichever is greater.

If grouting the entire drill hole (tendon bond length and unbonded length) in one operation, provide the corrosion protection of the unbonded length by a sheath completely filled with corrosion inhibiting grease or grout, or a heat shrinkable tube internally coated with an elastic adhesive. If using grease under the sheath, make provisions to prevent the grease from escaping at the ends of the sheath. With grease, completely coat the tendon, fill the void between the tendon and the sheath, and fill the interstices between the wires of the seven-wire strands. Ensure that the Shop Drawings show how to provide a transition between the bond length and the unbonded length corrosion protection. If the sheath is grout filled, provide a separate bondbreaker that prevents the tendon from bonding to the grout surrounding the unbonded length.

If providing grease-filled sheath corrosion protection and the drill hole above the bond length is grouted after locking off the prestressed soil anchor, grout the tendon inside a second sheath.

451-8.2.3 Anchorage and Trumpet: Use non-restressable anchorage devices except where indicated on the plans. Provide restressable anchorages on those prestressed soil anchors designated as restressable on the plans. Ensure that the post-tensioning supplier provides a restressable anchorage compatible with the post-tensioning system provided along with written recommendations concerning the restressing of the tendons.

If using strand tendons, provide written recommendations from the post-tensioning supplier for seating the wedges. Include with the recommendations the minimum load required to properly seat the wedges in the anchor head.

Size the bearing plates so that:

(a) the bending stresses in the plate do not exceed the yield strength of the steel when applying a load equal to 95% of the minimum specified ultimate tensile strength of the tendon; and

(b) the average bearing stress on the concrete does not exceed that recommended in Section 3.1.7 of the Post Tensioning Institute Guide Specification for Post-Tensioning Materials.

Weld the trumpet to the bearing plate. Provide a trumpet that has an inside diameter equal to or larger than the hole in the bearing plate. Ensure that the trumpet is long enough to accommodate movements of the structure during testing and stressing. For strand tendons with encapsulation over the unbonded length, provide a trumpet that is long enough to enable the tendon to make a transition from the diameter of the tendon in the unbonded length to the diameter of the tendon at the anchor head without damaging the encapsulation. Ensure that trumpets filled with corrosion-inhibiting grease have a permanent Buna-N synthetic rubber or approved equal seal provided between the trumpet and the unbonded length corrosion protection. Ensure that trumpets filled with grout have a temporary seal provided between the trumpet and the unbonded length corrosion protection or that the trumpet overlaps the unbonded length corrosion protection by a minimum of 12 inches [300 mm] and fits tightly over the unbonded length corrosion protection.

451-9 Submittals.

Prepare and submit to the Engineer for review and approval Shop Drawings and a design submission describing the prestressed soil anchor system or systems intended for use. Submit the Shop Drawings and design submission 30 working days prior to the commencement of the prestressed soil anchor work. Include the following in the Shop Drawings and design submission:

(a) A prestressed soil anchor schedule giving:

1. Prestressed soil anchor number;
2. Prestressed soil anchor design load;
3. Type and size of tendon;
4. Minimum total anchor length;
5. Minimum bond length;
6. Minimum tendon bond length; and
7. Minimum unbonded length.

(b) A drawing of the prestressed soil anchor tendon and the corrosion protection system. Include details for the following:

1. Spacers and their location;
2. Centralizers and their location;
3. Unbonded length corrosion protection system;
4. Bond length corrosion protection system;
5. Anchorage and trumpet; and
6. Anchorage corrosion protection system.

(c) Certificates of Compliance for the following materials, if used, stating that the material or assemblies to be provided will fully comply with the requirements of the Contract.

1. Prestressing steel, strand or bar;
2. Portland cement;
3. Prestressing hardware;
4. Bearing plates; and
5. Corrosion protection system.

The Engineer will approve or reject the Shop Drawings and design submission within 30 working days after receipt of the submission.

Submit to the Engineer for review and approval or rejection mill test reports for the prestressing steel and the bearing plate steel. The Engineer may require the Contractor to provide samples of any prestressed soil anchor material intended for use on the project. The Engineer will approve or reject the prestressing steel and bearing plate steel within five working days after receipt of the test reports. Do not incorporate the prestressing steel and bearing plates in the work without the Engineer's approval.

Submit to the Engineer for review and approval or rejection calibration data for each test jack, pressure gauge, and reference pressure gauge to be used. The Engineer will approve or reject the calibration data within fiveworking days after receipt of the data. Do not commence testing until the Engineer has approved the jack, pressure gauge, and reference pressure gauge calibrations.

Submit to the Engineer within 20 calendar days after completion of the prestressed soil anchor work a report containing:

(a) Prestressing steel manufacturer's mill test reports for the tendons incorporated in the installation;

(b) grouting records indicating the cement type, quantity injected, and the grout pressures; and

(c) prestressed soil anchors test results and graphs.

451-10 Tendon Storage and Handling.

Handle and store tendons in a manner to avoid damage or corrosion. The Engineer will consider damage to the prestressing steel as a result of abrasions, cuts, nicks, welds and weld splatter cause for rejection. Protect the prestressing steel if performing welding in the vicinity. Do not ground welding leads to the prestressing steel. Protect prestressing steel from dirt, rust, or deleterious substances.

The Engineer will allow a light coating of rust on the steel. If heavy corrosion or pitting is noted, the Engineer will reject the affected tendons.

Use care in handling and storing the tendons at the site. Prior to inserting a tendon in the drill hole, examine the tendon for damage to the encapsulation and the sheathing. If, in the opinion of the Engineer, the encapsulation is damaged, repair the encapsulation in accordance with the tendon supplier's recommendations. If, in the opinion of the Engineer, the smooth sheathing has been damaged, repair it with ultra high molecular weight polyethylene tape. Spiral wind the tape around the tendon to completely seal the damaged area at a pitch that ensures a double thickness at all points.

451-11 Method of Measurement.

Unless otherwise shown on the plans, the quantity to be paid for will be the number of prestressed soil anchors, installed and accepted. For prestressed soil anchors that do not meet the acceptance criteria, the original prestressed soil anchor and any required additional work or prestressed soil anchors will be, in sum, considered to be one prestressed soil anchor for payment purposes.

451-12 Basis of Payment.

Prices and payments will be full compensation for all work specified in this Section, including furnishing the materials necessary to complete the anchors in place and accepted. The quantity of performance and creep tests to be paid for will be the number of tests performed on accepted anchors.

The cost of proof testing will be included in Item No. 451-70 [2451-70].

No payment will be made for tests performed on unaccepted anchors.

Payment will be made under:

Item No. 451-70- Prestressed Soil Anchors - each.
Item No. 2451-70- Prestressed Soil Anchors - each.
Item No. 451-70-1 Prestressed Soil Anchor (Performance Tests) - each.
Item No. 2451-70-1 Prestressed Soil Anchor (Performance Tests) - each.
Item No. 451-70-2 Prestressed Soil Anchors (Creep Tests) - each.
Item No. 2451-70-2 Prestressed Soil Anchors (Creep Tests) - each.

SECTION 455

STRUCTURES FOUNDATIONS

Index

A. GENERAL

455-1 General Requirement.

The Contractor may examine available soil samples and/or rock cores obtained during the soil boring operations at the appropriate District Materials Office.

455-1.1 Protection of Existing Structures: When the plans require foundation construction operations in close proximity to existing structures, take all reasonable precautions to prevent damage to such structures. The requirements described herein apply to all types of structures (on or off the right-of-way) that may be adversely affected by foundation construction operations (including phase construction) due to vibrations, ground loss, ground heave, or dewatering. Protect utilities as described in 7-11.6.

Monitor structures for settlement in a manner approved by the Engineer, recording elevations to 0.001 foot [0.5 mm]. Monitor the following structures:

(1) shown in the plans.

(2) within a distance, in feet, of pile driving operations equal to 0.5 times the square root of the hammer energy, in foot-pounds [in meters, of pile driving operations equal to 4.14 times the square root of the hammer energy, in kilojoules]. Take required measurements before the initiation of driving and then daily on days when driving occurs or as indicated in the plans and weekly for two weeks after driving has stopped.

(3) within a distance of ten shaft diameters or the estimated depth of excavation, whichever is greater.

(4) within a distance of three times the depth of excavation for the footing.

Obtain the Engineer's approval of the number and location of monitoring points. Take elevation;

(1) before beginning construction,

(2) daily during the driving of any casings, piling, or sheeting,

(3) weekly for two weeks after stopping driving,

(4) during excavation,

(5) during blasting,

(6) or as directed by the Engineer.

Notify the Engineer of any movements detected and immediately take any remedial measures required to prevent damage to the existing structures.

Except as noted herein, employ a qualified Specialty Engineer to survey all structures, or portions thereof, within:

(1) a distance, in feet, of pile driving operations equal to 0.25 times the square root of the hammer energy, in foot-pounds [in meters, of pile driving operations equal to 2.07 times the square root of the hammer energy, in kilojoules]

(2) a distance of ten shaft diameters or the estimated depth of excavation, whichever is greater

(3) three times the excavation depth

(4) or as shown in the plans

The Department will make the necessary arrangements to provide right-of-way entry for the Contractor's engineer to survey. Adequately document the condition of the structures and all existing cracks with descriptions and pictures. Prepare two reports documenting the condition of the structures: one report before beginning foundation construction operations and a second report after completing foundation construction operations. The Department will take ownership of both reports. Do not perform pre-driving and post-driving surveys of the condition of bridges owned by the Department except when shown in the Contract Documents.

When shown in the Contract Documents, employ a qualified Specialty Engineer to monitor and record vibration levels during the driving of casings, piling, sheeting, or blasting operations. Provide vibration monitoring equipment capable of detecting velocities of 0.1 in/s [2.5 mm/s] or less.

Upon detecting settlement of 0.005 foot [1.5 mm], vibration levels reaching 0.5 in/s [13 mm/s], levels otherwise shown in the Contract Documents, or damage to the structure, immediately stop the source of vibrations, backfill any open drilled shaft excavations, and contact the Engineer for instructions.

When the plans require excavations for construction of footings or caps, the Contractor is responsible for evaluating the need for, design of, and providing any necessary features to protect adjacent structures. Construct sheeting and shoring as detailed in the plans. When sheeting and shoring are not detailed in the plans, employ a Specialty Engineer to design the sheeting and shoring, and to sign and seal the plans and specification requirements. Send these designs to the Engineer for his record before beginning construction.

Also, when shown in the Contract Documents or when authorized by the Engineer, install the piling to the depth required to minimize the effects of vibrations or ground heave on adjacent structures by approved methods other than driving (preformed holes, predrilling, jetting, etc.). In the event the Department authorizes the use of preformed pile holes to meet this requirement, the Department will pay for this work as described in 455-5.9.3

Do not drive piles within 200 feet [60 m] of concrete less than two days old unless authorized by the Engineer.

Also if not otherwise provided in the plans, the Contractor is responsible for evaluating the need for, design of, and providing all reasonable precautionary features to prevent damage, including, but not limited to, selecting construction methods and procedures that will prevent damaging caving of the shaft excavation and monitoring and controlling the vibrations from construction activities, including driving of casings, driving of sheeting, and blasting.

When shown in the plans or directed by the Engineer, install a piezometer near the right-of-way line and near any structure that may be affected by lowering the ground water when dewatering is required. Monitor the piezometer and record the ground water elevation level daily. Notify the Engineer of any ground water lowering near the structure of 12 inches [300 mm] or more.

455-1.2 Excavation: Complete all excavation of the foundations prior to installing piles or shafts unless otherwise authorized by the Engineer. After completing pile/shaft installation, remove all loose and displaced materials from around the piles/shafts, leaving a clean, solid surface. Compact the soil surface on which concrete is to be placed or which will support the forming system for the concrete to a density not less than 90% of the maximum density as determined by AASHTO T 180, and which will support the load of the plastic concrete without settling or causing the concrete to crack, or as shown in the Contract Documents. The Engineer will not require the Contractor to compact for excavations made below water for seals or when the footing or cap or forming system (including supports) does not rest on the ground surface.

455-1.2.1 Abutment (End Bent) Fill: Place and compact the fill before installing end-bent piling/shafts, except when:

(1) driving specified test piling in end bents or,

(2) the plans show uncased piles through proprietary retaining wall fills. When installing piles/shafts or casing prior to placing fill, take necessary precautions to prevent displacement of piles/shafts during placing and compacting fill materials within 15 feet [4.5 m] of the piles/shafts or casing. Reference and check the position of the piles/shafts or casing at three approximately equal intervals during construction of the embankment.

Place embankment material in 6 inch [150 mm] loose lifts in the 15 foot [4.5 m] area around the piles/shafts or casing. Compact embankment material within the 15 foot [4.5 m] area adjacent to the piles/shafts or casing to the required density with compaction equipment weighing less than 1,000 pounds [450 kg]. When installing piles/shafts prior to the completion of the surrounding fills, do not cap them until placing the fills as near to final grade as possible, leaving only the necessary working room for construction of the caps.

Provide permanent casings for all drilled shafts through mechanically stabilized fills (for example, behind proprietary retaining walls). Provide permanent casings for conventional fills 15 foot [4.5 m] or greater in height except when shown otherwise in the plans. Do not provide permanent casings for conventional fills less than 15 foot [4.5 m] in height except when shown in the plans or when directed by the Engineer. Install temporary casings through the completed conventional fill when permanent casings are not required.

Provide permanent casings, if required, before the fill is placed extending a sufficient distance into the existing ground to provide stability to the casings during construction of the abutment fill.

455-1.3 Cofferdams: Construct cofferdams as detailed in the plans. When cofferdams are not detailed in the plans, employ a Specialty Engineer to design cofferdams, and to sign and seal the plans and specification requirements. Send the designs to the Engineer for his records before beginning construction.

Provide a qualified diver and a safety diver to inspect the conditions of the foundation enclosure or cofferdam when the Contract Documents require a seal for construction. Equip these divers with suitable voice communications, and have them inspect the foundation enclosure and cofferdam periphery including each sheeting indentation and around each piling or drilled shaft to ensure that no layers of mud or other undesirable materials were left above the bottom of seal elevation during the excavation process. Also have the divers check to make sure the surfaces of the piles or drilled shafts are sufficiently clean to allow bond of the concrete down to the minimum bottom of seal elevation. When required, ensure that there are no mounds of stone, shell, or other authorized backfill material left after placement and grading. Assist the Engineer as required to ensure that the seal is placed as specified and evaluate the adequacy of the foundation soils or rock. Correct any deficiencies found by the divers. Upon completion of inspection by the divers, the Department may also elect to inspect the work before authorizing the Contractor to proceed with subsequent construction operations. Furnish the Engineer a written report by the divers indicating the results of their underwater inspection before requesting authorization to place the seal concrete.

455-2 Static Compression Load Tests.

455-2.1 General: Employ a professional testing laboratory, or Specialty Engineer with prior load test experience, to conduct the load test in compliance with these Specifications, to record all data, and to furnish reports of the test results to the Engineer except when the Contract Documents show that the Department will supply a Geotechnical Engineer to provide these services.

Use a load for the test that is three times the design load, the maximum load shown in the plans or as designated by the Engineer (within the limits of the test equipment provided), or the failure load, whichever occurs first.

Do not apply test loads to piles sooner than 48 hours (or the time interval shown in the plans) after driving of the test pile or reaction piles, whichever occurs last.

Allow up to four weeks after the last load test for the analysis of the load test data and to provide all the estimated production drilled shaft tip elevations. If the Contractor is willing to construct production shafts in areas designated by the Engineer, he shall set shaft tip elevations as required to keep him working, beginning one week after the final load test.

Do not begin static load testing of drilled shafts until the concrete has attained a compressive strength of 3,400 psi [23.5 MPa]. The Contractor may use high early strength concrete to obtain this strength at an earlier time to prevent testing delays.

Load test piles/shafts in the order directed by the Engineer. The Department will furnish certain load test equipment and/or personnel when shown in the plans. Inspect all equipment to be furnished by the Department at least 30 days prior to use, and notify the Engineer of any equipment that is not in satisfactory operating condition. The Department will consider any necessary repairs ordered by the Engineer to place the equipment in satisfactory operating condition as Unforeseeable Work. Provide the remainder of the equipment and personnel needed to conduct the load tests. Unless shown otherwise in the Contract Documents, provide all equipment, materials, labor, and technical personnel required to conduct the load tests, including determination of anchor reaction member depths. In this case, provide a loading apparatus designed to accommodate the maximum load plus an adequate safety factor.

While performing the load test, provide safety equipment, and employ safety procedures consistent with the latest approved practices for this work. Include with these safety procedures adequate support for the load test plates and jack to prevent them from falling in the event of a release of load due to hydraulic failure, test shaft failure, or any other cause.

Include in the bid the cost of transporting load test equipment and instrumentation supplied by the Department from their storage location to the job site and back. Handle these items with care. The Contractor is responsible for the safe return of these items. After completion of the static load tests, return all Department furnished equipment in satisfactory operating condition. Repair all damage to the test equipment furnished by the Department to the satisfaction of the Engineer. Clean all areas of rust on structural steel items, and repaint those areas in accordance with Section 561. Return all load test equipment supplied by the Department within 30 days after completing the load tests.

The Contractor is responsible for the equipment from the time it leaves its storage area until the time it is returned. During this time, insure the equipment against loss or damage for the replacement cost thereof (the greater of $150,000 or the amount shown in the plans) or for the full insurable value if replacement cost insurance is not available.

Notify the Engineer at the preconstruction conference or no later than 30 days before beginning test pile installation of the proposed testing schedule so that items supplied by the Department may be reserved. Notify the Department at least ten working days before pick-up or return of the equipment. During pick-up, the Department will complete a checklist of all equipment placed in the Contractor's possession. The Department will later use this checklist to verify that the Contractor has returned all equipment. Provide personnel and equipment to load or unload the equipment at the Department's storage location. Provide lifting tongs or nylon slings to handle Department owned test girders. Do not perform cutting, welding, or drilling on Department owned girders, jacks, load cells, or other equipment.

455-2.2 Loading Apparatus: Provide an apparatus for applying the vertical loads as described in one of the following:

(1) As shown and described in the Contract Documents.

(2) As supplied by the Contractor, one of the following devices designed to accommodate a load at least 20% higher than that shown in the Contract Documents or described herein for test loads:

(a) Load Applied by Hydraulic Jack Acting Against Weighted Box or

Platform: Construct a test box or test platform, resting on a suitable support, over the pile, and load it with earth, sand, concrete, pig iron, or other suitable material with a total weight greater than the anticipated maximum test load. Locate supports for the weighted box or platform at least 6 feet [2 m] or three pile/shaft diameters, whichever is greater, measured from the edge of the pile or shaft to the edge of the supports. Insert a hydraulic jack with pressure gauge between the test pile or shaft and the underside of the reaction beam, and apply the load to the pile or shaft by operating the jack between the reaction beam and the top of the pile or shaft.

(b) Load Applied to the Test Pile or Shaft by Hydraulic Jack Acting Against Anchored Reaction Member: Construct reaction member anchorages as far from the test piles/shafts as practical, but in no case closer than the greater of 3 pile/shaft diameters or 6 feet [2 m] from the edge of the test pile/shaft. Attach a girder(s) of sufficient strength to act as a reaction beam to the upper ends of the anchor piles or shafts. Insert a hydraulic jack with pressure gauges between the head of the test pile/shaft and the underside of the reaction beam, and apply the test load to the pile/shaft by operating the jack between the reaction beam and the pile/shaft head.

If using drilled shafts with bells as reaction member anchorages, locate the top of the bell of any reaction shaft anchorage at least three shaft diameters below the bottom of the test shaft.

(c) Combination Devices: The Contractor may use a combination of devices (a) and (b), as described above, to apply the test load to the pile or shaft.

(d) Other Systems Proposed by the Contractor and Approved by the Engineer: When necessary, provide horizontal supports for loading the pile/shaft, and space them so that the ratio of the unsupported length to the minimum radius of gyration of the pile does not exceed 120 for steel piles, and the unsupported length to the least cross-section dimension does not exceed 20 for concrete piles or drilled shafts. Ensure that horizontal supports provide full support without restraining the vertical movement of the pile in any way.

When required by the Contract Documents, apply a horizontal load to the shaft either separately or in conjunction with the vertical load. Apply the load to the test shaft by hydraulic jacks, jacking against Contractor provided reaction devices. After receiving the Engineer's approval of the proposed method of load application, apply the horizontal load in increments, and relieve it in decrements as required by the Contract Documents.

455-2.2.1 Modified Quick Test:

(a) Loading Procedure - Piles: Place the load on the pile continuously, in increments equal to approximately 5% of the maximum test load specified until approaching the failure load, as indicated by the measuring apparatus and/or instruments. Then, apply increments of approximately 2.5% until the pile "plunges" or attains the limiting load. The Engineer may elect to stop the loading increments when he determines the Contractor has met the failure criteria or when a settlement equal to 10% of the pile width or diameter is reached. Apply each load increment immediately after taking and verifying the complete set of readings from all gauges and instruments. Apply each increment of load within the minimum length of time practical, and immediately take the readings. Complete the addition of a load increment and the completion of the readings within five to 15 minutes. The

Engineer may elect to hold the maximum applied load up to one hour.

Remove the load in decrements of about 10% of the maximum test load. Remove each decrement of load within the minimum length of time practical, and immediately take the readings. Complete the removal of a load decrement and the taking of the readings within five to 15 minutes. The Engineer may also require up to two reloading cycles with five loading increments and three unloading decrements. Record the final recovery of the pile until movement is essentially complete for a period up to one hour after the last unload interval.

(b) Failure Criteria and Safe-Load: Use the criteria described herein to establish the failure load. The failure load is defined as the load that causes a pile top deflection equal to the calculated elastic compression plus 0.15 inch [3.8 mm] plus 1/120 of the pile minimum width or the diameter in inches [millimeters] for piles 24 inches [610 mm] or less in width, and equal to the calculated elastic compression plus 1/30 of the pile minimum width or diameter for piles greater than 24 inches [610 mm] in width. Consider the safe allowable load of any pile so tested as either 50% of the maximum applied load or 50% of the failure load, whichever is smaller.

455-2.2.2 Loading Procedure - Shafts: Apply vertical loads concentric with the longitudinal axis of the tested shaft to accurately determine and control the load acting on the shaft at any time.

Place the load on the shaft continuously in increments equal to approximately 5% of the maximum test load specified until approaching the failure load, as indicated by the instruments. Then, apply increments of approximately 2.5% until the shaft "plunges" or attains the limiting load. The Engineer may elect to stop the loading increments when he determines that the failure criteria has been met or a settlement equal to 10% of the shaft width is reached. Apply each load increment immediately after taking and verifying the complete set of readings from all gauges and instruments. Apply each increment of load within the minimum length of time practical, and immediately take the instrument system readings. Complete the addition of a load increment and the taking of the instrument system readings within five to fifteen minutes. The Engineer may elect to hold the maximum applied load up to one hour.

Remove the load in decrements of about 10% of the maximum test load. Remove each decrement of load within the minimum length of time practical and take the instrument system readings immediately. Complete the removal of a load decrement and the taking of the instrument system readings within five to fifteen minutes. The Engineer may also require up to two reloading cycles with five loading increments and three unloading decrements. Record the final recovery of the shaft until movement is essentially complete for a period up to one hour after the last unload interval.

Use the criteria described herein to establish the failure load unless shown otherwise in the Contract Documents. The failure load is defined as follows:

(1) for shafts with diameters up to 24 inches [610 mm], the load that causes a shaft top deflection equal to the calculated elastic compression, plus 0.15 inch [4 mm], plus 1/120 of the shaft diameter in feet [millimeters],

(2) for shafts with diameters larger than 24 inches [610 mm], the load that causes a shaft top deflection equal to the calculated elastic compression, plus 1/30 of the shaft diameter.

Consider the safe allowable load of any shaft so tested as either 50% of the maximum applied load or 50% of the failure load, whichever is smaller.

455-2.3 Measuring Apparatus: Provide an apparatus for measuring movement of the test piles/shafts that consists of all of the following devices:

(1) Wire Line and Scale: Stretch a wire as directed by the Engineer between two supports located at a distance at least:

(a) 10 feet [3 m] from the center of the test pile but not less than 3.5 times the pile diameter or width.

(b) 12 feet [3.7 m] from the centerline of the shaft to be tested but not less than three shaft diameters.

Locate the wire supports as far as practical from reaction beam anchorages. At over-water test sites, the Contractor may attach the wire line as directed by the Engineer to the sides of the service platform. Mount the wire with a pulley on one support and a weight at the end of the wire to provide constant tension on the wire. Ensure that the wire passes across the face of a scale mounted on a mirror attached to the test pile/shaft so that readings can be made directly from the scale. Use the scale readings as a check on an average of the dial readings. When measuring both horizontal and vertical movement, mount separate wires to indicate each movement, horizontal or vertical. Measure horizontal movements from two reference wires set normal to each other in a horizontal.

(2) Wooden Reference Beams And Dial Gauges: Attach wooden reference beams as detailed in the plans or approved by the Engineer to independent supports. For piles, install the greater of 3.5 times the pile diameter or width or 10 feet [3 m] from the centerline of the test pile. For drilled shafts install the greater of three shaft diameters or 12 feet [3.7 m] from the centerline of the shaft to be tested. Locate the reference beam supports as far as practical from reaction beam anchorages. For over-water test sites, the Contractor may attach the reference beams as directed by the Engineer between two diagonal platform supports. Attach dial gauges, with their stems resting either on the top of the pile/shaft or on lugs or similar reference points on the pile/shaft, to the fixed beams to record the movement of the pile/shaft head. Ensure that the area on the pile/shaft or lug on which the stem bears is a smooth surface which will not cause irregularities in the dial readings.

For piles, the minimum acceptable method for measuring vertical movement is two dial gauges, each with 0.001 inch [0.025 mm] divisions and with 2 inch [50 mm] minimum travel, placed at 180 degrees or at the diagonal corners of the pile.

For shafts, ensure that three dial gauges, each with 0.001 inch [0.025 mm] divisions and with 2 inch [50 mm] minimum travel, placed at 120-degree intervals around the shaft, are the minimum acceptable method for measuring vertical movement. Ensure that four dial gauges, each with 0.001 inch [0.025 mm] divisions and with 2 inch [50 mm] minimum travel, placed at 90 degree intervals are the minimum required for measuring horizontal movement.

(3) Survey Level: As a check on the dial gauges, determine the elevation of a point near the top of the test pile/shaft (on plan datum) by survey level at each load and unload interval during the load test. Unless approved otherwise by the Engineer, level survey precision is 0.001 foot [0.3 mm]. Alternately, the surveyor may read an engineer's 50 scale attached near the pile/shaft head. Determine the first elevation

before applying the first load increment; make intermediate readings immediately before a load increment or an unload decrement, and after the final unload decrement that completely removes the load. Make a final reading at the time of the last recovery reading or as directed by the Engineer.

For over-water test sites, when shown in the plans or directed by the Engineer, the Contractor shall drive an H pile through a 36 inch [914 mm] casing to provide a stable support for the level and to protect it against wave action interfering with level measurements. Provide a suitable movable jig for the surveyor to stand. Use a jig that has a minimum of three legs, has a work platform providing at least 4 feet [1.2 m] width of work area around the casing, and is approved by the Engineer before use. The described work platform may be supported by the protective casing when approved by the Engineer.

455-2.4 Load Test Instrumentation:

(1) General: The intent of the load test instrumentation is to measure the test load on top of the pile and, when provided in the Contract Documents, its distribution between side friction and end bearing to provide evaluation of the preliminary design calculations and settlement estimates and to provide information for final pile/shaft length design. Ensure that the instrumentation is as described in the Contract Documents.

When requested by the Engineer, provide assistance during installation of any instrumentation supplied by the Department. Supply 110 V, 60 Hz, 30 A of AC electric power in accordance with the National Electric Code to each test pile/shaft site during the installation of the instrumentation, during the load testing, and during any instrumented redrives ordered by the Engineer.

Place all of the internal instrumentation on the rebar cage before installation in the test shaft. Construct the rebar cage at least two days before it is required for construction of the test shaft. Provide assistance during installation of instrumentation supplied by the Department, including help to string, place, and tie the instrumentation and any assistance needed in moving or repositioning the cage to facilitate installation. Place the rebar cage in one segment complete with its instrumentation. The Engineer may require multiple lift points and/or a suitable "stiffleg" (length of H pile or other suitable section) to get the cage in a vertical position without causing damage to the instrumentation. Successfully demonstrate the lifting and handling procedures before the installing instrumentation.

(2) Hydraulic Jack and Load Cell: Provide hydraulic jack(s) of adequate size to deliver the required test load to the pile/shaft unless shown otherwise in the plans. Before load testing begins, furnish a certificate from a reputable testing laboratory showing a calibration of gauge readings for all stages of jack loading and unloading for jacks provided. Ensure that the jack has been calibrated within the preceding six months unless approved otherwise. Recalibrate the jack after completing load testing if so directed by the Engineer. Ensure that the accuracy of the gauge is within 5% of the true load.

Provide an adequate load cell approved by the Engineer that has been calibrated within the preceding six months. Provide an approved electrical readout device for the load cell. Before beginning load testing, furnish a certificate from a reputable testing laboratory showing a calibration of readings for all stages of loading and unloading for load cells furnished by the Contractor. Ensure that the accuracy of the load cell is within 1% of the true load.

If the Department supplies the Contractor with the jack and/or load cell, have the equipment calibrated and include the cost in the cost for static load test.

(3) Telltales: When shown in the Contract Documents, provide telltales that consist of an unstressed steel rod placed, with appropriate clearance and greased for reducing friction and corrosion, inside a constant-diameter pipe that rests on a flat plate attached to the end of the pipe at a point of interest shown in the plans. Construct telltales in accordance with details shown in the Contract Documents. Install dial gauges reading to 0.001 inch [0.025 mm] with 1 inch [25 mm] minimum travel as directed by the Engineer to measure the movement of the telltale with respect to the top of the pile/shaft.

(4) Embedded Strain Gauges: When shown in the Contract Documents, provide strain gauges which shall be placed in the test shaft to measure the distribution of the load. Ensure that the type, number, and location of the strain gauges are as shown in the plans or as directed by the Engineer. Use strain gauges that are waterproof and have suitable shielded cable that is unspliced within the shaft.

455-2.5 Support Facilities: Furnish adequate facilities for making load and settlement readings 24 hours per day. Provide such facilities for the instrumented area, and include lighting and shelter from rain, wind, and direct sunlight.

455-2.6 Load Test Personnel Furnished by the Contractor: Provide a certified welder, together with necessary cutting and welding equipment, to assist with the load test setup and to make any necessary adjustments during the load test. Provide personnel to operate the jack, generators, and lighting equipment, and also provide one person with transportation to assist as required during load test setup and conducting of the load tests. Provide personnel required to read the dial gauges, take level measurements, and conduct the load test, except when the Contract Documents show that the Department will provide these personnel.

455-2.7 Cooperation by the Contractor: Cooperate with the Department, and ensure that the Department has access to all facilities necessary for observation of the conduct and the results of the test.

455-2.8 Required Reports: Submit a preliminary static load test report to the Engineer within five days after completing the load test. When the Contract Documents do not require internal instrumentation, submit the final report within ten days after completing the load test. Furnish the final report of test results for internally instrumented shafts within 30 days after completing the load test. Include in the report of the load test the following information:

(1) A tabulation of the time of, and the amount of, the load and settlement readings, and the load and recovery readings taken during the loading and unloading of the pile.

(2) A graphic representation of the test results, during loading and unloading of pile top movement as measured by the average of the dial gauge readings, from wireline readings and from level readings.

(3) A graphic representation of the test results, when using telltales, showing pile compression and pile tip movement.

(4) The estimated failure and safe loads according to the criteria described herein.

(5) Remarks concerning any unusual occurrences during the loading of the pile.

(6) The names of those making the required observations of the results of the load test, the weather conditions prevailing during the load test, and the effect of weather conditions on the load test.

(7) All supporting data including jack and load cell calibrations and certificates and other equipment requiring calibration.

(8) When the Contract Document requires internal instrumentation of the shaft, furnish all of the data taken during the load test together with instrument calibration certifications. In addition, provide a report showing an analysis of the results of axial load and lateral load tests in which soil resistance along and against the shaft is reported as a function of deflection.

Provide the necessary report(s) prepared by a qualified Geotechnical Engineer registered in Florida as a Specialty Engineer except when the Contract Documents show that the Department will provide a Geotechnical Engineer.

B. PILING

455-3 Description.

Furnish and install concrete, steel, or wood piling including driving, jetting, preformed pile holes, cutting off, splicing, dynamic load testing, and static load testing of piling.

455-4 Classification.

The Department classifies piling as follows:

(1) Treated timber piling.
(2) Prestressed concrete piling.
(3) Steel piling.
(4) Driven test piling.
(5) Sheet piling.
  (a) Concrete sheet piling.
  (b) Steel sheet piling.

455-5 General Requirements.

455-5.1 Site Preparation:

455-5.1.1 Predrilling of Pile Holes: Predrilled pile holes are either 4 foot [1.2 m] maximum depth starter holes or holes drilled through embankment/fill material down to the natural ground surface. When using low displacement steel piling such as structural shapes, drive them through the compacted fill without the necessity of drilling holes through the fill except when the requirements for predrilling are shown in the plans. When using concrete or other high displacement piles, drill pile holes through fill, new or existing, to at least the elevation of the natural ground surface. Use the drill diameters listed below for square concrete piles.

12 inch [305mm] square piles	15 inches [380 mm]
14 inch [355 mm] square piles	18 inches [460 mm]
18 inch [455 mm] square piles	22 inches [560 mm]

20 inch [510 mm] square piles ....24 inches [610 mm]
24 inch [610 mm] square piles ....30 inches [760 mm]
30 inch [760 mm] square piles ....36 inches [910 mm]

For other pile sizes, use the diameter of the drills shown in the plans or approved by the Engineer. Accurately drill the pile holes with the hole centered over the plan location of the piling. Maintain the location and vertical alignment within the tolerances allowed for the piling.

For predrilled holes that are required through rock material that may damage the pile during installation, predrill hole diameters approximately 2 inches [50 mm] larger than the largest dimension across the pile cross-section. For predrilled holes which are required through material that caves during driving to the extent that the predrilled hole does not serve its intended purpose, case the hole from the embankment surface to the approximate elevation of the natural ground surface. Fill the casing with concrete sand or other approved clean sand in a manner approved by the Engineer after driving the pile. After driving the piles and obtaining the Engineer's acceptance, remove the casings unless shown otherwise in the plans.

In the setting of permanent and test piling, the Contractor may initially predrill holes to a depth up to 4 feet [1.2 m], except that, where installing piles in compacted fill, predrill the holes to the elevation of the natural ground surface. With prior written authorization from the Engineer, the Contractor may predrill holes to depths greater than 4 feet [1.2 m], to minimize the effects of vibrations on existing structures adjacent to the work and/or for other reasons the Contractor proposes. Perform such work the Engineer allows but does not require at no expense to the Department. When the Engineer requires such work and the plans do not provide for predrilled holes, the Department will pay for the additional cost of such work beyond the initial 4 feet [1.2 m] as Unforeseeable Work as described in 455-5.9.2.

Fill any voids between the pile and soil remaining after driving through predrilled holes with concrete sand or other approved clean sand.

455-5.1.2 Underwater Driving: Underwater driving is defined as any driving through water which is above the pile head at the time of driving.

When conducting underwater driving, provide a diver equipped with voice communications to aid in placing the hammer back on the pile for required cushion changes or for subsequent redriving, to attach or recover instrumentation the Engineer is using, to inspect the condition of the pile, or for other assistance as required.

Select one of the following methods for underwater driving:

(a) Accomplish underwater driving using conventional driving equipment and piling longer than authorized so that the piling will extend above the water surface during final driving. When choosing this option, furnish a pile hammer that satisfies the requirements of this Section for use with the longer pile.

(b) Accomplish underwater driving using an underwater hammer that meets the requirements of this Section and is approved by the Engineer. When choosing this option, provide at least one pile longer than authorized at each pile group, extending above the water surface at final driving. At each group location, drive the longer pile first. The Engineer will evaluate the adequacy of the underwater driving system. The Engineer may use the pile tip elevation of the longer pile that the Contractor has driven and the Engineer has accepted, to evaluate the acceptability of the piles driven with the underwater hammer.

(c) Accomplish underwater driving using conventional driving equipment with a suitable approved pile follower. When choosing this option, provide at least one pile longer than required at each pile group, extending above the water surface at final driving. At each group location, drive the full length pile first without using the follower. The Engineer will evaluate the adequacy of the follower used for underwater driving. The Engineer may choose to perform a dynamic load test on the first pile the Contractor drives with the follower in each group. The Engineer may use the pile tip elevation of the longer pile, that the Contractor has driven and the Engineer has accepted, to evaluate the acceptability of the piles driven with the follower.

Prior to use, submit details of the follower for the Engineer's evaluation and approval along with the information required in 455-10. Include the weight, cross-section details, stiffness, type of materials, and dimensions of the follower.

455-5.2 Pile Hammers: Furnish to the Engineer all technical specifications and operating instructions related to hammer equipment. All equipment is subject to satisfactory field performance.

455-5.2.1 Air/steam: Provide air/steam hammers based on the theoretical kinetic energy of the ram at impact. Use a variable energy hammer to drive concrete piles. Use air/steam hammers to drive concrete piles that are capable of providing at least two ram stroke lengths. Ensure that the short ram stroke length is approximately half of the full stroke for hammers with strokes up to 4 feet [1.2 m] and no more than 2 feet [0.6 m] for hammers with maximum strokes lengths over 4 feet [1.2 m]. Operate and maintain air/steam hammers within the manufacturer's specified ranges. Use a plant and equipment for steam and air hammers with sufficient capacity to maintain, under working conditions, the hammer, volume and pressure specified by the manufacturer. Equip the plant and equipment with accurate pressure gauges which are easily accessible to the Engineer. The Engineer will not accept final bearing on piles the Contractor drives with air/steam hammers unless the Contractor operates the hammers within 10% of the manufacturer's rated speed in blows per minute, unless otherwise authorized by the Engineer.

455-5.2.2 Diesel: Provide diesel hammers rated based on the theoretical kinetic energy of the ram at impact. Use a variable energy hammer to drive concrete piles. Use diesel hammers to drive concrete piles that are capable of providing a selection of at least three fuel settings that will produce reduced strokes. Operate and maintain diesel hammers within the manufacturer's specified ranges. Determine the rated energy of diesel hammers using measured ram stroke length multiplied by the weight of the ram for open end hammers and by methods recommended by the manufacturer for closed end hammers. Determine the actual hammer energy in the field so that it is consistent with the hammer energy used for each bearing capacity determination.

Use open-end (single acting) diesel hammers equipped with a scale (jump stick) extending above the ram cylinder to permit the Engineer to visually determine the hammer stroke at all times during pile driving operations. Provide the Engineer with a chart from the hammer manufacturer equating stroke and blows per minute for the open-end diesel hammer to be used. Also provide and maintain in working order for the Engineer's use an approved device to automatically determine and display ram stroke for open-end diesel hammers.

Use closed-end (double acting) diesel hammers equipped with a bounce chamber pressure gauge, in good working order, mounted near ground level so the Engineer can easily read. Also, provide the Engineer with a chart, calibrated to actual hammer performance within 30 days prior to initial use, equating bounce chamber pressure to either equivalent energy or stroke for the closed-end diesel hammer to be used.

455-5.2.3 Hydraulic: Provide hydraulic hammers rated based on the theoretical kinetic energy of the ram at impact. Use a variable energy hammer to drive concrete piles. Use hydraulic hammers to drive concrete piles with at least three hydraulic control settings that provide for predictable stroke control. Ensure that the shortest stroke is no more than 2 feet [0.6 m] for the driving of concrete piles. Ensure that the remaining strokes are full stroke and approximately halfway between minimum and maximum stroke.

Determine the hammer energy according to the manufacturer's recommendations. When pressure measuring equipment is required to determine hammer energy, calibrate the pressure gauges before use.

455-5.2.4 Vibratory: The Contractor may use vibratory hammers of sufficient capacity (force and amplitude) to drive steel sheet piles and, with approval of the Engineer, to drive steel bearing piles a sufficient distance to get the impact hammer on the pile (to stick the pile). The Engineer will determine the allowable depth of driving using the vibratory hammer based on site conditions. However, in all cases, use a power impact hammer for the last 15 feet [4.5 m] or more of the final driving of steel bearing piles for bearing determinations.

455-5.3 Cushions and Pile Helmet:

455-5.3.1 Capblock: Provide a capblock cushion (also called the hammer cushion) as recommended by the hammer manufacturer. Use capblocks constructed of durable manmade materials with uniform known properties. Do not use wood chips, wood blocks, rope, cable, or other material which permit excessive loss of hammer energy. Do not use capblocks constructed of asbestos materials. Obtain the Engineer's approval for all proposed capblock materials and proposed thickness for use. Maintain capblocks in good condition, and change them when charred, melted, or otherwise significantly deteriorated. The Engineer will inspect the capblock before driving begins and weekly or at appropriate intervals determined by the Engineer based on field trial. Replace or repair any hammer cushion which loses more than 25% of its original thickness, in accordance with the manufacturer's instructions, before permitting further driving.

455-5.3.2 Pile Cushion: Provide a pile cushion that is adequate to protect the pile from being overstressed in compression and tension during driving. Use a pile cushion sized so that it will fully fill the lateral dimensions of the pile helmet. Determine the thickness based upon the hammer-pile-soil system. For driving concrete piles, use a pile cushion made from pine plywood. The Contractor may use other materials once he provides the Engineer satisfactory proof that the cushion is acceptable. Obtain the Engineer's approval for all pile cushions. Maintain pile cushions in good condition and change when charred, splintered, excessively compressed, or otherwise deteriorated to the point it will not protect the pile against overstressing in tension and/or compression. Protect cushions from the weather, and keep them dry. Do not soak the cushions in any liquid unless approved by the Engineer. Replace the pile cushion if, during the driving of any pile, the cushion is either compressed more than one-half the original thickness or begins to burn. Provide a new cushion for each pile unless approved otherwise by the Engineer after satisfactory field trial.

Reuse pile cushions in good condition to perform all set-checks and redrives. Use the same cushion to perform the set-check or redrive as was used during the initial driving, unless this cushion is unacceptable due to deterioration, in which case use a similar cushion.

455-5.3.3 Pile Helmet: Provide a pile helmet suitable for the type and size of piling being driven. Use a pile helmet deep enough to adequately contain the required thickness of pile cushion and to assist in maintaining pile-hammer alignment. Use a pile helmet that fits loosely over the pile head and is at least 1 inch [25 mm] larger than the pile dimensions. Use a pile helmet designed so that it will not restrain the pile from rotating.

455-5.4 Leads: Provide pile leads constructed in a manner which offers freedom of movement to the hammer and that have the strength and rigidity to hold the hammer and pile in the correct position and alignment during driving. When using followers, use leads that are long enough and suitable to maintain position and alignment of the hammer, follower, and pile throughout driving.

455-5.5 Followers: Use followers only for underwater driving. Obtain the Engineer's approval for the type of follower, when used, and the method of connection to the leads and pile. Use followers constructed of steel with an adequate cross-section to withstand driving stresses. When driving concrete piles, ensure that the cross-sectional area of the follower is at least 18% of the cross-sectional area of the pile. When driving steel piles, ensure that the cross-sectional area of the follower is greater than or equal to the cross-sectional area of the pile. Provide a pile helmet at the lower end of the follower sized according to the requirements of 455-5.3.3. Use followers constructed that maintain the alignment of the pile, follower, and hammer and still allow the pile to be driven within the allowable tolerances. Use followers designed with guides adapted to the leads that maintain the hammer, follower, and the piles in alignment.

Use information from driving full length piles described in 455-5.1.2 compared to driving piles with the follower and/or dynamic load tests described in 455-5.13 to evaluate the adequacy of the follower and to establish the blow count criteria when using the follower.

455-5.6 Templates: Provide a fixed template, adequate to maintain the pile in proper position and alignment during driving with swinging leads or with semi-fixed leads. For piles on land, locate the template within 5 feet [1.5 m] of cutoff or within 5 feet [1.5 m] of ground line, whichever is less. For piles in water, locate the template within 5 feet [1.5 m] of cutoff or within 5 feet [1.5 m] of the waterline, whichever is less. Do not use floating templates (attached to a barge). Where practical, place the template so that the pile can be driven to cut-off elevation before removing the template. When proposing to use a free hammer, provide a rigid double template that will independently support the pile. Provide free hammers with approved guide extensions that hold the hammer in alignment with the pile to ensure that the hammer blow is applied axially to the pile at all times. When driving piles with a follower using floating equipment, provide a double template or other approved equipment to maintain alignment of the hammer, follower, and pile. Use a double template consisting of a pile template within 5 feet [1.5 m] of cut-off elevation and a second upper support above the water surface for the leads. Where practical, place the template so that the pile can be driven to cut-off elevation before removing the template. Ensure that the individual pile positions of the second upper template are adjustable in size to serve as a guide for both the pile and follower. Ensure that templates do not restrict the vertical movement of the pile.

455-5.7 Water Jets: Do not perform jetting without prior approval by the Engineer or unless allowed by the plans.

Do not perform jetting in the completed embankment. Where conditions warrant, with approval by the Engineer, perform jetting on the holes first, place the pile therein, then drive the pile to secure the last few feet [meters] of penetration. Only use one jet for prejetting or jetting through piles constructed with a center jet-hole. Use two jets when piles are jetted and driven concurrently when using external jets. When jetting and driving, position the jets slightly behind the advancing pile tip (approximately 3 feet [0.9 m] or as approved by the Engineer). When using water jets in the driving, determine the pile bearing only from the results of driving after withdrawing the jets, except where using jets to continuously eliminate soil resistance through the scour zone, ensure that they remain in place as directed by the Engineer and operating during pile bearing determination. Where practical, perform jetting on all piles in a pile group before driving begins. When large pile groups or pile spacing and batter make this impractical, or when the plans specify a jet-drive sequence, set check a sufficient number of previously driven piles in a pile group to confirm their capacity after completing all jetting. A set-check consists of ten hammer blows or 10 inches [250 mm] or more of driving. Use jet pumps, supply lines, and a jet pipe that provide adequate pressure and volume of water to freely erode the soil.

455-5.8 Penetration Requirements: Measure the penetration of piles from the elevation of natural ground, scour elevation shown in the plans, or the bottom of excavation, whichever is lower to the pile tip. When the Contract Documents show a minimum pile tip elevation or a required depth of penetration, drive the tip of the pile to this highest elevation or to achieve this minimum penetration depth. In all such cases, the Engineer will accept the bearing capacity of a pile only if the Contractor achieves the required bearing value when the tip of the pile is at or below the specified minimum tip elevation or depth of penetration.

When the plans do not show a minimum depth of penetration, scour elevation, or minimum tip elevation, ensure that the required penetration is at least 10 feet [3 m] into firm bearing material or at least 20 feet [6 m] into soft material unless otherwise permitted by the Engineer. If a scour elevation is shown in the plans, achieve these penetrations below the scour elevation. The Engineer may accept a penetration between 15 and 20 feet [4.5 and 6 m] when there is an accumulation of five consecutive feet [1.5 consecutive meters] or more of firm bearing material. Firm bearing material is any material offering a driving resistance greater than or equal to 30 tons/ft^2 [3 MPa] of gross pile area as determined by the

Wave Equation (455-5.11.2). Soft material is any material offering less than these resistances. The gross pile area is the actual pile tip cross-sectional area for solid concrete piles, the product of the width and depth for H piles, and the area within the outside perimeter for pipe piles and voided concrete piles.

Do not drive piles beyond practical refusal (20 blows per inch [25 mm]). To meet the requirements in this Subarticle, provide penetration aids, such as jetting or preformed pile holes, when the Contractor cannot drive piles to the required penetration without reaching practical refusal.

If the Contractor encounters unforeseeable, isolated obstructions that the Contractor cannot practically penetrate by driving, jetting, or preformed pile holes, and the Contractor must remove the pile to obtain the required pile penetration, the Department will pay the costs for such removal as Unforeseeable Work.

455-5.9 Preformed Pile Holes:

455-5.9.1 Description: Preformed Pile Holes are holes necessary due to the presence of rock or strong strata of soils which will not permit the installation of piles to the desired penetration by driving or a combination of jetting and driving, or holes determined necessary by the Engineer or when authorized by the Engineer to minimize the effects of vibrations on adjacent existing structures. The Engineer may require preformed holes for any type of pile. Preformed Pile Holes serve as a penetration aid when all other pile installation methods fail to produce the desired penetration and when authorized by the Engineer to minimize the effects of vibrations on adjacent structures. Drive all piles installed in Preformed Pile Holes to determine that the bearing requirements have been met.

Fill all voids between the pile and soil remaining after driving through preformed holes with concrete sand or clean sand.

455-5.9.2 Provisions for Use of Preformed Pile Holes: The Department generally anticipates the necessity for Preformed Pile Holes and includes a pay item in the proposal. When no pay item for Preformed Pile Holes is included in the Contract, the Department will consider the work of providing preformed holes as Unforeseeable Work when the Contractor establishes that the required results cannot be obtained when driving the piles with specified driving equipment, while jetting the piles and then driving, or while jetting the piles during driving.

455-5.9.3 Conditions Under Which Payment Will Be Made: The Department will make payment for Preformed Pile Holes where the Contractor demonstrates that such work is necessary to achieve the required penetration of the pile. The Department considers, but does not limit to, the following conditions as reasons for Preformed Pile Holes:

(a) Inability to drive piles to the required penetration with driving and jetting equipment.

(b) To penetrate a hard layer or layers of rock or strong stratum that the Engineer considers not sufficiently thick to support the structure.

(c) To obtain greater penetration into dense (strong) material and into dense material containing holes, cavities or unstable soft layers.

(d) To obtain penetration into a stratum in which it is desired to found the structure.

(e) To minimize the effects of vibrations or heave on adjacent existing structures.

(f) To obtain a penetration up to 20 feet [6 m] except where the Contract Documents show a required pile penetration in excess of 20 feet [6 m].

(g) To minimize the effects of ground heave on adjacent piles.

455-5.9.4 Construction Methods: Construct Preformed Pile Holes by drilling, or driving and withdrawing a suitable punch or chisel at the locations of the piles. Construct a hole that is equal to or slightly greater than the pile and of sufficient depth to obtain the required penetration. Carefully form the preformed hole by using a drill or punch guided by a template or other suitable device, and do not exceed the minimum dimensions necessary to achieve the required penetration of the pile. When Preformed Pile Holes are oversized to the extent that the sides of the pile are not in contact with the soil and the pile has inadequate lateral stability, restore lateral stability by filling the space between the pile and the sides of the hole with concrete sand or other approved clean sand. When the plans call for grouting the Preformed Pile Holes, provide the minimum dimension of the pile hole that is 2 inches [50 mm] larger than the largest pile dimension. Construct the holes at the plan position of the pile and the tolerances in location, and ensure that the batter is the same as allowed for the pile.

455-5.9.5 Grouting of Pile Holes: Do not grout Preformed Pile Holes for bearing piles, except when the plans require grouting after driving to provide for pile uplift and/or lateral resistance. Before grouting, clean the Preformed Pile Holes, and fill them with cement grout as shown in the plans. Use grout that has a minimum compressive strength of 3,000 psi [20 MPa] at 28 days or as specified. Pump the grout through three or more grout pipes initially placed at the bottom of the preformed hole. The Contractor may raise the grout pipes when necessary to prevent clogging and to complete the grouting operations. Maintain the grout pipes below the surface of the previously placed grout. Continue grouting until the grout reaches the ground surface all around the pile. Provide divers to monitor grouting operations when the water depth is such that it is impractical to monitor from the ground surface. When grouting is shown in the plans, include the cost in the price for Preformed Pile Holes. In the event that the Engineer determines the Contractor must grout and the required grouting is not shown in the plans, the Department will pay for the grouting work as Unforeseeable Work.

455-5.10 Bearing Requirements:

455-5.10.1 General: Drive piles to provide the bearing capacities required for carrying the loads shown in the plans. For all types of bearing piles, consider the driving resistance as determined by the methods described herein sufficient for carrying the specified loads as the minimum bearing which is accepted for any type of piles. Determine pile bearing using the method described herein or as shown in the plans.

The Engineer may accept a driven pile when the pile has achieved minimum penetration, the blow count is generally increasing and the minimum required bearing capacity obtained for 24 inches [600 mm] of consecutive driving. At his discretion, the Engineer may also accept a driven pile when the minimum penetration is achieved and driving has reached practical refusal in firm material.

455-5.10.2 Blow Count Criteria: The Engineer will determine the number of blows required to provide the required bearing according to the methods described herein. Determine the pile bearing by computing the penetration per blow averaged through 12 inches [300 mm] each of penetration. When it is considered necessary by the Engineer, the Contractor may determine the average penetration per blow by averaging the penetration per blow through the last 10 to 20 blows of the hammer. Supply driving equipment which provides the required resistance at a blow count ranging from three blows per inch [3 blows per 25 mm] (36 blows per foot [36 blows per 300 mm]) to 10 blows per inch [210 blows per 5 mm] (120 blows per foot [120 blows per 300 mm]) unless approved otherwise by the Engineer after satisfactory field trial.

455-5.10.3 Practical Refusal: Practical refusal is defined as 20 blows per inch [20 blows per 25 mm]. Stop driving as soon as the Engineer determines that the pile has reached practical refusal. The Engineer will generally make this determination within 2 inches [50 mm] of driving. However, the Engineer will in no case approve the continuation of driving at practical refusal for more than 12 inches [300 mm]. When the required pile penetration cannot be achieved by driving without exceeding practical refusal, use other penetration aids such as jetting or Preformed Pile Holes.

455-5.10.4 Set-checks and Pile Redrive:

(a) Set-checks: In the event that the Contractor has driven the pile to approximately 12 inches [300 mm] above cut-off without reaching the required resistance, the Engineer may require the Contractor to interrupt driving at least 15 minutes prior to performing a set-check. Provide an engineer's level or other suitable equipment for elevation determinations to determine accurate pile penetration during the set-checks. There will be no separate payment for an initial set-check. In the event the result of an initial set-check is not satisfactory, the Engineer may direct additional set-checks. For each additional set-check ordered by the Engineer within 72 hours from the end of original driving, the Contractor will be paid an additional quantity of 10 feet [3 m] of piling furnished. The Engineer may accept the pile as driven when a set-check shows that the Contractor has achieved the minimum required pile bearing and has met all other requirements of this Section.

(b) Pile Redrive: Pile Redrive consists of redriving the pile after 72 hours from original driving to determine time effects, to reestablish pile capacity due to pile heave, or for other reasons determined by the Engineer. Redrive piles as directed by the Engineer. Redrives may range from ten hammer blows to 12 inches [300 mm] or more of driving.

455-5.10.5 Pile Heave: Pile heave is the upward movement of a pile from its originally driven elevation. Drive the piles in an approved sequence to minimize the effects of heave and lateral displacement of the ground. Monitor piles previously driven in a pile group for possible heave during the driving of the remaining piles. When required by the Engineer, take elevation measurements to determine the magnitude of the movement of piles and the ground surface resulting from the driving process. Redrive all piles that have heaved 3 inch [6 mm] or more unless the Engineer determines that the heave is not detrimental to pile capacity. The Department will pay for all work in conjunction with redriving piles due to pile heave under the Pile Redrive item.

455-5.10.6 Piles with Insufficient Bearing: In the case that the Engineer determines that the safe bearing capacity of any pile is less than the required bearing capacity, the Contractor may splice the pile and continue driving or may extract the pile and drive a pile of greater length, or, if so ordered by the Engineer, drive additional piles until reducing the adjusted required bearing per pile to the determined bearing capacity of the piles already driven.

455-5.11 Methods to Determine Pile Capacity:

455-5.11.1 General: Use the Wave Equation to determine pile capacity for all structures or projects unless shown otherwise in the Contract Documents. When necessary, the Engineer may require static load tests or dynamic load tests, or both, to confirm pile capacities estimated from Wave Equation predictions. When the Contract Documents do not include items for static load tests or dynamic load tests, the Engineer will consider all required testing Unforeseeable Work. When considered necessary by the Engineer, adjust the blow count criteria for the Wave Equation to match the resistance determined from static load tests or dynamic load tests, or both.

455-5.11.2 Wave Equation:

(a) General: The Engineer may use the Wave Equation Analysis for Piles (WEAP) programs.

The Engineer will use the Wave Equation to evaluate the suitability of the Contractor's proposed driving system (including the hammer, follower, capblock and pile cushions) as well as to determine the driving resistance, in blows per 12 inches [300 mm] or blows per inch [25 mm], to achieve the pile bearing requirements and to evaluate pile driving stresses. The required driving resistance is equal to the design load multiplied by the appropriate factor of safety plus the scour and down drag resistance shown in the plans (no safety factor is required) or the ultimate bearing capacity shown in the plans, whichever is higher.

The factor of safety applied to the design load is:

2.0 ....when static load tests are required.

2.5 ....when the Pile Driving Analyzer and Wave Equation Analysis are required.

3.0 .... when only the Wave Equation Analysis is required.

The Engineer may modify the scour resistance shown in the plans if the dynamic load test is used to determine the actual soil resistance through the scour zone. Also, the Engineer may make modifications in scour resistance when the Contractor proposes drilling and/or jetting to reduce the soil resistance in the scour zone.

The Engineer will not approve any hammer for driving unless Wave Equation analyses show it capable of driving to a resistance equal to at least 3.0 times the design load plus the scour and down drag resistance (if applicable) shown in the Contract Documents or the ultimate resistance shown in the Contract Documents, whichever is higher, without overstressing the piling in compression or tension and without reaching practical refusal (20 blows per inch [20 blows per 25 mm]). Ensure that the hammer provided also meets the requirements described in 455-5.10.2.

(b) Required Equipment For Driving: Hammer approval is solely based on the Wave Equation Analysis, PDA and CAPWAP analysis. Supply for all pile driving a hammer system that meets the requirements described in the specifications based on the above analysis. Obtain approval from the Engineer for all proposed driving equipment and keep in mind that all equipment is subject to satisfactory field performance.

In the event that piles require different hammer sizes, the Contractor may elect to drive with more than one size hammer or with a variable energy hammer, provided the hammer is properly sized, cushioned, and the Wave Equation analyses show that it will not damage the pile and will develop the required resistance.

(c) Allowable Pile Stresses:

(1) General: The allowable stresses for concrete, steel, and timber piles are given below. In the event Wave Equation analyses show that the hammer will overstress the pile, the Engineer will reject the proposed driving system. Upon such rejection, modify the driving system or method of operation as required to prevent overstressing the pile. In such cases, meet the Engineer's reevaluation requirements by providing additional cushioning or making other appropriate agreed upon changes. For penetration of weak soils by concrete piles, use thick cushions and/or reduced stroke to control tension stresses during driving.

(2) Concrete Piles: The Engineer will use the wave equation to evaluate the pile cushioning the Contractor proposes to use. Use the following equations to determine the maximum allowable stresses as predicted by the wave equation when driving prestressed concrete piling:

Non SI Units

$$s_{apc} = 0.7\; f'_c\; 0.75\; f_{pe}$$

$$s_{apt} = 6.5\,(f'_c)^{0.5} + 1.05\; f_{pe}$$

$$s_{apt} = 3.25\,(f'_c)^{0.5} + 1.05\; f_{pe}$$

where:

s_{apc}= maximum allowable pile compressive stress, psi

s_{apt}= maximum allowable pile tensile stress, psi

$f\,!_c$= specified minimum compressive strength of concrete, psi

f_{pe}= effective prestress (after all losses) at the time of driving, psi, taken as 0.8 times the initial prestress force (f_{pe}= 0 for spliced piles).

SI Units

$$s_{apc} = 0.7\; f'_c\; 0.75\; f_{pe}$$

$$s_{apt} = 0.54\,(f'_c)^{0.5} + 1.05\ f_{pe}$$

$$s_{apt} = 0.27\,(f'_c)^{0.5} + 1.05\ f_{pe}$$

where:

s_{apc}= maximum allowable pile compressive stress, MPa

s_{apt}= maximum allowable pile tensile stress, MPa

f'_c= specified minimum compressive strength of concrete, MPa

f_{pe}= effective prestress (after all losses) at the time of driving, MPa, taken as 0.8 times the initial prestress force (f_{pe}= 0 for spliced piles).

(3) Steel Piles: Ensure that the maximum allowable pile compression and tensile stresses as predicted by the Wave Equation are equal to 0.9 times the yield strength (0.9 f_y) of the steel.

(4) Timber Piles: Ensure that the maximum allowable pile compression and tensile stresses as predicted by the wave equation are 3.6 ksi [25 MPa] for Southern Pine and Pacific Coast Douglas Fir and 0.9 of the ultimate parallel to the grain strength for piles of other wood.

455-5.11.3 Bearing Formulas: Use the following formula for temporary timber piles only:

$$R = \frac{2E}{S + 0.1} \ \ \text{for power hammers}$$

Non SI Units

where:

R = Safe bearing value, in tons

S = The average penetration per blow, in inches

E = Energy per blow of hammer, in foot tons; (which shall be the product WH, for single-acting hammers, and the manufacturer's rated capacity for the speed used in driving for double-acting hammers. The energy per blow for diesel hammers shall be determined in accordance with the manufacturer's recommendations for closed-end diesel hammers and the product of the ram weight and stroke for open-end hammers. Bounce chamber pressure for closed-end diesel hammers and stroke for open-end diesel hammers shall be determined in the field.)

SI Units

$$R = \frac{167E}{S + 2.54} \ \ \text{for power hammers}$$

where:

R = Safe bearing value, in kilonewtons

S = The average penetration per blow, in millimeters

E = Energy per blow of hammer, in kilojoules; (which equals the product

WH, for single-acting hammers, and the manufacturer's rated capacity for the speed used in driving for double-acting hammers. Determine the energy per blow for diesel hammers in accordance with the manufacturer's recommendations for closed-end diesel hammers and the product of the ram weight and stroke for open-end hammers. Determine bounce chamber pressure for closed-end diesel hammers and stroke for open-end diesel hammers in the field.)

Do not use Bearing Formulas to determine pile capacity for any other pile types.

455-5.11.4 Dynamic Load Tests: Dynamic load testing consists of predicting pile capacity from blows of the hammers during drive and/or redrive of an instrumented pile.

455-5.11.5 Static Load Tests: Static load testing consists of applying a static load to the pile to determine its capacity. Use The Modified Quick Test Procedure in accordance with 455-2.2.1.

455-5.11.6 Fender Pile Installation: For piles used in fender systems, regardless of type or size of pile, either drive them full length or jet the piles to within 2 feet [600 mm] of cutoff and drive to cutoff elevation to seat the pile. The Engineer will not require a specific driving resistance unless noted in the plans. Use methods and equipment for installation that do not damage the piles. If the method or equipment used causes damage to the pile, modify the methods or equipment at no expense to the Department.

455-5.12 Test Piles:

455-5.12.1 Description: Drive piles of the same cross-section and type as the permanent piles shown in the plans, in order to determine any or all of the following:

(a) the safe bearing value of the piles.
(b) the nature of the soil.
(c) the lengths of permanent piles required for the work.
(d) the driving resistance characteristics of the various soil strata.
(e) the amount of work necessary to obtain minimum required pile penetration.
(f) the ability of the driving system to do the work.
(g) the need for point protection.

Because test piles are exploratory in nature, drive them harder (within the limits of practical refusal), deeper, and to a greater bearing value than required for the permanent piling. Where practical, drive test piles their full length. Build up test piles which have been driven their full length and have developed only minimal required bearing, and proceed with further driving.

As a minimum, unless otherwise directed by the Engineer, do not cease driving of test piles until obtaining the required bearing capacity continuously, where the blow count is increasing, for 10 feet [3 m] unless reaching practical refusal first. For test piles which are to be statically load tested, ignore this minimum and drive these piles as anticipated for the production piles.

When test piles attain practical refusal prior to attaining minimum penetration, perform all work necessary to attain minimum penetration and the required bearing. Where practical use water jets to break the pile loose for further driving. Where jetting is impractical, extract the pile and install a Preformed Pile Hole through which driving will continue. When the Contract Documents do not include items for Preformed Pile Holes, the Department will consider the work of extracting the pile and providing a preformed pile hole to be Unforeseeable Work.

When driving test piles other than low displacement steel test piles, have water jets as specified in 455-5.7 at the site, ready for use, before the test pile driving begins. When the Contract Documents include Preformed Pile Hole items, supply the appropriate equipment for such work at the project site before the test pile driving begins.

The Engineer may elect to interrupt pile driving up to four times on each test pile, two times for 15 minutes and two additional times within 72 hours of initial driving to determine time effects during the driving of test piles at no additional cost to the Department. If set-checks are determined necessary by the Engineer after 72 hours from the end of initial driving, each set-check will be paid for as pile redrive. Install instruments on test piles when dynamic load tests are included in the plans or when directed by the Engineer.

455-5.12.2 Location of Test Piles: Drive all test piles in the position of permanent piles at the designated locations. Unless all piles at the designated location are battered, drive plumb test piles. Ensure that all test piles designated to be statically load tested are plumb. In the event that all the piles are battered at a static load test site, the Engineer will designate an out-of-position location for driving a plumb pile for the load test.

455-5.12.3 Equipment for Driving: Use the same type, size, and weight hammer and equipment for driving test piles as is intended for driving the permanent piles. Also use the same equipment to redrive any test piles.

455-5.12.4 Ground Elevations: At the time of driving test piles, furnish the Engineer with elevations of the original ground at each pile or pile group location. Note the highest and lowest elevation at each required location and the ground elevation at all the test piles. Present the elevations in plotted and tabular form and submit with the test pile data.

455-5.13 Dynamic Load Tests: The Engineer will take dynamic measurements during the driving of piles designated in the plans or authorized by the Engineer as Dynamic Load Test Piles. Install instruments on test piles and selected permanent piles for dynamic load testing. When the Contract Documents include Dynamic Load Tests, all test piles will have dynamic load tests. The Engineer will perform Dynamic Load Tests to evaluate any or all of the following:

1. Evaluate suitability of Contractor's driving equipment, including hammer, capblock, pile cushion, and any proposed follower.
2. Determine pile capacity.
3. Determine pile stresses.
4. Determine energy transfer to pile.
5. Determine distribution of soil resistance.
6. Evaluate soil variables including quake and damping.
7. Evaluate hammer-pile-soil system for Wave Equation analyses.

8. Evaluate pile installation problems.

9. Other.

Attach instruments (strain transducers to measure force and accelerometers to measure acceleration) with screws to the pile for dynamic load testing. To allow the Engineer to perform dynamic load testing, supply 110 V, 60 Hz, 30 A of AC electric power to operate an electric drill and to operate the pile driving analyzer equipment. When required in the plans, also provide a suitable shelter within 50 feet [15 m] and within view of the test location to protect the equipment from the elements. Ensure that this shelter is 7 feet [2 m] high and 8 by 8 feet [2.5 by 2.5 m] in plan. Provide a suitable man basket, having a working area of at least 4 by 4 feet [1.2 by 1.2 m] with 4 foot [1.2 m] high safety rails all around, to be lifted by the crane, for use as required, to provide access to the top of the pile. Supply a stable platform which is satisfactory, in the opinion of the Engineer, for reference of the pile penetration.

Make each pile to be dynamically tested available to drill holes for attaching instrumentation and for wave speed measurements. Support the pile with timber blocks placed at appropriate intervals. Ensure that the pile is in a horizontal position and does not contact adjacent piles. Provide a sufficient clear distance at the sides of the pile for drilling the holes. The Engineer will furnish the equipment, materials, and labor necessary for drilling holes and taking the wave speed measurements. If the Engineer directs dynamic load testing of piles already driven, provide the Engineer safe access to the top of the piles for drilling the attachment holes. After placing the leads provide the Engineer reasonable means of access to the piles to attach the instruments and for removal of the instruments after completing the pile driving.

The Engineer will monitor the stresses in the piles with the dynamic test equipment during driving to ensure the Contractor does not exceed the allowable stresses. If necessary, add additional cushioning, replace the cushions, or reduce the hammer stroke to maintain stresses below the maximum allowable. If dynamic test equipment measurements indicate non-axial driving, immediately realign the driving system. If the cushion is compressed to the point that a change in alignment of the hammer will not correct the problem, add cushioning or change the cushion as directed by the Engineer.

Drive the pile to the required penetration and resistance or as directed by the Engineer. The Engineer may elect to interrupt driving for up to two waiting periods, 15 minutes each (set-checks) during the initial driving of the pile. Dynamic load testing of a pile may average up to two hours longer than for driving an uninstrumented pile.

When directed by the Engineer, perform instrumented redrives. Do not use a cold diesel hammer for a redrive unless in the opinion of the Engineer it is impractical to do otherwise. Generally, warm up the hammer by applying at least 20 blows to a previously driven pile or to timber mats placed on the ground.

455-5.14 Pile Lengths:

455-5.14.1 Test Pile Length: Provide the length of test piles shown in the plans or as directed by the Engineer.

455-5.14.2 Production Pile Length: When shown in the plans, the lengths are based on information available during design and are approximate only. The

Engineer will determine final pile lengths in the field which may vary significantly from the lengths or quantities shown in the plans.

455-5.14.3 Authorized Pile Lengths: The authorized pile lengths are the lengths determined by the Engineer based on all information available before the driving of the permanent piles, including, but not limited to, information gained from the driving of test piles, dynamic load testing, static load testing, set-checks, pile redrives, supplemental soil testing, etc. These lengths represent the lengths that the Department has assumed to remain in the completed structure. The Contractor may elect to provide piling with lengths longer than authorized to suit his method of installation. When the Contractor elects to provide longer than authorized pile lengths, the Department will pay for the furnished length as either the originally authorized length or the length between cut-off elevation and the final accepted pile tip elevation, whichever is the longer length.

Within 30 days after driving all the test piles, completing all load tests, completing all redrives, and receiving all test reports, the Engineer will furnish the Contractor an itemized list of authorized pile lengths and driving criteria. Use these lengths for furnishing the permanent piling for the structure. If the Contractor is willing to start his pile driving operations in areas designated by the Engineer, and if the Contractor so requests in writing at the beginning of the test pile program, the Department will furnish pile lengths and driving criteria for these designated areas within seven days after driving all the test piles, completing all load tests, completing all redrives, and receiving all test reports for those designated areas.

On multiple phase projects, the Engineer will not furnish pile lengths on subsequent phases until completing the piling on initial phases.

455-5.15 Allowable Driving Tolerances:

455-5.15.1 General: Meet the tolerances described in this Subarticle to the piles that are free standing without lateral restraint (after the template is removed). After the piles are driven, do not move the piles laterally to force them to be within the specified tolerances. The Contractor may move battered piles laterally to overcome the deadload deflections caused by the pile's weight. When this is necessary, submit calculations signed and sealed by a Specialty Engineer to the Engineer that verify the amount of dead load deflection prior to moving any piles.

455-5.15.2 Position: Ensure that the final position of the pile head at cut-off elevation is no more than 3 inches [75 mm] from the plan position indicated in the plans.

455-5.15.3 Axial Alignment: Ensure that the axial alignment of the driven piles does not deviate by more than 3 in/ft [20 mm/m] from the vertical or batter line indicated in the plans.

455-5.15.4 Elevation: Ensure that the final elevation of the pile head is no more than 12 inches [38 mm] above, or more than 4 inches [100 mm] below, the elevation shown in the plans. Do not embed the pile less than 6 inches [150 mm] below the elevation shown in the plans unless a minimum penetration requirement is shown.

455-5.15.5 Deviation From Above Tolerances: When the Contractor has failed to meet the above tolerances, the Contractor may request design changes in the pile caps or footings to incorporate piles driven out of tolerance. Bear the expense of redesign and Unforeseeable Work resulting from approved design changes to incorporate piles driven out of tolerance. Employ a Specialty Engineer to perform any redesign and who shall sign and seal the redesign drawings and computations. Do not begin any proposed redesign until it has been reviewed for acceptability and approved by the Engineer.

455-5.16 Disposition of Pile Cut-offs, Test Piles, and Load Test Materials:

455-5.16.1 Pile Cut-offs:

(a) Steel Piling: Unless shown otherwise in the plans, the Department will retain ownership of cut-off sections, or portions of cut-off sections, and unused piling 20 feet [6 m] long or longer that are not damaged. Deliver them to the Department's nearest maintenance yard. Ensure that sections of piles delivered to the maintenance yard are straight and undamaged. Cut off the damaged portions prior to delivery. Take ownership of cut-off sections less than 20 feet [6 m] long. Remove them from the job, and dispose of them.

(b) Other Pile Types: Upon completion of all work under the Contract in connection with piling, unless shown otherwise in the plan, take ownership of any unused cut-off lengths remaining, and remove them from the right-of-way. Provide areas for their disposal.

455-5.16.2 Test Piles: Where so directed by the plans or the Engineer, cut off, or build-up as necessary, test piles, and leave them in place as permanent piles. Extract and replace test piles driven in permanent position and found not suitable for use at no expense to the Department. Pull, or cut off at an elevation 2 feet [0.6 m] below the ground surface or bottom of proposed excavation, test piles driven out of permanent position, and dispose of the removed portion of the test pile.

When test piles are required to be driven in permanent pile positions, the Contractor may elect to drive the test pile out of position, with the approval of the Engineer, provided that a replacement pile is furnished and driven by the Contractor at no expense to the Department in the position that was to be occupied by the test pile. Under this option, the Department will pay for the test pile in the same manner as if it were in permanent position.

Unless otherwise directed in the plans or by the Engineer, retain ownership of test piles that are pulled or cut off and provide areas for their disposal.

455-5.16.3 Load Test Materials: Upon completion of all load testing, remove all load test equipment and materials from the site. Thoroughly clean and repair and return in operating condition any load test equipment, materials, or instrumentation supplied by the Department to the required storage location. Cut off any reaction piles that are not extracted 24 inches [600 mm] below the ground surface. Provide disposal areas out of the right-of-way and remove all materials including reaction pile cut-offs and dispose of them. Restore the test pile site to a condition satisfactory to the Engineer.

455-6 Timber Piling.

455-6.1 Description: Drive timber piles constructed of round timber of the kind and dimensions specified in the plans at the locations and to the elevations shown in the plans, or as directed by the Engineer.

455-6.2 Materials: Meet the timber piling requirements of Section 953. Treat the piles according to the applicable provisions of Section 955.

455-6.3 Preparation for Driving:

455-6.3.1 Caps: Protect the heads of timber piles during driving, using a cap of approved type, that will distribute the hammer blow over the entire cross-section of the pile. When necessary, cut the head of the pile square before beginning pile driving.

455-6.3.2 Collars: Provide collars or bands to protect piles against splitting and brooming at no expense to the Department.

455-6.3.3 Shoes: Provide piles shod with metal shoes, of a design satisfactory to the Engineer, at no expense to the Department. Shape pile tips to receive the shoe and install according to the manufacturer's directions.

455-6.4 Storage and Handling: Store and handle piles in the manner necessary to avoid damage to the piling. Take special care to avoid breaking the surface of treated piles. Do not use cant dogs, hooks, or pike holes when handling and storing the piling. Give cuts or breaks in the surface of the treated piles three brush coats of hot creosote oil of approved quality, and pour hot creosote oil into all bolt holes.

455-6.5 Cutting Off: Saw off the tops of all timber piles at the elevation indicated in the plans. Saw off piles which support timber caps to the exact plane of the superimposed structure so that they exactly fit it. Withdraw and replace broken, split, or misplaced piles.

455-6.6 Build-ups: The Engineer will not permit splices or build-ups for timber piles. Extract piles driven below plan elevation and drive a longer pile.

455-6.7 Pile Heads:

455-6.7.1 Piles with Timber Caps: On piles wider than the timber caps, dress off to a slope of 45 degrees the part of the pile head projecting beyond the sides of the cap. After completing this and all other necessary cutting to receive the cap, give the heads of piles three coats of hot creosote oil. Then, cover them with a coat of hot tar over which place a sheet of copper, of a weight of 10 oz/ft^2 [3 kg/m^2] or greater, meeting the requirements of ASTM B 370. Provide a cover that measures at least 4 inches [100 mm] more in each dimension greater than the diameter of the pile. Bend the cover down over the pile and fasten the edges with large head copper nails or three wraps of No. 12 [2 mm] copper wire.

455-6.7.2 Fender and Bulkhead Piles: First paint the heads of fender piles and of bulkhead piles with hot creosote, covered with hot tar, and then cover with copper as provided above for piles supporting timber caps.

455-7 Prestressed Concrete Piling.

455-7.1 Description: Provide prestressed concrete piles that are manufactured, cured, and driven in accordance with the requirements of the Contract Documents. Provide piles full length without splices when transported by barge or transported by truck without the need of a special overlength permit. When piles are of a length which requires a special over-length permit to transport, provide minimal splices. Include the cost of the splices in the cost of the pile.

455-7.2 Manufacture: Fabricate piles in accordance with Section 450.

455-7.3 Storage and Handling:

455-7.3.1 Time of Driving Piles: Drive prestressed concrete piles at any time after the concrete has aged at least seven days and the concrete compressive strength is equal to or greater than the specified 28 day compressive strength.

Where concrete containing Microsilica is used, precast or prestressed piles, including test piles and sheet piles, must be at least 28 days old before installation is allowed.

455-7.3.2 Handling: Handle and store piles in the manner necessary to eliminate the danger of fracture by impact or of undue bending stresses in handling or transporting the piles from the forms and into the leads. In general, lift concrete piles by means of a suitable bridge or slings attached to the pile at the locations shown in the plans. Construct slings used to handle piles of a fabric material or braided wire rope constructed of six or more wire ropes which will not mar the corners or the surface finish of the piles. Do not use chains to handle piles. During transport, support concrete piles at the lifting locations shown in the plans or fully support them throughout 80% or more of their length. In handling piles for use in salty or brackish water, exercise special care to avoid damaging the surface and corners of the pile.

455-7.4 Cracked Piles: The Engineer will reject any pile that becomes cracked in handling to the point that a transverse or longitudinal crack extends through the pile, shows failure of the concrete as indicated by spalling of concrete on the main body of the pile adjacent to the crack, or which in the opinion of the Engineer will not withstand driving stresses. The Engineer will not reject any pile for the occasional minor surface hairline cracking caused by shrinkage or tensile stress in the concrete from handling.

Do not drive piling with irreparable damage, which is defined as any cracks that extend through the pile cross-sectional area that are, or will be, below ground or water level at the end of driving. Such cracks are normally evidenced by emitting concrete dust during their opening and closing with each hammer blow. Remove and replace broken piles or piles cracked to the extent described above at no expense to the Department. The Engineer will accept cracks less than 0.005 inch [0.15 mm] which do not extend through the pile. Using approved methods, cut off and splice or build-up to cut-off elevation piles with cracks greater than 0.005 inch [0.15 mm] at the pile head or above ground or water level, and piles with cracks above ground or water level which extend through the cross-sectional area of the pile. The Engineer, at his discretion, may require correction of pile damage or pile cracks by cutting down the concrete to the plane of sound concrete below the crack and rebuilding it to cut-off elevation, or the Engineer may reject the pile. Extract and replace rejected piles that cannot be repaired, at no expense to the Department.

Take appropriate steps to prevent the occurrence of cracking, whether due to handling or driving. When cracking occurs during driving take immediate steps to prevent additional cracking by using thicker cushions or reducing the ram stroke length. Revise handling and transporting equipment and procedures as necessary to prevent cracking during handling and transportation.

455-7.5 Preparation for Transportation: Cut any strands protruding beyond the ends of the pile flush with the surface of the concrete using an abrasive cutting blade before transporting the piles from the casting yard.

Cut the metal handling devices cast into the concrete back to a minimum depth of 1 inch [25 mm] and patch with an approved epoxy mortar, mixed, applied and cured in accordance with the manufacturer's recommendations before transporting the piles from the casting yard.

455-7.6 Method of Driving: Unless otherwise directed, drive piles by a hammer or by means of a combination of water jets and hammer. When using jets in combination with a hammer, withdraw the jets and drive the pile by the hammer alone, to secure final penetration and to rigidly fix the tip end of the pile. Keep jets in place if they are being used to continuously eliminate the soil resistance in the scour zone.

455-7.7 Extensions and Build-ups:

455-7.7.1 General: Where splices and build-ups for concrete piles are necessary, such splices and build-ups to be driven or those 5 feet [1.5 m] or longer are to be prestressed precast sections. Ensure that build-ups less than 5 feet [1.5 m] in length and not to be driven consist of a non-prestressed reinforced section meeting the requirements of 455-7.7.3. The Contractor may construct build-ups less than 2 feet [0.6 m] in length in accordance with 455-11.9. When splicing a prestressed precast section onto the original pile and, after driving, the length of spliced section below cut-off elevation is 5 feet [1.5 m] or less, use the following methods:

(a) If the spliced section is less than 2 feet [0.6 m], remove the pile concrete to the cut-off elevation and leave the dowels in place to be incorporated into the cap as directed by the Engineer. The Contractor may cut the length of dowels which becomes exposed to a length of 29 inches [740 mm] from the plane of pile cut-off.

(b) If the spliced section is greater than 2 feet [0.6 m] but less than or equal to 5 feet [1.5 m], remove the pile concrete to the cut-off elevation and leave the strands and dowels, if applicable, in place to be incorporated into the cap as directed by the Engineer. Do not use cut-off pile sections for build-ups of 5 feet [1.5 m] or less.

These requirements are not applicable to specially designed piling. Make splices for special pile designs as shown in the plans.

455-7.7.2 Extensions to be Driven or Those 5 feet [1.5 m] or Longer: Construct extensions to be driven or extensions 5 feet [1.5 m] or longer in length in accordance with the details shown in the plans and in a manner including the requirements, sequences, and procedures outlined below:

(a) Cast a spliced section in accordance with Section 450 with the dowel steel in the correct position and alignment, or provide a cut-off pile section of the same cross-section, mix design, and minimum strength for use as a spliced section in accordance with 455-11.2.6. If driving a spliced cut-off section, install the head of a cut-off pile section on the original pile in its required position. The Contractor may splice cut-off sections in good condition with the same cross-section, mix design, and minimum strength and approved by the Engineer to driven piles with epoxy bonded splices and use them as build-ups, or the Contractor may redrive them in the position of permanent piles as directed by the Engineer.

(b) Drill dowel holes using an approved steel template that will position and align the drill bit during drilling. Drill holes a minimum of 2 inches [50 mm] deeper than the length of the dowel to be inserted.

(c) Clean the drilled dowel holes by inserting a high pressure air hose to the bottom of the hole and blowing the hole clean from the bottom upward. Eliminate any oil, dust, water, and other deleterious materials from the holes and the concrete surfaces to be joined.

(d) Mix the epoxy components in accordance with the manufacturer's directions. Do not mix sand or any other filler material with the epoxy components unless it is prepackaged by the manufacturer for this specific purpose.

(e) After ensuring that all concrete surfaces are dry, fill the dowel holes with the mixed epoxy material.

(f) When using cut-off pile sections for splices, install the spliced section by (1) drilling and cleaning the dowel holes, (2) attaching the gasket and retaining form as shown on the Epoxy Bonded Build-up Details for Piles, (3) filling the holes with epoxy, (4) inserting the dowels and (5) allowing the epoxy to cure in accordance with the manufacturer's directions with the dowels held in correct position and alignment.

(g) Place forms around joints between the pile sections.

(h) Insert the dowels of the spliced section into the epoxy filled holes of the bottom section and position the spliced section so that the axes of the two sections are in concentric alignment and the ends of the abutting sections are spaced 2 inch [15 mm] apart. The Contractor may use small steel spacers of the required thickness provided they have 3 inches [75 mm] or more of cover after completing the splice. Fill the space between the abutting sections completely with the mixed epoxy.

(i) Secure the spliced sections in alignment until the epoxy is cured in accordance with the manufacturer's directions for the time appropriate with the prevailing ambient temperatures.

(j) After curing is completed, remove alignment braces and forms and clean and dress the spliced area to match the pile dimensions.

455-7.7.3 Precast Reinforced Build-ups: Construct Precast Reinforced Build-ups in accordance with the requirements of this Subarticle, Section 346, and Section 400. Provide the same material for the form surfaces for precast build-ups as was used to form the prestressed piles. Use concrete of the same mix as used in the prestressed pile and dimension the cross-section the same as piling being built up. Install build-ups as specified in 455-7.7.2(b) through 455-7.7.2(j) with the exception of 455-7.7.2(f). Apply to the build-ups the same surface treatment or sealant applied to the prestressed piles. The Department will make payment for authorized build-ups at the respective Contract unit prices per foot [meter] for Item No. 455-3 [Item No. 2455-3], Prestressed Concrete Piling Furnished.

455-8 Steel Piling.

455-8.1 Description: Furnish, splice, drive, and cut off structural steel shapes to form bearing piles. Include in this work the installation of bracing members of structural steel by bolting or welding and the construction of splices.

455-8.2 Material: For the material in rolled steel piles, pile bracing, scabs, wedges, and splices, meet the requirements for structural steel as specified in 962-2.

455-8.3 Pile Splices: Order and use the full authorized pile length where practicable. Do not splice to obtain authorized lengths less than 40 feet [12 m] except when shown in the plans. When approved by the Engineer, perform splicing to obtain authorized lengths between 40 and 60 feet [12 and 18 m]. The Engineer will permit splicing to obtain authorized lengths in excess of 60 feet [18 m].

Where the pile length authorized is not sufficient to obtain the required bearing value or penetration, order an additional length of pile and splice it to the original length.

Make all splices in accordance with the plan details. Payment for pile splicing will be limited as specified in 455-11.8.

455-8.4 Welding: Make all welded connections to steel piles by electric arc welding, in accordance with details shown in the plans and in compliance with the requirements of 460-6.

455-8.5 Pile Heads and Tips: Cut off all piles at the elevation shown in the plans. If using a cutting torch, make the surface as smooth as practical.

Where foundation material is so dense that the Contractor cannot drive the pile to the required penetration and firmly seat it without danger of crumpling the tip, reinforce the tips with approved cast steel point protectors as shown in the plans or required by the Engineer. Construct point protectors in one piece of cast steel meeting the requirements of ASTM A 27, Grade 65-35 [ASTM A 27M, Grade 450-240] heat treated to provide full bearing for the piles. Attach points by welding according to the recommendations of the manufacturer.

455-8.6 Pile Bent Bracing Members: Place structural steel sway and cross bracing, and all other steel tie bracing, on steel pile bents and bolt or weld in place as indicated in the plans. Where piles are not driven into position in exact alignment as shown in the plans, the Engineer may require the use of fills and shims between the bracing and the flanges of the pile. Furnish and place all fills and shims required to square and line up faces of flanges for cross bracing at no additional expense to the Department.

455-8.7 Painting: Paint exposed parts of steel piling, wedging, bracing, and splices in accordance with the provisions for painting structural steel as specified in Section 561, except as might be otherwise specified in the plans.

455-8.8 Storage and Handling: While handling or transporting the piles from the point of origin and into the leads, store and handle in the manner necessary to avoid damage due to bending stresses. In general, lift steel piles by means of a suitable bridge or a sling attached to the pile at appropriate points to prevent damage. Lift the pile from the horizontal position in a manner that will prevent damage due to bending of the flanges and/or web.

455-9 Sheet Piling.

455-9.1 Description: Leave permanent piling in place as part of the finished work and generally remove temporary piling after each construction phase.

455-9.2 Materials: Meet the following requirements:

Concrete with Air Entrainment ....Section 346
Bar Reinforcement 931-1.1
Prestressing Reinforcement..Section 933
Steel Sheet Piles 962-9.2*

* For temporary steel sheet piles meet the requirements specified in the plans.

455-9.3 Steel Sheet Piling: Drive steel sheet piling and cut off true to line and grade. Install steel sheet piling with a suitable hammer. Remove and replace any section damaged during handling and installation at no additional expense to the Department.

455-9.3.1 Method of Installation: Where rock or strong material is encountered such that the sheet piles cannot be set to grade by driving, remove the strong material by other acceptable means, such as excavation and backfilling or by punching. When the plans do not indicate the existence of rock or strong material, work of removing or punching the strong material or rock will be paid for as Unforeseeable Work.

455-9.4 Concrete Sheet Piling:

455-9.4.1 Description: Ensure that Concrete Sheet Piling is of prestressed concrete construction and manufactured, cured, and driven in accordance with the requirements of the Contract Documents. Use these piles in bulkheads and abutments and at other locations as shown in the plans.

455-9.4.2 Manufacture of Piles: Ensure that the piles are fabricated in accordance with Section 450.

455-9.4.3 Method of Installation: Jet concrete sheet piling to grade where practical. The Engineer will require a minimum of two jets. Provide water at the nozzles of sufficient volume and pressure to freely erode material adjacent to the piles. Where encountering rock or strong material, such that the sheet piles cannot be set to grade by jetting, remove the strong materials by other acceptable means, such as excavation and backfilling or by punching with a suitable punch. When the plans do not indicate the existence of rock or strong material and the piles cannot be set by jetting, the Department will pay for the work of removing or punching the strong material or rock as Unforeseeable Work.

455-9.4.4 Grouting and Caulking: Concrete sheet piles are generally detailed to have tongues and grooves on their lower ends, and double grooves on their upper ends. Where so detailed, after installation, clean the grooves of all sand, mud, or debris, and fully grout the grooves. Use approved plastic bags (sheaths) which will meet the shape and length of the groove to be grouted to contain the plastic grout within the double grooves. Provide grout composed of one part cement and two parts sand. The Contractor may use clean local sand or beach sand in this grout. In lieu of sand-cement grout, the Contractor may use Class I concrete, using small gravel or crushed stone coarse aggregate. Deposit the grout through a grout pipe placed within a watertight plastic sheath (bag) extending the full depth of the double grooves and which, when filled, completely fills the slot formed by the double grooves.

455-9.5 Storage and Handling: Handle and store all sheet piles in a manner to prevent damage. Handle long sheet piles with fabric slings or braided wire rope constructed of six or more wire ropes placed at appropriate lift points to prevent damage due to excessive bending.

455-10 Pile Installation Plan.

At the preconstruction conference, or no later than 30 days prior to driving the first pile, submit a pile installation plan for approval by the Engineer. Provide in this plan detailed information, including the following:

1. List and size of proposed equipment including cranes, barges, driving equipment, jetting equipment, compressors, and preformed pile hole equipment. Include manufacturer's data sheets on hammers, cranes, and compressors.

2. Department's Form Number 700-020-01-A and further described as follows:

(a) Manufacturer's specification data of the proposed hammer, including all modifications. These data include element weights, including ram weight, anvil weight, and helmet weight, rated energy, and the inside dimensions of the capblock and pile helmet assemblies.

(b) Complete description and dimensions, including thickness of the material in the capblock.

(c) Complete description and dimensions, including thickness of all the cushion material for use between the pile and hammer.

(d) Other requested pertinent information from the equipment manufacturer, cushion material suppliers, or other suitable sources necessary for input in the Wave Equation program.

3. Methods to determine hammer energy in the field for determination of pile capacity. Include in the submittal necessary charts and recent calibrations for any pressure measuring equipment.

4. Detailed drawings of any proposed followers.

5. Detailed drawings of templates.

6. Details of proposed load test equipment and procedures, including recent calibrations of jacks and required load cells.

7. Sequence of driving of piles for each different configuration of pile layout.

8. Proposed schedule for test pile program and production pile driving.

9. Details of proposed features and procedures for protection of existing structures.

10. Required shop drawings for piles, cofferdams, etc.

11. Methods and equipment proposed to prevent displacement of piles during placement and compaction of fill within 15 feet [4.5 m] of the piles.

12. Methods to prevent deflection of battered piles due to their own weight and to maintain their as-driven position until casting of the pile cap is complete.

13. Other information shown in the plans or required by the Engineer.

The Engineer will evaluate the pile installation plan for conformance with the Contract Documents requirements. Within 20 days after receipt of the plan, the Engineer will notify the Contractor of any additional information required and/or changes that may be necessary in the opinion of the Engineer to meet the Contract Documents requirements. The Engineer will reject any parts of the plan that are unacceptable. Resubmit changes agreed upon for reevaluation. The Engineer will notify the Contractor within seven days after receipt of proposed changes of their acceptance or rejection. All approvals given by the Engineer shall be subject to satisfactory field performance. Make any required changes that may result from unsatisfactory field performance. The Engineer will give final acceptance after the Contractor makes necessary modifications. Make no changes in the driving system after final approval without the further approval of the Engineer.

455-11 Method of Measurement (All Piling).

455-11.1 Treated Timber Piling: The quantity to be paid for will be the length, in feet [meters], furnished, placed, and accepted according to the authorized lengths list, including any additions and excluding any deletions thereto, as approved by the Engineer.

455-11.2 Prestressed Concrete Piling:

455-11.2.1 General: The quantity to be paid for will be as follows:

(1) The length, in feet [meters], of Prestressed Concrete Piling Furnished and accepted according to the authorized lengths list, including any additions and excluding any deletions thereto, as approved by the Engineer.

(2) The length, in feet [meters], of Prestressed Concrete Piling Driven measured from elevation of cut-off to tip of pile and accepted.

455-11.2.2 Furnished Length: The furnished length of precast concrete piles will be considered as the overall length from head to tip. Final pay length will be based on the casting length as authorized in accordance with 455-5.14.3 subject to provisions of 455-11.2.3 through 455-11.2.12, 455-11.8 and 455-11.9.

455-11.2.3 Build-ups: The lengths of pile build-ups authorized by the Engineer, measured from the plane of cutback or the joint between the sections, to head of build-up, will be included in the quantities of piling furnished.

455-11.2.4 Piles Requiring Cut-offs: No deduction from the length, in feet [meters], of piling furnished will be made if cut-offs are required after the pile has been driven to satisfactory bearing.

455-11.2.5 Piles Driven Below Cut-off Elevation: Where a pile is driven below cut-off elevation and satisfactory bearing is obtained so that no further driving is required, the length of pile driven will be measured from cut-off elevation to tip of the pile.

455-11.2.6 Use of Cut-offs as Build-ups: The length of cut-off sections used as build-ups, measured from the top of the original pile to elevation of cut-off, will be included for payment as Piling Driven, unless the cut-off section is transported to another bridge site under the same contract and used as a build-up, in which case it will be paid for at 30% of the furnished price and 100% of the driven price. No additional payment for Piling Furnished will be made if used at the same bridge site.

455-11.2.7 Use of Cut-offs as Permanent Piles: Pile cut-offs which meet specification requirements and are driven as permanent piles will be paid for as follows: If the cut-off section is to be driven in the same bridge, or adjacent bridge of a dual bridge, pile cut-offs will be paid for only as Piling Driven. If the section of piling is taken from another bridge in the same Contract, it will be paid for at 30% of the Contract price for Piling Furnished and 100% of the Contract price for Piling Driven.

455-11.2.8 Driving of Splice: If a pile is driven below cut-off and satisfactory bearing is not obtained, and additional driving is required after construction of a satisfactory splice, an additional 10 feet [3.0 m] of piling furnished will be paid for the additional driving. This compensation for driving of splice, however, will not be allowed for test piles that are spliced and redriven.

455-11.2.9 Replacing Piles: In the event a pile is broken or otherwise damaged to the extent that the damage is irreparable, in the opinion of the Engineer, the Contractor shall extract and replace the pile at no additional expense to the Department. In the event that a pile is mislocated by the Contractor, the Contractor shall extract and replace the pile at no expense to the Department except when a design change proposed by the Contractor is approved by the Department as provided in 455-5.15.5.

In the event that a pile is driven below cut-off without obtaining the required bearing, and the Engineer elects to have the pile pulled and a longer pile substituted therefor, it will be paid for as Unforeseeable Work. In the event a pile is damaged or mislocated, and the damage or mislocation is determined to be the Department's responsibility, the Engineer may elect to have the pile extracted, and it will be paid for as Unforeseeable Work. If the extracted pile is undamaged and driven elsewhere its length will again be included in the quantity of piling driven, but no additional compensation will be made under the item of piling furnished. When the Department determines that it is responsible for damaged or mislocated pile, and a replacement pile is required, compensation will be made under the item for piling furnished, for both the original pile and replacement pile.

The Contractor may substitute a longer pile in lieu of splicing and building-up a pile. In this event, the Contractor will be paid for the original authorized length of the pile, plus any additional length furnished by the Contractor up to the authorized length of the build-up, as piling furnished. No payment will be made for extracting the original pile furnished or will any payment be made for a pile splice.

455-11.2.10 Underwater Driving: When the Contractor selects one of the optional underwater driving methods, payment will be made by selecting the applicable method from the following:

(a) Using a pile longer than the authorized length: Payment for piling furnished will be made only for the authorized length at that location unless the length of pile from cut-off elevation to the final tip elevation is greater than the authorized length, in which case payment for piling furnished will be made from cut-off elevation to final tip elevation. No payment will be made for pile splice, when this option is selected, unless the pile is physically spliced and the splice is driven below cut-off elevation to achieve bearing. When making and driving a pile splice below cut-off elevation to achieve bearing, the length to be paid for piling furnished will be the length between cut-off elevation and final pile tip elevation. The length to be paid for piling driven will be from pile cut-off elevation to final tip elevation for all cases cited.

(b) Using an underwater hammer: Payment for piling and pile splices will be in accordance with 455-11.2.1 through 455-11.2.7 and 455-11.2.10. The Contractor shall furnish additional lengths required to provide the full length confirmation pile at no expense to the Department. Payment for piling furnished for the full length confirmation pile will be the authorized length of the pile, unless the length driven below cut-off elevation is greater than the authorized length, in which case the furnished length to be paid for will be the length between cut-off elevation and the final tip elevation. Splices in confirmation piles will be paid for only when the splice is driven below cut-off elevation.

(c) Using a pile follower: When a pile follower is used with a conventional pile driving system, the method of payment will be the same as shown above in 455-11.2.10(b).

455-11.2.11 Set-Checks/Test Piles: As described in 455-5.12.1, there will be no separate payment for the initial four set-checks performed within 72 hours of initial driving. For each additional set-check performed within 72 hours of initial driving, an additional quantity of 10 feet [3.0 m] piling furnished will be paid.

455-11.2.12 Set-Check/Production Piles: As described in 455-5.10.4(a), there will be no separate payment for one initial set-check. For each additional set-check performed within 72 hours from the end of initial driving, an additional quantity of 10 feet [3.0 m] of piling furnished will be paid.

455-11.3 Steel Piling:

455-11.3.1 General: The quantity to be paid for will be as follows:

(1) The length, in feet [meters], of Steel Piling Furnished and accepted, according to the authorized length list, including any additions and excluding any deletions thereto as approved by the Engineer.

(2) The length, in feet [meters], of Steel Piling Driven, measured from elevation of cut-off to tip of pile, and accepted.

455-11.3.2 Point Protectors: The quantity to be paid for will be each for the total of point protectors authorized, furnished, and properly installed.

455-11.4 Test Piles: The quantity to be paid for of test piles of various types, will be as follows:

(1) The length, in feet [meters], of Test Piling Furnished and accepted, according to the authorized length list, and any additions or deletions thereof as approved by the Engineer.

(2) The length, in feet [meters], of Test Piling Driven, measured from elevation of cut-off to tip of pile, and accepted for test piles incorporated in the structure or from the elevation shown in the plans to tip of pile, and accepted for test piles not incorporated in the structures.

Where a test pile is left in place as a permanent pile, it will be paid for only as Test Piles Furnished and Test Piles Driven. Any build-ups necessary to continue driving the pile for test purposes, as authorized by the Engineer, will be paid for as Test Piles Furnished and Test Piles Driven. Other build-ups made only to incorporate the pile into the structure as a permanent pile will be included in the quantities of regular Piling Furnished and Piling Driven and will not be paid for as Test Piling.

455-11.5 Dynamic Load Tests: The quantity to be paid for will be the number of dynamic load tests as shown in the plans or authorized by the Engineer, actually applied to piles, completed and accepted in accordance with the Contract Documents. Dynamic load tests may be applied to test piles and/or production piles.

No separate payment will be made for dynamic load tests used to evaluate the Contractor's driving equipment. This will generally be done on the first test pile or production pile driven on a project with each combination of proposed hammer and pile size and/or a separate pile to evaluate any proposed followers, or piles driven to evaluate proposed changes in the driving system.

The price for Dynamic Load Tests will include all costs related to dynamic testing as described in 455-5.13 including the initial instrumented drive, up to two set-checks, and two additional instrumented set-checks within 72 hours after the initial driving of a dynamic load test pile. In the event the Engineer requires an instrumented redrive of a pile previously instrumented more than 72 hours after initial driving, it will be paid for at 2 the bid price for a Dynamic Load Test.

455-11.6 Steel Sheet Piling: The quantity to be paid for will be the plan quantity area, in square feet [square meters], measured from top of pile elevation to the bottom of pile elevation and longitudinally along the top of the sheet piles as shown in the plans. Sheet piling used in cofferdams and to incorporate the Contractor's specific means and methods, and not ordered by the Engineer, will be paid for as required in Section 125.

455-11.7 Concrete Sheet Piling: The quantity to be paid for will be the product of the number of such piles satisfactorily completed, in place, times their lengths in feet [meters] as shown in the plans or authorized by the Engineer.

When the Engineer approves, the Contractor may furnish the concrete sheet piling in widths wider than shown in the plans; then the number of piles shall be the actual number of units completed times the width used divided by the width in the plans.

455-11.8 Pile Splices: Authorized splices in concrete piling, steel piling and test piling, which are made for the purpose of obtaining greater lengths than originally authorized by the Engineer, or to incorporate test piling in the finished structure, or for further driving of test piling, will be paid for as described in 455-12.13. No separate payment will be made for splices required to obtain the authorized length.

For concrete piles, where the head of the pile to be spliced is not more than 2 feet [0.6 m] below the elevation of cut-off, the Contractor, if he so elects, may cast the pile build-up with the cap, under the following conditions:

(a) Reinforcing steel and pile dimensions will conform in every respect to a standard splice.

(b) Reinforcing steel used for the build-up will be paid for as an overrun in the Contract quantity for substructure reinforcing steel.

(c) Concrete used for the build-up will be paid for as an overrun in the Contract quantity for substructure concrete.

(d) 9 feet [2.7 m] of piling furnished, will be paid for as compensation for drilling and grouting the dowels and all other costs for which provision has not otherwise been made.

(e) No payment for the build-up will be made under the item for Piling Furnished.

455-11.9 Pile Redrive: The quantity to be paid for will be the number of redrives, each, authorized by the Engineer. Pile Redrive is defined in 455-5.10.4(b). Payment for any pile redrive ordered by the Engineer will consist of 20 feet [6.0 m] of additional piling furnished. The size of the pile redriven will be the same size as the furnished item for payment.

Pile Redrive will be paid under any of the following conditions:

(a) When the Engineer directs the Contractor to redrive a pile to determine its capacity as described in 455-5.10.4.

(b) When the Engineer orders the Contractor to redrive piles to reestablish their capacity as the result of pile heave as described in 455-5.10.5.

455-11.10 Pile Extraction: Piles authorized to be extracted by the Engineer and successfully extracted as provided in 455-11.2.9 will be paid for as Unforeseeable Work. No payment for extraction will be made for piles shown in the plans to be extracted or piling damaged or mislocated by the Contractor that are ordered to be extracted by the Engineer.

455-11.11 Protection of Existing Structures: The quantity to be paid for will be at the Contract lump sum price. When the Contract Documents do not include an item for protection of existing structures, the cost of settlement monitoring as required by these Specifications will be included in the cost of the piling items; however, work in addition to settlement monitoring will be paid for as Unforeseeable Work when such additional work is ordered by the Engineer.

455-11.12 Static Load Tests: The quantity to be paid for will be the number of static load tests of the designated tonnages, each, as shown in the plans or authorized by the Engineer, actually applied to piles, completed and accepted in accordance with the plans and these Specifications.

455-11.13 Preformed Pile Holes: The quantity to be paid for will be the number of completed Preformed Pile Holes acceptably provided, complete for the installation of the bearing piles, regardless of the type of pile installed therein. Only those holes authorized to be paid for, as provided in 455-5.9.3, will be included in the measurement for payment. The Engineer will authorize payment for Preformed Pile Holes only when the pile has been placed in proper position and has achieved the required penetration.

When preformed holes are used to obtain total penetration of the piles in excess of 20 feet [6 m], the work of preforming the holes will be considered as Unforeseeable Work except when the required penetration in excess of 20 feet [6 m] is shown in the plans as provided in 455-5.9.3.

455-12 Basis of Payment (All Piling).

455-12.1 Treated Timber Piling: Price and payment will be full compensation for furnishing all materials, including collars, metal shoes, copper cover sheets, preservatives and tar, and for wrapping pile clusters with wire cable, where so shown in the plans.

455-12.2 Prestressed Concrete Piling: Price and payment will be full compensation for the cost of furnishing and placing all reinforcing steel, cutting off and predrilling the piles, and furnishing the material for and wrapping pile clusters with wire cable where so shown in the plans. The unit price per foot [meter] for Piling Driven will also include the cost of predrilling pile holes described in 455-5.1.1.

455-12.3 Steel Piling: Price and payment will be full compensation for furnishing all materials, including welding and painting as specified. The unit price per foot [meter] for Piling Driven will also include the cost of predrilling pile holes described in 455-5.1.1.

Bracing and other metal parts attached to or forming a part of piling or bracing and not otherwise classified, will be measured and paid for as provided in Section 460.

455-12.4 Test Piles: Price and payment will be full compensation for all incidentals necessary to complete all the work of this item except splices, build-ups, pile extractions and preformed pile holes authorized by the Engineer and paid for under the regular piling items. The cost of all work necessary to ensure required penetration and attain required bearing of the test piles will be included in the price bid per foot [meter] of Test Pile Driven, including driving and all other related costs.

455-12.5 Dynamic Load Tests: Price and payment will be full compensation for all labor, equipment, and materials required to perform this work.

455-12.6 Steel Sheet Piling: Price and payment will be full compensation for all labor, equipment, and materials required for furnishing and installing steel sheet piling, but will not include furnishing and placing anchors when an anchored wall system, temporary or permanent, is designed and detailed in the plans. In such cases, furnishing and installing anchors will be paid for separately. For installations designed by the Contractor, the cost of furnishing and installing anchors will be incidental to the cost of steel sheet piling. For temporary installations, removal of the sheet piling, anchors, and incidentals will be included in the cost per square foot [square meter] for Steel Sheet Piling (Temporary).

455-12.7 Concrete Sheet Piling: Price and payment will be full compensation for furnishing all materials, including reinforcing steel and grouting.

455-12.8 Preformed Pile Holes: Price and payment will be full compensation for all labor, equipment, and materials required to perform this work.

455-12.9 Protection of Existing Structures: Price and payment will be full compensation for all labor, equipment, and materials required to perform this work.

455-12.10 Point Protectors: Price and payment will be full compensation for all labor, equipment, and materials required to perform this work.

455-12.11 Static Load Tests: Price and payment will be full compensation for all labor, equipment, and materials required to perform this work.

455-12.12 Pile Splices: The quantity of this item will be determined as provided in 455-11.8. Payment for each Steel Pile Splice authorized by the Engineer will be made as 20 feet [6 m] of additional piling furnished. Payment for each Concrete Pile Splice authorized by the Engineer will be made as 30 feet [9 m] of additional piling furnished.

455-12.13 Prestressed Concrete Pile Cut-Off: There will be no separate pay item for pile cut-off. Payment for each cut-off will be made as 5 feet [1.5 m] of additional piling furnished.

455-12.14 Payment Items: Payment will be made under:

Item No. 455- 2- Treated Timber Piling - per foot.
Item No. 2455- 2- Treated Timber Piling - per meter.
Item No. 455- 3- Prestressed Concrete Piling Furnished - per foot.
Item No. 2455- 3- Prestressed Concrete Piling Furnished - per meter.
Item No. 455- 4- Prestressed Concrete Piling Driven - per foot.
Item No. 2455- 4- Prestressed Concrete Piling Driven - per meter.
Item No. 455- 7- Steel Piling Furnished - per foot.
Item No. 2455- 7- Steel Piling Furnished - per meter.
Item No. 455- 8- Steel Piling Driven - per foot.
Item No. 2455- 8- Steel Piling Driven - per meter.
Item No. 455- 14- Concrete Sheet Piling - per foot.
Item No. 2455- 14- Concrete Sheet Piling - per meter.
Item No. 455- 15- Preformed Pile Holes - each.
Item No. 2455- 15- Preformed Pile Holes - each.
Item No. 455- 18- Protection of Existing Structures - lump sum.
Item No. 2455- 18- Protection of Existing Structures - lump sum.
Item No. 455-119- Test Loads- each.
Item No. 2455-119- Test Loads- each.
Item No. 455-120- Point Protection - each.
Item No. 2455-120- Point Protection - each.
Item No. 455-133- Steel Sheet Piling - per square foot.

Item No. 2455-133- Steel Sheet Piling - per square meter.
Item No. 455-137- Dynamic Load Tests - each.
Item No. 2455-137- Dynamic Load Tests - each.
Item No. 455-140- Test Piles Furnished - per foot.
Item No. 2455-140- Test Piles Furnished - per meter.
Item No. 455-141- Test Piles Driven - per foot.
Item No. 2455-141- Test Piles Driven - per meter.

C. DRILLED SHAFTS

455-13 Description.

Construct drilled shaft foundations consisting of reinforced, or unreinforced when indicated in the plans, concrete drilled shafts with or without bell footings.

455-14 Materials.

455-14.1 Concrete: For all concrete materials, meet the requirements of Section 346. Use concrete that is specified in the plans.

455-14.2 Reinforcing Steel: Meet the reinforcing steel requirements of Section 415. Ensure that reinforcing steel is in accordance with the sizes, spacing, dimensions, and the details shown in the plans.

455-15 Construction Methods and Equipment.

455-15.1 General Requirements:

455-15.1.1 Templates: Provide a fixed template, adequate to maintain shaft position and alignment during all excavation and concreting operations, when drilling from a barge. Do not use floating templates (attached to a barge). The Engineer will not require a template for shafts drilled on land provided the Contractor demonstrates satisfactorily to the Engineer that shaft position and alignment can be properly maintained. The Engineer will require a fixed template, adequate to maintain shaft position and alignment during all excavation and concreting operations, for shafts drilled on land when the Contractor fails to demonstrate satisfactorily that he can properly maintain shaft position and alignment without use of a template.

455-15.1.2 Drilled Shaft Installation Plan: At the preconstruction conference or no later than 30 days before beginning drilled shaft construction, submit a drilled shaft installation plan for approval by the Engineer. Include in this plan the following details:

1. Name and experience record of drilled shaft superintendent or foreman in responsible charge of drilled shaft operations. Ensure that the person in responsible charge of day to day drilled shaft operations has prior experience constructing shafts similar to those described in the Contract Documents. Final approval by the Engineer will be subject to performance in the field.

2. List and size of proposed equipment, including cranes, drills, augers, bailing buckets, final cleaning equipment, desanding equipment, slurry pumps, core sampling equipment, tremies or concrete pumps, casings, etc.

3. Details of sequence of construction operations and sequence of shaft construction in bents or shaft groups.

4. Details of shaft excavation methods.

5. Details of slurry, including proposed methods to mix, circulate, desand, test methods, and proposed testing laboratory to document test results.

6. Details of proposed methods to clean shaft after initial excavation.

7. Details of shaft reinforcement, including methods to ensure centering/required cover, cage integrity during placement, placement procedures, cage support, and tie downs.

8. Details of concrete placement, including proposed operational procedures for concrete tremie or pump, including initial placement, raising during placement, and overfilling of the shaft concrete. Also provide provisions to ensure proper final shaft cutoff elevation.

9. Details of casing removal when removal is required, including minimum concrete head in casing during removal.

10. Required submittals, including shop drawing and concrete design mixes.

11. Details of any required load tests, including equipment and procedures, and recent calibrations for any jacks or load cells.

12. Methods and equipment proposed to prevent displacement of casing and/or shafts during placement and compaction of fill.

13. Details of environmental control procedures used to prevent loss of slurry or concrete into waterways or other protected areas.

14. Other information shown in the plans or requested by the Engineer.

The Engineer will evaluate the drilled shaft installation plan for conformance with the Contract Documents. Within 20 days after receipt of the plan, the Engineer will notify the Contractor of any additional information required and/or changes that may be necessary in the opinion of the Engineer to satisfy the Contract Documents. The Engineer will reject any part of the plan that is unacceptable. Submit changes agreed upon for reevaluation. The Engineer will notify the Contractor within seven days after receipt of proposed changes of their acceptance or rejection. All approvals given by the Engineer are subject to trial and satisfactory performance in the field.

Demonstrate the adequacy of methods and equipment during construction of the first drilled shaft which shall be an out-of-position test hole generally constructed as an unreinforced shaft. Drill this test hole in the position shown in the plans or as directed by the Engineer and drill to the maximum depth for any production shaft shown in the plans. Failure to demonstrate the adequacy of methods or equipment to the Engineer is cause for the Engineer to require appropriate alterations in equipment and/or method by the Contractor to eliminate unsatisfactory results. Provide any additional test holes required to demonstrate the adequacy of methods or equipment at no expense to the Department. Make no changes in methods or equipment after initial approval without the consent of the Engineer.

A separate test hole is not required for drilled shafts installed under mast arms, cantilever signs, overhead truss signs, high mast light poles or other miscellaneous structures. The first production shaft will serve as a test hole for determining acceptablility of the installation method.

455-15.1.3 General Methods & Equipment: Perform the excavations required for the shafts and bell footings, through whatever materials encountered, to the dimensions and elevations shown in the Contract Documents, using methods and equipment suitable for the intended purpose and the materials encountered. Provide equipment capable of constructing shafts supporting bridges to a depth equal to the deepest shaft shown in the plans plus 15 foot [4.5 m] or plus three times the shaft diameter, whichever is greater, except when the plans require equipment capable of constructing shafts to a deeper depth. Provide equipment capable of constructing shafts supporting non-bridge structures, including mast arms, signals, signs and light supports to a depth equal to the deepest shaft shown in the plans plus 5 feet [1.5 m].

Construct drilled shafts according to the Contract Documents using generally either the dry method, wet method, casing method, or permanent casing method as necessary to produce sound, durable concrete foundation shafts free of defects. Use the permanent casing method only when required by the plans or authorized by the Engineer. When the plans describe a particular method of construction, use this method except when permitted otherwise by the Engineer after field trial. When the plans do not describe a particular method, propose a method on the basis of its suitability to the site conditions and submit it for approval by the Engineer.

Set a suitable temporary removable surface casing. The minimum surface casing length is the length required to prevent caving of the surface soils and to aid in maintaining shaft position and alignment. The Engineer may require predrilling with slurry and/or overreaming to the outside diameter of the casing to install the surface casing at some sites.

455-15.2 Dry Construction Method: Use the dry construction method only at sites where the ground water table and soil conditions, generally stiff to hard clays or rock above the water table, make it feasible to construct the shaft in a relatively dry excavation and where the sides and bottom of the shaft are stable and may be visually inspected by the Engineer prior to placing the concrete.

In applying the dry construction method, drill the shaft excavation, remove accumulated seepage water and loose material from the excavation and place the shaft concrete in a relatively dry excavation.

Use the dry construction method only when shaft excavations, as demonstrated in a test hole, have 12 inches [300 mm] or less of seepage water accumulated over a four hour period, the sides and bottom remain stable without detrimental caving, sloughing, or swelling for a four hour period, and the loose material and water can be satisfactorily removed prior to inspection and prior to placing concrete. Use the wet construction method or the casing construction method for shafts that do not meet the requirements for the dry construction method.

Provide temporary surface casings to aid shaft alignment and position and to prevent sloughing unless the Engineer determines by demonstration that the surface casing is not required.

455-15.3 Wet Construction Method: Use the wet construction method at all sites where it is impractical to provide a dry excavation for placement of the shaft concrete.

The wet construction method consists of drilling the shaft excavation below the water table, keeping the shaft filled with fluid (mineral slurry, natural slurry or water), desanding and cleaning the mineral slurry and final cleaning of the excavation by means of a bailing bucket, air lift, submersible pump or other approved devices and placing the shaft concrete (with a tremie or concrete pump extending to the shaft bottom) which displaces the water or slurry during concreting of the shaft excavation. Provide temporary surface casings to aid shaft alignment and position and to prevent sloughing of the top of the shaft except when the Engineer declares that the surface casing is not required.

Where drilled shafts are located in open water areas, construct the shafts by the wet method using exterior casings extending from above the water elevation into the ground to protect the shaft concrete from water action during placement and curing of the concrete. Install the exterior casing in a manner that will produce a positive seal at the bottom of the casing so that there is no intrusion or extrusion of water or other materials into or from the shaft excavation.

If proposed, demonstrate in a test hole, that split casings can produce a positive seal for their entire length which will prevent intrusion of water into the shaft or extrusion of concrete or other materials from the shaft.

455-15.4 Casing Construction Method: Use the casing method at all sites where it is inappropriate to use the dry or wet construction methods without the use of temporary casings other than surface casings. In this method, the hole is advanced through caving material by the wet method as described above. When a formation is reached that is nearly impervious, place a casing in the hole and seal in the nearly impervious formation. Proceed with drilling as with the dry method to the projected depth. Proceed with the placement of the concrete as with the dry method except withdraw the casing after placing the concrete. In the event seepage conditions prevent use of the dry method, complete the excavation and concrete placement using wet methods.

Where drilling through materials having a tendency to cave, advance the excavation by drilling in a mineral slurry. In the event that a caving layer or layers are encountered that cannot be controlled by slurry, install temporary removable casing through such caving layer or layers. The Engineer may require overreaming to the outside diameter of the casing. Take whatever steps are required to prevent caving during shaft excavation including installation of deeper casings. If electing to remove a casing and replace it with a longer casing through caving soils, adequately stabilize the excavation with slurry or backfill the excavation. The Contractor may use soil previously excavated or soil from the site if backfilling the excavation. The Contractor may use other approved methods which will control the size of the excavation and protect the integrity of the foundation soils to excavate through caving layers.

Before withdrawing the casing, ensure that the level of fresh concrete is at such a level that the fluid trapped behind the casing is displaced upward. As the casing is withdrawn, maintain the level of concrete within the casing so that fluid trapped behind the casing is displaced upward out of the shaft excavation without mixing with or displacing the shaft concrete.

The Contractor may use the casing method, when approved by the Engineer, to construct shafts through weak caving soils that do not contribute significant shaft shear resistance. In this case, place a temporary casing through the weak caving soils before beginning excavation. Conduct excavation using the dry construction method where appropriate for site conditions and the wet construction method where the dry construction method is not appropriate. Withdraw the temporary casing during the concreting operations unless the Engineer approves otherwise.

455-15.5 Permanent Casing Method: Use the permanent casing method when required by the plans. In this method, place a casing to the prescribed depth before beginning excavation. If the Contractor cannot attain full penetration, the Engineer may direct the Contractor to excavate through the casing and advance the casing until reaching the desired penetration. In some cases the Engineer may require the Contractor to overream the outside diameter of the casing before placing the casing.

Cut the casing off at the prescribed elevation upon reaching the proper construction sequence and leave the remainder of the casing in place.

455-15.6 Excavations: The Contractor may extend drilled shaft excavations deeper by extra depth excavation when the Engineer determines that the material encountered while drilling the shaft excavation is unsuitable and/or is not the same as anticipated in the design of the drilled shaft.

Take cores when shown in the plans or directed by the Engineer to determine the character of the material directly below the shaft excavation. Cut the cores with an approved core barrel to a minimum depth of 5 feet [1.5 m] below the bottom of the drilled shaft excavation when completing the shaft excavation. The Engineer may require the Contractor to cut any core below the 5 foot [1.5 m] minimum depth and up to a total depth of 20 feet [6 m] below the bottom of the drilled shaft excavation. The Engineer will inspect the cores and determine the depth of required excavation. When considered necessary by the Engineer, take additional cores.

When shown in the plans, prior to excavation, take a core (Shaft Excavation) through part or all of the shaft, to a depth up to 20 feet [6 m] below that shaft's planned tip elevation.

Use a core barrel designed:

(a) to cut a core sample from 4 to 6 inches [100 to 150 mm] in diameter,

(b) so that the sample of material cored can be removed from the shaft excavation and the core barrel in an undisturbed state, and

(c) in sufficient length to provide core samples, as directed by the Engineer up to a depth of 20 feet [6 m] below the bottom of the drilled shaft excavation.

When called for in the plans, substitute Standard Penetration Tests (SPT) for coring. In such cases, supply these tests at no additional cost per foot [meter] to the Department above that bid for core (shaft excavation).

Maintain a drilling log during shaft excavation and during coring operations that contains information such as the description of and approximate top and bottom elevation of each stratum encountered, depth of penetration, drilling time in each of the various strata, material description, and remarks. Classify, measure, and describe core samples in the drilling log. Place the core samples in suitable containers, identified by shaft location, elevation from and to, and job number, and deliver to the Department within 48 hours after cutting. Furnish two copies of the drilling log, signed by a designated representative of the Contractor and co-signed by a designated representative of the Department, to the Department at the time the shaft excavation is completed and accepted.

Provide areas for the disposal of unsuitable materials and excess materials as defined in 120-5 that are removed from shaft excavations, and dispose of them in a manner meeting all requirements pertaining to pollution.

When shown in the plans, excavate bells to form a bearing area of the size and shape shown. Bell outlines varying from those shown in the plans are permissible provided the bottom bearing area equals or exceeds that specified. If the diameter of the bell exceeds three times the shaft diameter, drill the excavation deeper as directed and form a new bell footing. Excavate bells by mechanical methods.

Furnish the additional drilled shaft concrete over the theoretical amount required to complete filling any excavations for bells and shafts which are larger than required by the plans or authorized by the Engineer, at no expense to the Department.

455-15.7 Casings: Ensure that casings are metal, or concrete when indicated in the plans, of ample strength to withstand handling and driving stresses and the pressure of concrete and of the surrounding earth materials, and that they are smooth and water tight. Ensure that the inside diameter of casing is not less than the specified size of shaft except as provided below. The Department will not allow extra compensation for concrete required to fill an oversize casing or oversize excavation.

The Engineer will allow the Contractor to supply casing with an outside diameter equal to the specified shaft diameter (O.D. casing) provided he supplies additional shaft length at the shaft tip. Determine the additional length of shaft required by the following relationship:

$$\textit{Additional length} = \frac{(D_1 - D_2)\,L}{D_2}$$

where:

D_1= casing inside diameter specified = shaft diameter specified

D_2= casing inside diameter provided (D_2 = D_1 minus twice the wall thickness).

L= authorized shaft length below ground

Bear all costs relating to this additional length including but not limited to the cost of extra excavation, extra concrete, and extra reinforcing steel.

Remove all casings from shaft excavations except those used for the Permanent Casing Method. Ensure that the portion of casings installed under the Permanent Casing Method of construction below the shaft cut-off elevation remains in position as a permanent part of the Drilled Shaft. The Contractor may leave casings if in the opinion of the Engineer the casings will not adversely affect the shaft capacity in place. When casings that are to be removed become bound in the shaft excavation and cannot be practically removed, drill the shaft excavation deeper as directed by the Engineer to compensate for loss of capacity due to the presence of the casing. The Department will not compensate for the casing remaining. The

Department will pay for the additional length of shaft under Item No. 455-88 [Item No. 2455-88] and the additional excavation under Item No. 455-125 [Item No. 2455-125].

When the shaft extends above ground or through a body of water, the Contractor may form the portion exposed above ground or through a body of water, with removable casing except when the Permanent Casing Method is specified (see 455-23.10). When approved, the Contractor may form drilled shafts extending through a body of water with permanent or removable casings. However, for permanent casings, remove the portion of metal casings between an elevation 2 feet [0.6 m] below the lowest water elevation and the top of shaft elevation after the concrete is cured. Dismantle casings removed to expose the concrete as required above in a manner which will not damage the drilled shaft concrete. Dismantle removable casings in accordance with the provisions of 455-17.5.

Generally when removal of the temporary casing is required, do not start the removal until completing all concrete placement in the shaft. The Engineer will permit movement of the casing by rotating, exerting downward pressure, and tapping it to facilitate extraction, or extraction with a vibratory hammer. Extract casing at a slow, uniform rate with the pull in line with the axis of the shaft. Withdraw temporary casings while the concrete remains fluid.

When conditions warrant, the Contractor may pull the casing in partial stages. Maintain a sufficient head of concrete above the bottom of the casing to overcome the hydrostatic pressure of water outside the casing. At all times maintain the elevation of the concrete in the casing high enough to displace the drilling slurry between the outside of the casing and the edge of the hole while removing the casing.

The Contractor may use special casing systems in open water areas, when approved, which are designed to permit removal after the concrete has hardened. Design special casings so that no damage occurs to the drilled shaft concrete during their removal.

455-15.8 Slurry and Fluid in Excavation at Time of Concrete Placement:

455-15.8.1 Slurry: When slurry is used in an excavation, use only mineral slurry of processed attapulgite or bentonite clays. The Engineer will not allow polymer slurries. Use slurry having a mineral grain size such that it will remain in suspension and having sufficient viscosity and gel characteristics to transport excavated material to a suitable screening system. Use a percentage and specific gravity of the material to make the suspension sufficient to maintain the stability of the excavation and to allow proper placement of concrete. Ensure that the material used to make the slurry is not detrimental to concrete or surrounding ground strata. During construction, maintain the level of the slurry at a height sufficient to prevent caving of the hole. In the event of a sudden significant loss of slurry such that the slurry level cannot practically be maintained by adding slurry to the hole, delay the construction of that foundation until an alternate construction procedure has been approved.

Thoroughly premix the mineral slurry with clean fresh water prior to introduction into the shaft excavation. Ensure that the percentage of mineral admixture used to make the suspension is such as to maintain the stability of the shaft excavation. The Engineer will require adequate water and/or slurry tanks when necessary to perform the work in accordance with these Specifications. The Engineer will not allow excavated pits on projects requiring slurry tanks without the written permission of the Engineer. The Engineer will require adequate desanding equipment when shown in the Contract Documents. However, the Engineer will not require desanding equipment for drilled shafts for sign post or lighting mast foundations unless shown in the Contract Documents. Take the steps necessary to prevent the slurry from "setting up" in the shaft, including but not limited to agitation, circulation, and/or adjusting the composition and properties of the slurry. Provide suitable offsite disposal areas and dispose of all waste slurry in a manner meeting all requirements pertaining to pollution.

Provide a qualified professional soil testing laboratory approved by the Engineer to perform control tests using suitable apparatus on the mineral slurry mixture to determine the following parameters:

(a) Freshly mixed mineral slurry: Measure the density of the freshly mixed mineral slurry regularly as a check on the quality of the suspension being formed using a measuring device calibrated to read within ∀0.5 lb/ft^3 [∀8 kg/m^3].

(b) Mineral slurry supplied to the drilled shaft excavation: Perform the following tests on the mineral slurry supplied to the shaft excavation and ensure that the results are within the ranges stated in the table below:

Non SI Units

Item to be measured	Range of Results at 68EF	Test Method
Density	64 to 73 lb/ft^3 (in fresh water) 66 to 75 lb/ft^3 (in salt water)	Mud density balance: FM 8-RP13B-1
Viscosity	28 to 40 seconds	Marsh Cone Method: FM 8-RP13B-2
pH	8 to 11	Electric pH meter or pH indicator paper strips: FM 8-RP13B-4
Sand Content	4% or less	FM 8-RP13B-3

SI Units

Item to be measured	Range of Results at 20EC	Test Method
Density	1030 to 1170 kg/m^3 (in fresh water) 1060 to 1200 kg/m^3 (in salt water)	Mud density balance: FM 8-RP13B-1
Viscosity	28 to 40 seconds	Marsh Cone Method: FM 8-RP13B-2
pH	8 to 11	Electric pH meter or pH

SI Units

Item to be measured	Range of Results at 20EC	Test Method
		indicator paper strips: FM 8-RP13B-4
Sand Content	4% or less	FM 8-RP13B-3

The Contractor may adjust the limits in the above table(s) when field conditions warrant as successfully demonstrated in a Test Hole or with other methods approved by the Engineer. The Engineer must approve all changes in writing before the Contractor can continue to use them.

Perform tests to determine density, viscosity, and pH value to establish a consistent working pattern, taking into account the mixing process and blending of freshly mixed mineral slurry and previously used mineral slurry. Perform a minimum of four sets of tests to determine density, viscosity, and pH value during the first 8 hours mineral slurry is in use.

When the results show consistent behavior, discontinue the tests for pH value, and only carry out tests to determine density and viscosity during each four hours mineral slurry is in use. If the consistent working pattern changes, reintroduce the additional tests for pH value for the time required to establish consistency of the test values within the required parameters.

(c) Furnish reports of all mineral slurry tests required above, signed and sealed by a Specialty Engineer, representing the soil testing laboratory to the Department on completion of each drilled shaft.

(d) The Department may perform comparison tests as determined necessary during the mineral slurry operations.

During construction, maintain the level of mineral slurry in the shaft excavation within the excavation and at a level not less than 4 feet [1.2 m] above the highest expected piezometric water pressure along the depth of a shaft.

At any time the wet construction method of stabilizing excavations fails, in the opinion of the Engineer, to produce the desired final result, discontinue this method of construction, and propose modifications in procedure or alternate means of construction for approval.

Slurry testing is not required for drilled shafts installed under mast arms, cantilever signs, overhead truss signs, high mast light poles or other miscellaneous structures.

455-15.8.2 Fluid In Excavation At Time Of Concrete Placement: Prior to placing concrete in any shaft excavation, ensure that heavily contaminated suspensions, which could impair the free flow of concrete from the tremie pipe, have not accumulated in the bottom of the shaft. Take samples of the fluid in the shaft from the base of the shaft and at intervals not exceeding 10 feet [3 m] up the shaft, using an approved sampling tool. Ensure that the density of the fluid in the shaft excavation prior to concreting is less than 75 lb/ft^3 [1,200 kg/m^3]. The Engineer will not require tests for pH and viscosity when mineral slurry is not used in the excavation. Ensure that projects that require desanding equipment have a sand content not greater than 4% as determined by FM 8-RP13B-3. Take whatever action is necessary to modify the fluid in the shaft excavation prior to placing the concrete to bring the fluid within the specification requirements.

When using mineral slurry, the applicable density test method and reporting requirements described in 455-15.8.1 apply to tests of slurry in the shaft prior to placing the concrete. Such tests shall be performed by an approved soil testing laboratory engaged by the Contractor in the presence of a representative of the Department. When mineral slurry is not used, testing may be performed by an experienced person furnished by the Contractor and approved by the Engineer. The Department may also perform comparison tests. Provide equipment for such comparison tests when requested by the Engineer.

455-15.9 Tremies:

455-15.9.1 General: The requirements of 400-8.3 will apply when using a tremie to place drilled shaft concrete. The requirements of 400-7.7 will apply when using a pump to place drilled shaft concrete.

455-15.9.2 Dry Excavations: Ensure that the tremie for depositing concrete in a dry drilled shaft excavation consists of a tube of solid construction, a tube constructed of sections which can be added and removed, or a tube of other approved design. The Contractor may pass concrete through a hopper at the top of the tube or through side openings as the tremie is retrieved during concrete placement. Support the tremie so that the free fall of the concrete is less than 5 feet [1.5 m] at all times. If the free falling concrete causes the shaft excavation to cave or slough, control the movement of concrete by reducing the height of free fall of the concrete and/or reducing the rate of flow of concrete into the excavation.

455-15.9.3 Wet Excavations: Construct the tremie or pump line used to deposit concrete beneath the surface of water so that it is water-tight and will readily discharge concrete. Construct the discharge end of the tremie or pump line to prevent water intrusion and permit the free flow of concrete during placement operations. Ensure that the tremie or pump line has sufficient length and weight to rest on the shaft bottom before starting concrete placement. Ensure that the discharge end of the tremie or pump line is entirely immersed in concrete at all times during placement operations. Ensure that the free fall of concrete into the hopper is less than 5 feet [1.5 m] at all times. Support the tremie so that it can be raised to increase the discharge of concrete and lowered to reduce the discharge of concrete. The Engineer will not allow rapid raising or lowering of the tremie to increase the discharge of the concrete. Maintain a continuous flow of concrete and a positive pressure differential of the concrete in the tremie or pump line at all times to prevent water or slurry intrusion into the shaft concrete.

455-15.10 Excavation and Drilling Equipment:

455-15.10.1 General: All shaft excavation is Unclassified Shaft Excavation and extra depth excavation is Unclassified Extra Depth Excavation. The Engineer will require Drilled Shaft Sidewall Overreaming when inspections show it to be necessary. These terms are defined in 455-15.10.2, 455-15.10.3, and 455-15.10.4, respectively.

Use excavation and drilling equipment having adequate capacity, including power, torque, and downthrust, and excavation and overreaming tools of adequate design, size, and strength to perform the work shown in the plans or described herein. When the material encountered cannot be drilled using conventional earth augers and/or underreaming tools, provide special drilling equipment, including but not limited to rock augers, core barrels, rock tools, air tools, blasting materials, and other equipment as necessary to continue the shaft excavation to the size and depth required. In the event blasting is necessary, obtain all necessary permits. The Contractor is responsible for the effects of blasting on already completed work and adjacent structures. The Engineer must approve all blasting.

455-15.10.2 Unclassified Shaft Excavation: Unclassified Shaft Excavation is defined as all processes required to excavate a drilled shaft of the dimensions shown in the Contract Documents to the depth indicated in the plans or directed by the Engineer, completed and accepted. Include in the work all shaft excavation, whether the material encountered is soil, rock, weathered rock, stone, natural or man-made obstructions, or materials of other descriptions.

455-15.10.3 Unclassified Extra Depth Excavation: Unclassified Extra Depth Excavation is defined as all processes required to excavate a drilled shaft of plan dimensions below the elevation of the bottom of the shaft as indicated on the plans.

455-15.10.4 Drilled Shaft Sidewall Overreaming: Drilled Shaft Sidewall Overreaming is defined as the unclassified excavation required to roughen its surface or to enlarge the drilled shaft diameter due to softening of the sidewalls or to remove excessive buildup of slurry cake when slurry is used. Increase the shaft radius a minimum of 2 inch [15 mm] and a maximum of 3 inches [75 mm] by overreaming. The Contractor may accomplish overreaming with a grooving tool, overreaming bucket, or other approved equipment.

Meet the limit for depth of sidewall overreaming into the shaft sidewall material and the elevation limits between which sidewall overreaming is required.

455-15.11 Inspection of Excavations:

455-15.11.1 Dimensions and Alignment: Provide equipment for checking the dimensions and alignment of each permanent shaft excavation. Determine the dimensions and alignment of the shaft excavation under the observation and direction of the Department. Generally check the alignment and dimensions by any of the following methods as necessary:

(a) Check the dimensions and alignment of dry shaft excavations using reference stakes and a plumb bob.

(b) Check the dimensions and alignment of casing when inserted in the excavation.

(c) Insert a casing in shaft excavations temporarily for alignment and dimension checks.

(d) Insert a rigid rod or pipe assembly with several 90-degree offsets equal to the shaft diameter into the shaft excavation for alignment and dimension checks.

Insert any casing, rod or pipe assembly, or other device used to check dimensions and alignment into the excavation to full depth.

455-15.11.2 Depth: Generally reference the depth of the shaft during drilling to appropriate marks on the Kelly bar or other suitable methods. Measure final shaft depths with a suitable weighted tape or other approved methods after final cleaning.

455-15.11.3 Shaft Inspection Device: The Department, when shown in the plans, may use a shaft inspection device (SID) comprised of a television camera sealed inside a water-tight jacket to inspect the bottoms of the shafts. The Department may also use a sidewall sampler attached to the shaft inspection device to sample the sides of the shafts. Cooperate with the Department in using this device, including placing the device in position for inspection and removing it after the inspection. Furnish 110 V single phase current (minimum 30 A service), 220 V single phase current (minimum 15 A service), and a 150 psi [1.0 MPa] compressor (8 cfm [0.0038 m^3/s] minimum) to operate the SID. Include all cost related to the inspection device in the cost of drilled shaft items.

Provide the projected drilled shaft construction schedule to the Engineer at the preconstruction conference or no later than 30 days before beginning drilled shaft construction so that the SID may be scheduled. Include in the bid the cost of transporting the SID from its storage location to the job site and back. Notify the Department at least ten days prior to the desired pick-up date. During pick-up, the Department will complete a checklist of all equipment placed in the Contractor's possession. The Department will later use this checklist to verify that the Contractor has returned all equipment.

The Contractor is responsible for the device from the time it leaves its storage area until the time it is returned. During this time, insure the device against loss or damage for the replacement cost thereof (the greater of $400,000 or the amount shown in the plans) or for the full insurable value if replacement cost insurance is not available.

Return the device in good working condition to its proper location within 30 days after completing the drilled shafts. Notify the Department at least ten working days prior to returning the SID.

455-15.11.4 Shaft Cleanliness Requirements: Adjust cleaning operations so that a minimum of 50% of the base of each shaft will have less than 2 inch [13 mm] of sediment at the time of placement of the concrete. Ensure that the maximum depth of sedimentary deposits or any other debris at any place on the base of the shaft excavation does not exceed 12 inches [40 mm]. The Engineer will determine shaft cleanliness by visual inspection for dry shafts, using divers or SID or other methods the Engineer deems appropriate for wet shafts.

When using slurry, meet the requirements of 455-15.8 at the time of concrete placement.

Ensure that the depth of sedimentary deposits or other debris does not exceed 1 inch [25 mm] over the base of the shaft when installing drilled shafts under mast arms, overhead truss signs, high mast light poles or other miscellaneous structures

455-15.11.5 Time of Excavation: Any unclassified excavation work lasting more than 36 hours (measured from the beginning of excavation for all methods except the Permanent Casing Method, which begins at the time excavation begins below the casing) before placement of the concrete may require overreaming the sidewalls to the depth of softening or removing excessive slurry cake buildup as indicated by samples taken by the sidewall sampler or other test methods employed by the Engineer. Ensure that the minimum depth of overreaming the shaft diameter is 2 inch [13 mm] and the maximum depth is 3 inches [75 mm]. Provide any overreaming required at no expense to the Department when exceeding the 36-hour limit unless the time limit is exceeded solely to accomplish Unclassified Extra Depth Excavation ordered by the Engineer. The Department will pay the Contractor for authorized overreaming resulting from softening or excessive slurry cake buildup which is indicated by sidewall samples or other test methods employed by the Engineer during the initial 36-hour time period. The Department will pay the Contractor for authorized overreaming when sidewall samples indicate softening or excessive filter cake buildup in shaft excavations which exceed the 36-hour time limit in order to accomplish Unclassified Extra Depth Excavation ordered by the Engineer.

When using slurry, adjust excavation operations so that the maximum time that slurry is in contact with the bottom 5 feet [1.5 m] of the shaft (from time of drilling to concreting) does not exceed 12 hours. If exceeding the 12-hour time limit, overream the bottom 5 feet [1.5 m] of shaft at no additional expense to the Department prior to performing other operations in the shaft.

For drilled shafts installed under mast arms, cantilever signs, overhead truss signs, high mast light poles or other miscellaneous structures, all references to a 36-hour time limit is changed to a 12-hour time limit.

455-16 Reinforcing Steel Construction and Placement.

455-16.1 Cage Construction and Placement: Completely assemble and place as a unit the cage of reinforcing steel, consisting of longitudinal bars, ties, and cage stiffener bars, immediately after the Engineer inspects and accepts the shaft excavation and immediately prior to placing concrete. Tie all intersections of drilled shaft reinforcing steel with cross ties or "figure 8" ties. Use double strand ties or ties with larger tie wire when necessary. The Engineer will give final approval of the cage construction and placement subject to satisfactory performance in the field.

455-16.2 Splicing Cage: If the bottom of the constructed shaft elevation is lower than the bottom of the shaft elevation in the plans, extend a minimum of one half of the longitudinal bars required in the upper portion of the shaft the additional length. Continue the tie bars for the extra depth, spaced on 2 foot [0.6 m] centers, and extend the stiffener bars to the final depth. The Contractor may lap splice these bars or use unspliced bars of the proper length. Do not weld bars to the planned reinforcing steel unless shown in the Contract Documents.

455-16.3 Support, Alignment, and Tolerance: Tie and support the reinforcing steel in the shaft so that the reinforcing steel will remain within allowable tolerances as specified in 455-8 and Section 415.

Use concrete wheels or other approved noncorrosive spacing devices near the bottom and intervals not exceeding 15 feet [4.5 m] up the shaft to ensure concentric spacing for the entire length of the cage. Do not use block or wire type spacers. Use a minimum of one spacer per 30 inches [750 mm] of circumference of cage with a minimum of three at each level. Provide concrete spacers, constructed as shown in the Contract Documents, at the bottom of the drilled shaft reinforcing cage to maintain the specified distance between the bottom of the cage and the bottom of the shaft is maintained. Use the number of bottom spacers as shown in the Contract Documents. Use spacers constructed of approved material equal in quality and durability to the concrete specified for the shaft. The Engineer will approve spacers subject to satisfactory performance in the field.

Check the elevation of the top of the steel cage before and after placing the concrete. If the rebar cage is not maintained within the specified tolerances, correct it as directed by the Engineer. Do not construct additional shafts until modifying the rebar cage support in a manner satisfactory to the Engineer.

455-17 Concrete Placement.

455-17.1 General: Place concrete in accordance with the applicable portions of Sections 346 and 400, Standard Operating Procedures for Quality Control of Concrete, Subarticles 455-15.2, 455-15.3, 455-15.4, 455-15.5, 455-15.8, 455-15.9, and the requirements herein.

Place concrete as soon as possible after completing all excavation, cleaning the shaft excavation, inspecting and finding it satisfactory, and immediately after placing reinforcing steel. Continuously place concrete in the shaft to the top elevation of the shaft. Continue placing concrete after the shaft is full until good quality concrete is evident at the top of the shaft. Place concrete through a tremie or concrete pump using approved methods.

If the pressure head is lost during concrete placement for any reason, the Engineer may direct the Contractor to perform integrity testing at no expense to the Department.

455-17.2 Placement Time Requirements: The elapsed time for placing drilled shaft concrete includes the concrete mixing and transit time, the concrete placement time, and the time required to remove any temporary casing that causes or could cause the concrete to flow into the space previously occupied by the casing. Maintain a minimum slump of 4 inches [100 mm] throughout the elapsed time. Use materials to produce and maintain the required slump through the elapsed time that meets the class of concrete specified. Provide slump loss tests that demonstrate to the Engineer that the concrete will maintain a 4 inch [100 mm] or greater slump for the anticipated elapsed time before beginning drilled shaft construction.

455-17.3 Forms: When the top of shaft elevation is above ground, form the portion of the shaft above ground with a removable form or another approved method to the dimensions shown in the plans.

When the shaft extends above the ground through a body of water, the Contractor may form the portion through the water with removable forms except when the Permanent Casing Method is specified.

When approved, the Contractor may form the portion through the water with permanent forms, provided the forms are removed from 2 feet [0.6 m] below the lowest water elevation to the top of shaft elevation.

455-17.4 Riser Blocks: The Contractor may cast a riser block of equal diameter as the column and of a maximum height of 6 inches [150 mm] at the top of the completed shaft. When this option is chosen, extend any dowel steel above the top of shaft an additional 6 inches [150 mm].

455-17.5 Curing: Cure the top surface in accordance with 400-16, and construct any construction joint area as shown in the plans. Protect portions of drilled shafts exposed to a body of water from the action of water by leaving the forms in place for a minimum of seven days after casting the concrete. The Contractor may remove forms prior to seven days provided the concrete strength has reached 2,500 psi

[17 MPa] or greater as evidenced by cylinder breaks.

455-18 Test Holes.

The Engineer will use the construction of test holes to determine if the methods and equipment used by the Contractor are sufficient to produce a shaft excavation meeting the requirements of the Contract Documents. During test hole excavations, the Engineer will evaluate the ability to control dimensions and alignment of excavations within tolerances; to seal the casing into impervious materials; to control the size of the excavation under caving conditions by the use of mineral slurry or by other means; to properly clean the completed shaft excavation; to construct excavations in open water areas; to establish elevations for belling; to determine the elevation of ground water; to place concrete meeting the requirements of these Specifications within the prescribed time frame; and to execute any other necessary construction operation. Revise the methods and equipment as necessary at any time during the construction of the test hole when unable to satisfactorily carry out any of the necessary operations described above or when unable to control the dimensions and alignment of the shaft excavation within tolerances.

Drill test holes out of permanent position at the location shown in the plans or as directed by the Engineer. Ensure that the diameter and depth of the test hole or holes are the same diameter and depth as the production drilled shafts. Do not reinforce the test hole, but fill the test hole with concrete in the same manner that production reinforced shafts will be constructed. The Contractor may backfill the test holes with suitable soil in a manner satisfactory to the Engineer. Leave the concreted test holes in place, except remove the top of the shaft to a depth of 2 feet [0.6 m] below the ground line. Use the same procedure for shafts constructed in water. Restore the disturbed areas at the sites of test holes drilled out of position as nearly as practical to their original condition. When the Contractor fails to demonstrate to the Engineer the adequacy of his methods or equipment, and alterations are required, he shall provide additional test holes at no expense to the Department. Include the cost of all test holes in the cost of the Drilled Shafts.

455-19 Test Bells.

Ream the bells at specified test holes to establish the feasibility of belling in a specific soil strata. Use the diameter and shape of the test bell shown in the plans or as approved in writing.

455-20 Construction Tolerances.

Meet the following construction tolerances for drilled shafts:

(a) Ensure that the top of the drilled shaft is no more than 3 inches [75 mm] laterally from the position indicated in the plans.

(b) Ensure that the vertical alignment of the shaft excavation does not vary from the alignment shown in the plans by more than 3 in/ft [20 mm/m] of depth.

(c) After placing all the concrete, ensure that the top of the reinforcing steel cage is no more than 6 inches [150 mm] above and no more than 3 inches [75 mm] below plan position.

(d) Ensure that the reinforcing cage is concentric with the shaft within a tolerance of 12 inches [40 mm]. Ensure that concrete cover is 6 inches ∀ 12 inches

[150 ∀ 40 mm] unless shown otherwise in the plans.

(e) All casing diameters shown in the plans refer to I.D. (inside diameter) dimensions. However, the Contractor may use casing with an outside diameter equal to the specified shaft diameter if the extra length described in 455-15.7 is provided. In this case, ensure that the I.D. of the casing is not less than the specified shaft diameter less 1 inch [25 mm]. When approved, the Contractor may elect to provide a casing larger in diameter than shown in the plans to facilitate meeting this requirement. When casing is not used, ensure that the minimum diameter of the drilled shaft is 1 inch [25 mm] less than the specified shaft diameter. When conditions are such that a series of telescoping casings are used, provide the casing sized to maintain the minimum shaft diameters listed above.

(f) Excavate the bearing area of bells to the plan bearing area as a minimum. Ensure that the diameter of the bells does not exceed three times the specified shaft diameter. The Contractor may vary all other plan dimensions shown for the bells, when approved, to accommodate his equipment.

(g) Ensure that the top elevation of the drilled shaft concrete has a tolerance of +1 and - 3 inches [+25 and -75 mm] from the top of shaft elevation shown in the plans.

(h) The dimensions of casings are subject to American Pipe Institute tolerances applicable to regular steel pipe.

(i) Use excavation equipment and methods designed so that the completed shaft excavation will have a flat bottom. Ensure that the cutting edges of excavation equipment are normal to the vertical axis of the equipment within a tolerance of ∀δ in/ft [∀30 mm/m] of diameter.

455-21 Drilled Shaft Excavations Constructed out of Tolerance.

Do not construct drilled shaft excavations in such a manner that the concrete shaft cannot be completed within the required tolerances. The Contractor may make corrections to an unacceptable drilled shaft excavation by any combination of the following methods:

(a) Overdrilling the shaft excavation to a larger diameter to permit accurate placement of the reinforcing steel cage with the required minimum concrete cover.

(b) Increasing the number and/or size of the steel reinforcement bars.

(c) Enlargement of the bearing area of the bell excavation within tolerance allowed.

When the tolerances are not met, the Contractor may request design changes in the caps or footings to incorporate shafts installed out of tolerance. The Contractor shall bear the costs of redesign and Unforeseeable Work resulting from approved design changes to incorporate shafts installed out of tolerance. Employ a Specialty Engineer to perform any redesign and who shall sign and seal the redesign drawings and computations. Do not begin any proposed redesign until it has been reviewed for acceptability and approved by the Engineer.

Backfill any out of tolerance shafts in an approved manner when directed by the Engineer until the redesign is complete and approved. Furnish additional materials and work necessary, including engineering analysis and redesign, to effect corrections of out of tolerance drilled shaft excavations at no expense to the Department.

455-22 Static Compression Load Tests.

455-22.1 General: When the plans include load testing, perform all load tests in accordance with 455-2.

455-22.2 Disposition of Loading Material: After completing all load tests, clean, remove all rust on structural steel, repaint all areas having damage to the paint in accordance with Section 561, and return all load test equipment supplied by the Department to its designated storage area. Notify the Department at least ten working days in advance so that arrangements can be made to unload the equipment. The Contractor shall remove all equipment and materials which remains his property from the site. Clean up and restore the site to the satisfaction of the Engineer.

455-22.3 Disposition of Tested Shafts: After completing testing, cut off the tested shafts and any reaction shafts at an elevation 24 inches [610 mm] below the finished ground surface. Take ownership of the shaft cut-offs and provide areas for their disposal.

455-23 Method of Measurement.

455-23.1 Drilled Shafts: The quantity to be paid for will be the length, in feet [meters], of the reinforced concrete drilled shaft of the diameter shown in the plans, completed and accepted. The length will be determined as the difference between the top of shaft elevation as shown in the plans and the final bottom of shaft elevation as authorized and accepted. When the Contractor elects to provide outside diameter (O.D.) sized casing rather than inside diameter (I.D.) sized casing as allowed in 455-15.7, the pay quantity measured as described above will be multiplied by a factor (F) determined as follows:

$$F = \frac{2D_2 - D_1}{D_2}$$

where:

F= factor to adjust pay quantities to compensate for smaller shafts.

D_1= casing inside diameter specified = shaft diameter specified.

D_2= casing inside diameter provided (D_2 = D_1 minus twice the wall thickness).

455-23.2 Drilled Shafts (Unreinforced): The quantity to be paid for will be the length, in feet [meters], of unreinforced concrete drilled shaft of the diameters shown in the plans, completed and accepted. The length will be determined as the difference between the top of shaft elevation as shown in the plans and the final bottom of shaft elevation as authorized and accepted. When the Contractor elects to use O.D. casing, the quantity as determined above will be multiplied by the factor "F" determined as described in 455-23.1.

455-23.3 Unclassified Shaft Excavation: The quantity to be paid for will be the length, in feet [meters], of unclassified shaft excavation of the diameter shown in the plans, completed and accepted, measured along the centerline of the shaft from the ground surface elevation to the plan bottom of shaft elevation authorized and accepted. When drilled shafts are constructed through fills placed by the Contractor, the original ground surface before the fill was placed will be used to determine the quantity of unclassified shaft excavation. When the Contractor elects to use O.D. casing, the quantity as determined above will be multiplied by the factor "F" determined as described in 455-23.1.

455-23.4 Unclassified Extra Depth Excavation: The quantity to be paid for will be the length, in feet [meters], of unclassified shaft excavation of the diameter shown in the plans measured along the centerline of the shaft from the bottom of shaft elevation shown in the plans to the final authorized bottom of shaft elevation when below the plan bottom of shaft elevation. When the Contractor elects to use O.D. casing, the quantity as determined above will be multiplied by the factor "F" determined as described in 455-23.1.

455-23.5 Drilled Shaft Sidewall Overreaming: The quantity to be paid for will be the length, in feet [meters], of drilled shaft sidewall overreaming authorized, completed and accepted, measured between the elevation limits shown in the plans or authorized by the Engineer. When the Contractor elects to use O.D. casing, the quantity as determined above will be multiplied by the factor "F" determined as described in 455-23.1.

455-23.6 Bell Footings: The quantity to be paid for will be the number of bells of the diameter and shape shown in the plans, completed and accepted.

455-23.7 Test Holes: The cost of all test holes will be included in the cost of Drilled Shafts.

455-23.8 Test Bells: The quantity to be paid for will be the number of test bells, completed and accepted.

455-23.9 Core (Shaft Excavation): The quantity to be paid for will be the length, in feet [meters], measured from the bottom of shaft elevation to the bottom of the core-hole, for each authorized core drilled below the shaft excavation, completed and accepted. When the Engineer authorizes Core (Shaft Excavation) extending through part or all of the shaft, prior to excavation, to some depth below the shaft bottom, the quantity will be the length in feet [meters], measured from the top elevation to the bottom elevation authorized by the Engineer, completed and accepted. When SPT tests are substituted for coring as provided in 455-15.6, the quantity will be determined as described above for coring.

455-23.10 Casings: The quantity to be paid for will be the length, in feet [meters], of each size casing as directed and authorized to be used. The length will be measured along the casing from the top of the shaft elevation or the top of casing whichever is lower to the bottom of the casing at each shaft location where casing is authorized and used, except as described below when the top of casing elevation is shown in the plans. Casing will be paid for only when the Permanent Casing Method is specified, when the plans show a casing that becomes a permanent part of the shaft, or when the Engineer directs the Contractor to leave a casing in place which then becomes a permanent part of the shaft. No payment will be made for casings which become bound or fouled during shaft construction and cannot be practically removed. The Contractor shall include the cost of all temporary removable casings for methods of construction other than that of the Permanent Casing Method in the bid price for Unclassified Shaft Excavation item.

When the Permanent Casing Method and the top of casing elevation are specified, the casing will be continuous from top to bottom. Authorization for temporary casing will not be given unless the Contractor demonstrates that he can maintain alignment of the temporary upper casing with the lower casing to be left in place during excavation and concreting operations. When artesian conditions are or may be encountered, the Contractor shall also demonstrate that he can maintain a positive water-tight seal between the two casings during excavation and concreting operations.

When the top of casing elevation is shown in the Contract Documents, payment will be from the elevation shown in the plans or from the actual top of casing elevation, whichever is lower, to the bottom of the casing. When the Contractor elects to use an approved special temporary casing system in open water locations, the length to be paid for will be measured as a single casing as provided above.

455-23.11 Protection of Existing Structures: The quantity to be paid for will be at the lump sum price.

455-23.12 Static Load Tests: The quantity to be paid for will be the number of load tests conducted.

455-23.13 Instrumentation and Data Collection: The quantity to be paid for will be at the lump sum price.

455-24 Basis of Payment.

455-24.1 Drilled Shafts: Price and payment will be full compensation for all drilled shafts, including the cost of concrete and reinforcing steel, including all labor, materials, equipment, and incidentals necessary to complete the drilled shaft.

455-24.2 Drilled Shafts (Unreinforced): Price and payment will be full compensation for all drilled shafts (unreinforced), including the cost of concrete and all labor, equipment, materials, and incidentals necessary to complete the drilled shaft.

455-24.3 Unclassified Shaft Excavation: Price and payment will be full compensation for the shaft excavation (except for the additional costs included under the associated pay items for casing); removal from the site and disposal of excavated materials; restoring the site as required; cleaning and inspecting shaft excavations; using slurry as necessary; using drilling equipment; blasting procedures, special tools and special drilling equipment to excavate the shaft to the depth indicated in the plans; and furnishing all other labor, materials, and equipment necessary to complete the work in an acceptable manner.

455-24.4 Unclassified Extra Depth Excavation: Price and payment will be full compensation for all costs of excavating below the bottom of shaft elevations shown in the plans, except for the additional costs included under the associated pay items for casing. Work under Unclassified Extra Depth Excavation is the same as that described under Unclassified Shaft Excavation together with any additional work as a result of excavating below the bottom of shaft elevation shown in the plans. Compensation under this item will be paid only when Unclassified Extra Depth Excavation is authorized by the Engineer.

455-24.5 Drilled Shaft Sidewall Overreaming: Price and payment will be full compensation for all labor, equipment, and incidentals necessary to accomplish acceptable construction.

455-24.6 Bell Footings: Price and payment will be full compensation for forming and excavating the bell beyond the diameter of the drilled shaft, furnishing and casting additional concrete necessary to fill the bell outside the shaft together with any extra reinforcing steel required, removing excavated materials from the site, and all other expenses necessary to complete the work.

455-24.7 Test Holes: No separate payment will be made for Test Hole. All cost of Test Holes will be included in the cost of Drilled Shafts.

455-24.8 Test Bells: Price and payment will be full compensation for forming the test bell, providing inspection facilities, backfilling the bell when the test hole is drilled out of position, and all other expenses necessary to complete the work.

455-24.9 Core (Shaft Excavation): Price and payment will be full compensation for drilling and classifying the cores, delivering them to the Department, furnishing drilled shaft concrete to fill the core hole, and all other expenses necessary to complete the work. When SPT tests are substituted for coring as provided in 455-15.6, they will be paid for at the price per foot [meter] for coring.

455-24.10 Casings: Price and payment will be full compensation for additional costs necessary for furnishing and placing the casing in the shaft excavation above the costs attributable to the work paid for under associated pay items for Unclassified Shaft Excavation and Unclassified Extra Depth Excavation.

455-24.11 Protection of Existing Structures: Price and payment will include all cost of work shown in the plans or described herein for protection of existing structures. When the Contract Documents do not include an item for protection of existing structures, the cost of settlement monitoring as required by these Specifications will be included in the cost of Unclassified Shaft Excavation; however, work in addition to settlement monitoring will be paid for as Unforeseeable Work when such additional work is ordered by the Engineer.

455-24.12 Static Load Tests: Price and payment will include all costs related to the performance of the load test.

455-24.13 Instrumentation and Data Collection: Price and payment will include all labor, equipment, and materials incidental to the instrumentation and data collection, and, when required, the load test report.

455-24.14 Payment Items: Payment will be made under:

Item No. 455- 18- Protection of Existing Structures - lump sum.
Item No. 2455- 18- Protection of Existing Structures - lump sum.
Item No. 455- 88- Drilled Shaft - per foot.
Item No. 2455- 88- Drilled Shaft - per meter.
Item No. 455- 90- Bell Footings - each.
Item No. 2455- 90- Bell Footings - each.
Item No. 455- 92- Test Bells - each.
Item No. 2455- 92- Test Bells - each.
Item No. 455-107- Casing - per foot.
Item No. 2455-107- Casing - per meter.
Item No. 455-111- Core (Shaft Excavation) - per foot.
Item No. 2455-111- Core (Shaft Excavation) - per meter.
Item No. 455-119- Test Loads - each.
Item No. 2455-119- Test Loads - each.
Item No. 455-122- Unclassified Shaft Excavation - per foot.
Item No. 2455-122- Unclassified Shaft Excavation - per meter.
Item No. 455-124- Drilled Shaft Sidewall Overreaming - per foot.

Item No. 2455-124- Drilled Shaft Sidewall Overreaming - per meter.
Item No. 455-125- Unclassified Extra Depth Excavation - per foot.
Item No. 2455-125- Unclassified Extra Depth Excavation - per meter.
Item No. 455-129- Instrumentation and Data Collection - lump sum.
Item No. 2455-129- Instrumentation and Data Collection - lump sum.

D. SPREAD FOOTINGS

455-25 Description.

Construct reinforced concrete spread footing foundations, including dewatering when necessary, excavating to the required limits, compacting the underlying soil as required, and constructing seals when required.

455-26 General Requirements.

Meet the following requirements for all spread footings:

1. Perform excavations, including the removal of all material, of whatever nature, necessary for the construction of spread footings. As used herein, the term "soil" shall constitute any material, whether soil, rock, or other materials.
2. Slope excavations as required, or support them with sheeting, and shore them if necessary, to provide a safe excavation that is adequate for construction purposes and that will adequately protect any existing adjacent structures.
3. Ensure that the foundation soils are firm, stable, and, in the opinion of the Engineer, meet or exceed the design bearing and compressibility requirements before constructing the footings or any required seals. The Department may elect to use any type of test(s) to evaluate the foundation soils that is appropriate in the opinion of the Engineer. Cooperate with the Engineer in the evaluation of the foundation soils, and assist the Engineer as necessary to provide access to the site.
4. The elevation of the bottom of footings or seals and/or the depth of over-excavation shown in the plans is approximate and the Engineer may order, in writing, such changes as may be necessary to secure a satisfactory foundation.
5. Place all spread footing concrete in the dry.

455-27 Protection of Existing Structures.

Protect existing structures in accordance with 455-1.1. Also, if not otherwise provided in the plans, evaluate the need for, design, and provide all reasonable precautionary features to prevent damage, including, but not limited to, the installation of sheet piling, shoring as necessary, maintenance of the water table beneath such structures as nearly as practical to existing conditions, and monitoring and controlling vibrations from construction activities including driving of sheeting or from blasting.

455-28 Dewatering.

The Contractor is responsible for the design, installation, and operation of an adequate dewatering system to dewater excavations for spread footings. Use a wellpoint or well system. Submit a dewatering plan to the Engineer for his records before beginning construction.

Use wellpoints or wells where the piezometric water level is above an elevation 2 feet [0.6 m] below the bottom of the excavation. Maintain the water table 2 feet

[0.6 m] or more below the maximum depth of excavation. Provide continuous dewatering until completing construction of the footing and backfill the excavation at least 2 feet [0.6 m] above the water table elevation before beginning dewatering. Continue dewatering until the Engineer considers conditions safe to discontinue dewatering. In the event of a dewatering failure, assist the Engineer as required in determining the effects of such a failure on the foundation soils, and take whatever corrective measures are required at no additional expense to the Department. When the Engineer approves the discontinuing of dewatering, decrease the rate of pumping, allowing the water level to rise slowly. Use a rate, in feet per hour [millimeters per hour], that the water table is allowed to rise equal to the total number of feet [millimeters] the water table was lowered, divided by ten hours or a rate of 1 ft/hr [300 mm/h], whichever is less.

Install one piezometer well approximately every 15 feet [4.5 m] of footing perimeter. Provide a minimum of two and a maximum of six piezometers at locations within 2 feet [0.6 m] from the outside of the footing perimeter. Install piezometer wells to a depth at least 10 feet [3 m] below the bottom of footing elevation or as directed by the Engineer. Measure water elevation in the piezometer wells prior to excavation and at 12-hour intervals between excavation and discontinuation of dewatering. Maintain the piezometers in working condition throughout the dewatering process, and repair or replace them when damaged at no expense to the Department.

455-29 Excavations.

455-29.1 Dry Excavations: Dry excavations are excavations that can be completed without the need to lower the piezometric water level. Perform dry excavations when the piezometric water level at the time of construction is and, in the opinion of the Engineer, will remain at least 2 feet [0.6 m] below the bottom of the authorized excavation or over-excavation. Demonstrate to the Engineer that a stable excavation can be made without dewatering. Make adequate provisions to divert surface runoff and to collect and remove any water entering the excavation.

Excavate to the bottom of footing, to the over-excavation limits shown in the plans, or as directed by the Engineer. Save any suitable materials for backfill. Provide areas for the disposal of all unsuitable materials, and dispose of them in a satisfactory method. Compact the foundation soils below the footing as shown in the plans or described herein before constructing the footing.

455-29.2 Dewatered Excavations: Dewatered excavations are excavations made after first lowering the piezometric water level with wellpoints or wells. Perform dewatering as described in 455-28. Excavate in the dry after lowering of the water table.

When dewatering is required, the Contractor may excavate within 2 feet [0.6 m] of the ground water table before dewatering begins if the dewatering system is operating and the Contractor has demonstrated that the water level has been lowered to and maintained at acceptable limits. Where large excavations require stage lowering of the water table (additional wellpoint systems installed at lower elevations), the Contractor may continue excavating as long as the water elevation is maintained at least 2 feet [0.6 m] below the excavation.

Ensure that surface runoff is diverted from the excavation. Compact the foundation soils as shown in the plans or as described herein before constructing the footing.

455-29.3 Wet Excavations: Wet excavations are excavations made below the existing water table without prior dewatering. When the plans show a cofferdam and seal, perform the excavation in the wet. Maintain the water level during excavation at or above the water level outside the cofferdam.

Place the seal directly upon the foundation soils or rock when using wet excavations. Do not compact foundation soils for wet excavations. Ensure that the foundation soils or rock are disturbed as little as practical. Remove all materials that are determined by the Engineer to be loose or disturbed before placing the seal concrete.

455-30 Fill or Backfill.

Only use fill or backfill, including over-excavations below the footing, that is clean cohesionless material, free of rubble, debris, or rocks that would prevent uniform placement and compaction. For backfill materials, use A-1, A-2, or A-3 materials, materials as shown in the plans, or materials approved by the Engineer.

455-31 Compaction and Density Requirements.

Compact the bottom of the excavation with suitable equipment. Compact the soil beneath footing excavation (whether dug to the bottom of footing or over-excavated) to a density not less than 95% of the maximum density as determined by AASHTO T 180 for a minimum depth of 2 feet [0.6 m] below the bottom of the excavation or to the depth shown in the plans before backfilling begins. Perform at least one density determination at each footing excavation at a depth of one to 2 feet [0.3 to 0.6 m] below the bottom of the excavation. Compact the backfill in footing excavations which have been over-excavated in 12 inch [300 mm] maximum loose lifts to a density not less than 95% of the maximum density as determined by AASHTO T 180 to the bottom of footing elevation. Perform at least one density determination in each lift of backfill at each footing excavation.

For compaction, use an approved heavy vibratory roller with a static drum weight of at least 4 tons [3.6 metric tons]. Compact each lift to the required density. Also, compact the final lift below the footing with a suitable sled vibratory compactor to remove any upper disturbance caused by the drum roller. When conditions require use of smaller compaction equipment, obtain the Engineer's approval for the equipment, and reduce the lift thickness to achieve the required density.

Perform backfilling to the original ground surface, finished grade, or subgrade as required by the plans in the immediate vicinity by approved mechanical compactors weighing less than 1,000 pounds [450 kg]. The Contractor may compact backfill located more than 15 feet [4.5 m] away from the exterior periphery of the footing with heavier compactors. Do not place backfill on the footing until the Engineer has given permission and until the concrete is at least seven days old.

455-32 Forming.

Form spread footings if it can be demonstrated that the natural soil or rock is strong enough to prevent caving during construction. For forms, meet the applicable requirements of 400-5. When forms are not required, meet the requirements of 400-5.4.4.

455-33 Materials.

455-33.1 Concrete: Meet the requirements of Section 346.

455-33.2 Reinforcing Steel: Meet the requirements of Section 415. For spread footing reinforcing steel, use Grade 60 [Grade 420].

455-34 Reinforcing Steel Placement.

Place and fasten reinforcing steel for footings according to the applicable provisions of 415-5.

455-35 Concrete Placement.

455-35.1 Placement: Place all footing concrete in the dry and according to the applicable provisions of 400-7. Do not construct joints in footings.

455-35.2 Finish: After placing and consolidating the concrete, strike-off the top surface to the grades shown in the Contract Documents, leaving the surface smooth and free of undesirable cavities and other defects. Do not provide a special finish unless the footing will be visible after construction, in which case, meet the applicable provisions of 400-15.

455-35.3 Curing: Provide continuous-moisture-curing for footings. For cover materials, use clean sand, sawdust, or other materials meeting the approval of the Engineer. Continuously wet the cover materials for a period of 72 hours.

455-36 Method of Measurement.

455-36.1 Protection of Existing Structures: The quantity to be paid for, when included in the Contract Documents, will be at the Contract lump sum price.

455-36.2 Dewatering: The quantity to be paid for will be at the Contract unit price for each footing excavation, only at locations authorized by the Engineer and acceptably dewatered.

455-36.3 Excavation: No separate payment will be made for backfill or will separate payment be made for excavation above bottom of footing elevation. The cost of this work will be included in the Contract unit price for Concrete (Substructure). For footings with excavation (over-excavation) below the bottom of the footing elevation shown in the plans, the cost of this excavation, backfilling, and compaction will be included in the Contract unit price for Excavation for Structures. The pay quantity will be the volume in cubic yards [cubic meters] bounded by vertical planes 12 inches [300 mm] outside of the limits of the footing and parallel thereto and extending from the bottom of the footing elevation to the authorized bottom of over-excavation or within the pay limits shown in the plans.

455-36.4 Reinforcing Steel: The quantity to be paid for will be the total weight, in pounds [kilograms], determined as described in 415-7.

455-36.5 Concrete: The quantity to be paid for will be the volume of the classes shown in the plans, in cubic yards [cubic meters], determined as described in 400-20.

455-37 Basis of Payment.

455-37.1 Protection of Existing Structures: When separate payment for

Protection of Existing Structures is provided, price and payment will be full compensation for all work necessary to evaluate the need for, design of, and to provide the necessary features to protect existing structures, including all cost of work shown in the plans or described herein for protection of existing structures.

When a separate payment for Protection of Existing Structures is not provided, the cost of this work will be included in the Contract unit prices for Excavation for Structures and/or for Concrete (Substructure).

455-37.2 Dewatering: Price and payment will be full compensation for all work related to the successful dewatering of footings, including installing, maintaining, and monitoring piezometer wells. Dewatering will be considered Unforeseeable Work when the Engineer determines that dewatering is required and the plans do not include a Dewatering item.

455-37.3 Excavation: Price and payment will be full compensation for all work related to over-excavating below the bottom of footing elevation, backfill, and compaction as specified.

455-37.4 Reinforcing Steel: Price and payment will be full compensation for all work required to furnish and place the steel as shown in the plans and as specified herein.

455-37.5 Concrete: Price and payment will be full compensation for all work required to construct footings and seals as shown in the plans and described herein.

No separate payment will be made for sheeting and shoring required for excavation and footing construction except when a separate pay item for sheeting and shoring is included in the plans. The cost of all work not specifically mentioned in the other footing items will be included in the price per cubic yard [cubic meter] for substructure Concrete.

455-37.6 Payment Items: Payment will be made under:

Item No. 125- 1- Excavation For Structures - per cubic yard.
Item No. 2125- 1- Excavation For Structures - per cubic meter.
Item No. 400- 2- Class II Concrete - per cubic yard.
Item No. 2400- 2- Class II Concrete - per cubic meter.
Item No. 400- 3- Class III Concrete - per cubic yard.
Item No. 2400- 3- Class III Concrete - per cubic meter.
Item No. 400- 4- Class IV Concrete - per cubic yard.
Item No. 2400- 4- Class IV Concrete - per cubic meter.
Item No. 400- 91- Dewatering For Spread Footings - each.
Item No. 2400- 91- Dewatering For Spread Footings - each.
Item No. 415- 1- Reinforcing Steel - per pound.
Item No. 2415- 1- Reinforcing Steel - per kilogram.
Item No. 455- 18- Protection of Existing Structures - lump sum.
Item No. 2455- 18- Protection of Existing Structures - lump sum.

E. STRUCTURES (OTHER THAN BRIDGE) FOUNDATIONS - AUGER CAST PILES

455-38 Description.

Furnish and install auger cast piles used for structural support, other than bridge foundations.

455-39 General Requirements.

455-39.1 Contractor's Operations: Submit an Auger Cast Pile Installation Plan in accordance with 455-47. Prior to the start of production piles, demonstrate to the satisfaction of the Engineer, the dependability of the equipment, techniques, and source of materials by construction of a demonstration pile.

455-39.2 Protection of Existing Structures: Protect existing structures in accordance with 455-1.1.

455-40 Materials.

Meet the following material requirements:

(1) Portland Cement (Types I, II, III, IP, and IS) ....Section 921
(2) Fly Ash, Slag and other Pozzolanic Materials for Portland Cement Concrete..Section 929
(3) Fine Aggregate (Sand)* ....Section 902
(4) Admixtures ....Section 924
(5) Water ....Section 923
(6) Fluidizer..ASTM C 937

* The Contractor may use any clean sand with 100% passing δ inch [9.5 mm] sieve and not more than 10% passing the 200 mesh [75 μm] sieve. The Engineer will only permit Silica Sand except as provided in 902-5.2.3.

455-41 Grout Mix Proportions.

Use a grout mix consisting of a mixture of Portland cement, fly ash, retarder, fluidizer, sand and water proportioned and mixed to produce a mortar capable of maintaining the solids in suspension without appreciable water gain and which may be pumped without difficulty and fill open voids in the adjacent soils. Proportion these materials to produce a hardened grout of the required strength shown on the plans.

455-42 Mixing and Pumping Cement Grout.

Meet the following requirements:

1. Only use pumping equipment approved by the Engineer in the preparation and handling of the grout. Before using the mixers, remove all oil or other rust inhibitors from the mixing drums, stirring mechanisms, and other portions of the equipment in contact with the grout.

2. Accurately measure all materials by volume or weight as they are fed to the mixer. Place the materials in the mixer in the following order: 1) water, 2) fluidifier, 3) other solids in order of increasing particle sizes.

3. Use a quantity of water and mixing time that will produce a homogenous grout having a consistency of 18 to 24 seconds, or higher if specified by the Engineer, when tested with a flow cone in accordance with ASTM C 939 (: inch [19 mm] diameter outlet), with a frequency at the discretion of the Engineer. Mix the grout at least one minute. If agitated continuously, the grout may be held in the mixer or agitator for a period not exceeding 2.5 hours at grout temperatures below 70EF [20EC]; two hours for temperatures from 70 to 100EF [20 to 38EC]. Do not

place grout when its temperature exceeds 100EF [38EC]. If there is a lapse in the operation of grout injection, recirculate the grout through the pump, or through the mixer drum or agitator.

4. Use mixers capable of combining components of the cement grout into a throughly mixed and uniform mass, free from balls or lumps of cementitious material and capable of discharging the concrete with a satisfactory degree of uniformity. The Engineer=s approval of grout mixers and all other equipment will be conditioned on proper performance during construction of the demonstration pile and subsequent production work.

5. Use a screen no larger than : inch [19.0 mm] mesh between the mixer and pump to remove large particles which might clog the injection system.

6. Use a positive displacement piston type grout pump capable of developing displacing pressures at the pump up to 350 psi [2.4 MPa]. Place a minimum volume of grout in the hole of at least 115% of the column of the auger hole.

7. Use a grout pump/system equipped with a pressure gauge to accurately monitor the pressure of the grout flow. Test and calibrate the equipment during construction of the demonstration pile to demonstrate flow rate measurement accuracy of ∀3% over the range of grouting pressures anticipated during this work. Also calibrate the equipment any time the Engineer suspects that the grout pump performance has changed.

455-43 Testing Cement Grout.

Make four cubes, 2 by 2 inch [50.8 by 50.8 mm] each, for each 50 yd^3 [38 m^3] of grout placed, per day of pile placement. The Engineer will test two cubes at seven days and two cubes at 28 days. The minimum required strength will be specified on the plans. When a cement grout acceptance strength test falls more than 10% or 500 psi [3.5 MPa] below the specified minimum strength, whichever is less deviation from the specified minimum strength, perform one of the following:

(a) Remove and replace the LOT of concrete in question at no additional cost to the Department, or

(b) Submit a structural analysis performed by a Specialty Engineer. If the results of the analysis, approved by the Department, indicate adequate strength to serve the intended purpose with adequate durability, the concrete may remain in place. Otherwise, remove and replace the LOT of concrete in question at no additional cost to the Department.

All low strength cement grout accepted by the Engineer will be subject to reduced payment as follows: \$0.80/yd^3 for each 10 psi [\$1.05/m^3 for each 70 kPa] of strength test value below the specified minimum strength.

Reduction in pay will be applied to the entire length of all piles containing low strength cement grout, in any quantity. The quantity of cement grout affected by the price reduction may exceed the quantity of cement grout contained in the LOT. The dollar reduction will be equated to an equivalent length of pile not to exceed the total pile length constructed utilizing the subject LOT based on the following formula:

PLR = RC/UC

where PLR = Equivalent Pile Length Reduction in feet [meters]

RC = Total Reduction in payment, dollars
UC = Unit Cost of pile, dollars /foot [dollars /meter]

455-44 Pile Installation.

Meet the following requirements:

1. Locate the piles as shown on the drawings.

2. Should soft, compressible muck, organics, clay or other unsuitable materials (non A-1, A-3, A-2-4 or limestone materials) be encountered, remove the unsuitable material to a maximum depth of 5 feet [1.5 m] and a maximum diameter about the pile centerline, not to exceed 2 of the distance to the adjacent pile. Backfill with clean granular backfill materials (A-1, A-3, A-2-4), placed and compacted in maximum 12 inch [300 mm] lifts to at least 95% of maximum dry density as determined by AASHTO T 180. Complete this work to the Engineer's satisfaction prior to auger cast pile construction. Should more than 5 feet [1.5 m] or excessive quantities of unsuitable material be encountered, immediately advise the Engineer and proceed with the work as directed by the Engineer.

3. Provide continuous auger flighting from the auger head to the top of auger with no gaps or other breaks, uniform in diameter throughout its length, and of the diameter specified for the piles less a maximum of 3%. Provide augers with a distance between flights of approximately half the diameter of the auger.

4. Use augers with the grout injection hole located at the bottom of the auger head below the bar containing the cutting teeth, and with pile auger leads containing a bottom guide.

5. Construct piles of the length and diameter shown on the drawings.

6. Place piles by rotating a continuous flight hollow shaft auger into the ground at a continuous rate that prevents removal of excess soil. Stop advancement after reaching the predetermined depth.

7. Should auger penetration to the required depth prove difficult due to hard materials/refusal, the pile location may be predrilled, upon approval of the Engineer, through the obstruction using appropriate drilling equipment, to a diameter no larger than 2 the prescribed finish diameter of the auger cast pile. Commence auger cast pile construction immediately upon predrilling to minimize ground loss and soil relaxation. Should non-drillable material be encountered preventing placement to the depth required, immediately advise the Engineer and proceed with the work as directed by the Engineer. Refusal is defined as the depth where the penetration of the standard auger equipment is less than 12 inches/minute [300 mm/minute].

8. Plug the hole in the bottom of the auger while being advanced into the ground. Remove the plug by the grout or with the reinforcing bar.

9. Pump the grout with sufficient pressure as the auger is withdrawn to fill the auger hole, preventing hole collapse and to cause the lateral penetration of the grout into soft or porous zones of the surrounding soil. Carry a head of at least 5 feet [1.5 m] of grout above the injection point around the perimeter of the auger to displace and remove any loose material from the hole. Maintain positive rotation of the auger at least until placement of the grout.

10. Once the grout head has been established, stop or greatly reduce the speed of rotation of the auger and commence extraction at a rate consistent with the pump discharge. Maintain extraction at a steady rate to prevent a locked-in auger,

necking of the pile, or a substantially reduced pile section. Grout should start flowing out from the hole when the cutting head is within 5 feet [1.5 m] of the ground surface. Place a total volume of grout of at least 115% of the theoretical volume for each pile. If the cutting head reaches the ground surface without any grout, redrill the pile under the direction of the Engineer. If grouting is interrupted for any reason, reinsert the auger by drilling at least 5 feet [1.5 m] below the tip of the auger when the interruption occurred, and then regrout.

Use this method of placement at all times. Do not depend on the stability of the hole without the earth filled auger. Place the required steel reinforcement while the grout is still fluid, but no later than 2 hour after pulling of the auger.

11. Assume responsibility for monitoring the grout volume placed and document for each 6.5 feet [2 m] of pile grouted/placed. If less than 115% of the theoretical volume of grout is placed in any 6.5 foot [2 m] increment (until the grout head on the auger flighting reaches the ground surface), reinstall the pile by advancing the auger 10 feet [3 m] or to the bottom of the pile if that is less, followed by controlled removal and grout injection.

12. Maintain accurate records showing the placement depth of each pile and the amount of material used in each pile. Note any unusual conditions encountered during the installation.

13. Furnish and install the reinforcing steel and anchoring bolts as shown in the Contract drawings.

14. Use reinforcement that is without kinks or nonspecified bends, free of mud, oil or other coatings that could adversely affect the bond. Make splices in reinforcement as shown on the Contract drawings, unless otherwise approved by the Engineer.

15. Leave any temporary supports of/for items placed into a grouted pile (reinforcement template, anchor bolt template, precast column supports, etc.) in place until the grout reaches a minimum of 50% design strength or three days cure time, whichever is earlier. Do not place wall panels or other significant loads, before the grout has set a minimum of seven days or reached the 28 day strength.

455-45 Construction Tolerances.

Locate piles as shown on the drawings, or as otherwise directed by the Engineer. Locate pile centers to an accuracy of ∀3 inches [∀75 mm]. Ensure that the top of pile elevation is within an accuracy of ∀3 inches [∀75 mm] of the plan elevation.

Locate all precast post, anchor bolts, etc. within the following tolerances unless otherwise shown in the plans: variation from plum (∀3 inch/post height [∀6 mm/post height]); specified elevation (∀2 inch [∀13 mm]); and specified location (∀3 inch [∀6 mm]).

455-46 Unacceptable Piles.

Repair or replace unacceptable piles, as directed by the Engineer, at no cost to the Department. Unacceptable piles are defined as piles that fail for any reason, including but not limited to the following: piles placed out of position or to improper elevation; piles with reduced cross section, contaminated grout, lack of grout consolidation (honeycombed), or deficient grout strength; and piles with reinforcement, anchor devices or other components cast or placed into the fluid grout out of position.

455-47 Auger Cast Pile Installation Plan.

At the preconstruction conference, but no later than 30 days before auger cast pile construction begins, submit an auger cast pile installation plan for approval by the Engineer. Provide the following detailed information on the plan:

1. Name and experience record of auger cast pile superintendent or foreman in responsible charge of auger cast pile operations. Place a person in responsible charge of day to day auger cast pile operations who possesses satisfactory prior experience constructing shafts similar to those described in the Contract documents. The Engineer will give final approval subject to satisfactory performance in the field.
2. List and size of the proposed equipment, including cranes, augers, concrete pumps, mixing equipment etc., including details of proposed pump calibration procedures.
3. Details of pile installation methods.
4. Details of reinforcement placement and method of centering in pile, including details of all temporary supports for reinforcement, anchor bolts, precast columns, etc.
5. Details of how and by whom the grout volumes will be determined, monitored and documented.
6. Required submittals, including shop drawings and concrete grout design mixes.
7. Other information shown in the plans or requested by the Engineer.

455-48 Inspection and Records.

The Engineer will monitor pile installation. Maintain records of each pile installed, separate from those of the Engineer, showing:

1. Pile location
2. Ground elevation
3. Pile length
4. Tip elevation
5. Pile top elevation
6. Pay length (when piles are paid for separately)
7. Overburden length (length cast above the final grade point)
8. Pile diameter
9. Quantity of grout placed per yard [meter] of pile length
10. Theoretical quantity of grout required
11. Drilling time
12. Grouting time
13. All other pertinent data relative to the pile installation
14. Grout truck time of arrival to the site and batch time
15. Flow cone (consistency) results

455-49 Method of Measurement.

455-49.1 Protection of Existing Structures: The quantity to be paid for, when included in the Contract Documents, will be at the Contract lump sum price.

455-49.2 Auger Cast Pile: The quantity to be paid for will be at the Contract unit price per foot [meter] between tip and required pile top elevations for all piles completed and accepted.

455-50 Basis of Payment.

455-50.1 Protection of Existing Structures: When separate payment for Protection of Existing Structures is provided, price and payment will be full compensation for all work necessary to evaluate the need for, design of, and to provide the necessary features to protect the existing structures, including all cost of work shown in the plans or described herein for protection of existing structures.

When a separate payment for Protection of Existing Structures is not provided, the cost of settlement monitoring will be included in the cost of the structure. Work ordered by the Engineer for protection of existing structures, other than settlement monitoring, will be paid for as Unforeseeable Work.

455-50.2 Auger Cast Piles: Price and payment will be full compensation for all labor, materials, and incidentals for construction of auger cast piles of the sizes and depths indicated on the Contract drawings or otherwise required under this Contract. Price and payment will also include the removal and proper disposal off site of all spoil from the auger operation and all excess grout displaced from the auger hole, unless otherwise approved by the Engineer. Work to remove and replace unsuitable material when necessary as specified in 455-44 will be considered Unforeseeable Work.

455-50.3 Payment Items: Payment will be made under:

Item No. 455- 18- Protection of Existing Structures - lump sum.
Item No. 2455- 18- Protection of Existing Structures - lump sum.
Item No. 455-112- Auger Grouted Piles - per foot.
Item No. 2455-112- Auger Grouted Piles - per meter.

SECTION 459

BITUMEN COATING AND POLYETHYLENE SHEETING

ON CONCRETE PILES

459-1 Description.

Furnish and apply bituminous coating and primer, or install polyethylene sheeting and lubricant to prestressed concrete piles.

459-2 Materials.

459-2.1 Bituminous Coating: Use an asphalt type bituminous coating meeting the requirements of Section 916, with a minimum viscosity (at 140EF [60EC]) of 3,000 poises [300 Pa≅s] and a maximum of 1,000 poises [100 Pa≅s]. Apply bituminous coating uniformly over an asphalt primer.

459-2.2 Primer: Meet the requirements of ASTM D 41.

459-2.3 Polyethylene Sheeting: Use polyethylene sheeting that is 6 mils [0.15 mm] thick and is clean, new and has a smooth surface.

459-2.4 Lubricant: Use a lubricant between the two layers of sheeting that is either a vegetable oil or other approved environmentally and functionally acceptable lubricant.

459-3 Construction Requirements.

Before surfaces are coated with bitumen, dry and thoroughly clean them of dust and loose materials. Do not apply primer or bitumen in wet weather or when the temperature is below 65EF [18EC].

Apply the primer to the surfaces and allow it to dry completely before applying the bituminous coating. Apply primer uniformly at the quantity of 1 gal/100 ft^2 [0.4075 L/m^2] of surface.

Apply bitumen uniformly at a temperature of not less than 300EF [150EC], or more than 350EF [175EC], and apply either by mopping, brushing, or spraying at the project site. Completely fill all holes or depressions in the concrete surface with bitumen. Apply the bituminous coating to a minimum dry thickness of χ inch [3 mm], but not less than 8 gal/100 ft^2 [3.25 L/m^2].

Store bitumen coated piles before driving, and protect piles from sunlight and heat. Ensure that pile coatings are not damaged during storage, hauling, or handling. Take appropriate measures to preserve and maintain the bitumen coating. At the time of pile driving, ensure that the bitumen coating has a minimum dry thickness of χ inch [3 mm]. If necessary, recoat the piles, at no cost to the Department, to comply with the requirements of this Section.

Ensure that all surfaces to be wrapped with polyethylene sheeting are dry and thoroughly cleaned of dust and loose materials.

Place the sheeting on the pile to the limits shown on the plans. Wrap the pile with a minimum of two, 3 wraps of sheeting. Apply a uniform coating of a lubricant between the first and the second layers. Ensure that this coating fully covers the entire surface of the first layer of sheeting. Once the pile has been wrapped with the minimum of two, 3 wraps of sheeting, secure the sheeting with tape or other means that does not damage the sheeting or restrict its movement. Do not place any tape or other material other than the lubricant between the first and second layers of sheeting. Protect the sheeting from construction damage. Where sheeting has been damaged, completely remove the damaged sheet of polyethylene and replace it, at no cost to the Department, as directed by the Engineer.

Where the sheeting will not wrap the specified limits of the pile in one sheet, overlap the previous sheet with each subsequent sheet by 12 inches [300 mm].

459-4 Method of Measurement.

459-4.1 Bitumen Coating: The quantity will be paid for by the square yard [square meter] of coating in place on concrete pile surfaces.

459-4.2 Polyethylene Sheeting: The quantity will be paid for by the square yard [square meter] of wrapped concrete pile surfaces.

459-5 Basis of Payment.

459-5.1 Bitumen Coating: Price and payment will be full compensation for all work specified in this Section, including furnishing all labor, materials, tools, equipment, and incidentals, and doing all the work involved in applying the bituminous coating and primer, as specified in the Contract Documents.

459-5.2 Polyethylene Sheeting: Price and payment will be full compensation for furnishing all labor, materials, including primer and lubricant, tools, equipment, and incidentals, and for doing all the work involved in installing the polyethylene sheeting and lubricant, as specified in the Contract Documents.

459-5.3 Payment Items: Payment will be made under:

Item No. 459- 70-	Bitumen Coating on Concrete Piles - per square yard.
Item No. 2459- 70-	Bitumen Coating on Concrete Piles - per square meter.
Item No. 459- 71-	Polyethylene Sheeting on Concrete Piles - per square yard.
Item No. 2459- 71-	Polyethylene Sheeting on Concrete Piles - per square meter.

SECTION 460

STRUCTURAL STEEL AND MISCELLANEOUS METALS

460-1 Description.

Prepare, fabricate, assemble, erect, and paint structural steel, shear connectors, castings and forgings, plates and bolts, and certain special metals for structures or portions of structures.

460-2 Materials.

460-2.1 General: Meet the material requirements of Section 502 and Division III, with specific reference to Sections 961 through 964.

Except where otherwise shown in the plans, use structural steel for all major members, and rivet steel for all rivets. Use either cast steel or cast iron for castings, as shown in the plans.

For paint, meet the requirements of Section 971.

460-2.2 Weathering Steel: When the plans call for weathering steel to be used, meet the requirements of ASTM A709 Grade 50W [ASTM A709M, Grade 345W], unless otherwise noted on the plans. Fabricate all unpainted structural elements with steel with weathering characteristics. For bolts, nuts and washers, meet the physical and chemical requirements of ASTM A325 Type 3 [ASTM A325M Type 3], ASTM A563 Grade C3 [ASTM A563M Grade 8S3] and ASTM F436 Type 3 [ASTM F436M Type 3], respectively.

The Engineer will not allow the use of marking materials which leave behind residual material which may affect the weathering process of the steel (grease sticks, crayons, etc.). Store the girders as required for non-weathering steels; except fabricated weathering steel girders shall be stored exposed to the elements.

Prior to erection, blast clean all surfaces to meet SSPC-SP6 criteria. Blast clean the exposed fascia of the exterior girders to meet SSPC-SP10 criteria.

Prior to erection of the girders, wrap all exposed substructure concrete surfaces with polyethylene sheeting to protect against staining from the girders. Leave the sheeting in place and keep the sheeting free of tears or separations until the application of the Class V finish. Do not, in any case, remove the sheeting prior to placement of the deck.

Upon completion of construction, remove all oil, grease, dirt or other foreign material from the steel. Solvent cleaning (SSPC-SP1) may be used to remove oil, grease and other compounds. Hand cleaning (SSPC-SP2) or power cleaning (SSPC-SP3) may be used to remove deposits of excess rust scale, paint or other foreign matter. Do not use acids for cleaning steel surfaces. Clean all concrete stains in areas without a Class V finish by sandblasting, cleaning with a stain remover or commercial cleaner after completion of the structure.

460-2.3 Fracture Critical Members: When the plans designate fracture critical members, submit to the Engineer evidence of fabricator certification for Major Steel Bridges with Fracture Critical Rating under the AISC Quality Certification Program before beginning fabrication.

460-3 Drawings.

460-3.1 General: Furnish working, shop, and erection drawings showing details, dimensions, sizes of materials, and other information and data necessary for the complete fabrication and erection of metal work. Submit drawings to the Department as specified in Section 5 for review and approval.

460-3.2 Changes: Do not make changes in any drawing after it has been approved, except by written consent or direction of the Engineer. The Contractor may substitute sections having dimensions different from those shown in the plans only when approved in writing by the Engineer.

460-4 Storage of Materials.

Store structural steel materials above the ground on platforms, skids, or other supports, and protect the materials as is necessary and practicable from exposure to conditions producing rust or other surface deterioration. Keep materials free from accumulations of dirt, oil or other foreign matter. Place girders and beams in an upright and normal position, and support them to prevent undue stress or stresses.

460-5 Straightening Material.

Use rolled material, before being laid off or worked, that is straight. If straightening is necessary, use methods that will not injure the metal. Do not heat straighten ASTM A 514 [ASTM A 514M] or ASTM A 517 [ASTM A 517M] steel. The Engineer will consider sharp kinks and bends cause for rejection of the material.

460-6 Welds.

Where shown in the plans, make connections by electric arc welding. Proportion weld details and weld in accordance with the AASHTO Standard Specifications for Welding of Structural Steel Highway Bridges, and the referenced AWS Structural Welding Code. The following additional provisions apply:

(1) The Department will use radiographic inspection in lieu of ultrasonic

inspection wherever ultrasonic inspection is specified or permitted as an alternate.

(2) The Department will perform the initial radiographic examinations, testing, and inspections required by the Contract Documents, exclusive of the qualifying of welders and welding procedures. The actual cost of any additional radiographic examinations, tests and inspections made by the Department to determine the extent of defects and to ascertain that all flaws so detected are corrected will be charged to the Contractor.

(3) Electro-slag welding will not be permitted.

(4) Documentation of their qualifications to perform the specific welding task in accordance with the appropriate code governing the work will be required prior to permitting welders, welding operators, or tackers to perform construction or maintenance welding on Department structures.

460-7 Rivets.

460-7.1 General Requirements: The diameter of the rivets as indicated in the plans designates their diameter prior to heating. Form heads of driven rivets of approved shape, concentric with the shanks, true to size, full, neatly formed, free from fins, and in full contact with the surface of the member. Use rivets free from furnace scale on their shanks and from fins on the underside of the machine-formed heads.

460-7.2 Field Rivets: Supply field rivets, for each size and length, in excess of the actual number to be driven, to allow for losses due to misuse, improper driving, or other contingencies.

460-8 Bolts and Bolted Connections.

460-8.1 High-Strength Bolts:

460-8.1.1 General: Where bolted connections are shown in the plans, unless otherwise specifically stated, make the connections using the turn-of-nut method with fastener assemblies consisting of Type 1 steel bolts meeting the physical and chemical requirements designated in ASTM A 325, Grade DH or 2H [ASTM A 325M, Class 8S or 8S3] plain finish nuts meeting the physical and chemical requirements as designated in ASTM A 563 or ASTM A 194 [ASTM A 563M or ASTM A 194M], respectively, and hardened steel washers meeting all requirements designated in ASTM F 436 [ASTM F 436M]. Use galvanized fastener assemblies in the top flanges of main girders, stringers and floorbeams in bascule spans. Do not use galvanizing on other fastener assemblies unless otherwise shown in the plans. Provide nuts that are free running the full length of the bolt threads. When galvanizing is required, galvanize all components of the fastener assemblies by the same process. To document compliance with these Specifications, secure and provide to the Department certified reports of all test results from representative samples of fastener components selected from LOTs to be used on the project. Provide a statement with the certified reports including:

(a) The name and location of the facility where each test was performed.

(b) Number of samples in LOT and LOT size.

(c) A certificate that all test results show compliance with these Specifications.

(d) Corresponding LOT numbers which appear on the shipping package.

(e) Facsimilies of markings which appear on each LOT of fastener components delivered.

(f) A table of test requirements and actual test results.

Maintain and document the integrity of this LOT audit system during any intermediate or subsequent operations (plating, heat treating, warehousing, resale, etc.). If the Contractor fails to maintain and document at any point, the Engineer may reject the LOT or require additional sampling and testing of the LOT at a frequency suitable to the Department to accept the LOT. Perform all such additional sampling and testing to reinstate audit integrity at no expense to the Department.

Provided that the integrity of the LOT audit system has been maintained, perform sampling and testing for the purpose of verifying chemical and physical properties of the fastener components as specified in the ASTM standards governing individual fastener components. For the purpose of verifying properties of galvanizing, sample and test the fastener assembly components in accordance with ASTM B 602 Table 2 for nondestructive tests or Table 4 for destructive tests unless otherwise designated in the plans.

The Department reserves the right to independently select and test fastener components and assemblies.

460-8.1.2 Additional Material Requirements: Ensure that the maximum hardness for AASHTO M 164 (ASTM A 325) [ASHTO M164 M (ASTM A 325M)] bolts is: 34 Rc for bolts M16 to M36, 33 Rc for bolts 2 to 1 inch [12.7 to 25.4 mm] in diameter, and 30 Rc for bolts 1χ to 12 inch [28.6 to 38.1 mm] in diameter.

Provide Grade 2H or DH [Class 8S or 8S3] nuts for black or galvanized fasteners. For coated fasteners, overtap the nuts to the minimum amount required for the fastener assembly. Provide all nuts, bolts, and washers with manufacturer's markings on them.

When zinc coating is required, furnish either hot-dip galvanizing (Class C of ASTM A 153) or mechanically deposited zinc (Class 50 of ASTM B 695) products unless the specific process is called for in the plans. Coat the bolt, nut and washer used in the fastener assembly by the same zinc process, i.e. hot-dip or mechanically deposited.

460-8.1.3 Additional Test Requirements: Perform the rotational-capacity tests indicated below on a minimum of two units of each combination of the LOTs of bolts, nuts, and washers supplied. Test and report zinc coating thickness when galvanized fasteners are required. The manufacturer or distributor who combines the bolts, nut, and washer into assembly will perform these tests.

For high strength fastener assemblies (bolt, nut, and washer), black and galvanized, perform a rotational-capacity test (AASHTO M 64, Section 8.5 [ASHTO M 164M, Section 8.2]), and meet the following requirements:

(a) Perform twice the required number of turns (from snug tight conditions) indicated in the 1988 Interim AASHTO Bridge Specification, Table 10.17B, in a Skidmore-Wilhelm Calibrator, or equivalent tension measuring device, without stripping or failure.

(b) After making the required number of turns, achieve a recorded tension equal to or greater than 1.15 times the Required Fastener Tension, AASHTO Standard Specifications for Highway Bridges, Division II, Table 11.5A.

(c) When measuring the torque to produce the Required Fastener

$$Torque = 0.25\ PD$$

Tension, do not exceed the value obtained by the following equation:

Where:

Torque = Measured Torque in foot-pounds [newton meters]

P = Measured Bolt Tension in pounds [newtons]

D = Nominal Diameter in feet [meters]

Perform proof load tests (ASTM F 606 [ASTM F 606M], Method 1) for the bolts. Perform wedge tests of full size bolts in accordance with Section 8.3 of AASHTO M 164 [Section 8.1 of AASHTO M 164M]. Wedge test galvanized bolts after galvanizing. Perform proof load tests (AASHTO M 291 [AASHTO M 291M]) for the nuts. Perform the proof load tests for nuts to be used with galvanized bolts after galvanizing, overtapping and lubricating.

460-8.1.4 Lubricant: Coat fastener assembly components with a lubricant commercially produced for lubricating high strength fastener assemblies. Use a lubricant of a visually obvious color. Use a lubricant that is clean and dry to the touch, and apply it prior to testing and packaging for shipment to the job site. Lubricate all nuts. Lubricate the face of the bolt head when the bolt is the element to be turned in the tightening process. Prior to lubrication, clean fastener elements of dirt, rust, and other deleterious substances. Clean and relubricate fastener elements which are weathered or rusted after lubrication.

460-8.1.5 Packaging for Shipment: Ship fastener assembly components in sealed, watertight containers, each labeled on the side of the container with the supplier's name and LOT identification number, and marked to identify the contents and size of the component, i.e. bolt, nut, or washer. Lubricate all surfaces of the nuts prior to placing in watertight containers. Provide containers for fastener assembly components that are capable of protecting the components from moisture and other deleterious materials until they are opened for use at the job site. The Engineer may reject containers of fastener assemblies received at the job site when there is visible damage to the fastener components.

460-8.1.6 Handling and Storage: Store containers of fastener assembly components at the job site in a weatherproof storage enclosure. Take only as many containers of fastener assembly components as are anticipated to be installed and tightened during a work shift from protected storage, and leave the containers unopened until needed for erection. Return fastener assembly components not used to protected storage at the end of the work shift for use on the next succeeding work shift. Protect opened containers of fastener assembly components from the elements, such as precipitation, debris, dust, and contaminants, with removable covers at all times until emptied.

460-8.1.7 Procedure and Demonstration: Submit in writing for approval proposed methods for removal of lubricant from the exposed surfaces of the installed fastener assemblies in preparation for application of required coats of paint. Perform surface preparation, including the removal of lubricant, in accordance with the paint manufacturer's surface preparation requirements prior to paint application.

Demonstrate procedures for surface preparation prior to painting, and obtain the Engineer's approval prior to installation of fastener assemblies.

460-8.1.8 Installation:

460-8.1.8.1 General: Perform the rotational-capacity test described in 460-8.1.3 on each rotational capacity LOT prior to the start of bolt installation and at any other time the Engineer orders the test to be performed. Proceed with installation upon obtaining satisfactory test results. Tighten a bolt, nut, and washer fastener assembly to provide at least the minimum bolt tension shown in Table A below for the size used when all fastener assemblies in the joint are tight:

Table A
Bolt Tension
Non SI Bolts

Bolt Size (in.)	Minimum Bolt Tension* (lbs.)	
	AASHTO M 164 (ASTM A 325) Bolts	AASHTO M 253 (ASTM A 490) Bolts
2	12,050	14,900
ε	19,200	23,700
:	28,400	35,100
φ	39,250	48,500
1	51,500	63,600
1χ	56,450	80,100
13	71,700	101,800
1δ	85,450	121,300
12	104,000	147,500

*Equal to 70% of specified minimum tensile strength of bolts.

Table A

Bolt Tension
SI Bolts

Bolt Size mm	Minimum Bolt Tension* (kN)	
	AASHTO M 164M (ASTM A 325M) Bolts	AASHTO M 253M (ASTM A 490M) Bolts
M16	94.2	130
M20	147	203
M22	182	251
M24	212	293

M27	275	381
M30	337	466
M36	490	678

*Equal to 70% of specified minimum tensile strength of bolts.

If required, because of bolt entering and wrench operational clearances, the Contractor may perform tightening by the required procedure by turning the bolt while the nut is prevented from rotating. Remember that normally the nut is turned while the bolt is held stationary. When it is necessary to turn the bolt instead of the nut, lubricate the face of the bolt head prior to installation of the fastener assembly.

The Contractor may reuse AASHTO M 164 (ASTM A 325) [AASHTO M 164M (ASTM A 325M)] bolts if approved by the Engineer, but not more than once. Consider a fastener assembly as used when the required turn has been made after achieving "snug tight". Do not retighten previously tightened bolts which may have been loosened by the tightening of adjacent bolts as reuse.

Provide all fastener assemblies with a hardened washer under the element (bolt head or nut) turned in tightening. Where an outer face of the bolted parts has a slope more than 1:20 with respect to a plane normal to the bolt axis, use a smooth beveled washer to compensate for the lack of parallelism.

Use the turn-of-nut method to tighten a bolt, nut, and washer assembly.

In the turn-of-nut method, first bring all the fastener assemblies (bolts, nuts, and washers) of a steel connection to a "snug tight" condition to ensure that all parts of the connection are brought into full contact with each other. Regard "snug tight" as the tightness obtained by an impact wrench producing a torque and corresponding bolt tension, which produces at least the minimum required bolt tension when applying further rotations in accordance with Table B. In all cases, the final test for approval of "snug tight" condition is the visual observation by the inspector that all parts in the joint have been brought into full contact in the faying surface areas with no fasteners loose in the connection. After all of the connection fastener assemblies are in "snug tight" condition, additionally tighten all fastener assemblies in the joint by the applicable amount of nut rotation specified in Table B below:

Table B

Nut Rotation* From Snug Tight Condition			
	Disposition of Outer Faces of Bolted Parts		
Bolt Length Measured From Underside of Head to Extreme End of Point	Both Faces Normal to Bolt Axis	One Face Normal to Bolt Axis and Other Face Sloped Not More Than 1:20 (Bevel Washer Not Used)	Both Faces Sloped Not More Than 1:20 From Normal to Bolt Axis (Bevel Washer Not Used)
Up to and including four diameters	1/3 turn	1/2 turn	2/3 turn
Over four	1/2 turn	2/3 turn	5/6 turn

diameters but not exceeding eight diameters			
Over eight diameters but not exceeding 12 diameters**	2/3 turn	5/6 turn	1 turn

*Nut rotation is relative to bolt, regardless of the element (nut or bolt) being turned. For bolts installed by 2 turn and less, maintain a tolerance of ∀30 degrees; for bolts installed by β turn and more, maintain a tolerance of ∀45 degrees.

**No research work has been performed by the Research Council on Riveted and Bolted Structural Joints to establish the turn-of-nut procedure when bolt lengths exceed 12 diameters. Therefore, determine the required rotation by actual tests in a suitable tension device simulating the actual condition.

Furnish calibrated torque wrenches with dial faces to be used by the Engineer for inspection of fastener assemblies in bolted connections which have been installed and brought to "snug tight" condition. If impact wrenches are used to obtain "snug tight" condition, calibrate and check them at appropriate intervals as suggested by the manufacturer to ensure that all bolt assemblies are installed correctly.

Furnish a Skidmore-Wilhelm calibrator or other acceptable bolt tension indicating device at each job site for use during bolt installation. Confirm the accuracy of the tension measuring device through calibration by an approved testing agency at least once a year. The Engineer will perform and witness daily testing to ensure the installed bolt/nut/washer assembly meets the above requirements. Make daily tests of a representative sample of five bolt assemblies from each combination of nut/bolt being tightened on that day. Tighten with the tension measuring device by the same method used for the field bolt installation process to a "snug tight" tension and corresponding torque, which, when the additional turns required in Table B are added, will result in a least 1.05 times the minimum required bolt installation tension. Place a washer under the part turned in tightening the bolt. Consider the job inspection "snug tight" torque as the average of three test values determined after rejecting the high and low test values.

460-8.1.8.2 Snugging: When tightening, systematically progress from the most rigid part of the connection (usually the center area of the fastener assemblies group) to the free edges. During this operation, do not allow rotation of the part of the fastener assembly not turned by the wrench.

After all of the fastener assemblies in any structural steel connection are tightened to the "snug tight" condition, and all parts in the joint have been brought into full contact with the faying surface areas, the Engineer will check no less than three bolts and a minimum of 10% of the fastener assemblies in that connection with the torque wrench prior to final tightening by the turn-of-the-nut method. Tighten any fastener failing to produce the torque required to achieve the "snug tight" condition, as established with the Skidmore-Wilhelm Calibrator, as required, and perform torque wrench testing on all remaining untested fasteners in the connection.

460-8.1.8.3 Final Tightening: After the "snug tight" condition of the fasteners of a structural steel connection is verified by the Engineer, the inspector will matchmark the fastener assemblies on the bolt thread end and the nut. Thereafter, turn the nut with respect to the bolt the prescribed amount shown in Table B. Once all scribe marks indicate the amount of nut rotation with respect to the bolt as being equal to or more than the minimum rotation required in Table B, the Engineer will accept the structural steel connection.

460-8.2 Other Types of Bolts:

460-8.2.1 Use of Other Types of Bolts: Except for connections made with high-strength bolts, do not use bolted connections unless authorized by the Engineer.

460-8.2.2 Bolts: Where bolted connections are permitted, furnish unfinished bolts (ordinary rough or machine bolts) or turned bolts, as specified or directed by the Engineer. Provide unfinished bolts that are standard bolts with square or hexagonal heads and nuts. Do not use "button head" bolts. Use bolts transmitting shear that are threaded to such length that not more than one thread will be within the grip of the metal. Provide bolts of lengths which will extend entirely through their nuts but not more than 3 inch [5 mm] beyond them.

460-8.2.3 Bolt Holes: Make the diameter of the bolt holes 1/16 inch [2 mm] greater than the diameter of the bolts used. Carefully ream or drill holes for turned bolts, and turn the bolts to a driving fit by giving them a finishing cut. Ensure that the threads for turn bolts are entirely outside of the holes, and the heads and nuts are hexagonal.

460-8.2.4 Nutlocks: The Contractor shall use approved nutlocks on all bolts unless he obtains permission to the contrary from the Engineer. Where nutlocks are not used, place round washers having a thickness of χ inch [3 mm] under the nuts.

460-9 Shop Assembly of Main Members.

Subpunch holes for field connections in all main members, including trusses, portal bracing, girders, continuous I-beams, rigid frames, bents, towers, etc. Ream holes to full size while shop-assembling the parts. Ream floor beams and stringer connections to a metal template not less than 1 inch [25 mm] thick.

Fit and line trunnion and racks to the main girders in the shop. Set the pitch lines of racks at exact radial distances from the trunnion centers. Place the face of rack teeth exactly normal to the plane of the girders.

Fit trunnion journals to their bearings in the shop, and matchmark corresponding parts.

Assemble all parts of the gear trains for span operations, except the racks, with parts in correct relative positions, and anchor them to supports.

With all parts thus placed and anchored, perform a power-driven test run of not less than four hours on the machinery. Correct any irregularities or defects which may develop or are exposed by such test run before shipping of the machinery to the project.

460-10 Holes for Rivets and Bolts.

460-10.1 General Requirements: Except for main members, as provided above, and where general reaming is not specified in the plans, the Contractor may punch full-size holes in material : inch [20 mm] or less in thickness. For material more than : inch [20 mm] in thickness, subpunch and ream, or drill holes.

460-10.2 Punched Holes:

460-10.2.1 Size of Holes: Punch full-size holes 1/16 inch [2 mm] larger than the nominal diameter of the rivet or bolt. Do not allow the diameter of the die to exceed the diameter of the punch by more than 3/32 inch [2.5 mm]. Provide holes that are clean-cut without torn or ragged edges. Ream holes that must be enlarged to admit the rivets or bolts.

460-10.2.2 Accuracy of Punching: Punch holes so that, after assembling the component parts of a member, a cylindrical pin χ inch [3 mm] smaller than the nominal diameter of the punched hole may be passed through at least 75% of any group of contiguous holes in the same plane. The Engineer will reject the improperly punched pieces if this requirement is not met. The Engineer may reject the member if any hole will not pass a pin 3/16 inch [5 mm] smaller than the nominal diameter of the punched hole.

460-10.3 Drilled Holes: Drill holes 1/16 inch [2 mm] larger than the nominal diameter of the rivet or bolt. Remove burrs on the outside surface.

460-10.4 Subpunched and Reamed Holes: For subpunched and reamed holes for rivets having diameters greater than : inch [20 mm], punch holes 3/16 inch [5 mm] smaller than the nominal diameter of the rivet, and for rivets and bolts having diameters : inch [20 mm] or less, punch holes 1/16 inch [2 mm] less than the nominal diameter of the rivet or bolt. Use a punch and die having the same relative size as specified for full-size punched holes. After the punching, ream the holes to a diameter 1/16 inch [2 mm] larger than the nominal diameter of the rivet or bolt. Remove burrs resulting from reaming. Ream rivet holes with twist drills or with short taper reamers.

460-10.5 Accuracy of Reamed and Drilled Holes: Ensure that reamed or drilled holes are cylindrical and perpendicular to the member and that their accuracy is the same as specified for punched holes, except that, after reaming or drilling, ensure that 85% of any group of contiguous holes in the same plane does not show an offset greater than 1/32 inch [1 mm] between adjacent thicknesses of metal.

460-10.6 Drifting of Holes: Allow only enough drifting during assembling to bring the parts into position but not sufficient enough to enlarge the holes or distort the metal.

460-10.7 General Reaming: The Engineer may require general reaming, in which case it will be shown in the plans. Where general reaming is required, subpunch and ream all holes in material forming a part of the section of main members if the thickness of the material is not greater than the nominal diameter of the rivet or bolt. The Contractor may punch holes full size in material used for lateral, longitudinal, and sway bracing, lacing bars, stay plates, and diaphragms not forming a part of the section of main members, if the thickness of the material is not greater than the nominal diameter of the rivet or bolt. Drill holes in material of a greater thickness than the nominal diameter of the rivet or bolt.

Perform reaming after the pieces forming a built member are assembled and firmly bolted together. Do not interchange reamed parts.

Ream or drill holes for field connections, except those in lateral, longitudinal and sway bracing, with the connected parts assembled, or else ream or drill to a metal template not less than 1 inch [25 mm] thick.

460-10.8 Holes in Bearing Plates: The Contractor may form holes in bearing plates by drilling, punching or oxygen cutting. Remove all burrs by grinding. Unless plans establish different requirements, the Engineer will use the following criteria to judge the acceptability of holes in bearing plates:

Centering and alignment is within a tolerance of 1/16 inch [2 mm].
Cut faces are perpendicular to the plane of the plate.
Holes do not exceed a uniform excess of 1/16 inch [2 mm] in size.
Notches or gouges do not exceed χ inch [3 mm] in depth.

460-11 Riveting.

460-11.1 General: Uniformly heat rivets to a light cherry red color, and drive while hot. Do not heat the points of rivets more than the remainder. When ready for driving, use rivets that are free from slag, scale, and other adhering matter, and that completely fill the holes when driven. Do not drive burned, burred, or otherwise defective rivets, and rivets which throw off sparks when taken from the furnace or forge. Drive rivets using power tools. Do not use hand tools for riveting unless authorized in writing by the Engineer.

460-11.2 Defective Rivets: Cut out rivets which are loose, burned, badly formed, or otherwise defective. Do not perform caulking and re-cupping of rivet heads. When cutting out defective rivets, take care not to injure the adjacent metal and, if necessary, remove the rivet shanks by drilling.

460-11.3 Countersinking: Neatly countersink rivets to completely fill the holes.

460-12 Shop Assembly.

460-12.1 General: Ensure that the component parts of a built member are assembled, drift-pinned to prevent lateral movement, and firmly bolted to draw the parts into close contact before reaming, drilling or beginning riveting. Take apart assembled parts, if necessary, for removal of burrs and shavings produced by the reaming operation. Ensure that members are free from twists, bends, or other deformations. In preparation for shop-connecting full-size punched material, clear the rivet or bolt holes by reaming.

460-12.2 End Connection and Stiffener Angles: Carefully adjust end connection angles, stiffener angles, etc., to correct locations, and rigidly bolt, clamp, or otherwise firmly hold them in place until connected.

460-12.3 Riveting: Drive shop rivets by direct-acting rivet machines where practicable.

460-12.4 Matchmarking: Matchmark connecting parts assembled in the shop for the purpose of reaming or drilling holes in field connections. Furnish a diagram showing such marks to the Engineer.

460-13 Planing.

460-13.1 Edge Planing: When required by the Engineer, plane sheared edges of material more than ε inch [16 mm] in thickness to a depth of not less than χ inch [3 mm]. Fillet re-entrant cuts before cutting.

460-13.2 Planing of Bearing Surfaces:

460-13.2.1 Columns Bearing on Base and Cap Plates: Mill ends of columns that are bearing upon base and cap plates to true surfaces and correct bevels after the main section of these members and the end connection angles have been fully riveted or bolted.

460-13.2.2 Caps and Base and Sole Plates: Ensure that caps and base plates of columns, and the sole plates of girders and trusses, have full contact when assembled. If the plates are warped or deformed, hot-straighten, plane, or otherwise treat them to secure an accurate, uniform contact. After riveting in place, chip the excess metal of counter-sunk rivet heads smooth and flush with the surrounding metal, and plane or mill the surfaces which are to come in contact with other metal surfaces, if necessary, to secure proper contact. Rough-finish surfaces of base and sole plates which are to come in contact with masonry so that they are free from warps and other deformities.

460-13.2.3 Cast Pedestals, Shoes, and Bearing Plates: Plane surfaces of cast pedestals and shoes which are to come in contact with metal surfaces, and rough-finish surfaces which will bear upon the masonry. Plane the surfaces of expansion bearings in the direction of expansion. Carefully mill and polish-finish surfaces of bronze bearing plates intended for sliding contact.

460-13.3 Abutting Joints:

460-13.3.1 Compression Members: Accurately face abutting ends of compression members, after riveting or bolting the members, to secure an even bearing when assembled in the structure.

460-13.3.2 Tension Members: Rough-finish ends of tension members at splices to secure close and neat, but not contact, fitting joints.

460-14 End Connection Angles.

Locate end connection angles of floor beams and stringers flush with each other and accurately set as to position and length of member. In general, do not finish end connection angles unless so shown in the plans. However, faulty assembling and riveting may be cause for requiring end connection angles to be milled, in which case reduce their thickness, but do not exceed 1/16 inch [2 mm], or reduce their rivet bearing value below design requirements.

460-15 Built Members.

Make several pieces forming one straight and close fitting built member. Use members that are true to detailed dimensions and free from twists, bends, open joints, and other defects resulting from faulty fabrication and workmanship.

460-16 Lacing Bars.

Neatly round the ends of lacing bars unless otherwise indicated in the plans.

460-17 Plate Girders.

460-17.1 Web Plates: The Contractor may use web plates of girders having no cover plates that are detailed with the top edge of the web flush with the backs of the angles. Chip web plates of girders having cover plates beyond the angles flush with the backs of the angles. The Contractor may use web plates of girders having cover plates that are 2 inch [13 mm] less in width than the distance, back to back, of flange angles.

460-17.2 Splicing: Where splicing web plates, ensure that there is not more than δ inch [10 mm] clearance between ends of plates.

460-17.3 Stiffener Angles: Mill or grind end stiffener angles of girders and stiffener angles intended as supports for concentrated loads to secure a uniform, even bearing against the flange angles. Provide intermediate stiffener angles with a sufficiently tight fit to exclude water after being painted.

460-17.4 Splice Plates and Fillers: Ensure that web splice plates and fillers under stiffeners fit within χ inch [3 mm] at each end.

460-17.5 Field Bolted Splices - Fillers: When fillers for field bolted splices are shown on the plans to be less than 3/16 inch [5 mm thick], the Contractor may provide fillers from low-alloy sheet material as specified in 962-2. Do not subject fillers to CVN testing, but paint them as specified in 560-11.2.

460-18 Pins and Rollers.

Use pins and rollers accurately turned to detailed dimensions that are smooth, straight, and free from flaws. Produce the final surface by a finishing cut.

Use pins and rollers with diameters greater than 6 inches [150 mm] that are forged and annealed.

Ensure that pins and rollers larger than 8 inches [200 mm] in diameter have a hole not less than 2 inches [50 mm] in diameter bored longitudinally through their centers. Bore the hole after forging and before annealing. The Engineer will reject pins and rollers showing defective interior conditions.

460-19 Boring Pin Holes.

460-19.1 General: Bore pin holes true to detailed dimensions, smooth and straight, at right angles with the axis of the member and parallel with each. Always make a finishing cut. Perform boring of holes in built-up members after completing riveting.

460-19.2 Dimensional Tolerance: Ensure that the length outside-to-outside of holes in tension members and inside-to-inside of holes in compression members does not vary from detailed dimensions more than 1/32 inch [1 mm].

460-20 Pin Clearances.

Ensure that the difference in diameter between the pin and the pin holes is not more than 1/32 inch [1 mm].

460-21 Screw Threads for Pins.

Make screw threads as shown in the plans, and make close fits in the nuts.

460-22 Pilot and Driving Nuts.

Furnish two pilot nuts and two driving nuts for each size pin, unless otherwise shown in the plans.

460-23 Notice of Rolling and Fabrication.

Give ample advance notice to the Engineer of the beginning of work at the mill and shop, so that the Engineer may inspect the work. After placing the order, do not roll or fabricate any material before notifying the Engineer.

460-24 Facilities for Inspection.

Furnish all facilities for the inspection of materials and workmanship in the mill and shop, and allow inspectors free access to the necessary parts of the premises.

460-25 Inspector's Authority.

460-25.1 Right of Rejection: The inspector has the authority to reject materials or workmanship which do not fulfill the requirements of these Specifications, but in case of dispute, the Contractor may appeal to the Engineer. The Engineer will make the final decision.

460-25.2 Subsequent Rejection of Materials Previously Approved: Although previously accepted, the inspector may reject materials or furnished members if they are later found defective. Promptly replace or make good rejected material and workmanship.

460-25.3 Mill and Shop Inspection: Inspection at the mill and shop is intended as a means of facilitating the work and avoiding errors; however, the Contractor is fully responsible in regard to imperfect material or workmanship and the necessity for replacement, as might be required by later inspections.

460-26 Rejection of Fabricated Work at Site.

The Engineer may waive shop inspection and make complete inspection of all fabricated work upon its delivery at the site of the structure. Whether or not shop inspection is made, the Engineer may reject fabricated steel at any time he might find it does not conform to the Contract Documents.

460-27 Marking and Shipping.

460-27.1 General: Mark the weight on members weighing more than 3 tons [3 metric tons]. Pack bolts and rivets of one length and diameter, and loose nuts or washers of each size, separately. Ship pins, small parts, and small packages of bolts, rivets, washers, and nuts in boxes, crates, kegs, or barrels of convenient sizes. Plainly display a list and description of the contained material on the outside of each shipping container. Keep the weight of all tools and erection material separate.

The Engineer will allow metal die stamping in the fabrication of structural steel in conformance with the requirements specified herein. Do not use die stamps on fracture-critical members, or near the edges of plate members subject to tensile stresses. The Engineer will accept numbers, letters, or combinations thereof impressed into steel components for the purpose of identifying the fabricated member in lieu of paint, metal tags, or other methods of identification.

The Contractor may accomplish marking of fabricated structural steel as required herein and in 460-12.4 by the use of paint, attached metal tags, or low stress dies with blunt-nosed continuous or blunt-nosed interrupted dot die stamps (i.e., dies manufactured to produce impressions that are rounded at the bottom of the impression).

The maximum allowed depth of the impression is 0.010 inch [0.3 mm]. Use die stamping tools that make character sizes with corresponding face radii as shown in the following table:

Size of Steel Die Stamp Markings

Character Size inch [mm]	Minimum Face Radii inch [mm]
0.125 [3]	0.007 [0.2]
0.1,875 [5]	0.004 [0.1]
0.250 [6]	0.010 [0.3]

In all cases, ensure that shop drawings submitted by the fabricator indicate proposed location of all low stress metal die stamping.

For bridge members, the Contractor may apply the low stress metal die stamping at the following locations:

(1) Girder field splices or beam ends:

a. Outer fourth of top flange splice plates.

b. Middle third of web splice plates.

c. Outer half of girder flange bolt hole pattern at splice.

d. Within 6 inches [150 mm] of bearing stiffeners in the top flange areas at end of girder.

(2) Diaphragms:

a. The preferred location is the middle portion of a top horizontal diaphragm bracing member.

b. In lieu of the above, the middle of the bottom horizontal diaphragm bracing member.

(3) Other members: Clearly indicate the location on shop drawings submitted for approval.

Make any marking to be done at the mill, as required by AASHTO M 160 (ASTM A 6) [AASHTO M 160M (ASTM A 6M)], in no more than one place on each piece. The Contractor may use die stamping, using low-stress blunt-nosed continuous or low-stress blunt-nosed interrupted dot steel dies.

460-27.2 Anchor Bolts and Grillage Materials: Ship anchor bolts, washers, and other anchorage or grillage materials to suit the requirements of the masonry construction.

460-27.3 Handling and Transportation: Conduct the loading, transportation, and unloading of structural material so that the metal will be kept clean and free from injury by rough handling.

460-28 Mill Orders and Shipping Statements.

Furnish the Engineer with six copies of mill orders and shipping statements. Show the weights of the individual members.

460-29 Field Inspection.

The Engineer will inspect all work of erection. Provide the Engineer with all facilities required for a thorough inspection of workmanship. The Engineer will inspect material and workmanship not previously inspected after its delivery to the construction site.

460-30 Furnishing and Setting Anchor Bolts.

460-30.1 General: Fabricate anchor bolts with the material specified on the plans, and galvanize them in accordance with ASTM A 153, except that apply electroplated zinc coating SC 3, Type II in accordance with ASTM B 633 for anchor bolts fabricated of a material having a yield strength greater than 80,000 psi [550 MPa]. Treat the coated bolts, nuts, and washers with chromate after coating in a water solution containing 0.2% sodium dichromate 3 oz/10 gal [(2.2 g/L)]. Store the quenched chromated bolts, nuts, and washers in a dry area protected from the weather. After erection, clean the bolts, nuts, and washers of all oil and deleterious material and coat with a primer recommended by the paint manufacturer for coating galvanized surfaces.

460-30.2 Responsibilities of Substructure and Superstructure Contractors: Where the substructure and superstructure are built by different contractors, the substructure contractor shall set anchor bolts. The superstructure contractor is responsible, however, to provide the substructure contractor with anchor bolts and correct plans for their setting, and he shall cause the substructure contractor no delay in such work. In any case the superstructure contractor is responsible to inspect the setting of anchor bolts at the time the substructure contractor is working and to check the placing of them. The superstructure contractor shall bear any expense incurred because of any error in setting anchor bolts.

460-30.3 Adjustments for Temperature: Vary the location of the anchor bolts in relation to the slotted holes in expansion shoes with the prevailing temperature. Install nuts on anchor bolts at the expansion ends of spans to permit the free movement of the span.

460-30.4 Methods of Setting:

460-30.4.1 General: Set anchor bolts by a method specified below. The Contractor may use either of these methods unless the Engineer designates the method to be used in any particular case.

460-30.4.2 Setting Bolts in Drilled Holes: Drill anchor bolt holes, in correct locations, vertically to the plane of the bridge seat, and set the anchor bolts in portland cement mortar. Provide mortar consisting of one part cement to one part clean, fine-grained sand, mixed sufficiently wet to flow freely. Drop anchor bolts into the dry holes to ensure their proper fit after setting. Set bolts as follows: Fill the hole about β full of mortar. Force the bolt down the hole using a uniform, even pressure or by light blows with a hammer (without flogging or ramming) until the mortar rises to the top of the hole and the anchor bolt nut rests firmly against the metal shoe or pedestal. Remove all excess mortar which may have flushed out of the hole, to permit proper field painting of the metal surfaces.

460-30.4.3 Setting Bolts in Formed Holes: The Contractor may form bolt holes in concrete masonry by the insertion in the fresh concrete of plastic or metal pipe sleeves, which are withdrawn after the concrete has partially set. When forming the holes by this method, ensure that they are not less than 4 inches [100 mm] in diameter, to allow for horizontal adjustment of the bolts.

460-31 Preparation of Bearing Areas, and Setting Shoes and Pedestals.

Ensure that column bases, truss and girder pedestals, and shoes have full and uniform bearing on the substructure masonry. Do not place masonry bearing plates on the bridge seat area of piers or abutments that are irregular. Rigidly and permanently locate the shoes and pedestals of truss and girder spans and of I-beam spans and the bases of columns to correct alignments and elevations. Place the shoes or pedestals on bearing pads of the type and size shown on the plans.

In setting the trunnion bearings, machinery supports and principal machinery, use the following procedure:

Pour and finish the concrete supports at least 1 inch [25 mm] below grade. After these have set for not less than 72 hours, set the machinery parts thereon and accurately position them in all directions by the use of steel shim supports and the anchor bolts. With the parts thus set, dampen the top of the concrete and pack the space between concrete and bearing base with a dry grout containing a nonshrink admixture.

Mix grout in the following proportions by volume:

(a) One part cement

(b) One part fine aggregate

(c) Proportion nonshrink admixture as recommended by the manufacturer.

First, thoroughly mix the dry elements to form a uniform mixture. Add only enough water to give a mealy, slightly adhesive mix.

Ram or hammer the mixture into position to produce complete contact between the bearing base and the supporting concrete. Generally do this by ramming from the edges toward the center. After this grout has set for at least 24 hours, remove the steel shim supports, patch the resulting holes with grout, and finish the edge areas around the bearing as shown in the plans.

460-32 Handling Members.

Complete the field assembling of the component parts of a structure by the use of methods and appliances not likely to produce injury by twisting, bending, or otherwise deforming the metal. Do not put any member slightly bent or twisted in place until correcting its defects. The Engineer will reject any members seriously damaged in handling.

460-33 Alignment.

Before the beginning of the field riveting or bolting, adjust the structure to correct grade and alignment and properly regulate the elevations of panel points (ends of floor beams). For truss spans the Engineer will allow a slight excess camber while riveting or bolting the bottom chords, but secure the correct camber and relative elevations of panel points before riveting or bolting the top chord joints, top lateral system, and sway bracing.

460-34 Field Assembly.

For field assembling and connecting of members, generally meet the requirements for shop assembly as specified in 460-12, and the following additional requirements: Securely drift-pin and bolt all field connections and splices before riveting or bolting. Fill at least 50% of the holes of important connections in trusses, girders, floor systems, etc. Do not paint field-driven rivets and high-strength bolts until the Engineer has inspected and accepted them. For field riveting and high-strength bolting, meet the requirements of 460-11 and 460-8.1, respectively. Use pneumatic tools for field riveting.

460-35 Adjustment of Pin Nuts.

Thoroughly tighten all nuts on pins and locate the pins in the holes so that the members will take full and even bearing upon them.

460-36 Movable Bridges.

Fabricate and erect the machinery and other operating parts of movable bridges in accordance with the requirements of Section 465 and the AASHTO Specifications for Movable Highway Bridges. Generally erect movable bridges in the open position. Keep the navigable channel unobstructed during construction.

460-37 Painting.

Meet the painting requirements of Section 560 or Section 561, as specified.

460-38 Method of Measurement.

460-38.1 General: The quantities to be paid for will be the items covered by this Section, completed and accepted, and may include the following:

460-38.2 Structural Steel: The quantity of structural steel entering into and becoming a part of the completed structure, and accepted by the Engineer, to be paid for will be at the plan quantity, in pounds [kilograms], or at the lump sum price for Structural Steel, as specified.

460-38.3 Structural Steel Weights:

460-38.3.1 Table: Structural steel weights will be the computed weights, assuming the weight per cubic foot [cubic meter] of the various metals to be as follows:

Structural and Rivet Steel	490 lbs [7,850 kg]
Steel Castings and Forgings	490 lbs [7,850 kg]
Gray-Iron Castings	450 lbs [7,210 kg]
Malleable Iron	480 lbs [7,690 kg]
Phosphor Bronze	562 lbs [9,000 kg]
Wrought Iron	485 lbs [7,770 kg]
Lead	706 lbs [11,310 kg]

460-38.3.2 Rolled Shapes, Bars, Plates, and Pipe Railings: The weights of rolled shapes, bars, plates, and pipe railings will be computed on the basis of the nominal weights as given in manufacturers' handbooks, using the dimensions shown in the plans. The weight of shims shown in the plans will be included in the quantity of Structural Steel.

460-38.3.3 Deductions and Allowances: No deductions from the computed weight of rolled steel will be made for copes, clips, sheared edges, punchings, borings, drillings, milling, or planing, and no allowance will be made for the weight of weld metal or for overrun in weight.

460-38.3.4 Rivets and High-Strength Bolts: The weights of shop and field rivets and of high-strength bolts, including nuts and washers, all as installed and accepted, will be computed on the basis of average lengths in accordance with the following table:

Diameter of Rivet or Bolt	: inch [M20]	ϕ inch [M22]	1 inch [M24]
Weight per 100 lbs [kg]	50 [24]	100 [45]	150 [61]

460-38.4 Ladders and Platforms: Where so shown in the proposal, ladders and platforms will be paid for as a separate item. The quantity to be paid for will be at the lump sum price or as plan quantity, in pounds [kilograms], for Ladders and Platforms, whether aluminum or steel is used.

460-38.5 Endwall Grates: The quantity to be paid for will be at the unit price per pound [kilogram] for Endwall Grate.

460-38.6 Expansion Joint Seals: The quantity to be paid for will be the length, in feet [meters], of Expansion Joint Seal measured in place, along the centerline of the seal, completed and accepted.

460-38.7 Machinery and Castings: The quantity to be paid for will be at the Contract lump sum price.

460-38.8 Aluminum Railings: The quantity to be paid for will be the plan quantity, in feet [meters], of Aluminum Railings installed in accordance with Structures Standard Indexes 710 and 720, and accepted.

460-39 Basis of Payment.

460-39.1 General: Prices and payments will be full compensation for all work specified in this Section, including welding and all paint materials and painting. No separate payment will be made for falsework or other erection expense.

460-39.2 Items Included Under Structural Steel: For the purpose of payment, shear connectors, shoes, rockers, pins, masonry plates, anchor bolts, and lead bearing plates for fixed spans will be classified as Structural Steel. Structural Steel will also include all parts of rolled or cast steel which can be fabricated by the ordinary structural shop methods usual for fixed structures, and all bolts and anchors used to fasten machinery to structural parts or to masonry. Where aluminum ladders and platforms are shown in the plans as alternates to steel ladders and platforms which are specified to be included in the lump sum item for Structural Steel, the aluminum ladders and platforms, if used, will be included in such payment as Structural Steel. When the furnishing and installation of welded shear connectors is required by the plans, the quantities will be determined in the same manner as required for the accompanying Item of Structural Steel. Payment for shear connectors will be included in the accompanying Item of Structural Steel.

460-39.3 Machinery and Castings: Machinery and Castings will include winding drums, tread plates, pistons and cylinders, eccentrics, pivots, trunnions and their cast supports, shafts, spools, gears, racks, bearings, couplings, clutches, brakes (unless part of the prime mover), discs, cast sheaves and wheels, rollers, valves, pins about whose axis the connecting parts rotate, screws, wedges, toggles, bridge locks, cranks, axles, hooks, wrenches, turned bolts attaching machinery parts, and similar parts which require machine shop work and which are not included in any other class.

460-39.4 Payment Items: Payment will be made under:

Item No. 460- 1- Structural Steel - per pound.
Item No. 2460- 1- Structural Steel - per kilogram.
Item No. 460- 2- Structural Steel - lump sum.
Item No. 2460- 2- Structural Steel - lump sum.
Item No. 460- 3- Machinery and Castings - lump sum.
Item No. 2460- 3- Machinery and Castings - lump sum.
Item No. 460- 4- Ladders and Platforms - lump sum.
Item No. 2460- 4- Ladders and Platforms - lump sum.
Item No. 460- 5- Endwall Grate - per pound.
Item No. 2460- 5- Endwall Grate - per kilogram.
Item No. 460- 6- Ladders and Platforms - per pound.
Item No. 2460- 6- Ladders and Platforms - per kilogram.
Item No. 460- 7- Expansion Joint Seal - per foot.
Item No. 2460- 7- Expansion Joint Seal - per meter.
Item No. 460- 70- Aluminum Railings - per foot.
Item No. 2460- 70- Aluminum Railings - per meter.

SECTION 465

MOVABLE BRIDGES

465-1 Description.

Construct bascule bridges.

465-2 Alternate Design for Bascule.

Refer to the plans for details of the bascule span. With the written approval of the Engineer, the Contractor may use riveted or bolted construction in lieu of welded construction.

Submit proposed alternate designs with complete plans, Technical Special Provisions, and design calculations. Ensure that the design is in accordance with the AASHTO Standard Specifications for Moveable Highway Bridges hereafter referred to in this Section as the AASHTO Specifications and to the satisfaction of the Department.

For riveted or bolted alternates, comply with the following:

(a) Use structural steel complying with ASTM A 36 [ASTM A 36M].

(b) Design members for the stresses shown on the Contract Documents.

(c) Use the same general arrangement of members shown on the plans.

(d) Use all members except girder flanges and girder stiffeners that are the same size as shown in the plans.

(e) Design the girder flange for the allowable stresses for ASTM A 36 [ASTM A 36M] steel.

(f) Use angle stiffeners in lieu of plates and of the thickness and width shown in the plans.

465-3 Materials.

Meet the requirements specified in the applicable Sections for the items which constitute the complete structure.

465-4 Construction Methods.

Construct in accordance with the requirements of Sections 346, 460, and 508, and of any other applicable Sections, and with the following additional requirement.

Satisfactorily operate the movable spans, and provide materials, workmanship, and erection along with necessary extra work which are not covered by the plans.

465-5 Drawings.

Provide the plans in accordance with 460-3, including detail and assembly drawings for all operating machinery and parts, together with an outline drawing containing all information necessary for computing the strength of the machinery parts. Complete these drawings with sufficient detail to permit the duplication of the machinery parts without reference to patterns, other drawings, or individual shop practice. Show the estimated weights of individual parts and the total weights of all parts furnished under this item.

Furnish permanent reproducibles of the detailed shop drawings for the bascule leaves and machinery, including centerlock mechanisms, to the Department upon request.

465-6 Machinery Requirements.

465-6.1 General: Refer to the plans for requirements for machinery for each movable bridge.

465-6.2 Design Specifications: Design machinery and proportion operating parts in accordance with the AASHTO Specifications.

465-6.3 Requirements for Contractor's Working Drawings:

465-6.3.1 General Machinery Layout by Department: The plans for all movable bridges will show general details of the machinery, in keeping with the detail requirements and with parts proportioned in accordance with the AASHTO Specifications. Machinery plans are not intended to be complete in all details. The Contractor may vary the ratios of teeth between individual pairs of gears, and the layout and arrangement of parts to permit maximum use of his standard patterns and shop procedures. However, maintain the overall ratios and times of operation for manual and motor power, as specified. Proportion the sizes and strengths of all machinery parts to meet the requirements of the AASHTO Specifications. Maintain the standard of quality in details as shown by the plans.

465-6.3.2 Detailed Layout by the Contractor: Detail structural support for machinery, and exact positions of parts, after determining the final machinery layout. Detail minor parts that are required but not shown in detail in the plans in accordance with best standard practice.

Gear each leaf to fully open from the closed position with approximately 900 revolutions of the driving motors.

Provide two racks and main pinions and an equalizer for each leaf.

Provide a shear lock of the bar-and-socket type in each line of the main girders between leaves. Use locks that are pulled or driven in not more than ten seconds. Provide detachable manual operation for the locks.

Refer to the plans for a layout of machinery in general accordance with the above requirements. The Contractor may rearrange and vary parts to permit the use of standard patterns or alternate schemes of operation, subject to the limitations and requirements given herein.

For any substitution, use the general details shown in the plans as a standard of quality, and ensure that any alternate types or parts provide performance and quality equivalent in all respects, as determined by the Engineer, to machinery construction in accordance with the plans.

465-6.4 Lubrication: Lubricate all moving parts in accordance with the AASHTO Specifications. In addition, provide pressure grease fittings for all journal bearings.

For bascule spans, make provisions for lubricating all mechanisms. Provide a lubrication system that generally consists of small pipes or flexible lubrication hose attached to the parts, with pressure grease fittings at their tops, extending and connected to the deck near the curbs where they will be accessible out of the roadway lanes. Lubricate all mechanisms at the time the Department accepts the structure for maintenance.

465-6.5 Equipment for Limit Switches: For electrically controlled installations, ensure that the machinery manufacturer supplies the necessary gearing and couplings for limit switches to be operated by the bridge machinery.

465-6.6 Teeth for Racks: Cut the teeth for the racks for the bascule leaves.

465-6.7 Pitch Lines: Scribe a pitch line on each side of each gear.

465-7 Counterweights.

Determine the weight and, where necessary, the location of the center of gravity of the movable span and of the counterweights, and furnish details of the counterweight shop plans. Base determinations on weights computed from shop plans. Make provision for movable blocks equal to 3.5% under and 5% over the calculated weight. Furnish blocks equal to 5% of the calculated weight.

Drain all counterweight pockets. After erection, make any necessary adjustments in the counterweight to properly balance the leaf.

465-8 Operating Instructions.

Provide a complete set of operating instructions, including the following:

1. Complete directions for every operation from the stoppage of traffic through the opening and closing of the span to the final release of traffic.

2. Directions for bypassing current when necessary and for shifting from regular operation to the auxiliary operation provided.

3. Lubrication and maintenance charts or instructions that give the manufacturer's recommendations for the frequency of lubrication of all parts requiring lubrication and that show the type of lubricant to be used. Frame all such instructions and charts under glass, and mount them in a conspicuous place in the

control house.

465-9 Conditional Acceptance and Contractor=s Warranty of Movable Bridges.

The Engineer will make a conditional acceptance upon completion of the project with the condition of acceptance being that the Contractor maintain and operate the movable portions of the bridge for a period of 60 days. Open the bridge a minimum of four times daily during the 60 day period. During the last 15 days of this 60-day period, train the Department in the maintenance and operation of the bridge.

Repair or replace, at no expense to the Department, any mechanical or electrical component of the bridge which becomes inoperative during the 60-day period.

The Department will not charge Contract Time for this 60-day period.

After the 60-day operation and training period, and as a condition precedent to final acceptance of all work under the Contract in accordance with 5-11, provide a Maintenance Bond for the repair or replacement of any defective mechanical or electrical components of the movable portions of the bridge which shall be in effect for a one year period after final acceptance in accordance with 5-11. Include the costs of the bond in the costs of other bid items.

In addition to satisfying the provisions of Section 287.0935, Florida Statutes, the bonding company is required to have a A.M. Best rating of AA≅ or better. If the bonding company drops below the AA≅ rating during the one year Maintenance Bond period, provide a new Maintenance Bond for the balance of the one year period from a bonding company with an AA≅ or better rating. In such event, all costs of the premium for the new Maintenance Bond will be at the Contractor=s expense.

The Maintenance Bond shall be written and issued in the amount of the total sums bid for the mechanical and electrical components of the movable portions of the bridge.

At the end of the one year warranty period, the Contractor will be released by the Engineer from further warranty work and responsibility, provided all previous warranty work and remedial work, if any, has been completed satisfactorily.

465-10 Method of Measurement.

The work described and specified in this Section will be measured and paid for as provided in the applicable Sections for the various items making up the complete structure, as follows:

Structural Concrete .... Section 400
Reinforcing Steel .... Section 415
Structural Steel and Miscellaneous Metals .... Section 460
Steel Grid Floors .... Section 504
Electrical Equipment .... Section 508
Control House .... Section 512

465-11 Basis of Payment.

Price and payment will constitute full compensation for all work specified in this Section.

SECTION 470

TIMBER STRUCTURES

470-1 Description.

Furnish and erect timber into various structures.

470-2 Materials.

Meet the following requirements:

Timber ....Section 952
Preservative ....Section 955

Use treated or untreated timber as specified in the plans.

470-3 Treated Timber.

470-3.1 Handling: Handle treated timber with rope slings, without sudden dropping, breaking of outer fibers, bruising, or penetration of the surface with tools. Do not use cant dogs, hooks, or pike poles.

470-3.2 Cutting and Framing: Before treatment, cut and frame all timbers which are shown by the plans to be furnished in special lengths or framed to detailed dimensions. Limit the cutting of treated timber to minor fitting which might be necessary and that is authorized by the Engineer. For all places where the surface is broken, by cutting or otherwise, thoroughly coat with the preservatives and by the methods specified in AWPA M4, Sections 1.512, 1.52, 1.521, and 1.522.

470-3.3 Bolt Holes: The Contractor may bore bolt holes in the field. Pour hot preservative oil into the bolt holes before the insertion of the bolts. Coat the entire surface of the holes with the preservative.

470-4 Untreated Timber.

In structures of untreated timber, thoroughly coat the following surfaces with a thick coat of hot tar, hot asphalt, or hot creosote before assembly:

(a) heads of piles; ends, tops, and all contact surfaces of pile caps.
(b) floor beams and stringer ends.
(c) joints and all contact surfaces of truss members, laterals, and braces.
(d) back face of bulkheads and all other timber to be in contact with earth.

470-5 Pile Caps.

Ensure that pile caps have full even bearing on all piles in the bent, and secure them to each pile by a : inch [20 mm] diameter drift bolt extending at least 9 inches [225 mm] into the pile. Where so shown in the plans, cover the tops and ends of pile caps with 10 ounce [3 kg/m^2], minimum weight, copper sheet meeting the requirements of ASTM B 370.

470-6 Floors.

Attach the planks to each joist or nailing strip with at least two 8 inch [200 mm] nails for 3 inch [64 mm] planks, or two 10 inch [250 mm] nails for 4 inch [89 mm] planks. Use nails that are at least 3 inch [6 mm] in diameter. For treated timber floors where a bituminous wearing surface is to be applied, lay the planks with the best side up and with adjacent edges in contact. For untreated timber floors, lay the planks heart side down with 3 inch [6 mm] openings between adjacent planks. Grade the planks as to thickness before laying, and lay the planks so that no two adjacent planks vary in thickness more than χ inch [3 mm]. Cut the floor to straight lines along the side of the roadway and walkway.

470-7 Framing.

Cut and frame truss and bent timbers to a close fit in such manner that they will have even bearing over the entire contact surface of the joint. Do not perform blocking or shimming of any kind in making the joints. The Engineer will not accept open joints.

470-8 Holes for Bolts, Dowels, Rods, and Lag Screws.

Bore holes to the diameters shown in the table.

Hole use	Hole diameter
drift bolts and dowels	1/16 inch [1.6 mm] less in diameter than the bolt or dowel to be used
machine bolts	same diameter as the bolt
rods	1/16 inch [1.6 mm] greater in diameter than the rod
lag screws	not larger than the body of the screw at the base of the thread

470-9 Stringers.

The Contractor may use butt joints for outside stringers, but shall frame interior stringers to bear over the full width of floor beam or cap at each end. Separate the ends at least 2 inch [13 mm] to allow circulation of air, and securely fasten the ends to the timber on which they rest.

470-10 Railings.

Construct railings of untreated dressed lumber. Paint railings with two coats of paint meeting the requirements of 971-9.1 for Code W-1.

470-11 Hardware.

470-11.1 General: Use hardware, including bolts, driftpins, dowels, rods, nuts, washers, spikes, nails and all similar incidental metal items, necessary to complete the work in accordance with the details shown in the plans. Use common wire nails as commercially manufactured. Use ogee washers of cast or malleable iron. The Contractor may use other hardware of steel, iron, or any similar material ordinarily used in the manufacture of such articles.

470-11.2 Bolts: Use bolts of the sizes shown in the plans with square heads and nuts and with screw threads that make close fits in the nuts. Upon completion of the installation, check all nuts for tightness, and cut off protruding bolt ends so that not more than 3 inch [6 mm] extends beyond the nut.

470-11.3 Galvanizing: Use galvanized bolts, nuts, and washers. Refer to the plans for other articles that may require galvanizing. Meet the galvanizing requirements of ASTM A 153.

470-11.4 Testing: The Engineer will not require laboratory tests other than tests of the galvanizing, but will inspect and approve of hardware for quality of manufacture and accuracy of size.

470-12 Countersinking.

Perform countersinking wherever the heads of screws or bolts would otherwise interfere with the assembly of the work. Fill recesses formed by countersinking with hot asphalt.

470-13 Method of Measurement.

470-13.1 General: The quantity to be paid for will be the plan quantity, in feet board measure [cubic meters], of such timber actually incorporated in and forming a part of the completed structure.

470-13.2 Method of Calculation: For calculating the quantity of timber, the width and thickness will be taken as the actual sizes shown in the plans or ordered by the Engineer. Where special sizing is required, the width and thickness to be used will be that of the smallest commercial size from which the special piece could be cut. Lengths to be used in the calculations will be the overall lengths of the pieces as shown in the plans, except that, where the lengths actually incorporated in the structure are less than the lengths shown in the plans, the lengths actually incorporated will be used in the calculations. Deductions will not be made for copes, scarfs, or crownings.

470-14 Basis of Payment.

Prices and payments will be full compensation for all the work specified in this Section, including all copper covering over pile heads, caps, etc., as shown in the plans, all hardware except such plates, lag screws, and other metal parts as may be shown in the plans to be paid for as structural steel and all paint materials and all excavation, painting, and incidentals necessary to complete the work.

Payment will be made under:

Item No. 470- 1- Treated Structural Timber - per Thousand Board Measure
Item No. 2470- 1- Treated Structural Timber - per cubic meter.
Item No. 470- 2- Untreated Structural Timber- per Thousand Board Measure
Item No. 2470- 2- Untreated Structural Timber - per cubic meter.

INCIDENTAL CONSTRUCTION

SECTION 502

SHEAR CONNECTORS

502-1 Description.

Furnish and install welded shear connectors on the flanges of steel beams to form steel and concrete composite beams.

502-2 General Requirements.

502-2.1 Design: Provide shear connector studs of a design suitable for end-welding to steel beams and girders, with automatically timed stud welding equipment. Provide the type, size or diameter, and length of stud as specified by the Contract Documents, and as approved by the Engineer. Meet the allowable tolerances on dimensions as specified in 502-7.

502-2.2 Arc-Shield: Furnish an arc-shield (ferrule), of heat-resistant ceramic or other suitable material, with each stud. Use material that is not detrimental to the welds, does not cause excessive slag, and has sufficient strength not to crumble or break due to thermal or structure shock before the weld is completed.

502-2.3 Flux: Furnish flux for welding with each stud, either attached to the end of the stud or combined with the arc-shield for automatic application in the welding operation.

502-2.4 Coatings: Do not paint or galvanize studs.

502-2.5 Qualification: Use only qualified studs, passing the tests prescribed in 502-6. Use the same arc-shield in production as used in the qualification tests.

502-2.6 Data to be Submitted: Before placing orders for studs, submit to the Engineer, for his approval, the following information on the studs to be purchased:

(1) The name of the manufacturer.

(2) A detailed description of the stud and arc-shield to be furnished.

(3) A certification from the manufacturer that the stud is qualified as specified in 502-2.5.

(4) A copy of the qualification test report as certified by the testing laboratory.

502-2.7 Freedom from Defects: After welding, ensure that the studs are free from any defect or substance that would interfere with their function as shear connectors.

502-3 Materials.

502-3.1 Metal: For shear connector studs, meet the requirements of ASTM A 108, cold-drawn bar, Grades 1015, 1017, or 1020, either semi-killed or fully-killed. If using flux-retaining caps, use caps of a low-carbon grade steel suitable for welding and meeting the requirements of ASTM A 109 [ASTM A 109M].

502-3.2 Mechanical Properties: For tensile properties as determined by tests of bar stock after drawing, or of finished studs, meet the following requirements:

Tensile strength .... 60,000 psi [410 MPa] (minimum)
Yield strength* .... 50,000 psi [345 MPa] (minimum)
Elongation .... 20% in 2 inches [50 mm] (minimum)
Reduction of area .... 50% (minimum)

*As determined by 0.2% offset method.

Determine tensile properties in accordance with ASTM A 370. Perform tensile tests of finished studs on studs welded to test plates. If fracture occurs outside of the middle half of the gage length, repeat the test.

502-3.3 Quality and Finish: Provide finished studs of uniform quality and condition, free from injurious laps, fins, seams, cracks, twists, bends, and other injurious defects. Produce a finish by cold drawing, cold rolling, or machining.

502-3.4 Certification: Ensure that the manufacturer certifies that the studs, as delivered, are in accordance with the materials requirements of this Subarticle. Furnish certified copies of in-plant quality control test reports to the Engineer upon request.

502-4 Construction Requirements.

502-4.1 Equipment: End weld stud shear connectors to steel beams or girders with automatically timed stud welding equipment connected to a suitable power source.

502-4.2 Interlocking: If two or more stud welding guns are to be operated from the same power source, interlock them so that only one gun at a time can operate and the operating gun finishes each weld before starting another weld.

502-4.3 Condition of Studs: At the time of welding, ensure that the studs are free from rust, rust pits, scale, oil, and other deleterious matter which would adversely affect the welding operation.

502-4.4 Weather Limitations: Do not weld when the base metal temperature is below 0EF [-18EC], or when the surface is wet or exposed to rain or snow.

502-4.5 Position of Welding Gun: While operating, hold the welding gun in position without movement until the weld metal has solidified.

502-4.6 Preparation of Areas: When necessary in order to obtain satisfactory welds, wire-brush, peen, prick-punch, or grind areas on the beam or girder to which the studs are to be welded free of scale and rust.

502-4.7 Spacing: Ensure that longitudinal and lateral spacing of studs with respect to each other and to edges of beam or girder flanges does not vary more than 2 inch [13 mm] from the dimensions shown in the plans. However, the Engineer will allow a variation of 1 inch [25 mm] where required to avoid interference with other attachments on the beam or where welding a new stud to replace a defective stud. Provide a minimum distance of 1 inch [25 mm] from the edge of a stud to the edge of a beam, but where possible provide at least 12 inches [38 mm].

502-4.8 Testing: After allowing them to cool, bend the first two studs welded on each beam or girder, 45 degrees by striking the stud with a hammer. If failure occurs in the weld of either stud, correct the procedure, and weld and test two successive studs successfully before welding any more studs to the beam or girder. Inform the Engineer of any changes in the welding procedure at any time during construction. When the temperature of the base metal is below 32EF [0EC], bend one stud in each 100 studs welded 45 degrees in addition to the first two bent as specified above.

502-4.9 Repair of Welds: The Contractor may repair studs, on which a full 360 degrees weld is not obtained, in accordance with the procedures of ANSI/AASHTO/AWS D1.5, Bridge Welding Code.

502-4.10 Reduction in Height: If the reduction in the height of studs as they are welded becomes less than 1/16 inch [2 mm], immediately stop welding and correct the cause. Do not resume welding until the cause has been corrected.

502-4.11 Replacing Studs: Before welding the replacement stud, remove the defective stud, grind the area smooth and flush or, in the case of a pullout of metal, fill the pocket with weld metal, using the shielded metal-arc process with low-hydrogen welding electrodes, and then grind flush. In compression areas of flanges, the Contractor may weld a new stud adjacent to the defective area in lieu of repair and replacement of the existing weld.

502-5 Inspection Requirements.

502-5.1 Bend Test: If visual inspection reveals any stud which does not show a full 360 degrees weld, any stud which has been repaired by welding, or any stud in which the reduction in height due to welding is less than normal, strike such stud with a hammer and bend 15 degrees off the vertical. For studs showing less than a 360 degrees weld, bend the stud in the direction opposite to the lack of weld. Replace studs that crack in either the weld or the shank. The Engineer may select additional studs to be subjected to the bend test specified above. The Contractor may leave the tested studs that show no sign of failure in the bent position.

502-5.2 Unsatisfactory Work: If, during the progress of the shear connectors work, inspection and testing indicate that the shear connectors being obtained are not satisfactory, make such changes in welding procedure, welding equipment, and type of shear connector as necessary to secure satisfactory results, at no expense to the Department.

502-5.3 Requalification: If the Engineer requests, require the manufacturer of the studs to submit sample studs for requalification in accordance with the procedures of 502-6, at no expense to the Department.

502-6 Qualification Procedure.

502-6.1 Purpose: The purpose of this procedure is to prescribe weldability tests which will qualify a shear connector stud for welding under shop or field conditions. The Contractor may have a university, independent laboratory, other testing authority, or agency perform the tests. Ensure that the agency performing the tests submits to the manufacturer of the stud a certified report giving procedures and results for all tests, including the information listed under 502-6.9.

502-6.2 Duration of Qualification: Once a type and size of stud with arc-shield has been qualified, the Engineer will consider the stud qualified until the manufacturer makes any change in the base of the stud, the flux, or the arc-shield, which affects the welding characteristics.

502-6.3 Preparation of Specimens: Prepare test specimens by welding representative studs to the center of square specimen plates, 2 to : inch [13 to 19 mm] thick, of structural steel, ASTM A 36 [ASTM A 36M]. The manufacturer may weld studs to a large plate and cut the specimen plates to a size suitable for test equipment used.

502-6.4 Welding Procedure: Weld studs with manufacturer recommended power source, welding gun, and control equipment. Measure welding voltage, current, and time by suitable instrumentation, and record these measurements for each specimen. Ensure that lift and plunge are at the manufacturer-recommended optimum setting.

502-6.5 Number of Test Specimens:

(1) Weld 30 test specimens consecutively, with optimum current and time. Make the optimum current and time the midpoint of the range normally recommended by the manufacturer for production welding.

(2) Weld 30 test specimens consecutively, with time held constant at optimum but with current 10% below optimum.

(3) Weld 30 test specimens consecutively, with time held constant at optimum but with current 10% above optimum.

502-6.6 Qualification Tests:

502-6.6.1 Tensile Tests: Subject ten of the specimens welded in accordance with 502-6.5 (1), ten in accordance with 502-6.5 (2), and ten in accordance with 502-6.5 (3) to a tensile test. The Engineer will consider a stud qualified if all test specimens have a tensile strength above the minimum specified in 502-3.2.

502-6.6.2 Bend Tests: Place 20 of the specimens welded in accordance with 502-6.5 (1), 20 in accordance with 502-6.5 (2), and 20 in accordance with 502-6.5 (3) in a bend testing device, and bend alternately 30 degrees in opposite directions until failure occurs. The Engineer will consider a stud qualified if, on all test specimens, fracture occurs in the shank of the stud and not in the weld.

502-6.7 Retest: If weld failure occurs in any of the tensile or bend test groups, the Contractor may retest that group. If weld failure repeats, consider the stud as having failed to qualify.

502-6.8 Qualification: For a manufacturer's studs and arc-shields to be qualified, ensure that each group of 30 studs, by test or retest, meets the requirements prescribed in 502-6.6.

502-6.9 Report of Tests: Include the following in the laboratory report:

(a) Drawings which show shapes and dimensions with tolerances of studs, arc-shields, and flux.

(b) A complete description of materials used in the studs and arc-shields, including the quantity and analysis of the flux.

(c) A certification that the studs and arc-shields described in the report are qualified in accordance with 502-6.8.

502-7 Dimensions and Tolerances.

Meet the following dimensions and tolerances:

Non SI Units

C	L*	H	T
	4 +0.062 inches		

Non SI Units

: - 1/64 inch	4 -0.125 inches	13 ∀ 1/64 inch	δ inch minimum
ϕ - 1/64 inch	4 +0.062 inches 4 -0.125 inches	1δ ∀ 1/64 inch	δ inch minimum

*4 inches length is standard.
The Contractor may obtain other lengths by special order.

SI Units

C	L*	H	T
19 - 0.4 mm	102 +1 mm 102 -4 mm	35 ∀ 0.4 mm	10 mm minimum
22 - 0.4 mm	102 +1 mm 102 -4 mm	35 ∀ 0.4 mm	10 mm minimum

*102 mm length is standard.
The Contractor may obtain other lengths by special order.

Where C = Shaft diameter
L = Total stud length measured from top of head to base of shaft
H = Diameter of head
T = Thickness of head

502-8 Method of Measurement.

For the purpose of payment, shear connectors will be classified as Structural Steel. The quantity to be paid for will be determined in accordance with 460-38.

502-9 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section, including furnishing and installing shear connectors.

Payment will be made in accordance with 460-39.

SECTION 504

STEEL GRID FLOORS

504-1 Description.

Furnish and erect open-type steel grid roadway and sidewalk floors, on the movable spans of bridges and at other locations shown in the plans. Where specified in the plans, completely fill the floor with concrete.

504-2 Materials and Construction Methods.

504-2.1 General: Meet the following requirements:

Portland Cement Concrete..Section 346
Structural Steel and Miscellaneous Metals..............................Section 460
Shop, Field, and Maintenance Painting of Structural Steel......Section 560

504-2.2 Roadway Floor: Construct the roadway floor as an open steel grid with rectangular openings. Place and weld the grid to the floor stringers as shown in the plans. If the flooring requires secondary or supplemental stringers, the Department will consider these stringers and their fastenings a part of, and included in, the materials to be furnished and erected under this Section.

504-2.3 Sidewalk Floor: Erect sidewalk flooring consisting of a system of main bars and secondary bars, arranged in a system of rectangular, reticulum or U-shaped openings. Do not allow the clear distance in any opening to exceed ε inch [16 mm] in one direction. Do not allow the longest dimension of any opening to exceed 3 inches [75 mm]. Place and weld the floor to the supporting members in accordance with the details shown in the plans, or in accordance with the manufacturer's directions as approved by the Engineer.

504-2.4 Conformance with Manufacturer's Specifications: Meet the manufacturer's specifications for the material and construction methods, as approved by the Engineer, for any type of steel floor used.

504-2.5 Use of Trade Names: Where the plans refer to the type of floor by manufacturer's designation or trade name, the Contractor may use a similar floor providing equivalent section modulus per unit width, and equivalent surface qualities, if approved by the Engineer.

504-3 Painting.

Apply to all exposed areas of steel grid floors the same number, type, and thicknesses of paint coatings as are specified for painting structural steel. Prepare the surface the same as required for painting structural steel. Although not required, the Contractor may apply paint on areas to be covered by concrete.

504-4 Method of Measurement.

The quantities to be paid for will be the plan quantity, in square feet [square meters], installed, complete and accepted. Proper deductions for open joints in the floor will be made in calculating plan quantity.

504-5 Basis of Payment.

Prices and payments will be full compensation for all work specified in this Section, including furnishing and installing the complete floor above the tops of the main floor members shown in the plans, furnishing and installing any secondary joists which are required in addition to the main floor members, filling any specified portion with concrete, furnishing paint materials, painting, and welding.

Payment will be made under:

Item No. 504 - 1- Steel Roadway Floor - per square foot.
Item No. 2504 - 1- Steel Roadway Floor - per square meter.
Item No. 504 - 2- Steel Roadway Floor - per square foot.
Item No. 2504 - 2- Steel Sidewalk Floor - per square meter.

SECTION 506

BRIDGE DRAINAGE SYSTEM

506-1 Description.

Construct drainage facilities and accessories to collect and dispose of water from drains on the bridge structures, in accordance with the details shown in the plans.

506-2 Materials.

Use materials as specified or required in the plans. For aluminum materials, submit six certified copies of the mill analysis, along with a certificate from the producer stating that the materials used meet all requirements of these Specifications. Forward such reports to the Engineer.

506-3 Method of Measurement.

The quantity for Bridge Drainage System to be paid for will be at the Contract lump sum price.

If Bridge Drainage Piping is included in the Contract, the quantity to be paid for will be at the length, in feet [meters].

If Bridge Drains are included in the Contract, the quantity to be paid for will be at the Contract unit price for each.

506-4 Basis of Payment.

Prices and payments will be full compensation for all work, equipment, and materials specified in this Section or shown on the plans, including the complete installation of the drainage system for the bridge structure.

Payment will be made under:

Item No. 506- 1- Bridge Drainage System - lump sum.
Item No. 2506- 1- Bridge Drainage System - lump sum.
Item No. 506- 2- Bridge Drainage Piping - per foot.
Item No. 2506- 2- Bridge Drainage Piping - per meter.
Item No. 506- 3- Bridge Drains - each.
Item No. 2506- 3- Bridge Drains - each.

SECTION 508

ELECTRICAL CONSTRUCTION FOR MOVABLE BRIDGES

508-1 Description.

Furnish and install an electrical system for the operation of movable bridges, in accordance with the details shown in the plans. Install electric motors; electrically operated brakes; safety gates; traffic lights; warning bells and horns; navigation and pier lights; lights for control house and machinery platforms; limit switches; resistors; control panel with the required circuit breakers, fuses, conductors, relays, etc.; lighting panel board; control desk with the required controllers, meters, switches, push button stations, indicator lights, etc.; transformers; submarine and parkway cable; conduit; wiring and other electrical parts or equipment; together with the necessary clamps, bolts, hangers, etc., for proper installation as shown in the plans or required for the operation of the movable span and safety devices.

508-2 Power Source.

When obtaining electric power from an external source, refer to the Contract Documents for the approximate location of the service pole or manhole. Refer to the plans for the size of the service conductors.

508-3 Working Drawings and Shop Drawings.

508-3.1 General: Submit working drawings, shop drawings, and descriptive material of each separately mounted piece of equipment to the Department as specified in Section 5. Upon completion of the work, furnish the Department five instruction books containing instructions for operation, description of apparatus, maintenance instructions, renewal parts data, and wiring diagrams. The Department will accept the manufacturer's standard leaflets covering standard apparatus. Furnish the special control drawings for a particular job as listed in 508-3.2. Incorporate these drawings in the instruction books, either as reduced size prints or as full size drawings, neatly folded and suitably bound into the book or folded and inserted into a pocket included in the book.

508-3.2 Drawings: Furnish the following drawings:

1. Motor Control Center:

a. Assembly drawing, with front and end views, which gives the necessary dimensions and notations to permit proper equipment installation.

b. Approximate location of all apparatus on the front and at the rear of the panel.

c. The size of the individual panels, showing segregation for shipment.

d. Approved engraved metal nameplates with designation as to function of the apparatus mounted on the front of the board.

e. Bill of material of all apparatus furnished, on both the front and rear of the panels (a different drawing may be supplied for the bill of material if quantity of material or other drawing complications so dictate) with the necessary terminals and terminal blocks clearly designated and notations as to special construction, finishes, etc.

2. Control Console:

a. Assembly drawing, which gives the necessary dimensions and notations to permit the proper installation.

b. Location of all apparatus, approved nameplates with designation as to function of the apparatus.

c. Bill of material and apparatus furnished with the desk.

d. Necessary terminal and terminal blocks clearly designated and notations as to special construction, finishes, etc.

3. Elementary wiring diagram, which shows the control scheme and general connection of all apparatus furnished under this Section, arranged to permit ready analysis of the sequence of operation.

4. A wiring diagram showing the detailed wiring of the panels and controllers, listing all apparatus furnished under this Section, with terminals, etc., properly identified and coordinated.

5. A control console wiring diagram, showing detail wiring and position of all apparatus and terminal boards on the control console.

508-4 Materials and Equipment.

Except where the Contract might permit or specifically require the use of other than new equipment, such as might be specified to be furnished by others, provide only materials and equipment of new stock produced by established, reputable manufacturers of electrical equipment, meeting NEC and UL requirements, and approved by the Engineer.

508-5 Motors.

508-5.1 Main Drive Motors: For the main drive motors, provide totally enclosed, weatherproof, crane type, wound rotor induction motors, with oil ring lubricated sleeve bearings or an approved prelubricated and sealed ball bearing design. Provide motors having a maximum running torque of not less than 275% of the full load torque and the capability of developing twice the full load torque for a period of three minutes without electrical or mechanical damage. Ensure that each main motor has a tapered shaft extension for the motor mounted brake and a straight shaft extension on the drive end, unless a pinion is to be mounted directly on the motor shaft, in which case furnish a tapered shaft. Provide wound rotor motors with primary and secondary conduit boxes of adequate sizes.

508-5.2 Accessories and Insulation: Use motors with a suitable bracket to support motor mounted brakes. Use main drive motors that are 30 minute rated in accordance with current NEMA standards. Use only motors provided with inorganic insulation in accordance with current NEMA standards. Ensure that both the mechanical and electrical designs for all motors are suitable for exposure to the excessive moisture conditions incident to the application. Provide a drain plug.

508-5.3 Testing of Main Motors: Perform standard factory short commercial tests on all main motors in accordance with the Standards of the American Institute of Electrical Engineers. Furnish three copies of certified test reports on the short commercial test of each machine and prints of complete test performance curves of one machine, or a machine of an identical design, to the Engineer.

508-6 Controllers and Resistors.

508-6.1 Controllers:

508-6.1.1 General: Provide a separate semi-magnetic reversing controller for each main motor or power unit if two motors are shown to operate as a unit. Provide each controller with at least six power points and a drift point in each direction with an off position reset. Arrange interlocking so that only the first three power points are available after reaching the nearly-open and nearly-closed positions of the span.

508-6.1.2 Operation: Operate the controller with a horizontal handle with positive stop at the off position and at each drift point.

508-6.1.3 Location: Place the controllers in the control console with handles mounted near the front center. Provide brass operating heads and handles plated with heavy chrome.

508-6.2 Resistors: Ensure that the resistors for the main motors are heavy intermittent duty, as defined by NEMA No. 151, and provide approximately 25% full load motor torque for break away on the first power point of the controller. Use non-corroding, edge wound type resistors provided with heavy-duty terminals mounted on the frame for main connections. Provide a permanent resistor section to give approximately 6% slip at rated load and voltage.

508-7 Brakes.

508-7.1 For Main Motors: Provide each main motor with a motor-mounted, spring-set shoe brake, released by a three phase thrustor with adjustable setting time feature, sized as shown in the plans.

508-7.2 Machinery Brakes: Where shown in the plans, provide three phase, thrustor operated, floor mounted machinery brakes, duplicate as to features, construction, etc., of the motor brakes. Size machinery brakes as shown in the plans.

508-7.3 General Requirements: Equip all brakes with corrosion resisting fittings and with a drip proof and splash proof enclosure with ventilation louvers, arranged to be lifted as a unit from the brake. If the plans call for water tight brakes, construct the enclosing case of welded steel sheets of at least χ inch [3 mm] thickness, and divide the case diagonally so that the brake mechanism will be accessible from above when the upper half of the cover is removed. Construct the joint between the two halves with a neoprene gasket at least 3 inch [6 mm] in width, and hold it in place by embedding it in a groove or other approved means. Hold the cover in place by heavy hinge bolts and wing-nuts with the hinge-bolts attached to the lower half of the enclosing case. Provide the motor brakes and the machinery brakes with hand release levers or mechanisms built as integral parts of the brakes. Provide the motor brakes with electric interlocking switches to prevent power from being applied to the main motors with the brakes in the manually released position. Ensure that all brakes have satisfactory means of adjusting torque and taking up the wear.

508-8 Interlocking.

Interlock the electrical equipment by suitable conductors, relays, limit switches, etc., so that only the following sequence of operation is possible for opening the spans:

1. Set warning lights and bells.
2. Lower all safety gates and all traffic barriers.
3. Pull locks.
4. Release brakes.
5. Open span.

For closing the spans, reverse the sequence.

Make provision for bypassing the interlocking for emergency operation, with sealable heavy duty tumbler switches, semiflush mounted on the control desk.

508-9 Limit Switches.

508-9.1 For Motors: Provide cam type limit switches to stop the main drive motors at the fully open, nearly open, and nearly closed positions, and to stop the lock bars at the fully pulled and fully driven positions. Provide a single foot operated, spring opening switch for fully closing and fully opening the leaf with limited power.

508-9.2 For Span Lock and Traffic Gates: Provide plunger type, fully closed limit switches (or other accurate types if approved by the Engineer) for interlocking the control with the span lock and traffic gates, and also for indicating the fully closed position by means of lights on the control console. Provide switches that have an adjustable plunger with snap action contacts. Ensure that the switch mechanism changes the contacts within 3 inch [6 mm] movement of the operating plunger. Only provide limit switches that are of watertight construction and fully enclosed.

508-9.3 Gearing and Coupling: The machinery manufacturer will provide gearing and coupling when required for the leaf and span lock limit switches.

508-10 Traffic Gates.

Meet the requirements shown in the plans and specified herein. Obtain the Engineer's approval of the gates before installing them.

508-11 Traffic Lights and Bells.

508-11.1 Design and Location: Locate traffic lights and warning bells as shown in the plans. Provide warning bells that are either motor-driven or have an approved equal drive mechanism, and are equipped with 12 inch [300 mm], bell metal gongs. Place the drive mechanism in a water tight enclosure provided with a drain hole.

508-11.2 Switches: Operate the traffic lights, the warning bells, and the safety gate lights by a single circuit. Provide a limit switch in each off going gate to break the bell circuit when the gate is fully closed.

508-12 Navigation Lights and Horn.

508-12.1 Navigation Lights: Meet the regulations of the Department of Transportation, U.S. Coast Guard. Provide lighting units of the types shown in the plans. Ensure that they are aluminum or bronze castings, rugged in construction, and weatherproof, with corrosion resistant fittings.

508-12.2 Horn: Place a fully weatherproof electric horn on the roof of the control house. Provide a horn of the type shown in the plans.

508-13 Conduit and Wiring.

508-13.1 General: Place all conductors in conduit. Provide conduit of standard galvanized rigid steel. Ensure that each joint of the conduit bears a UL stamp of approval. Install all runs of conduit on a slope, and make provisions for drainage. Support the conduit at intervals of approximately 5 feet [1.5 m]. Only use rugged and corrosion resistant conduit fittings and supports on exposed conduit runs. Use back straps or stand offs to keep the conduit far enough away from supporting surfaces to allow painting and to prevent the accumulation of dirt and moisture. Make adequate provisions for the expansion and contraction of long conduit runs, and install expansion joints when deemed necessary by the Engineer. If placing the conduit in concrete, or in other locations, if specifically approved by the Engineer, the Contractor may use high-impact, PVC, Schedule 40 conduit, with a UL stamp, provided that the Contractor provides a satisfactory grounding system. Provide all conduit passing through an expansion joint of the structure with an effective expansion joint at the structural joint.

508-13.2 Insulation: Use interconnecting conductors with UL approved Type RHW or THW insulation.

508-13.3 Conductor Sizes: Provide conductors of such sizes that the voltage drop through the feeders does not exceed 3% for combined lighting and power load and that the voltage drop at any point in the system does not exceed 5% of the rated voltage at that point. Do not use conductors smaller than No. 12 AWG.

508-13.4 Flexible Connections: Where flexible connections are necessary, generally use extra flexible conductors. Use flexible conduit or basket weave armor to provide mechanical protection. Terminate submarine cables in sealed fittings at junction boxes provided with terminal blocks.

508-13.5 Identification: Number and tag all interconnecting circuits between motors, brakes, limit switches, control desk, control panel, etc., in accordance with the wiring diagrams. Use tags of rust resistant metal or other durable material, and neatly paint or stamp the numbering thereon. Equip all junction boxes with numbered terminal blocks.

508-13.6 Grounding: Bond all noncurrent carrying metal frames of the electrical apparatus and machinery together, and connect them to the system ground. If the system ground is inadequate, the Engineer may also require driven ground rods. Provide conduit lines used for grounding with jumpers or approved equal grounding devices on the expansion joints.

508-14 Motor Control Center or Control Panel.

508-14.1 Equipment Arrangement: Refer to the wiring diagram in the plans for the general arrangement of the equipment involved, its connection, and control. For any equipment not specifically described, arrange the equipment in accordance with the best practice, and obtain the Engineer's approval.

508-14.2 Location and Installation: Place the control panel in the operator's house. Enclose the panel in a free standing NEMA Type 12 cabinet, having panel type hinged doors with internal hinges and sectionalized lift off panels on the rear. Use approved fasteners to hold the doors in place. Externally operate the feeder circuit breakers, and mount them on a separate section behind a non-hinged panel. Apply two coats of red chromate primer and two coats of dull finish air drying lacquer to both the inside and outside of the cabinet. Ensure that the painting materials and procedures are in accordance with the manufacturer's standard practices. Paint the outside black or gray and the inside light gray, unless otherwise approved by the Engineer. Arrange the apparatus on the control board to provide a neat appearance and ready accessibility for inspection and maintenance.

508-14.3 Assembly and Testing: Provide a control panel that is completely factory assembled, with all the required devices fully wired and factory tested with the control desk to check the correct functioning and sequencing of the control system. Ensure that the detailed apparatus is of the type and rating specified or shown in the plans, or approved equal. Identify all devices mounted on the switchboard with approved, easy to read, engraved metal nameplates.

508-14.4 Individual Circuit Protection: Provide individual circuit protection by air circuit breakers for the main driving motors and brakes, lock and wedge motors, safety gates, and heater circuits for the control desk and the control cubicle.

508-14.5 Additional Circuit Protection: Provide reverse phase protection on the incoming lines, and provide overload and low-voltage protection for each of the drives. Provide magnetic-type relays that include an instantaneous overload trip for the main drive bridge motors. Also, provide thermal overload type relays for all auxiliary drives. Ensure that sensitive relays, whose action would be hampered by dust, have special coverings.

508-14.6 Heaters and Light Receptacles: Furnish suitable heaters, receiving power from the lighting circuit, to keep the equipment above the dew point. Install porcelain receptacles for lights in the control panel.

508-15 Control Desk.

508-15.1 Design and Construction: Design and construct a cabinet type control desk of 0.125 inch [3 mm] steel. Provide corners that are ground smooth or well rounded. Construct the desk top, including the sloping back section, of non-glare stainless steel. Design the back section to slope 30 degrees or more from a horizontal front section. Mount the meters and position indicators on the sloping section. Mount the controller handle and operating switches on the horizontal section. Identify all devices with easy to read, engraved metal nameplates. Conveniently mount the controller, terminal board, etc., on the desk. Design the front of the desk with a large double door, and the ends with either doors or removable panels. Use hinges of the concealed or flush-mounted type. Provide opening handles of a type and mounting that, in the closed position, will not protrude far enough to catch the clothing or hamper the movements of the operator. Provide a pocket for instruction books and drawings on the back of one of the doors. Form the pocket approximately 3 inches [75 mm] deep by 10 inches [250 mm] high and of a width determined by the door width and clearances.

508-15.2 Illumination: Illuminate the top of the control desk by a fluorescent, or approved equal, lighting unit (or units) with a switch. Ensure that the intensity, the mounting, and the shielding of the unit is such as to give sufficient light for the operation of the bridge, without glare in the operator's eyes, and without obscuring the action of the indicator lights.

508-15.3 Assembly, Testing, and Finish: Ensure that the electrical manufacturer assembles, completely wires, and factory tests the control desk. Provide a finish, for other than the stainless steel portions, similar to that specified for the Motor Control Center.

508-16 Submarine Cable.

508-16.1 General Requirements: Provide submarine cable of the nonlead type with a neoprene jacket and galvanized steel wire armor. Use UL approved Type RHW insulation meeting the requirements of ASTM D 754. Choose an insulation thickness in accordance with IPCEA requirements for non-leaded submarine cable.

508-16.2 Neoprene and other Materials: Use neoprene meeting the requirements of ASTM D 4247. For other materials and construction, meet IPCEA and industry standards.

508-16.3 Installation: Install submarine cables, as shown in the plans, and securely clamp them to the structure to eliminate sway. Terminate the armor in fittings which will support the cable by clamping armor strands. Use these fittings to prevent the entrance of water into the cable. Refer to the plans for additional details and location information.

508-17 Lights.

Install conduit fixtures, complete with lamps and conveniently located wall switches, over all machinery units and at all platforms and stairways. Place a suitable ceiling light fixture, with a concealed light source, and a wall switch in the control house.

508-18 Indicators.

Install indicating lights on the control desk to show the fully opened and fully closed positions of each traffic gate and traffic barrier and each span lock; and the fully opened, fully closed, nearly opened, and nearly closed positions of each leaf. Provide position indicators to show the position of each leaf through all stages of span operation. Provide indicators consisting of moving pointers approximately 4 inches [100 mm] long, operating over a fixed, graduated scale mounted on the control desk. Also, provide vernier pointers to show the span movement through at least the last ten degrees of opening and closing.

508-19 Spare Parts.

Furnish and store conveniently in boxes two sets of coils and contacts for each different size contactor on the switchboard and also one thrustor motor for each different size thrustor brake. Also, furnish 12 extra indicator lamps.

508-20 Engine-Generator Unit.

508-20.1 Generator: If specified in the plans, furnish an engine-generator of the indicated size and voltage.

508-20.2 Testing: Furnish three copies of the electrical manufacturer's Standard Commercial Test Report to the Engineer. Ensure that the rating, tests, etc., are in accordance with IEEE standards.

508-20.3 Voltage Regulator: Provide a voltage regulator for the generator, of quick-acting, dynamic, or semistatic type, or other approved design, complete with stabilizer, transformers, etc. Ensure that the regulator has sensitivity of 5% or better.

508-20.4 Engine: Provide a four cycle, diesel operated engine, having a rated output of at least 25% greater than that required to operate the generator and equipped with a complete electric starting system (starter, battery, and charging unit), muffler, radiator, and fan; governor for close regulation; and all necessary accessory equipment such as water, oil, and fuel pumps; oil, fuel, and air filters; flywheel; carburetor with choke control; and a 20 gallon [75 L] fuel tank.

508-20.5 Battery Charger: Provide a battery charger to charge the diesel engine starting battery. Use a charger capable of charging the battery from completely discharged to fully charged in not over eight hours and having provisions for automatically (and independently if more than one battery is involved) stopping the charge when the battery is fully charged. Use a charger suitable for operation from 120 V, single-phase, 60 Hz.

508-20.6 Control Information: If the supplier of the engine generator is not also the control manufacturer, furnish the control manufacturer with all necessary information for the proper control of this unit and data for the wiring diagrams.

508-21 Method of Measurement.

The quantity to be paid for will be at the Contract lump sum price, completed and accepted.

508-22 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section, including furnishing and installing all equipment and materials.

Payment will be made under:

Item No. 508- 1- Electrical Equipment - lump sum.
Item No. 2508- 1- Electrical Equipment - lump sum.

SECTION 510

NAVIGATION LIGHTS FOR FIXED BRIDGES

510-1 Description.

Furnish and install navigation lighting systems, including all wiring, conduit, wiring devices, transformers, enclosures, grounding system, controls, protective devices, lights, etc., as shown in the plans.

510-2 Materials and Equipment.

Meet the equipment and material requirements as shown in the plans and as specified in Section 508.

510-3 Construction Methods.

Install a weatherhead on a riser on a service pole extended through the power company's meter to the navigation lights at the channel.

510-4 Method of Measurement.

The quantity to be paid for will be at the Contract lump sum price, completed and accepted.

510-5 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section.

Payment will be made under:

Item No. 510- 1- Navigation Lights - lump sum.
Item No. 2510- 1- Navigation Lights - lump sum.

SECTION 512

CONTROL HOUSE

512-1 Description.

Construct a complete bridge control house.

512-2 Materials and Construction Methods.

Meet the material and construction requirements specified in the Contract Documents for the various items which constitute the control house.

512-3 Method of Measurement.

The quantity to be paid for will be at the Contract lump sum price, completed and accepted.

512-4 Basis of Payment.

512-4.1 General. Price and payment will be full compensation for all work specified in this Section, including special windows and doors; plumbing fixtures; and all materials, equipment, tools, labor, and incidentals necessary for the control house. Anchor bolts and steel framing and plates will be paid for as specified in Section 460.

512-4.2 Sashes and Doors on Machinery Rooms: Where the plans include sashes and doors on machinery rooms that are constructed as integral parts of the piers for movable bridges, the sashes and doors will be included in the Contract lump sum price for Control House.

512-4.3 Water Supply: Where the plans require connection of plumbing fixtures to an existing water supply, or the provision of a water supply and connecting the plumbing fixtures thereto, the water supply and connections will be included in the Contract lump sum price for Control House.

512-4.4 Payment Items: Payment will be made under:

Item No. 512- 1- Control House - lump sum.
Item No. 2512- 1- Control House - lump sum.

SECTION 514

PLASTIC FILTER FABRIC (GEOTEXTILE)

514-1 Description.

Install a plastic filter fabric.

514-2 Material.

Meet the plastic filter fabric requirements as specified in Section 985.

514-3 Construction Methods.

514-3.1 General: Place the fabric in the manner and locations as shown on the construction drawings, in accordance with the manufacturer's directions, and as specified in these Specifications. Place the fabric on areas with a uniform slope that are reasonably smooth, free from mounds and windrows, and free of any debris or projections which might damage the fabric.

Loosely lay the material. Do not stretch the material. Replace or repair any fabric damaged or displaced before or during placement of overlying layers to the satisfaction of the Engineer and at no expense to the Department.

When overlapping is necessary, the Contractor may sew the seams to reduce overlaps as specified in 985-3.

Schedule work so that covering the fabric with the specified material does not exceed the manufacturer's recommendations for exposure to ultraviolet light or five days, whichever is less. If the Engineer determines the exposure time was exceeded, the Contractor shall replace the fabric at no expense to the Department.

514-3.2 Subsurface Drainage: When indicated in the plans, place the fabric with the long dimension parallel to the trench. Place the fabric to provide a minimum 12 inch [300 mm] overlap for each joint. Do not drop the filter material from heights greater than 3 feet [900 mm].

514-3.3 Stabilization and Reinforcement: Overlap adjacent strips of fabric a minimum of 2 feet [600 mm].

514-3.4 Riprap Filter: Overlap adjacent strips of fabric a minimum of 24 inches [600 mm], and anchor them with securing pins (as recommended by the manufacturer) inserted through both strips of fabric along a line through the midpoint of the overlap and to the extent necessary to prevent displacement of the fabric.

Place the fabric so that the upstream (upper) strip of fabric overlaps the downstream (lower) strip.

Stagger vertical laps a minimum of 5 feet [1.5 m]. Use full rolls of fabric whenever possible in order to reduce the number of vertical laps.

Do not drop bedding stone or riprap from heights greater than 3 feet [900 mm] onto the fabric.

514-4 Method of Measurement.

When separate payment is indicated in the plans, the quantity to be paid for will be the area, in square yards [square meters], of plastic filter fabric placed excluding all laps, completed and accepted.

When no separate payment for furnishing and placing the plastic filter fabric is contained in the proposal, the Contractor shall include the cost of all work in the Contract price for the item or items to which it is incidental.

514-5 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section, including furnishing, placing, and sewing or overlapping the fabric.

Payment will be made under:

Item No. 514- 71- Plastic Filter Fabric - per square yard.
Item No. 2514- 71- Plastic Filter Fabric - per square meter.

SECTION 515

PIPE HANDRAIL

515-1 Description.

Furnish, erect, and paint pipe handrail.

515-2 Materials.

Provide rails and posts of 12 inch [38 mm] outside diameter standard steel pipe meeting the requirements of 962-9.1. When specified in the plans, the Contractor may use aluminum pipe of the sizes shown.

515-3 Construction Methods.

515-3.1 Erection: Erect handrail in accordance with the details shown in the plans or at the direction of the Engineer. Anchor the posts to the concrete by means of standard pipe fittings, and at intervals shown in the plans or approved by the Engineer. Make connections by electric arc welding or with standard pipe fittings.

515-3.2 Painting: Cover the posts and handrail with two prime coats of a good commercial grade of zinc-chromate paint, and a third coat of a good grade commercial aluminum paint, as approved by the Engineer. The Engineer will not require testing of the paint. The Engineer will not require painting of aluminum pipe railing.

515-4 Method of Measurement.

The quantity to be paid for will be the plan quantity, in feet [meters], furnished, painted, and erected, completed and accepted. Plan quantity will be measured as the length along the top rail.

515-5 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section, including completing the handrail.

Payment will be made under:

Item No. 515- 1 - Pipe Handrail - per foot.
Item No. 2515- 1 - Pipe Handrail - per meter.

SECTION 518

PAVEMENT WATERPROOFING FABRIC

518-1 Description.

Furnish and install a waterproofing fabric between layers of asphaltic concrete for the purpose of providing a moisture barrier and reinforcing the pavement structure.

518-2 Materials.

Use non-woven heat resistant fabric capable of being saturated by asphalt cement so as to provide an adequate bond without an excessive film of asphalt.

Meet the fabric requirements listed below:

Properties	Test Method	Characteristics
Grab Tensile	ASTM D 5034 & ASTM D 5035*	150 lb./in. minimum [26 kN/m minimum]
Elongation	ASTM D 5034 & ASTM D 5035*	15% minimum
Mullen Burst	ASTM D 751	300 psi minimum [2 MPa minimum]
Asphalt Retention		0.30 gal./sy minimum [1.4 L/m^2 minimum]
Weight		6 oz./sy minimum [0.2 kg/m^2 minimum]

*Modified for 1 inch [25.4 mm] opening.

Use fabric capable of withstanding 300EF [150EC] in the presence of asphalt without disintegration. Present evidence to show that the fabric has been successfully used in a similar installation and that it can withstand construction installation procedures.

Store and handle the fabric in accordance with the manufacturer's recommendations, and protect it from direct sunlight, ultraviolet rays, and temperatures greater than 140EF [60EC].

Furnish the Engineer with six copies of a certified test report from the manufacturer that show all data required to indicate compliance with the above requirements.

518-3 Installation Procedures.

518-3.1 Cleaning of Pavement: Sweep the surface of the pavement to remove dirt, rocks, and other deleterious material which may prevent a clean bonding surface immediately prior to application of the asphalt binder.

518-3.2 Application of Binder: Uniformly apply the asphalt binder material over the surface area where placing the fabric with the equipment specified in 300-3.1 at a rate of 0.33 to 0.40 gal/yd^2 [1.5 to 1.8 L/m^2], and allow the material to cure as directed by the Engineer. For the asphalt cement binder, use a minimum temperature of 290EF [145EC], with a maximum temperature not to exceed the manufacturer's recommendation.

518-3.3 Placing Fabric: Place the fabric on the pavement using a mechanical device in a manner so as to cause the fabric to be smooth without wrinkles. Ensure that the material is clean and any folds in the fabric are cut and laid flat. Broom or squeeze the surface to cause the fabric to be in total contact with the underlying pavement.

518-3.4 Overlap: Overlap the fabric a minimum of 6 inches [150 mm] at longitudinal joints and a minimum of 1 foot [300 mm] at transverse joints. Make all joint overlaps in a manner so as to prevent pickup by the paving train placing the asphaltic concrete.

518-4 Protection of Fabric.

Schedule work to place the fabric and cover it with asphaltic concrete on the same day. Do not allow traffic, other than necessary construction equipment or emergency vehicles, on unprotected fabric.

518-5 Method of Measurement.

518-5.1 Pavement Overlay Fabric: The quantity to be paid for will be the area, in square yards [square meters], completed and accepted with no allowance made for overlapping at joints.

518-5.2 Bituminous Material: The quantity to be paid for will be the volume, in gallons [liters], actually applied and accepted, determined as provided in 300-8.

518-6 Basis of Payment.

518-6.1 Pavement Overlay Fabric: Price and payment will be full compensation for all work specified in this Section, except furnishing, heating, and applying asphalt binder.

518-6.2 Bituminous Material: Price and payment will be full compensation for the work of furnishing, heating, and applying the asphalt binder.

518-6.3 Payment Items: Payment will be made under:

Item No. 518- 70- Pavement Overlay Fabric - per square yard.
Item No. 2518- 70- Pavement Overlay Fabric - per square meter.
Item No. 300- 1- Bituminous Material - per gallon.
Item No. 2300- 1- Bituminous Material - per liter.

SECTION 520

CONCRETE GUTTER, CURB ELEMENTS,

AND TRAFFIC SEPARATOR

520-1 Description.

Construct portland cement concrete curb and gutter, concrete traffic separator, valley gutter, special concrete gutter, and any other types of concrete curb not specified in other Sections.

520-2 Materials.

520-2.1 Concrete: Use Class I concrete meeting the requirements of Section 347.

520-2.2 Reinforcement: For all steel reinforcement required by the plans, meet the requirements of Section 415.

520-2.3 Joint Materials: Meet the requirements of Section 932.

520-3 Forms.

520-3.1 Form Materials: Construct forms for this work of either wood or metal. Provide forms that are straight, free from warp or bends, and of sufficient strength, when staked, to resist the pressure of the concrete without deviation from line and grade. For all items constructed on a radius, use flexible forms.

520-3.2 Depth of Forms: Ensure that forms have a depth equal to the plan dimensions for the depth of concrete being deposited against them.

520-3.3 Machine Placement: The Contractor may place these items by machine methods with the approval of the Engineer provided that the Contractor consistently produces an acceptable finished product, true to line, grade, and cross section.

520-4 Excavation.

Excavate to the required depth, and compact the foundation material upon which these items are to be placed as specified in 120-9.

520-5 Placing Concrete.

Place the concrete in the forms, and tamp and spade it to prevent honeycombing, and until the top of the structure can be floated smooth and the edges rounded to the radius shown in the plans.

520-6 Joints.

520-6.1 Contraction Joints: Except for machine placed items, the Contractor may form joints by using dummy joints (either formed or sawed) or by using sheet metal templates. If using sheet metal templates, ensure that they are of the dimensions, and are set to the lines, shown in the plans. Hold templates firmly while placing the concrete. Leave templates in place until the concrete has set sufficiently to hold its shape, but remove them while the forms are still in place.

Saw contraction joints, for machine placed items, unless the Engineer approves an alternate method. Saw the joints as soon as the concrete has hardened to the degree that excessive raveling will not occur and before uncontrolled shrinkage cracking begins.

Space contraction joints at intervals of 10 feet [3 m] except where closure requires a lesser interval, but do not allow any section to be less than 4 feet [1.2 m] in length.

520-6.2 Expansion Joints: Construct expansion joints at all inlets, at all radius points, and at other locations indicated in the plans. Locate them at intervals of 500 feet [150 m] between other expansion joints or ends of a run. Ensure that the joint is 2 inch [13 mm] in width.

520-7 Finishing.

520-7.1 Repair of Minor Defects: Remove the forms within 24 hours after placing the concrete, and then fill minor defects with mortar composed of one part portland cement and two parts fine aggregate. The Engineer will not allow plastering on the face of the curb. Remove and replace any rejected curb, curb and gutter, or valley gutter without additional compensation.

520-7.2 Final Finish: Finish all exposed surfaces while the concrete is still green. In general, the Engineer will only require a brush finish. For any surface areas, however, which are too rough or where other surface defects make additional finishing necessary, the Engineer may require the Contractor to rub the curb to a smooth surface with a soft brick or wood block, using water liberally. Also, if necessary to provide a suitable surface, the Engineer may require the Contractor to rub further, using thin grout or mortar.

520-8 Curing.

520-8.1 General: Continuously cure the concrete for a period of at least 72 hours. Commence curing after completely finishing and as soon as the concrete has hardened sufficiently to permit application of the curing material without marring the surface. Immediately replace any curing material removed or damaged during the 72 hour period.

After removing the forms, cure the surfaces exposed by placing a berm of moist earth against them or by any of the methods described below, for the remainder of the 72 hour curing period.

520-8.2 Wet Burlap Method: Place burlap, as specified in 925-1, over the entire exposed surface of the concrete, with sufficient extension beyond each side to ensure complete coverage. Overlap adjacent strips a minimum of 6 inches [150 mm]. Hold the burlap securely in place such that it will be in continuous contact with the concrete at all times, and do not allow any earth between the burlap surfaces at laps or between the burlap and the concrete. Saturate the burlap with water before placing it, and keep it thoroughly wet throughout the curing period.

520-8.3 Membrane Curing Compound Method: Apply clear membrane curing compound or white pigmented curing compound, as specified in 925-2, by a hand sprayer meeting the requirements of 350-3.10, in a single coat continuous film at a uniform coverage of at least 200 square feet per gallon [0.2 L/m^2]. Immediately recoat any cracks, checks, or other defects appearing in the coating. Thoroughly agitate the curing compound in the drum prior to application, and during application as necessary to prevent settlement of the pigment.

520-8.4 Polyethylene Sheeting Method: Place polyethylene sheeting, as specified in 925-3, over the entire exposed surface of the concrete, with sufficient extension beyond each side to ensure complete coverage. Overlap adjacent strips a minimum of 6 inches [150 mm]. Hold the sheeting securely in place and in continuous contact with the concrete at all times.

520-9 Backfilling and Compaction.

After the concrete has set sufficiently, but not later than three days after pouring, refill the spaces in front and back of the curb to the required elevation with suitable material. Place and thoroughly compact the material in layers not thicker than 6 inches [150 mm].

520-10 Surface Requirements.

Test the gutter section of curb and gutter with a 10 foot [3.048 m] straightedge laid parallel to the centerline of the roadway and while the concrete is still plastic. Perform straightedging along the edge of the gutter adjacent to the pavement or along other lines on the gutter cross-section, as directed by the Engineer. Immediately correct irregularities in excess of 3 inch [6 mm].

520-11 Method of Measurement.

For curb or curb and gutter, the quantity to be paid will be plan quantity, in feet [meters], measured along the face of the completed and accepted curb or curb and gutter.

For valley gutter or shoulder gutter, the quantity to be paid will be plan quantity, in feet [meters], measured along the gutter line of the completed and accepted valley gutter or shoulder gutter.

For concrete traffic separator of constant width, the quantity to be paid will be plan quantity, in feet [meters], measured along the center of its width, completed and accepted, including the length of the nose.

For concrete traffic separator of varying width, the quantity to be paid will be plan quantity, in square yards [square meters], completed and accepted.

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520-12 Basis of Payment.

520-12.1 General: Price and payment will be full compensation for all work specified in this Section.

520-12.2 Excavation: Excavation will be paid for as Roadway Excavation in accordance with 120-12.1.2.

520-12.3 Reinforcement: Reinforcing steel will not be paid for separately. The Contractor shall include the cost of the steel in the Contract unit price for the item in which the steel is placed.

520-12.4 Joint Materials: The Contractor shall include the cost of all joint materials in the Contract unit price for the item in which they are used.

520-12.5 Payment Items: Payment will be made under:

Item No. 520- 1- Concrete Curb and Gutter - per foot.
Item No. 2520- 1- Concrete Curb and Gutter - per meter.
Item No. 520- 2- Concrete Curb - per foot.
Item No. 2520- 2- Concrete Curb - per meter.
Item No. 520- 3- Concrete Valley Gutter - per foot.
Item No. 2520- 3- Concrete Valley Gutter - per meter.
Item No. 520- 4- Special Concrete Gutter - per foot.
Item No. 2520- 4- Special Concrete Gutter - per meter.
Item No. 520- 5- Concrete Traffic Separator - per foot.
Item No. 2520- 5- Concrete Traffic Separator - per meter.
Item No. 520- 6- Concrete Shoulder Gutter - per foot.
Item No. 2520- 6- Concrete Shoulder Gutter - per meter.
Item No. 520-70- Concrete Traffic Separator - per square yard.
Item No. 2520-70- Concrete Traffic Separator - per square meter.

SECTION 521

CONCRETE BARRIER WALL

521-1 Description.

Construct a plain or reinforced concrete barrier wall, with precast or cast in place concrete, in accordance with the details shown in the plans. Use stationary removable forms or sliding forms to construct the wall.

521-2 Materials.

Meet the following requirements:

Portland Cement Concrete..Section 346
Reinforcing Steel..Section 415
Joint Materials..Section 932

521-3 Construction.

521-3.1 General: The Contractor may use stationary removable forms provided they render a completed barrier wall with acceptable alignment and finish. Construct forms of metal or timber with a form liner. Do not use forms which are damaged or are not in alignment.

When electing to use the slip form method in lieu of the stationary forming method, place the concrete with a slip form machine approved by the Engineer, designed to form and consolidate the concrete in one pass in such a manner that a minimum of hand finishing is necessary to provide a dense, suitably finished barrier wall in accordance with the Contract Documents. Rigidly hold the sliding forms together laterally so that the forms will not spread. Operate the slip form machine with a continuous forward movement to minimize stops and starts of the machine. Arrange the concrete consolidation elements of the machine to start and stop simultaneously with the starting movement and stopping movement of the slip form machine. Ensure that the consolidation elements consist of internal vibrators and form vibrators. Provide a slip form machine that is a self contained, self powered unit.

521-3.2 Stationary Form Construction: Provide precast or cast in place concrete barrier walls constructed using stationary forms with a Class 3 finish. Align and erect the stationary form so that all plane surfaces of the finished wall will have no deviation greater than δ inch [10 mm] measured as an ordinate between the concrete and a 10 foot [3.048 m] straightedge. Correct all deviations greater than δ inch [10 mm] in a manner approved by the Engineer at no expense to the Department. Remove and replace sections of wall showing evidence of unconsolidated concrete, deviations in alignment and profile, or other defects which cannot be repaired to the satisfaction of the Engineer at no expense to the Department. Straightedge by half lapping the straightedge for the full length of all plane surfaces.

521-3.3 Slip Form Construction: Provide a finished texture to the slip formed barrier walls by hand troweling, brushing, or both to eliminate pockmarks, blemishes and any other discontinuities in surface texture. Ensure that the final finish has a fine texture and is free of pinholes, pockmarks, and blemishes.

Remove and recast or repair sections of slip formed barrier walls having areas of unconsolidated concrete, having blemishes, or having pockmarks greater than 2 inch [13 mm] in diameter after hand troweling and brushing in an approved manner at no expense to the Department. Repair areas of unsatisfactory surface finish by hand methods using mortar screened from the concrete used to construct the barrier wall. Use the mortar screened from the barrier wall concrete only to fill holes and surface blemishes below the slip formed surface of the concrete. Do not use mortar as a surface overlay coating on the barrier wall concrete.

During the finishing operation, while the concrete remains plastic, straightedge all plane surfaces of the slip formed barrier wall with a 10 foot [3.048 m] straightedge. Straightedge by half lapping the straightedge for the full length of the plane surfaces. Correct any deviation found during straightedging, greater than δ inch [10 mm], measured as an ordinate between the concrete surface and the straightedge, in an approved manner at no expense to the Department. Do not use surface overlay coatings of mortar screened from the concrete, or surface overlay coatings of concrete to correct alignment deviations.

Remove and replace sections of slip formed barrier wall having unconsolidated concrete, surface blemishes, deviations in alignment or profile, or other defects which cannot be repaired to the satisfaction of the Engineer at no expense to the Department.

521-4 Curing.

Cure cast in place and precast barrier walls for 12 hours by leaving the form in place. After removing the form, cure the barrier wall by one of the methods specified in 400-16, for the remainder of the 72-hour curing period.

Cure slip formed barrier walls in accordance with 400-16.

521-5 Joints.

521-5.1 General: Place expansion and contraction joints in concrete barrier wall mounted on or adjoining rigid structures in a manner similar to the type and method of jointing used in the supporting or adjoining structure. Place expansion and contraction joints in concrete barrier walls supported by soil or flexible foundation materials in the manner detailed in the plans.

521-5.2 Contraction Joints in Walls Supported by or Adjoining Rigid Structures: The Contractor may form or saw contraction joints. When sawing contraction joints, saw them as soon as the concrete has hardened sufficiently to permit sawing without raveling and before uncontrolled cracking occurs, but in no case later than 12 hours after casting. Match contraction joints to adjacent contraction joints in the structure. Space contraction joints at 15 to 30 foot [4.5 to 9.0 m] intervals.

521-5.3 Expansion Joints in Walls Supported by or Adjoining Rigid Structures: Construct expansion joints at right angles to the face, and extend them through the entire cross-section of the barrier wall. Construct wall expansion joints at the same location and width as the expansion joints in the structure on which the wall rests. The Contractor may form expansion joints for precast or cast in place stationary form construction or may preset an expansion filler material and attach it to the forms as required. When using slip forming, saw the joint through the plastic concrete the full depth and width of the barrier section. Where using the plastic sawing method, place close fitting shields over the concrete on each side of the joint for protection during sawing and hand finishing of the concrete at the joint.

521-6 Method of Measurement.

The quantity to be paid for under this Section will be the plan quantity, in feet [meters], completed and accepted.

521-7 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section, including all materials and incidentals necessary to complete the work.

Payment will be made under:

Item No. 521- Concrete Barrier Wall - per foot.
Item No. 2521- Concrete Barrier Wall - per meter.

SECTION 522

CONCRETE SIDEWALK

522-1 Description.

Construct concrete sidewalks.

522-2 Materials.

Meet the requirements specified in 520-2.

522-3 Forms.

Provide forms as specified in 520-3.

522-4 Foundation.

Compact fill areas, including cut areas under the sidewalk that have been excavated more than 6 inches [150 mm] below the bottom of sidewalk, to a minimum of 95% of AASHTO T 99 density. The area to be compacted is defined as that area directly under the sidewalk and 1 foot [300 mm] beyond each side of the sidewalk when right-of-way allows.

522-5 Joints.

522-5.1 Expansion Joints: Form 2 inch [13 mm] expansion joints between the sidewalk and the curb or driveway or at fixed objects and sidewalk intersections with a preformed joint filler meeting the requirements specified in 932-1.1.

522-5.2 Contraction Joints:

522-5.2.1 Types: The Contractor may use open type or sawed contraction joints.

522-5.2.2 Open-Type Joints: Form open type contraction joints by staking a metal bulkhead in place and depositing the concrete on both sides. After the concrete has set sufficiently to preserve the width and shape of the joint, remove the bulkhead. After finishing the sidewalk over the joint, edge the slot with a tool having a 2 inch [13 mm] radius.

522-5.2.3 Sawed Joints: If electing to saw the contraction joints, cut a slot approximately 3/16 inch [5 mm] wide and not less than 12 inches [40 mm] deep with a concrete saw after the concrete has set, and within the following periods of time:

Joints at not more than 30 feet [9 m] intervals...within 12 hours after finishing.

Remaining joints .... within 96 hours after finishing.

522-6 Placing Concrete.

Place the concrete as specified in 520-5.

522-7 Finishing.

522-7.1 Screeding: Strike-off the concrete by means of a wood or metal screed, used perpendicular to the forms, to obtain the required grade and remove surplus water and laitance.

522-7.2 Surface Requirements: Provide the concrete with a broom finish. Ensure that the surface variations are not more than 3 inch [6 mm] under a 10 foot [3.048 m] straightedge, or more than χ inch [3 mm] on a 5 foot [1.5 m] transverse section. Finish the edge of the sidewalk with an edging tool having a radius of 2 inch [13 mm].

Apply a tine finish by an approved hand method to curb cut ramps in lieu of a broom finish.

Ensure that the tine finish consists of transverse grooves which are 0.03 to 0.12 inch [0.8 to 3.0 mm] in width and 0.10 to 0.15 inch [2.5 to 3.8 mm] in depth, spaced at approximately 2 inch [13 mm] center to center.

522-8 Curing.

Cure the concrete as specified in 520-8.

522-9 Method of Measurement.

The quantity to be paid for will be the area, in square yards [square meters], measured in place, completed and accepted. No deduction will be made for the area occupied by ornamental trees left within the area of the sidewalk. No deduction will be made for any areas occupied by manholes, inlets, or other drainage structures or by public utility appurtenances within the normal sidewalk area.

522-10 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section. Excavation will be paid for under the items for the grading work on the project.

Payment will be made under:

Item No. 522 - Concrete Sidewalk - per square yard.
Item No. 2522 - Concrete Sidewalk - per square meter.

SECTION 524

CONCRETE DITCH AND SLOPE PAVEMENT

524-1 Description.

Construct concrete pavement in the flow channel of drainage ditches and on slopes.

524-2 Materials.

Use Class I concrete meeting the requirements of Section 347.

524-3 Forms.

Provide forms as specified in 520-3.

524-4 Foundation.

Shape and compact the foundation materials upon which the pavement is to be constructed to a firm, even surface, true to grade and cross-section.

524-5 Joints and Weep Holes.

524-5.1 Joints: Form open or tooled (dummy) type joints as shown in the plans. Form open joints by staking a metal bulkhead in place and placing the concrete on both sides of it. When the concrete has set sufficiently to preserve the width and shape of the joints, remove the bulkhead. Upon finishing the pavement over the joint, open and edge the slot with a tool having a 3 inch [6 mm] radius.

524-5.2 Method of Placing Slope Pavement: Place slope pavement in vertical strips, 4 feet ∀ 1 inch [1,200 ∀ 25 mm wide], except taper radii strips from the 4 foot [1,200 mm] width at the bottom to a minimum width of 1 foot [300 mm] at the top. Score the strips horizontally at intervals of 2 feet ∀ 1 inch [600 ∀ 25 mm], with a tool having a double 3 inch [6 mm] radius. Edge construction joints between strips with a tool having a 3 inch [6 mm radius]. The Engineer will allow construction joints at horizontal scorings.

524-5.3 Weep Holes: Locate and construct weep holes as shown in the plans. Construct weep holes at the toe of slope for all slope pavements.

524-6 Placing Concrete.

Place the concrete as specified in 520-5.

524-7 Finishing.

Use rough surfaced concrete ditch pavement unless a smooth surfaced ditch bottom is specified. Roughen the surface after screeding concrete to the approximate shape and grade by a rake or other suitable tool drawn perpendicular to the direction of flow. Ensure that the furrows are at least 3 inch [6 mm] deep.

Strike off slope pavement or smooth surfaced ditch pavement true to line and cross-section, and remove all surplus water and laitance from the surface. Lightly broom the finish.

524-8 Curing.

Cure the concrete as specified in 520-8.1.

524-9 Method of Measurement.

The quantities to be paid for will be the area, in square yards [square meters], completed and accepted. Where the plans show headers or cut-off walls at the end or edge of the pavement, the volume of the additional thickness of pavement that constitutes the headers, calculated in accordance with plan dimensions, will be converted into equivalent square yards [square meters] of standard thickness pavement and included in the quantity to be paid for.

No deduction will be made for any areas occupied by manholes, inlets, or other drainage structures or by public utility appurtenances within the pavement area.

524-10 Basis of Payment.

Prices and payments will be full compensation for all work specified in this Section, including all excavation below the finished grade of the ditch pavement, refilling and tamping, disposing of surplus materials, providing the weep holes, furnishing and placing the filter aggregate, and placing the wire mesh at weep holes for the slope pavement.

Payment will be made under:

Item No. 524- 1- Concrete Ditch Pavement - per square yard.
Item No. 2524- 1- Concrete Ditch Pavement - per square meter.
Item No. 524- 2- Concrete Slope Pavement - per square yard.
Item No. 2524- 2- Concrete Slope Pavement - per square meter.

SECTION 525

ASPHALTIC CONCRETE CURB

525-1 Description.

Construct an asphaltic concrete curb on a previously laid pavement at the locations shown in the plans.

525-2 Materials.

Use Type S-I asphaltic concrete mixture.

525-3 Construction Methods.

Sufficiently roughen the surface of the roadway pavement at the locations where the curb will be constructed to provide suitable bonding of the pavement and the curb.

Lay the curb by a machine or by other methods to provide the required cross-section. The Engineer may allow variation in the plan cross-section for using the particular machine, provided the Contractor obtains the equivalent cross-sectional area and the specified height of curb. Provide appropriate compaction as directed by the Engineer.

525-4 Method of Measurement.

The quantity to be paid for will be the length plan quantity, in feet [meters], completed and accepted. Any additions or deletions thereto as authorized by the Engineer will be determined by plan dimensions, station-to-station dimensions, final measurement, or any combination thereof, as measured along the face of the completed and accepted curb.

525-5 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section, including all materials and incidentals necessary to complete the work.

Payment will be made under:

Item No. 525- 1- Asphaltic Concrete Curb - per foot.
Item No. 2525- 1- Asphaltic Concrete Curb - per meter.

SECTION 530

RIPRAP

530-1 Description.

Construct riprap composed of sand-cement or rubble (consisting of broken stone or broken concrete) as shown in the plans. When specified in the plans, place bedding stone under the rubble riprap.

530-2 Materials.

530-2.1 Sand-Cement:

(1) Portland Cement: Do not subject the portland cement used in sand-cement riprap to the tests required under the provisions of Section 921, provided the portland cement is from an approved source.

(2) Fine Aggregate: Meet the requirements of 902-3.3.

(3) Sacks: Provide sacks made of jute, cotton, or scrim reinforced paper capable of holding the sand-cement mixture without leakage. Ensure that sack material is permeable and absorptive enough to permit passage of water to provide for hydration of the cement. Ensure that paper used in sacks is non-asphaltic laminated with a polyester fiber scrim reinforcement in a three-way directional pattern, has an embossed finish, and is perforated approximately 3/32 inch [2.5 mm] in approximate 1 inch [25 mm] centers. Extend perforations continuously through the entire wall.

Provide sacks of uniform size and dimensions, in order to provide uniformity of lines in the completed work. Use sacks that are free from holes and strong enough to withstand handling without ripping or splitting. Use only one type and size of sack at any one structure.

(4) Grout: The Contractor need not test the cement or sand between the sacks in accordance with Section 346, provided the cement is of a type and quality appropriate for this work as determined by the Engineer, and the sand is a clean commercial sand meeting the approval of the Engineer for this particular use.

(5) Geotextile Fabric: Meet the requirements of Section 514.

530-2.2 Rubble:

530-2.2.1 Rubble (Bank and Shore Protection): Provide sound, hard, durable rubble, free of open or incipient cracks, soft seams, or other structural defects, consisting of broken stone with a specific gravity of at least 2.30. Ensure that stones are rough and angular.

For this application, use broken stone meeting the following gradation and thickness requirements:

Weight Maximum Pounds [Kilograms]	Weight 50% Pounds [Kilograms]	Weight Minimum Pounds [Kilograms]	Minimum Blanket Thickness in Feet [Thickness in Meters]
700 [320]	300 [135]	60 [25]	2.5 [0.75]

Ensure that at least 97% of the material by weight is smaller than Weight Maximum pounds [kilograms]. Ensure that at least 50% of the material by weight is greater than Weight 50% pounds [kilograms]. Ensure that at least 85% of the material by weight is greater than Weight Minimum pounds [kilograms].

530-2.2.2 Rubble (Ditch Lining): Use sound, hard, durable rubble, free of open or incipient cracks, soft seams, or other structural defects, consisting of broken stone or broken concrete with a specific gravity of at least 1.90. Ensure that stones or broken concrete are rough and angular.

Use broken stone or broken concrete meeting the following gradation and thickness requirements:

Weight Maximum Pounds [Kilograms]	Weight 50% Pounds [Kilograms]	Weight Minimum Pounds [Kilograms]	Minimum Blanket Thickness in Feet [Thickness in Meters]
75 [35]	30 [15]	4 [2]	1.5 [0.45]

Ensure that at least 97% of the material by weight is smaller than Weight Maximum pounds [kilograms]. Ensure that at least 50% of the material by weight is greater than Weight 50% pounds [kilograms]. Ensure that at least 90% of the material by weight is greater than Weight Minimum pounds [kilograms].

530-2.2.3 Physical Requirements of Broken Stone and Broken Concrete: Use broken stone and broken concrete meeting the following physical requirements:

Absorption	maximum 5%
Los Angeles Abrasion (FM 1-T096)	maximum loss 45%*
Soundness (Sodium Sulphate) (FM 1-T104)	maximum loss 12%**
Flat and elongated pieces	materials with least dimension less than one third of greatest dimension not exceeding 10% by weight.
Dirt and Fines	materials less than 2 inch [13 mm] in maximum dimension accumulated from interledge layers, blasting or handling operations not exceeding 5% by weight.

* Ensure that granite does not have a loss greater than 55%.
** The Engineer may accept rubble exceeding the soundness loss limitation if performance history shows that the material will be acceptable for the intended use.

530-2.2.4 Source Approval and Project Control: The Engineer will approve mineral aggregate sources in accordance with 6-3.3 as amended by the following:

(1) The Engineer will subject all materials placed on the project to inspection confirmation tests. Perform such tests at no expense to the Department.

(2) The Engineer may control the gradation of the riprap by visual inspection either at the source or the project site. Resolve any difference of opinion with the Engineer in accordance with the method provided in FM 5-538. Provide all equipment, labor, and the sorting site at no expense to the Department.

530-2.2.5 Geotextile Fabric: Meet the requirements of Section 514.

530-2.3 Bedding Stone: Use Bedding Stone of either a durable quality limestone or other quarry run stone, with a specific gravity of not less than 1.90 and that is reasonably free from thin, flat and elongated pieces. Ensure that the bedding stone is also reasonably free from organic matter and soft, friable particles. Meet the following gradation limits:

Standard Sieve Sizes inches	Standard Sieve Sizes [millimeters]	Individual Percentage by Weight Passing
12 inches	[305 mm]	100
10 inches	[254 mm]	70 to 100
6 inches	[152 mm]	60 to 80
3 inches	[75 mm]	30 to 50
1 inch	[25 mm]	0 to 15

The Engineer will conduct source approval and project control of bedding stone as specified in 530-2.2.4. In lieu of limestone or other quarry run stone, the Contractor may substitute non-reinforced concrete from existing pavement that is to be removed and which meets the above requirements for commercial bedding stone.

530-3 Construction Methods.

530-3.1 Sand-Cement:

530-3.1.1 Mixing Materials: Proportion sand and cement in the ratio of 5 cubic feet [0.14 m^3] of sand to 94 lbs. [43 kg] (1 bag) of cement. If proportioning the materials by weight, use a unit weight of 85 lbs\ft^3 [1,360 kg/m^3] (loose volume) for sand. The Contractor may batch sand at the moisture content occurring in the stockpile.

Mix the sand and cement until the mixture is of uniform color.

530-3.1.2 Filling Sacks: Accurately measure the mixed material into each sack, taking care to place the same amount of material in each sack; keep at least the top 6 inches [150 mm] of the sacks unfilled to allow for proper tying or folding and to ensure against breaking of the sack during placing.

530-3.1.3 Placing: Place the filled sacks with their tied or folded ends all in the same direction. Lay the sacks with broken joints, in a regular pattern. Ram or pack the sacks against each other so as to form a close and molded contact after the sand and cement mixture has set up. Remove and replace sacks ripped or torn in placing with sound, unbroken sacks. Then, thoroughly saturate all sacks with water.

530-3.1.4 Grouting: Immediately after watering, fill all openings between sacks with dry grout composed of one part portland cement and five parts sand.

530-3.1.5 Toe Walls: The Contractor may construct toe walls of riprap for fill slopes of poured in place concrete in lieu of sand cement in sacks. Meet the concrete requirements specified in Section 347 for Class I Concrete. If using sand cement in sacks for the toe walls, fill the entire trench excavated for the toe walls with sand cement in sacks.

530-3.2 Rubble: Dump rubble in place forming a compact layer conforming to the neat lines and thickness specified in the plans. Ensure that rubble does not segregate so that smaller pieces evenly fill the voids between the larger pieces.

530-3.3 Bedding Stone: Place bedding stone without puncturing or tearing the geotextile fabric. Remove and replace geotextile fabric damaged as a result of operations at no expense to the Department.

The Engineer will allow an in place thickness tolerance of ∀1 inch [25 mm].

530-4 Method of Measurement.

530-4.1 Sand-Cement: The quantity to be paid for will be the volume, in cubic yards [cubic meters], of sand actually used in the sand cement mixture and grout, satisfactorily placed and accepted.

If sand cement is proportioned by volume, the sand will be measured loose in an approved measure prior to mixing with cement. If sand cement is proportioned by weight, approved scales will be used for this purpose and the volume will be calculated using a standard conversion factor for sand of 85 lbs./ft; [1,360 kg/m^3]. No adjustment of batch weights to allow for varying moisture content of the sand will be made.

For toe walls, the quantity to be paid for will include only the volume of sand cement in sacks or concrete placed within the neat lines shown in the plans for the toe walls.

530-4.2 Rubble and Bedding Stone: The quantities to be paid for will be the weight, in tons [metric tons], in surface dry natural state, by railroad scales, truck scales, or barge displacement. The Contractor shall determine the weights as follows:

(1) Railroad Weights: The Contractor shall weigh railroad cars on railroad scales, before and after loading or before and after unloading. If weighed by other than the Engineer, a certified statement of weights will be required. Certificates of weight, furnished by the railroad company, will be acceptable without further certification.

(2) Truck Weights: The Contractor shall weigh trucks on certified scales, loaded and empty, as prescribed above for railroad weights. The Contractor shall weigh trucks in the presence of the Engineer, or furnish certificates of weights.

(3) Barge Displacement: The Engineer will measure each barge. The Contractor shall fit each barge with gauges graduated in tenths of a foot [30.48 mm] increments. The Contractor shall locate a gauge at each corner of the barge near the lower end of the rake. The Contractor shall furnish additional gauges amidships if the Engineer deems necessary. The Engineer will compute all weights.

530-5 Basis of Payment.

530-5.1 Sand-Cement: Price and payment will be full compensation for all work specified in this Section, including all materials, labor, hauling, excavation, and backfill.

The Contractor shall include the cost of dressing and shaping the existing fills (or subgrade) for placing riprap in the Contract unit price for Riprap (Sand-Cement).

530-5.2 Rubble: Price and payment will be full compensation for all work specified in this Section, including all materials, hauling, excavation, and backfill.

The Contractor shall include the cost of dressing and shaping the existing fills (or subgrade) for placing riprap in the Contract unit price for Riprap (Rubble).

As an exception to the above, concrete that is shown to be removed from an existing structure and subsequently disposed of by being used in the embankment as riprap will not be paid for under this Section. The Contractor shall include the cost of such work under Removal of Existing Structures.

530-5.3 Bedding Stone: Price and payment will be full compensation for all work specified in this Section, including all materials and hauling.

The Contractor shall include the cost of dressing and shaping the existing fills (or subgrade) for placing bedding stone in the Contract unit price for Riprap (Rubble).

530-5.4 Payment Items. Payment will be made under:

Item No. 530- 1- Riprap (Sand-Cement) - per cubic yard.
Item No. 2530- 1- Riprap (Sand-Cement) - per cubic meter.
Item No. 530- 3- Riprap (Rubble) - per ton.
Item No. 2530- 3- Riprap (Rubble) - per metric ton.
Item No. 530- 74- Bedding Stone - per ton.
Item No. 2530- 74- Bedding Stone - per metric ton.

SECTION 534

NOISE BARRIER WALL

534-1 Description.

Furnish and install noise barrier walls.

534-2 Materials.

534-2.1 Metal Noise Barrier Walls: Construct metal noise barrier wall, including all material, labor, and equipment required, in accordance with the Contract Documents and the following:

(1) Panels: Provide steel facing material of cold-formed steel meeting ASTM A 653 [ASTM A 653 M], Grade B. Provide panels having a minimum covering width of 12 inches [300 mm]. To prevent vibration and noise leaks, provide each panel with a male-female rib providing a friction interlock connection with adjacent panels, or otherwise adequately join panels in accordance with the manufacturer's specifications. Ensure that the friction interlock connection provides sufficient connection strength to support its own weight without using fasteners when connecting to another panel and being in the vertical or horizontal positions. Galvanize panels in accordance with ASTM A 653 [ASTM A 653M], Class Z275 [G-90]. Fabricate the wall to the shape shown on the plans or in approved shop drawings.

(2) Protective Color Coating: Apply a coating of polyvinyl fluoride or polyvinylidene fluoride film with a minimum thickness of 1 mil. [25 µm] to both sides of all panels and flashings. Ensure that a qualified laminator factory applies the coating film to a cleaned and treated galvanized steel surface as per the manufacturer's specifications. Match the Federal Standard Color specified in the plans for the color of the coating. Only use caulking that is color pigmented to match the color of walls and meets Federal Specification TT-S-00230-C or TT-S-1657.

(3) Posts: Ensure that posts are fabricated from hot-rolled steel meeting ASTM A 36 [ASTM A 36M] and hot-dip galvanized in accordance with ASTM A 123, except that the coating weight will be a total of 2 ounces [600 g/m5], minimum on all sides.

(4) Steel Flashing and Caps: Only provide flashings, caps, and bracing of the same material as the panels. For flashings and caps, meet the same protective coating requirements as the panels.

(5) Self-Drilling Screws: Only use self-drilling screws that are cadmium coated in accordance with ASTM B 766.

(6) Nuts and Bolts: Only use nuts and bolts of the size shown in the plans or on approved shop drawings and galvanized as per ASTM B 663.

Before proceeding with the manufacture or assembly of the wall, submit shop drawings covering the complete system, including structural supports and complete erection requirements.

534-2.2 Concrete Noise Barrier Walls: Construct concrete noise barrier wall, including all material, labor, and equipment required, in accordance with the Contract Documents and the following:

(1) Precast Concrete:

a. General: Fabricate, transport, and erect panels in such a manner as to prevent damage thereto.

Fabricate the panels in accordance with Section 400, except as modified below, and in the plans:

1. Use forms that are true to the dimensions shown in the plans.

2. Place the concrete in one continuous lift resulting in no cold joints.

3. Provide all accessories, materials, and methods which are not specifically specified in the Contract Documents, but which are essential for installation or construction of the panels commensurate with the best standard practice of the industry, subject to the approval of the Engineer, without additional compensation.

Apply the surface treatment specified in the plans to both traffic and residential faces of the walls.

b. Materials: Furnish the Engineer with certification that the panels supplied for the construction of the wall meet the concrete class and strength requirements specified in the plans.

c. Construction:

1. Fill any and all holes on the panels resulting from their fabrication or installation with an approved mortar grout.

2. Cut all exposed bars, etc., used in lifting or assembling the panels flush with the surface. Then clean the bars, and coat the opening with an approved epoxy.

3. Paint all exposed metal fasteners in the finished work with an approved galvanized paint.

4. Do not use panels damaged by improper storing or handling.

(2) Cast-in-Place Concrete:

a. General: Construct the wall in accordance with the Contract Documents.

b. Materials:

1. Provide concrete of the class specified in the plans.

2. Provide reinforcing steel of deformed bars meeting the requirements of ASTM A 615, Grade 60 [ASTM A 615 M, Grade 400].

3. Use anchor bolts made of steel meeting the requirements of ASTM A 307 and galvanized in accordance with ASTM A 153. Use nuts and washers of steel meeting the requirements of ASTM A 325 [ASTM A 325M] and galvanized in accordance with ASTM A 153.

534-2.3 Wood Noise Barrier Walls: Construct wood noise barrier wall in accordance with the plans or as directed by the Engineer.

(1) Wood Planking: Provide planks and/or battens of Southern Pine or Douglas Fir, No. 2 grade or better. Use only planks with no holes and with tight knots. Do not intermix the species of wood.

Consider all specified thickness and width dimensions of solid sawn wood for timber facing material to be actual dimensions.

Joint facing boards with a wedge-shaped cut on their edge. Stamp facing lumber and battens with the appropriate grade mark.

(2) Plywood Panels: Provide sheeting of Douglas Fir or Southern Pine, exterior grade, which meets the requirements of the American Institute of Timber Construction (AITC).

Use glue meeting the requirements of ASTM D 2559 to fabricate the plywood panels.

(3) Sealant: Use a caulking sealant having a life expectancy of 20 years and meeting the requirements of Federal Specification TT-S-230. Ensure that the finished color of the sealant is similar to the wood stain as approved by the Engineer.

(4) Preservative Treatment (Water-Borne):

a. Dry all lumber materials, other than wood posts, to 19% moisture content or less prior to treatment.

b. Use the same preservative to treat bolt holes, saw cuts, etc., (if any), and for additional dressing deemed necessary by the Engineer.

c. Kiln-dry all wood members, except posts, to a moisture content of 15% or less after preservative treatment.

d. After completion of the preservative treatment, protect all lumber materials from increases in moisture content until incorporating them into the wall as required by AITC-111-65.

e. Treat all timber materials with Chromated Copper Arsenate (CCA) or Pentachlorophenol in accordance with Section 955.

534-2.4 Posts: Use Class I concrete for backfilling the post holes.

Provide wood posts of Douglas Fir or Southern Pine meeting the requirements of the AITC and treated as per 534-2.3(4)e.

Use structural steel posts fabricated from steel meeting the requirements of ASTM A 36 [ASTM A 36M] and galvanized in accordance with ASTM A 123 [ASTM A 123M].

Use concrete for reinforced concrete posts of the class shown in the plans. Form the concrete to the dimensions shown in the plans. Provide reinforcing steel of deformed bars meeting the requirements of 931-1.1.

534-3 Construction Methods.

A. Prior to beginning earthwork on the project, stake the wall location in the field, and establish the final groundline elevations at the barrier walls. Use these elevations to develop the shop plans, including a complete elevation view of each wall indicating top and bottom elevations as well as the roadway grade. Protect the final ground elevations established in the field for the duration of the project, and do not adjust without prior approval of the Engineer. Keep to a minimum the clearing and grubbing, and trimming of trees as necessary to construct the walls.

B. Do not mix wall types or colors at any one site. Install the walls in accordance with the plans, and in accordance with shop drawings submitted to and approved by the Engineer. Secure joints and connections in such a manner as to be structurally sound with no visible openings for sound transmission. Ensure metal walls do not produce a secondary source of noise transmission due to vibration.

C. Repair marred, chipped, scratched, or spalled areas of walls at no expense to the Department in accordance with the manufacturer's recommendations or at the Engineer's direction.

D. The Contractor may substitute welded for fixed bolt connections or vice versa on metal walls, where applicable, provided he submits load calculations for the specific modified connection and uses a minimum safety factor of 3.0.

E. Place trench backfill for wall construction in accordance with 125-8. Use select materials for the trench backfill.

If, in the opinion of the Engineer, the trench is too narrow to compact, backfill the trench excavation with concrete grout to the satisfaction of the Engineer at no expense to the Department.

F. Dispose of all excess excavation in a manner satisfactory to the Engineer.

G. Keep right-of-way fence that is scheduled to be salvaged in place until completing the wall or, in the opinion of the Engineer, as long as possible.

H. Place 4 mil [100 μm] polyethylene sheeting between the timber walls and the earth.

I. Stain wood and concrete walls the color shown in the plans.

J. After erecting the wall, leave the disturbed area in a finished condition at the direction of the Engineer, and grass or sod the area as indicated in the plans.

K. Tolerances:

(1) Ensure that vertical alignment for walls and posts is:

2 inch [13 mm] for wall heights to 10 feet [3 m];

1 inch [25 mm] for wall heights 10+ feet [3 m plus] to 20 feet [6 m]; and,

12 inches [38 mm] for wall heights greater than 20 feet [6 m].

(2) Ensure that horizontal alignment for walls is in reasonably close alignment to that shown in the plans so as to prevent panels from slipping out of the post joints.

(3) Set post spacings ∀2 inch [13 mm] of their intended location.

L. When building noise walls on top of earth berms, construct the berms of fill material compacted to 95% of the maximum density as determined by AASHTO T 99.

M. Provide the concrete wall (Precast or Cast-in-Place) with a uniform color, pattern, and texture.

N. Design the walls to be capable of withstanding a wind loading as required by the AASHTO Guide Specifications for Structural Design of Sound Barriers with a minimum of 110 mph [175 km/h] of wind velocity for exposures B2, C, or D.

O. Ensure that the walls effect and provide for a 20 decibel sound transmission loss at 500 Hz.

534-4 Test Wall.

Erect a test wall section not less than 50 feet [15.0 m] in length before starting general wall construction at the project site. The Engineer will use the erection of the test wall to determine if the Contractor's methods and equipment are sufficient to produce a noise barrier wall that meets the requirements of the Contract Documents. The Contractor may revise his methods and equipment as necessary, at any time during the positioning of the test wall, in order to satisfactorily meet all Contract requirements. Build the test wall at a permanent wall location, as directed by the

Engineer. If the test wall does not meet the construction tolerances, remove and dispose of it at no expense to the Department. Include the cost of the test wall in the cost of the noise barrier wall.

534-5 Method of Measurement.

The quantity to be paid for will be the area, in square feet [square meters], measured in place, completed and accepted.

534-6 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section, including furnishing all materials, labor, and equipment necessary to construct the noise barrier walls.

Payment will be made under:

Item No. 534-72 - Noise Barrier Wall - per square foot.
Item No. 2534-72 - Noise Barrier Wall - per square meter.

SECTION 536

GUARDRAIL

536-1 Description.

Construct metal guardrail on posts of timber, steel, or as specified in accordance with the Contract Documents and the Roadway and Traffic Design Standards.

Also, remove existing guardrail, construct guardrail anchorages, and replace guardrail posts, as specified in the plans.

536-2 Materials.

536-2.1 Guardrail: Construct guardrail of the standard W-beam or thrie beam type. Use materials for the rail and rail elements meeting the steel requirements of 967-1.

536-2.2 Posts:

536-2.2.1 General: Unless the Contract Documents designate a particular type of post, the Contractor may choose the type of post to use. Use posts of either timber, or steel, and of the sizes and dimensions shown in the plans. Use the particular type selected throughout a run of rail, except where special steel posts are required.

536-2.2.2 Timber Posts: Meet the requirements of the latest edition of the Southern Pine Inspection Bureau's Standard Grading Rules for Southern Pine Lumber, for No. 1 grade timber, and treat the posts in accordance with the requirements for posts in 955-5.3. Ensure that penetration of preservative is in accordance with requirements for round piles and fence posts in 955-6.2. Shape and drill the posts prior to treatment, and ensure that they do not vary more than 1 inch [∀25 mm] from the specified length. Dress all timber posts on all four sides (S4S).

536-2.2.3 Steel Posts: Use steel posts meeting the requirements of ASTM A36 [ASTM A 36M] steel. Galvanize the posts in accordance with the requirements of ASTM A 123 [ASTM A 123M], with 2 oz/ft5 [600 g/m^2] of zinc coating. Drill the posts prior to galvanizing. Ensure that the manufacturer furnishes certification showing physical and chemical properties of each heat, the amount of spelter coating, and conformance ASTM A 123 [ASTM A 123M].

The Contractor may use steel guardrail posts of either a rolled section or a welded structural shape with nominal dimensions as shown in the Roadway and Traffic Design Standards.

For welded structural shapes, meet the following requirements:

(1) Ensure that the design properties of the shape meet or exceed the design properties for a W 6 x 8.5 [W 150 H 13.5] shape as contained in the AISC Manual of Steel Construction.

(2) Weld in accordance with the requirements of ASTM A 769 [ASTM A 769M].

(3) After cutting posts to length, place a weld to seal the spaces between the web plate and flange plates.

(4) Galvanize as specified above after completing all drilling and welding.

536-2.3 Anchor Blocks: Use anchor blocks of Class I concrete, and construct and place them in accordance with the requirements shown in the plans or as directed by the Engineer.

536-2.4 Offset Blocks: Use guardrail offset blocks of either timber, steel, recycled plastic, or rubber, and of the sizes specified in the Roadway and Traffic Design Standards.

The Contractor may cut steel blocks from a section of post. Ensure that steel blocks do not vary more than 0.25 inch [6 mm] from the specified length.

Treat timber blocks in accordance with the requirements for posts in 955-5.3. Ensure that penetration of preservative is in accordance with requirements for round piles and fence posts in 955-6.2. For timber offset blocks, meet the requirements of the latest edition of the Southern Pine Inspection Bureau's Standard Grading Rules for Southern Pine Lumber, for No. 1 grade timber. Dress all timber offset blocks on all four sides (S4S). Ensure that timber offset blocks do not vary more than 0.25 inch [6 mm] from the specified length.

Use rubber blocks that have a minimum Durometer hardness of 50 (ASTM D 2240), show no cracking at the end of an ozone exposure of 100 ∀ 10 pphm for 15 hours at 100EF [38EC] (ASTM D 1149 mounting type A), do not exceed 15 points change in Durometer hardness in oven ageing for 70 hours at 158EF [70EC] (ASTM D 573), and show no cutting or tearing under a 6,500 lb [29 kN] load applied through a guardrail section. Ensure that the blocks present a neat appearance and have plane surfaces. Provide rubber blocks that are 4 inches [150 mm] wide, 8 inches [200 mm] deep and 14 inches [360 mm] high. Allow dimensional tolerances of ∀ε inch [16 mm] in height, ∀δ inch [10 mm] in width, and ∀δ inch [10 mm] in depth.

For Recycled Plastic offset blocks, meet the requirements of Section 972.

536-2.5 Reflector Elements: Mount acrylic plastic reflectors on the guardrail in accordance with the details shown in the plans. Provide reflectors that meet the requirements of 993-5 and are colorless or amber, in accordance with the locations of use for each, as specified in the plans.

536-3 Setting Posts.

Set standard length posts vertically to the depth shown in the Roadway and Traffic Design Standards. Set special length posts vertically to the depth shown in the plans. Align and realign posts as necessary, until final acceptance. Where the posts are not set in concrete or mounted on structures, backfill the post holes with suitable thoroughly tamped material. As an alternate method, the Contractor may use a post-driving machine, meeting the approval of the Engineer and capable of driving the posts without damaging them.

For guardrail post replacement, backfill and compact the existing hole prior to setting the new post.

If driving posts through asphalt pavement, the Contractor may either block out holes for the posts during the paving operation or cut holes through the mat prior to the post installation. Either block-out or cut through an area that is at least 50% larger than the area of the post being driven. After completing installation of the posts and compaction of the backfill material, patch the area around each post with fresh hot bituminous mixture.

536-4 Erection of Rail.

Erect the guardrail panels, supports, anchors, etc., as shown in the Roadway and Traffic Design Standards.

536-5 Existing Guardrail.

Stockpile guardrail, so specified, within the right-of-way at a location approved by the Engineer. Dispose of all remaining guardrail not specified for stockpiling.

536-6 Method of Measurement.

536-6.1 Guardrail: The quantity to be paid for will be the plan quantity, in feet [meters], constructed, in place and accepted.

The plan length of a run of guardrail will be determined as a multiple of the nominal panel lengths plus the nominal lengths of terminal sections, unless payment for the terminal sections are included in the end anchorage or bridge anchorage assemblies.

536-6.2 End Anchorage Assemblies: The quantity to be paid for will be the number of each type as designated, constructed, in place and accepted.

536-6.3 Special Guardrail Posts: The quantity to be paid for will be the number of each, constructed, in place and accepted.

The designation "Special Guardrail Posts" will include only such posts as require special fabrication, for installation at locations where the normal setting would conflict with concrete structures, such as approach slabs, culvert slabs, footings, inlets, etc. Special posts, however, will not include posts for double-face median guardrail, regardless of whether they are embedded in or attached to concrete.

536-6.4 Bridge Anchorage Assemblies: The quantity to be paid for will be the number of each, constructed, in place and accepted.

536-6.5 Guardrail Anchorage (Concrete Barrier Wall): The quantity to be paid for will be the number of each, constructed, in place and accepted.

536-6.6 Guardrail Post Replacement: The quantity to be paid for will be the number of each, replaced.

536-6.7 Removal of Existing Guardrail: The quantity to be paid for will be the length, in feet [meters], measured prior to removal.

536-6.8 Special Steel Guardrail Posts: The quantity to be paid for will be the number of each, constructed, in place and accepted.

536-7 Basis of Payment.

536-7.1 Guardrail: Price and payment will be full compensation for all work specified under this Section, including the furnishing and installing of the acrylic plastic reflectors and all other materials as specified. Payment will be made under the items as follows:

a. Where the Contractor furnishes all materials for the guardrail, and the Engineer does not require shop-bent rails, payment will be made under the basic item of Guardrail.

b. Where the radius of the guardrail installation is such as to require shop bending of the guardrail panels, payment will be made under the item of Guardrail (Shop-bent Panels).

All component parts of the complete guardrail installation will be included in the price per foot [meter] for the above items except for the separate payments to be made under the special items listed below.

536-7.2 End Anchorage Assemblies: Price and payment will include all components specified on the plans and Roadway and Traffic Design Standards.

536-7.3 Special Guardrail Posts: Price and payment will include all costs for furnishing and installing the special posts that are over and above the costs for the normal posts, which are replaced by such special posts.

536-7.4 Bridge Anchorage Assemblies: When the plans provide for direct payment for Bridge Anchorage Assemblies, price and payment will include furnishing and installing the special End Shoes, Wood Blocks or Retrofit Wing Posts, Concrete Anchor Posts and necessary hardware.

When the plans do not provide for direct payment for Bridge Anchorage Assemblies, the Contractor shall include the cost for the assemblies in the Contract price per foot [meter] for the guardrail.

536-7.5 Guardrail Anchorage (Concrete Barrier Wall): Price and payment will include installing connections to concrete barrier walls, as shown on the Roadway and Traffic Design Standards, Index No. 400 and 410.

536-7.6 Guardrail Post Replacement: Price and payment will include all labor, materials, and equipment required for removal and disposal of existing posts in areas provided by the Contractor, backfilling and compacting existing holes, and replacement with new posts.

536-7.7 Removal of Existing Guardrail: Price and payment will be full compensation for all work specified in this Section, including all labor and equipment required for removal and disposition of the existing guardrail, as specified in the plans.

536-7.8 Special Steel Guardrail Posts with Accessories: Price and payment will include all components specified on the plans and Roadway and Traffic Design

Standards.

536-7.9 Payment Items: Payment will be made under:

Item No. 536- 1- Guardrail - per foot
Item No. 2536- 1- Guardrail - per meter.
Item No. 536- 2- Guardrail (Shop-Bent Panels) - per foot.
Item No. 2536- 2- Guardrail (Shop-Bent Panels) - per meter.
Item No. 536- 7- Special Guardrail Post - each.
Item No. 2536- 7- Special Guardrail Post - each.
Item No. 536- 8- Bridge Anchorage Assemblies - each.
Item No. 2536- 8- Bridge Anchorage Assemblies - each.
Item No. 536- 73- Removal of Existing Guardrail - per foot.
Item No. 2536- 73- Removal of Existing Guardrail - per meter.
Item No. 536- 75- Special Steel Guardrail Posts with Accessories - each.
Item No. 2536- 75- Special Steel Guardrail Posts with Accessories - each.
Item No. 536- 76- Special Length Guardrail Posts - each.
Item No. 2536- 76- Special Length Guardrail Posts - each.
Item No. 536- 82- Guardrail Anchorage (Concrete Barrier Wall)- each.
Item No. 2536- 82- Guardrail Anchorage (Concrete Barrier Wall)- each.
Item No. 536- 83- Guardrail Post Replacement- each.
Item No. 2536- 83- Guardrail Post Replacement- each.
Item No. 536- 85- End Anchorage Assemblies - each.
Item No. 2536- 85- End Anchorage Assemblies - each.

SECTION 538

RESETTING GUARDRAIL

538-1 Description.

Remove the existing guardrail, and reset the salvaged guardrail with new materials. Reset the guardrail at locations shown in the plans in accordance with the design standards for guardrail construction or as modified by the plans.

538-2 Materials.

Prevent damage to reusable materials when removing existing guardrail. Furnish all new materials necessary to complete the reset guardrail installation. Provide only new offset blocks.

Meet the requirements specified in 536-2.

538-3 Construction Methods.

Set posts in accordance with the requirements of 536-3.

Erect guardrail panels, anchors, and hardware in accordance with the design standards for guardrail construction or as modified by the detailed plans.

Replace any salvageable materials damaged by operations at no expense to the Department.

Use a consistent type of post throughout a run of guardrail.

538-4 Method of Measurement.

The quantities to be paid for will be: (1) the length, in feet [meters], of reset guardrail, (2) the number of end anchorage assemblies of each type as designated, (3) the number of special posts, and (4) the number of bridge anchorage assemblies; all as actually constructed and accepted.

The plan length of a run of reset guardrail will be determined as a multiple of the nominal panel lengths except that any panel which is cut off will be field-measured.

538-5 Basis of Payment.

Prices and payments for resetting guardrail will be full compensation for all work specified in this Section, including furnishing all required new hardware and additional posts, all new offset blocks, and replacement of any material damaged by the Contractor except as specified below.

Price and payment for end anchorage assemblies, special guardrail posts, and bridge anchorage assemblies will be as specified in 536-7.

Payment for new guardrail panels and posts furnished to replace such items determined to be non-salvageable, excluding any items damaged by the Contractor, will be paid for at the actual invoiced cost including transportation charges, to which cost will be added an amount equal to 25% of the total charges.

Payment will be made under:

Item No. 538- 1- Resetting Guardrail - per foot.
Item No. 2538- 1- Resetting Guardrail - per meter.
Item No. 536- 6- End Anchorage Assemblies, Type II - each.
Item No. 2536- 6- End Anchorage Assemblies, Type II - each.
Item No. 536- 7- Special Guardrail Post - each.
Item No. 2536- 7- Special Guardrail Post - each.
Item No. 536- 8- Bridge Anchorage Assemblies - each.
Item No. 2536- 8- Bridge Anchorage Assemblies - each.
Item No. 536- 9- End Anchorage Assemblies, Type IV - each.
Item No. 2536- 9- End Anchorage Assemblies, Type IV - each.
Item No. 536- 85- Guardrail, End Anchorage Assembly - each.
Item No. 2536- 85- Guardrail, End Anchorage Assembly - each.

SECTION 544

VEHICULAR IMPACT ATTENUATORS

544-1 Description.

Install redirective and non-redirective vehicular impact attenuators (VIA) of the sizes and types designated in the plans. Redirective VIA=s are safety devices with capabilities to redirect the impacting vehicle over the full length of the device. Non-redirective VIA=s allow controlled penetration of the impacting vehicle over the full length of the device.

544-2 Qualified Products List.

Use Vehicle Impact Attenuators listed on the QPL. Manufacturers seeking evaluation of their VIA=s shall furnish certified test reports showing that their products meet all test requirements of NCHRP 350.

544-3 Construction.

Handle and install manufactured materials or articles in accordance with the manufacturer=s instructions and the Roadway and Traffic Design Standards.

Use attenuators delineated with a Type I Object Marker specified in Section 705.

Perform repairs necessary due to defective material, work, or operations without additional cost to the Department.

Restore the attenuator damaged by the traveling public after the installation is completed, accepted and serving its intended purpose on an open section of bridge or roadway within 24 hours.

544-4 Compensation.

Price and payment will be full compensation for the complete system or module in place and accepted, including object marker. Restoration of the attenuator will be paid for at the invoice price plus 20%, for the new parts authorized by the Engineer. Payment for restoration will be full compensation for all necessary work and materials.

Relocation of an existing attenuator system to a permanent location called for in the plans shall be paid for at the Contract unit price for relocating existing systems. Price and payment will be full compensation for relocating and reinstalling the system in accordance with the manufacturer=s instructions and the Roadway and Traffic Design Standards.

Payment will be made under:

Item No. 544- 74- Vehicular Impact Attenuator, Relocate Existing - each.
Item No. 2544- 74- Vehicular Impact Attenuator, Relocate Existing - each.
Item No. 544- 75- Vehicular Impact Attenuator - each.
Item No. 2544- 75- Vehicular Impact Attenuator - each.
Item No. 544- 76- Attenuator Module (Sand Filled) - each.
Item No. 2544- 76- Attenuator Module (Sand Filled) - each.

SECTION 546

RUMBLE STRIPS

546-1 Description.

Construct Rumble Strips in accordance with the details shown in the plans and Roadway and Traffic Design Standards.

546-2 Materials for Raised Rumble Strips.

Construct Raised Rumble Strips using one of the following:

(a) Thermoplastic materials listed on the Qualified Products List (QPL), meeting the requirements of 971-1 and 971-21. Ensure that the material used can be restored to its original dimensions by using a self bonding overlay meeting these requirements. Submit a certified test report to the Engineer indicating that the materials meet all requirements specified.

Before applying thermoplastic materials on portland cement concrete surfaces, apply a primer sealer recommended by the manufacturer.

(b) Any plant-mixed hot bituminous mixture meeting the requirements of a job-mix formula issued by the Department, except open-graded friction course.

Prior to the application of any plant-mixed hot bituminous material, apply a tack coat meeting the requirements of 300-2.3.

The mixture will be accepted on the basis of visual inspection by the Engineer with no further testing required.

546-3 Application.

546-3.1 Raised Rumble Strips: Notify the Engineer before the placement of raised rumble strips. Apply raised rumble strips having well defined edges. Remove and replace any raised rumble strips not meeting the requirements of the Contract Documents at no additional cost to the Department.

Before applying raised rumble strips, remove any material that would adversely affect the bond of the raised rumble strips by a method approved by the Engineer.

Apply raised rumble strips only to dry surfaces, and only when the ambient air and surface temperature is at least 55EF [13EC] and rising.

546-3.2 Ground-In Rumble Strips: Before the construction of any ground-in rumble strips, demonstrate to the Engineer that the equipment to be used can achieve a depression having well defined edges and a smooth interior finish without snagging or tearing the finished pavement.

Before opening the adjacent lane to traffic, ensure that all debris generated by the grinding process is removed and disposed of daily by vacuum or a method approved by the Engineer. Do not dispose of the debris within the right-of-way. Do not use the debris generated by the grinding process in recycled asphalt.

Restore any pavement to the satisfaction of the Engineer at no additional cost to the Department, when ground-in rumble strips do not meet the requirements of the Contract Documents.

546-4 Method of Measurement.

The quantity of Raised Rumble Strips to be paid for under this Section will be the plan quantity per set, constructed and accepted.

The quantity of Ground-In Rumble Strips to be paid for under this Section will be the plan quantity in miles [kilometers], constructed and accepted. The plan quantity will be determined based on the roadway length minus bridge lengths for each shoulder on which Rumble Strips are to be constructed.

546-5 Compensation.

Prices and payments will be full compensation for all work specified in this Section, including, all cleaning and preparing of surfaces, disposal of all debris, furnishing of all materials, application, curing and protection of all items, protection of traffic, furnishing of all tools, machines and equipment, and all incidentals necessary to complete the work. Final payment will be withheld until all deficiencies are corrected.

Payment will be made under:

Item No. 546-71 - Rumble Strip Sets - per set.
Item No. 2546-71 - Rumble Strip Sets - per set.
Item No. 546-72 - Rumble Strips - per mile.
Item No. 2546-72 - Rumble Strips - per kilometer.

SECTION 548

RETAINING WALL SYSTEMS

548-1 Description.

Construct permanent and temporary retaining wall systems in accordance with this Section and in conformance with the lines, grades, design, and dimensions shown in the Contract Documents or established by the Engineer. The wall system chosen must be included in the Roadway and Traffic Design Standards and listed as an alternate in the Contract Documents. Sheet pile walls and Cast-In-Place walls are not included in this specification. Wall systems used to cut back existing slopes are covered by Technical Special Provisions for those systems; however they are paid for under the same pay item numbers shown in the Basis of Payment Article of this Specification. Construct all walls of a specific type (MSE (Mechanically Stabilized Earth), counterfort, etc) using the same wall system and supplier. If different types of wall systems must be used in a manner that causes one wall to interact with or influence another wall, coordinate the detailing of these areas of interaction/influence with the assistance of the Specialty Engineer.

548-2 Materials.

Purchase the precast components, soil reinforcement, attachment devices, joint filler, filter fabric, and all necessary incidentals from the wall supplier chosen.

548-2.1 Concrete: Ensure that concrete utilized for wall components is as specified in the Contract Documents and is consistent with the concrete class, environmental classification and admixture requirements for durability as stated in the Contract Documents. Produce and supply concrete for all wall components meeting the requirements of Section 346. Produce and supply concrete for the leveling pad meeting the requirements of Section 347. Assume responsibility for performance of all testing required by Section 346. Use Department approved mix designs.

548-2.2 Reinforcing Steel: Meet the requirements of Section 931 utilizing Grade 420 (Black) steel.

548-2.3 Soil Reinforcement: For walls utilizing soil reinforcement, use reinforcement consisting of steel wire mesh, metal strips or structural geosynthetics as required for the wall system chosen.

Use steel wire mesh and embedded loops shop fabricated from cold drawn steel wire meeting the minimum requirements of ASTM A 82, and weld into the finished mesh fabric in accordance with ASTM A 185. Use steel strips hot rolled from bars to the required shape and dimensions with physical and mechanical properties meeting ASTM A 572 [ASTM A 572M] Grade 65 [450] or as shown in the Contract Documents. Use shop-fabricated hot rolled steel tie straps meeting the minimum requirements of ASTM A 570 [ASTM A 570M], Grade 50 [345], or as shown in the Contract Documents.

Ensure that steel reinforcing strips, tie strips, reinforcing mesh and connectors used in permanent walls are galvanized in accordance with ASTM A 123 [ASTM A 123M] or ASTM A 153 [ASTM A 153M], as applicable.

Use structural geosynthetics made of polypropylene, select high density polyethylene or high-tenacity polyester fibers having cross-sections sufficient to permit significant mechanical interlock with the soil/backfill. Use geosynthetics having a high tensile modulus in relation to the soil/backfill. Use geosynthetics having high resistance to deformation under sustained long term design load while in service and resistant to ultraviolet degradation, to damage under normal construction practices and to all forms of biological or chemical degradation normally encountered in the material being reinforced.

Store the geosynthetics in conditions above 20EF [-7EC] and not greater than 140EF [60EC]. Prevent mud, wet cement, epoxy, and like materials from coming into contact with and affixing to the geosynthetic material. Rolled geosynthetic may be laid flat or stood on end for storage. Cover the geosynthetic and protect from sunlight prior to placement in the wall system.

Carefully inspect all reinforcement, steel and geosynthetics to ensure they are the proper size and free from defects that may impair their strength and durability.

548-2.4 Attachment Devices: Use soil reinforcement attachment devices as required by the wall system chosen.

548-2.5 Joint Materials and Filter Fabrics:

548-2.5.1 Horizontal Joint Filler: Use elastomeric or polymeric pads/fillers in all horizontal joints between precast components as recommended by the wall manufacturer. Ensure that the pads are of sufficient size and hardness to limit vertical stresses on the pad and concrete surface and to prevent concrete to concrete contact at the joints.

548-2.5.2 Joint Covers: Cover joints and other wall openings with geotextile fabric meeting the requirements of Section 985 and Type D-5 of the Roadway and Traffic Design Standards, Index No. 199. Apply an adhesive approved by the Engineer to the back of the precast component for attachment of the fabric material.

548-2.5.3 Alignment Pins: Ensure that pins used to align the precast components during construction are of the size, shape and material required for the wall system chosen.

548-2.6 Backfill Material: Ensure that all backfill material used in the retaining wall volume is free draining and meets the requirements of this Section. Have the backfill material tested by a Department approved independent testing laboratory prior to placement. The retaining wall volume is defined to extend from the top of the leveling pad or footing, or bottom of walls which do not have footing or leveling pads, to the finish grade line and from the face of the wall to a vertical plane passing through the end of the extreme wall component (straps, counterforts, etc.) plus 1 foot [300 mm].

For constructing the retaining wall volume, do not use backfill material containing more than 2.0% by weight of organic material, as determined by FM 1-T 267 and by averaging the test results for three randomly selected samples from each stratum or stockpile of a particular material. If an individual test value of the three samples exceeds 3%, the stratum or stockpile will not be suitable for constructing the retaining wall volume.

Ensure that the plasticity index as determined by FM 1-T 090 does not exceed six and the liquid limit as determined by FM 1-T 089 is less than 15. The pH, as determined by FM 5-550, shall not be lower than five and not higher than ten, unless approved otherwise by the Engineer, as follows: For walls utilizing non-metallic soil reinforcement, the Engineer may approve using a backfill with a pH value between three and ten, if no metallic structures, such as metallic pipes, are placed within the backfill. Do not use backfill with a pH lower than three or higher than ten.

Use backfill for walls using soil reinforcements that meets the following gradation limits determined in accordance with FM 1-T 027 and FM 1-T 011:

Sieve Size		Percent Passing
32 inches	[90 mm]	100
: inch	[19.0 mm]	70-100
No. 4	[4.75 mm]	30-100
No. 40	[425 µm]	15-100
No. 100	[150 µm]	5-65
No. 200	[75 µm]	0-15

In addition, for permanent walls utilizing metallic soil reinforcement, use backfill that meets the following electro-chemical test criteria for determining corrosiveness:

Criteria	Test Method
Resistivity: > 30 Ω≅m	FM 5-551
Sulfate content: < 200 PPM	FM 5-553
Soluble chloride content < 100 PPM	FM 5-556 or FM 5-552

For walls not using soil reinforcement, use backfill that meets the following gradation limits determined in accordance with FM 1-T 027 and FM 1-T 011:

Sieve Size		Percent Passing
32 inches	[90 mm]	100
No. 200	[75µm]	0-15

548-3 Concrete Component Construction.

Construct concrete components in accordance with Section 400. Precast wall components are produced using certification acceptance; therefore, assume responsibility for performance of all testing and inspection required by Section 400 for the precast component construction. Perform all Quality Control and Assurance Testing using ACI qualified testing personnel. Perform compressive strength testing in a laboratory inspected by CCRL or CMEC, with all deficiencies corrected. The minimum time for form removal is 12 hours. Unless otherwise indicated in the Contract Documents, apply a Class 3 finish to the concrete surface for the front face, and roughly screed the rear face to eliminate open pockets of aggregate and surface distortions in excess of 3 inch [6 mm].

548-3.1 Curing: Cure concrete components in accordance with Section 400.

548-3.2 Tolerances: Meet the following manufactured tolerances:

1. Precast Component Dimensions: Lateral position of soil reinforcement attachment devices - within 1 inch [25 mm]. All other dimensions - within 3/16 inch [5 mm].

2. Precast Component Squareness: Angular distortion of the component shall not exceed 0.2 inches in 5 feet [5 mm in 1.5 m].

3. Precast Component Surface Finish: Surface defects on smooth formed surfaces measured on a length of 5 feet [1.5 m] shall not exceed more than 0.1 inch [3 mm]. Surface defects on textured finished surfaces measured on a length of 5 feet. [1.5 m] shall not exceed 5/16 inch [8 mm].

548-3.3 Marking of Precast Components. Clearly mark each precast components with the date of manufacture, the 346 concrete production LOT number and the piece-mark.

548-4 Rejection of Precast Components.

Precast wall components not meeting the quality standard of this Section and referenced Specifications will be rejected by the Department. In addition, any of the following defects will be sufficient cause for rejection by the Department.

1. Defects that indicate unsatisfactory molding.
2. Defects indicating honeycombed or open texture concrete.
3. Defects in the physical characteristics such as:

    Signs of aggregate segregation;
    Broken or cracked corners;
    Soil reinforcement attachment devices improperly installed/damaged;
    Lifting inserts not useable;
    Exposed reinforcing steel;
    Insufficient cover over reinforcing steel;
    Cracks at the alignment pipe or pin;
    Insufficient concrete compressive strength;

Precast Component thickness in excess of ∀3/16 inch [∀5 mm] from that shown in the Contract Documents; or

Stained front face, due to excess form oil or other reasons.

If the face of the precast component is stained or discolored to the point of rejection, the stain or discoloration may be removed or a Department approved stain or a Class 5 finish may be applied to attain a uniform appearance for the entire structure, to the satisfaction of the Engineer.

548-5 Handling Storage and Shipping.

Handle, store and ship all components in a manner that prevents chipping, cracks, fractures, excessive bending stresses, mud, dirt and debris. Support precast components in storage on firm blocking located immediately adjacent to the attachment device.

548-6 Construction Requirements.

548-6.1 General: Due to the unique nature of the structure and concept, procure from the Wall Supplier fully detailed shop drawings, technical instructions, guidance in preconstruction activities and on-site technical assistance during construction. Closely follow any instructions from the Wall Supplier, unless otherwise directed by the Engineer. Submit a copy of any instructions from the Wall Supplier to the Engineer. Verify all pertinent retaining wall information (soil parameters, wall alignment, utility locations, conflicting structures) prior to the Wall Supplier finalizing shop drawings. Bring any conflicts not shown in the Contract Documents to the Engineer=s attention.

548-6.2 Wall Excavation: Excavate to the limits shown in the Contract Documents and in conformance with Section 125.

548-6.3 Foundation Preparation: Grade the foundation for the structure level for a width equal to or exceeding the limits of the retaining wall volume or as shown in the Contract Documents. Prepare the foundation in conformance with Section 125.

In addition to the compaction requirements of Section 125, compact the graded area with an appropriate vibratory roller weighing a minimum of 8 tons [7 metric tons] for at least five passes or as directed by the Department's District Geotechnical Engineer. Remove and replace any soft or loose foundation subsoils which, in the Engineer=s opinion, are incapable of sustaining the required compaction.

For permanent MSE wall systems, provide an unreinforced concrete leveling pad as shown in the Contract Documents. Cure the leveling pad a minimum of 12 hours before placement of precast wall components.

548-6.4 Wall Erection: Assemble, connect and support wall components as recommended by the Wall Supplier. As backfill material is placed behind the wall face, maintain the wall in the vertical position or slightly battered into the backfill to provide a final vertical alignment (by means of bracing, temporary wooden wedges placed in the joint at the junction of the two adjacent precast components on the external side of the wall or other alignment aids). Remove wooden wedges as soon as the precast component above the wedged precast component is completely erected and backfilled. External bracing is required for the initial lift of MSE systems.

Place soil reinforcement normal to the face of the wall, unless otherwise shown in the Contract Documents or directed by the Engineer. Prior to placement of the reinforcement, compact the backfill in accordance with 548-7.5.

548-6.4.1 Tolerances for Permanent Walls: Ensure that vertical tolerances (plumbness) and horizontal alignment tolerances do not exceed : inch [20 mm] when measured with a 10 foot [3.048 m] straight edge. The maximum allowable offset in the joint between precast components is : inch [20 mm]. The final overall vertical tolerance of the completed wall (plumbness from top to bottom) shall not exceed 2 inch per 10 feet [5 mm per meter] of wall height. Horizontal and vertical joints between precast components shall not be less than 2 inch [13 mm] or more than 13 inch [30 mm]. Walls which do not meet these tolerances will not be accepted by the Department and must be removed and reconstructed at no cost to the Department.

548-6.4.2 Tolerances for Temporary Walls: Ensure that vertical tolerances (plumbness) and horizontal alignment tolerances do not exceed 3 inches [75 mm] when measured with a 10 foot [3.048 m] straight edge. The final overall vertical tolerance of the completed wall (plumbness from top to bottom) shall not exceed 1 inch per 3 feet [13 mm per meter] of wall height, not to exceed a total of 6 inches [150 mm]. Walls which do not meet these tolerances will not be accepted by the Department and must be removed and reconstructed at no cost to the Department.

548-6.5 Backfill Placement: Place the backfill closely following the erection of each course of precast components or soil reinforcement layers and spread by moving the machinery parallel to the wall face. Do not allow equipment heavier than 8 tons [7.5 metric tons] closer than 3 feet [1 m] behind the wall face. Place backfill in a manner to avoid any damage or disturbance to the wall materials or misalignment of the facing materials. Remove and replace any wall materials which become damaged or disturbed during backfill placement at no cost to the Department, or correct as directed by the Engineer. Remove and reconstruct any misalignment or distortion of the wall facing due to placement of backfill outside the limits of this specification at no cost to the Department.

Compact retaining wall backfill and embankment fill from the beginning stationing of the retaining wall volume to the ending stationing of the retaining wall volume to at least 95% of the maximum dry density as determined by FM 5-521. As an exception, compact backfill placed within 3 feet [1 m] behind the wall face to at least 90% of the maximum dry density. Sheepfoot, grid rollers or other types of equipment employing a foot are not allowed. Achieve compaction within 3 feet [1 m] of the back of the wall face using a power operated roller or plate weighing less than 1,000 lbs [450 kg]. At a distance greater than 3 feet [1 m] from the back of the wall, a vibratory roller may be used, provided that the frequency and amplitude combined with bulk weight of the roller has performed satisfactorily at a trial section of the same type of wall. A smooth wheel or rubber tire roller is considered adequate. Ensure that the maximum lift thickness after compaction does not exceed 6 inches [150 mm]. Decrease the lift thickness if necessary, to obtain specified density.

Perform backfill compaction in a way that the compactor moves in a direction parallel to the wall face and proceeds from a distance not less than 3 feet

[1 m] behind the wall face toward the end of the soil reinforcement element.

Ensure that the moisture content of the backfill material prior to and during compaction is uniformly distributed throughout each layer of material. Use backfill material having a placement moisture content at the dry side of the Optimum Moisture content. To achieve the required compaction moisture content, use water that meets the requirements of Section 923. Do not use saltwater. Do not transport excessively moist backfill materials to the site for any reason. The Engineer will determine the Optimum Moisture Content in accordance with FM 5-521.

At the end of each day's operation, shape the last level of backfill to permit runoff of rainwater away from the wall face or provide a positive means of controlling run off away from the wall such as temporary pipe, etc.

548-7 Certification.

Furnish a copy of all test reports which are necessary to document compliance with the Specifications, at least ten days prior to wall construction.

Also furnish the Engineer a Certificate of Compliance certifying that the retaining wall materials, backfill and construction practices comply with this Specification.

Acceptance of furnished material will be based on the Certificate of Compliance, accompanying test reports, and visual inspection by the Engineer.

548-8 Method of Measurement.

The quantity to be paid for will be the plan quantity, in square feet [square meters], completed and accepted, of the area bounded by the top of the traffic barrier, coping or parapet (or the top of the wall in areas with no top treatment), the top of the leveling pad, top of structural footings, bottom of walls which do not have footings or leveling pads, and the beginning and end wall limits as shown on the wall control drawings.

548-9 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section, including the design of the wall system, excavation and fill required specifically for wall construction below the normal roadway template, soil reinforcement, leveling pad, footings, traffic barriers, copings, parapets, fabric material, horizontal joint materials, alignment pins, repairs, labor, equipment, and other materials necessary to complete the wall in an acceptable manner as shown on the Contract drawings. The cost of granular fill for the normal roadway template will be included in the cost of embankment or borrow excavation, as applicable.

Payment will be made under:

Item No. 548-10- Retaining Wall System (Permanent) - per square foot.
Item No. 2548-10- Retaining Wall System (Permanent) - per square meter.
Item No. 548-11- Retaining Wall System (Temporary) - per square foot.
Item No. 2548-11- Retaining Wall System (Temporary) - per square meter.

SECTION 550

FENCING

550-1 Description.

Furnish, erect and reset metal fence of the type and at the locations shown in the plans.

550-2 Types of Fence.

The types of fence are designated as follows:

Type A (Farm Fence).

Type B (Chain-Link Fence).

Type R (Chain-Link Fence for Pedestrian Overpass).

550-3 Materials.

550-3.1 Type A Fence (Farm Fence): Meet the requirements of Section 954 for timber posts and braces. For metal posts and braces, meet the requirements of the Roadway and Traffic Design Standards. For recycled plastic fence posts, meet the requirements of Section 972.

For the fabric and all other accessories, meet the requirements of the Roadway and Traffic Design Standards.

550-3.2 Type B Fence (Chain-Link): For the posts, braces, fabric and all accessories other than the concrete for bases, meet the requirements of the Roadway and Traffic Design Standards.

Use Class I concrete as specified in Section 347, or a premix approved by the Engineer for bases. The requirements contained in 347-2.4, 347-7 and 347-8 will not apply.

550-3.3 Type R Fence (Chain-Link for Pedestrian Overpass): Use the fabric and accessories specified in the plans.

550-3.4 Resetting Fence: Use material from the existing fence. For any additional materials required, provide the same type of material as in the existing fence and as specified herein, including gates when applicable.

550-3.5 Optional Use of Materials: For Type A Fence, a combination of steel, aluminum, timber, recycled plastic or concrete posts may be used. Unless otherwise called for in the plans, line posts of one material may be used with corner, pull and end post assemblies of a different material. The Engineer will permit the use of line posts of only one optional material and pull posts assemblies of only one optional material between corner and end post assemblies. Within individual corner and end post assemblies, the Engineer will allow the use of only one optional material.

For Type B Fence, a combination of zinc-coated steel fence members, aluminum coated fence members and aluminum alloy fence members may be used. Unless otherwise indicated on the plans, the Engineer will allow the use of only one type of fabric material, one type of line post material and one type of pull assembly material between corner and end post assemblies.

550-4 Construction Methods.

550-4.1 General: Install the fence in accordance with the specific requirements of this Article and with the details shown on the Roadway and Traffic Design Standards for the particular type of fence called for, except for Type R Fence which shall be detailed in the plans. Construct the fence in close proximity to the right of way line except as may be detailed otherwise in the plans. Assume responsibility for obtaining satisfactory permits or permission from property owners for any encroachments required to perform the work, and for proper scheduling of the fence installation with the removal of existing fence where it is necessary to provide continuous security to adjacent areas already fenced. In order to meet this requirement, where necessary for maintaining security of livestock on adjacent property during construction of the new fence, the Engineer may require the erection and subsequent removal of temporary fencing.

Construct Type R fencing in accordance with details shown in the plans.

550-4.2 Spacing of Posts: Space posts as shown in the plans, within a tolerance of 12 inches [300 mm], except where definite spotting of corner posts is required. Ensure that, in any line of fence, the over-spacings and the under-spacings shall approximately compensate. Set additional line posts at abrupt changes in grade.

550-4.3 Clearing: Where the clearing and grubbing for the project does not include the area occupied by the fence, clear the area to the limits shown in the plans. If the limits are not shown in the plans, clear the area at least 2 feet [0.6 m] wide on each side of the fence line. The Engineer may direct that desirable trees be left in place. Do not extend such clearing beyond the right-of-way line.

550-4.4 Construction Over Irregular Terrain and Other Obstructions:

550-4.4.1 Clearance of Bottom of Fence: Install the fence such that the bottom of the fence, in general, follows the contour of the ground. The fence is detailed in the plans at approximately 3 inches [75 mm] above ground line. Over irregular ground, however, the Engineer will permit a minimum clearance of 1 inch [25 mm] and a maximum of 6 inches [150 mm] for a length not to exceed 8 feet [2.4 m], and, for Type A fence, with the barbed wire spaced midway between ground and bottom of fabric.

550-4.4.2 Grading: Where necessary to secure proper vertical alignment and to meet the clearance requirements, fill depressions (except where filling would obstruct proper drainage) and cut down knolls and ridges. Provide a substantial and permanent foundation for the fence.

550-4.4.3 Use of Extra-Length Posts. At locations where it is impracticable to adjust the ground level, the Engineer may require that posts of additional length be set and that the opening at the bottom be closed by additional barbed wire, stretched taut between poles, with no vertical distance between wires greater than 3 inches [75 mm]. For all such posts requiring a concrete base, extend the concrete downward to the bottom of the extra-length post.

550-4.5 Setting Posts: If rock occurs within the required depth of the post hole, or pavement which is to remain in place exists at the location of a post, drill a hole of a diameter slightly larger than the greatest dimension of the post or footing and grout in the post or footing. Set timber posts either by digging or by driving. Set recycled plastic fence posts in accordance with Roadway and Traffic Design Standards, Index No. 451.

550-4.6 Placing Fabric: Do not place fabric and barbed wire until the posts have been permanently positioned and concrete foundations have attained adequate strength. Place the fabric by securing one end and applying sufficient tension to remove all slack before making permanent attachments at intermediate points. Fasten the fabric to all end, corner and pull posts by approved means. Fasten the fabric using tools designed for the purpose, in accordance with the manufacturer's recommendations. Apply the tension for stretching by mechanical fence stretchers or with single-wire stretchers designed for the purpose.

550-4.7 Electrical Grounds: Wherever a power line passes over the fence, install a ground directly below the point of crossing. Install a ground rod consisting of a galvanized rod with connection of similar metal if required, or of other appropriate material, 8 feet [2.4 m] in length and at least ε inch [16 mm] in diameter. Drive the rod vertically until the top of the rod is approximately 6 inches [150 mm] below the ground surface. Use a No. 6 conductor to connect the rod and all fence elements. Connect the conductor to each fence element and the ground rod by means of electrical-type clamps which will prevent corrosion.

550-5 Method of Measurement.

550-5.1 General: The quantities to be paid for will be the number of gates, the length of each type of fence, the number of corner post assemblies, and the number of pull and end post assemblies, constructed and accepted. In addition, extra payment will be made, in accordance with 550-6.3, for additional lengths of post approved by the Engineer for the crossing of depressions in accordance with 550-4.4.3, muck areas, or other areas of inadequate support for a post of standard length.

550-5.2 Measurement of Fence Length, and Payment: The length of fence to be paid for will be measured along the bottom of the fabric, out-to-out of end posts, in the completed and accepted fence. Measurement for Resetting Fence will be the actual length of existing fence reset, including gates when applicable.

550-5.3 Corner Post Assemblies, and Pull and End Post Assemblies: The number of corner post assemblies and of pull and end post assemblies to be paid for will be the number of such post assemblies constructed and accepted.

550-6 Basis of Payment.

550-6.1 Basic Items of Fencing: The Contract unit price per foot [meter] for the Item of Fencing, measured as specified in 550-5.2, will be full compensation for all work and materials necessary for the complete installation, including line posts, but not including the corner, end, and pull posts and the assemblies therefor, as provided below, and not including the payment stipulated for extra-length posts. Such price and payment will include, but not be limited to, the following specific incidental work.

(a) Any work required to level and prepare the terrain along the line of the fence.

(b) Any additional clearing incidental to construction of the fence.

(c) All preparation for post holes, in whatever type of material, as specified herein.

(d) Any furnishing and installing of electrical grounds.

(e) Any additional work or materials required for special construction over irregular terrain, or terrain of inadequate support for the posts, including the additional barbed wire, but not including the extra lengths of posts ordered by the Engineer.

(f) Any cost of erection and removal of any temporary fencing, which may be necessary for maintaining security of livestock, etc., on adjacent property during construction of the new fence.

550-6.2 Items of Post Assemblies: The Contract unit prices for the items of Corner Post Assemblies and Pull and End Post Assemblies will include the posts and the complete assemblies therewith for each such item. Approach posts and brace posts will be considered as part of the assembly of the corner, end or pull post being paid for separately, regardless of whether the corner, end, or pull post serves as a brace in more than one horizontal line.

550-6.3 Payment Rates for Extra-Length Posts: For any length of posts in excess of the standard length for each particular type of post, approved by the Engineer as provided above, payment will be made for each foot [meter] in excess of the standard length at the percentage of the Contract unit price per foot [meter] for the item of Fencing, as shown in the following schedule.

Additional Payment for Each Foot [Meter] of Post in Excess of the Standard Length (in percent of Contract Unit Price for Fencing)

Total Length of Post	Steel and Aluminum Posts	Recycled Plastic and Timber Posts
Standard, up to 14 feet [Standard, up to 4.3 m]	50%	60%
Over 14 ft, up to 20 feet [Over 4.3 m, up to 6.1 m]	60%	80%
Over 20 feet* [Over 6.1 m*]	*	*

*When the length of post exceeds 20 feet [6.1 m], the work of furnishing and installing such posts and the costs incidental thereto will be paid for as unforeseeable work.

The standard length of steel, recycled plastic and aluminum posts will be the required length as indicated in the plans for each type and case. The above provisions for extra length payment will apply to end, corner and pull posts.

The payment for additional length of post will include the cost of additional concrete to extend concrete bases, as applicable.

550-6.4 Gate Payment: The quantities to be paid for will be full compensation for all labor, materials, posts and associated hardware for the complete installation of the type gate specified in the plans, and accepted by the Engineer.

550-6.5 Payment Items: Payment shall be made under:

Item No. 550-1 - Fencing, Type A - per foot.
Item No. 2550-1 - Fencing, Type A - per meter.
Item No. 550-2 - Fencing, Type B - per foot.
Item No. 2550-2 - Fencing, Type B - per meter.
Item No. 550-3 - Corner Post Assemblies - each.
Item No. 2550-3 - Corner Post Assemblies - each.

Item No. 550-4 - Pull and End Post Assemblies - each.
Item No. 2550-4 - Pull and End Post Assemblies - each.
Item No. 550-5 - Pull Post Assemblies (Type B) - each.
Item No. 2550-5 - Pull Post Assemblies (Type B) - each.
Item No. 550-6 - End Post Assemblies (Type B) - each.
Item No. 2550-6 - End Post Assemblies (Type B) - each.
Item No. 550-71 - Fencing, Type R - per foot.
Item No. 2550-71 - Fencing, Type R - per meter.
Item No. 550-73 - Fencing (Special) - per foot.
Item No. 2550-73 - Fencing (Special) - per meter.
Item No. 550-74 - Resetting Existing Fence - per foot.
Item No. 2550-74 - Resetting Existing Fence - per meter.
Item No. 550-75 - Fence Gate - Type A - per each.
Item No. 2550-75 - Fence Gate - Type A - per each.
Item No. 550-76 - Fence Gate - Type B - per each.
Item No. 2550-76 - Fence Gate - Type B - per each.
Item No. 550-79 - Sliding Gate - per each.
Item No. 2550-79 - Sliding Gate - per each.

SECTION 560

SHOP, FIELD, AND MAINTENANCE

PAINTING OF STRUCTURAL STEEL

560-1 Description.

Perform the shop, field, and maintenance painting of structural steel surfaces in accordance with this Section.

560-2 Definitions.

(a) Shop, Field, and Maintenance Painting: The various painting operations which include the surface preparation and the application of paints to structural steel surfaces, whether in the shop or in the field, including all labor, materials and equipment, and extending to the drying and protection of the painted surfaces; also including the protection of property and traffic.

(b) Paint: When used in the general sense, this term includes paints, varnishes, emulsions, bituminous coatings, and other coatings, inorganic as well as organic.

(c) Shop Painting: The painting which is done at the shop or plant before shipment to the site.

(d) Field Painting: The painting of new or rebuilt steel structures at the site of erection, either before or after erection, and the repainting of existing structures where the original paint has been entirely removed to base metal.

(e) Maintenance Painting: The painting of in service structures that have previously been completely painted and require repainting.

560-3 Surfaces Not to be Painted.

(a) Do not paint machine finished surfaces. (Coat machine finished surfaces as provided in 560-11.3.)

(b) Do not paint galvanized surfaces except where painting of such surfaces is specifically required.

(c) Do not paint the areas of contact surfaces of steel to be encased or embedded in concrete, or coated with concrete, unless otherwise specified. However, when steel surfaces are to be painted with an inorganic zinc paint coating system, paint the areas of contact surfaces embedded in concrete or coated in concrete with the inorganic zinc prime coat in accordance with the same requirements as other steel surfaces to be painted with inorganic zinc prime coat. As an exception, surfaces of shear connectors may or may not be painted. When surfaces of shear connectors are painted, the requirements for surface cleaning and minimum film thickness will not apply; however, remove runs, sags and cracks in the paint film.

(d) Keep contact surfaces of members to be joined by high-strength bolts in friction-type joints free of paint, lacquer, or other coatings other than the following:

(1) Hot dip galvanizing, if contact surfaces are scored by wire brushing or blasting, after galvanizing and prior to assembly.

(2) Inorganic zinc rich paints when such paints are specified.

560-4 Storage of Paint.

Do not open containers of paint until required for use. Use any open containers first. In general, open and use the oldest paint of each kind first.

Store all paint and thinner in an area that is well ventilated and is protected from sparks, flame, direct rays of the sun, and excessive heat.

Do not use paint that has livered, gelled, or otherwise deteriorated during storage. The Engineer will accept thixotropic materials that the Contractor can bring to normal consistency by stirring.

In closed or recirculating paint systems where gas under pressure is used over the liquid, use only an inert gas (such as nitrogen) for such purpose.

560-5 Mixing and Thinning.

560-5.1 General: Thoroughly mix all ingredients in any container before use, and repeatedly agitate them during application as necessary to keep the paint in a uniform, homogeneous condition.

The Contractor may mix by hand for containers of up to 5 gallons [20 L]. For larger containers, mix by mechanical methods.

560-5.2 Dry Pigments and Pastes:

(a) Mix in dry pigments that are separately packaged in a manner that thoroughly and uniformly blends the pigments and wets all particles of the dry powder.

(b) Incorporate pastes into the paint in a manner that uniformly blends the pastes and breaks up all lumps and particles to provide a homogeneous solution.

(c) Add a small amount of thinner, vehicle, or paint to tinting pastes or colors and thoroughly mix. Strain the thinned mixture, and then add it to the large container of paint and mix until the paint color is uniform.

(d) Add thinner to the paint only as necessary for proper application. Do not add more than 1 pint [0.13 L] of thinner per gallon [liter] of paint except where the paint is intentionally formulated by the manufacturer for such greater thinning. Use a type of thinner conforming to the paint specification or the manufacturer's instructions.

560-6 Cleaning Surface.

Clean surfaces to be painted in accordance with the Surface Preparation Specifications of SSPC. Protect adjacent surfaces in accordance with 560-7.2.

Remove any oil, grease, soil, dust, or other foreign matter that becomes deposited on the surface after the surface preparation has been completed. In the event that any rusting occurs after the completion of the surface preparation, clean the surfaces again in accordance with SSPC-SP 1.

560-7 Application of Paint.

560-7.1 Methods of Application: Apply paint by the following methods, except where another particular method is specified in the Contract Documents:

(1) Brushing.

(2) Air spraying.

(3) Airless spraying.

(4) Any combination of methods 1), (2), and (3) above.

(5) Use daubers or sheepskins where none of the above methods is practical for proper application to surfaces difficult to access.

(6) Use roller coat application on flat or slightly curved surfaces, blast-cleaned or pickled surfaces, or primed or striped portions of surfaces. Unless specifically authorized by the Department, or unless the paint over such areas is subsequently brushed out, do not use roller coat application to apply primer over hand tool cleaned, or power tool cleaned irregular surfaces such as rivets, bolts, crevices, welds, corners, and edges.

(7) Use dipping or flow coating methods only when specifically authorized by the Department.

560-7.2 Protection of Adjacent Surfaces: Consider wind direction, velocity and geographic location as having a major impact on all cleaning and painting operations. If conditions are such that material is dispersed to areas where vehicles or other property may be damaged, suspend operations until conditions improve enough to permit work without damage. Protect all surfaces not intended to be painted, which are adjacent to, or in close proximity to the surfaces to be painted, during the application of paint. Clean surfaces other than those intended to be painted until all traces of paint have been removed and the surface has an acceptable appearance. Use all necessary precautions to prevent material from cleaning and painting operations from being dispersed outside the work site.

560-7.3 Weather and Temperature Limitations:

(a) Temperature: Do not apply paint when the temperature of either the steel or the paint is below 40EF [4EC]. As an exception, the Contractor may apply paints which dry solely by the evaporation of the solvent as long as the temperature is not below 35EF [2EC]. Do not apply paint when expecting the surface temperature to drop to 32EF [0EC] before the paint has dried.

With chemically cured coatings, exercise particular care to follow manufacturer's special temperature requirements (usually 55EF [13EC] or above).

(b) Weather Conditions: Do not apply paint in rain, wind, fog, or mist, or when the steel surface temperature is below the dew point, resulting in condensation of moisture. Do not apply paint to wet or damp surfaces unless the paint is of the water thinned type. Do not apply paint on frosted or ice coated surfaces.

(c) Painting Under Cover in Inclement Weather: When paint must be applied in damp or cold weather, paint the steel under cover or otherwise protect and shelter it, or heat the surrounding air and the steel to the specified temperature. Keep such steel under cover or protected until dry or until weather conditions permit its exposure.

(d) Repairing Damaged Areas: Allow all wet paint exposed to freezing, excess humidity, rain, or condensation to dry before removing damaged areas of paint. Prepare the surface again, and repaint it with the same number of coats of paint of the same kind as the undamaged areas.

560-7.4 Striping of Irregular Surfaces: Stripe paint all edges, corners, crevices, rivets, bolts, welds, and sharp edges with the priming paint before the steel receives its first full prime coat of paint. Extend such striping at least 1 inch [25 mm] from the edge. When practicable, allow this stripe coat to dry before applying the prime coat; otherwise allow the stripe coat to set to touch before applying the full prime coat. However, do not allow the stripe coat to dry for a period long enough to allow rusting of the unprimed steel. When desired, the Contractor may apply the stripe coat after a complete prime coat.

560-7.5 Requirements for Individual Coats: To the maximum extent practical, apply each coat of paint as a continuous film, of uniform thickness, free of pores. Repaint all thin spots or areas missed in the application, and allow them to dry before applying the next coat of paint.

560-7.6 Thickness of Coats: Unless specified otherwise by the specification covering the paint or the paint systems, apply the prime coat(s) of paint and the first field coat of primer, when specified, each at least 1.5 and up to 2.25 mils [40 μm and up to 60 μm] thick when dry. Apply each intermediate coat of paint at least 2.0 and up to 2.5 mils [50 μm and up to 65 μm] thick when dry. Do not allow any portion of the paint films to be less than the specified minimum film thicknesses. Ensure that the total minimum film thickness for any combination of coats equals the sum total of the averages of the specified thickness range of the individual coats. Achieve the total minimum film thickness before the application of the finish coat. (Vinyls, lacquers, emulsions, and bituminous coatings usually deviate from this thickness. Apply finish coats at the specified thickness for the individual material.)

After application of the first 3 coats of paint on structural steel, the Engineer will thoroughly inspect the surfaces. Obtain the approval of the Engineer before applying the final coat. The Engineer will take film thickness measurements at the approximate rate of one for each 25 ft^2 [2.25 m^2] of area unless deficient thickness is found, in which case the Engineer will increase the rate of sub-measurements as required to determine the extent of the deficient areas. Provide the necessary ladders or scaffolds for making the inspection.

When a paint or coating different than those specified in 560-11 through 560-13 is required, use the thickness specified for the particular paint or coating required in lieu of the thickness requirements stipulated above.

560-7.7 Tinting (For Color Differential): When successive coats of paint of the same color have been specified, sufficiently tint alternate coats of paint, when practical, to produce enough contrast to indicate complete coverage of the surface. Use a tinting material that is compatible with the paint and not detrimental to its service life.

560-7.8 Recoating: When recoating is required, allow each coat of paint to dry for at least 48 hours before applying the succeeding coat.

560-7.9 Inaccessible Surfaces: Provide steel surfaces, except contact surfaces inaccessible after assembly, with either the full specified paint system or three shop coats of the specified primer before assembly.

560-7.10 Timing Requirements: Immediately following the cleaning of the surface, apply the prime coat and apply succeeding coats before allowing any contamination of the previous coats to occur. In the event that such timing of the application is not possible or is impractical, make any required modifications as approved by the Engineer.

560-8 Specific Requirements for Brush Application.

(a) Brushes: Use brushes of a style and quality that will enable proper application of paint. Provide round or oval brushes for rivets, bolts, irregular surfaces, and rough or pitted steel. Use flat brushes, 5 inches [125 mm] wide or less, for large flat areas.

(b) Painting: Brush to obtain a smooth coat as nearly uniform in thickness as possible. Work paint into all crevices and corners where possible. Paint surfaces not accessible to brushes by spray or by daubers or sheepskins.

560-9 Specific Requirements for Spray Painting.

560-9.1 General: Perform all spray application of paint, whether air spray, airless, or hot spray, in accordance with 560-7. Also meet the following additional specific requirements for each such type.

560-9.2 Equipment: Use spray equipment suitable for the specific purpose, capable of properly atomizing the paint, and equipped with suitable pressure regulators and gauges.

Keep the spray equipment clean. Completely remove any solvents left in the equipment before use.

560-9.3 Pressure: Adjust the pressure on the material in the pot and of the air at the gun as necessary to maintain optimum spraying effectiveness. Adjust the pressure on the material in the pot, when necessary, for changes in elevation of the gun above the pot. Keep the atomizing air pressure at the gun high enough to properly atomize the paint, but not so high as to cause excessive fogging of paint, excessive evaporation of solvent, or loss by overspray.

560-9.4 Airless (or High-Pressure) Spraying: For this type of spray-painting, meet the following requirements (in addition to those specified above).

(1) Use fluid tips of proper orifice size and fan angle and a fluid control gun of proper construction, as the manufacturer of the material being sprayed and the equipment being used recommends.

(2) Adjust the regulated air pressure to the paint pump so that the paint pressure to the gun is proper for optimum spraying effectiveness. Ensure that this

pressure is sufficiently high to properly atomize the paint.

(3) Provide spraying equipment with proper filters in the high pressure line to keep dirt, dry paint, and other foreign materials out of the paint film. Pump paint through the system to completely remove any solvents left in the equipment before applying paint to the surface being painted.

(4) Provide airless paint spray equipment with an electric ground wire in the high pressure line between the gun and the pumping equipment. Ground the pumping equipment to avoid the build-up of any electrostatic charge on the gun.

560-10 Other Types of Application.

The Contractor may use roller application at the locations, and under the provisions, specified in 560-7.1(6). If used, perform roller application in accordance with the recommendations of the manufacturer of the paint and of the rollers. Use paint rollers of a design and quality which will enable proper application of paint, with the continuity and thickness required in 560-7.5 and 560-7.6.

Refer to the limitations for the use of dip and flow methods specified in 560-7.1(7).

560-11 Shop Painting.

560-11.1 General: Paint all fabricated steel with at least one coat of primer in the shop where such fabrication is done. Apply this paint during or after fabrication and before allowing any damage to the surface to occur from weather or other exposure. If unavoidable exposure occurs which detrimentally affects the condition of the steel, the Department and the fabricator will agree on the procedure to follow. If the shop coat is damaged in fabrication, ensure that it is repaired before leaving the shop. Unless otherwise provided in the plans, use Code Z-C primer for the shop coats as specified in 971-5.

560-11.2 Contact Surfaces and Painting Welds: Paint contact surfaces (or leave them unpainted) as required in 560-3. When painting contact surfaces, apply the first coat required thereunder in the shop. Apply subsequent coats in the field, but while the surfaces are still accessible. Do not apply the finish coat of paint to contact surfaces.

Do not paint surfaces within 2 inches [50 mm] of field welds until after completing welding. Complete all other welding in the shop before applying the shop coat.

Clean shop welds and areas within 2 inches [50 mm] of such welds in the shop before painting, using surface preparation methods at least as effective as those specified for the structure itself. All welds shall either be blast cleaned, power wire brushed, chemically scrubbed, or water scrubbed of all detrimental welding deposits.

560-11.3 Machine Finished Surfaces: Protect machine finished or similar surfaces that should not be painted with a coating of rust inhibitive petrolatum conforming to requirements of Type B, "Medium," of U.S. Maritime Administration Specification 52-MA-602a, "Compounds; Rust Inhibitive," or with other coatings (such as "blue lacquer") that may be more suitable for special conditions.

560-11.4 Markings and Tags: Copy erection marks and weight marks on areas that have been previously painted with the shop coat, or attach markers or tags.

560-12 Field Painting.

560-12.1 General: Apply the following specific provisions to field painting.

560-12.2 Types of Paint: Unless otherwise provided in the plans or herein, apply four coats of paint to all new structural steel and castings. For the first two coats (prime coats), use Code Z-C as specified in 971-5. Unless otherwise shown in the plans or herein, for the third coat (intermediate coat), use Code B-8 as specified in 971-6, and for the fourth coat (finish coat), use Code B-A as specified in 971-7.

560-12.3 Sequence of Painting: Field paint shop-coated steel members after completing erection of such members. The Contractor may field paint steel members on the ground before erection provided he touches up such painting where damaged, with the same number of coats and kinds of paint, after erection, and provided he applies the last complete coat of paint after erection.

560-12.4 Touch Up: Touch up steel that has been shop coated with the same type of paint as used for the shop coat. Include in this touch-up cleaning and painting of field connections, welds or rivets, and bolts, and all damaged or defective paint and rusted areas. Clean areas requiring touch up in the same manner as that required for the paint system specified. The Contractor may clean and apply an overall coat of primer for each shop coat, in place of touch up or spot painting. Apply a touch up of shop coat paint to structural steel, particularly field connections, as it is erected in its permanent position.

560-12.5 Surfaces Not Shop Coated: Clean and prime steel which has not been shop coated before application of intermediate and finish coats and before any damage to the surface from contaminates, weather, or other exposure occurs.

560-12.6 Contact Surfaces: While the surfaces are still accessible, apply all of the required coats except the finish coats to those contact surfaces which require painting under 560-3.

560-12.7 Surfaces Which Will Become Inaccessible: For surfaces, other than contact surfaces, that are accessible before erection but which will not be accessible after erection, apply all field coats of paint before erection.

560-12.8 Cracks and Crevices: Fill all cracks and crevices with paint as far as practicable. Seal off crevices with a caulking compound as the paint manufacturer recommends.

560-12.9 Final Coats and Cleaning: Do not apply the final coat of paint until finishing all concrete work. In addition to the cleaning specified in 560-5.1, remove all cement or concrete spatter and drippings before applying paint. If concreting or other operations damage any paint, clean and repaint the damaged surface.

560-12.10 Areas of Welds: Clean all welds in accordance with the requirements of 560-11.2.

560-13 Maintenance Painting.

560-13.1 General: In addition to the applicable provisions of 560-11 and 560-12, apply the following provisions to maintenance painting, except as may be otherwise specified in the plans.

560-13.2 Sequence of Painting: Paint (spot paint) all surfaces from which paint and rust have been removed by cleaning with a coat of Code Z-C, as specified in 971-5. After spot painting, apply to all surfaces one full coat of Code B-8, as specified in 971-6, and one finish coat of Code B-A, as specified in 971-7.

While cleaning, remove only loose, cracked, brittle or nonadherent paint, unless otherwise specified. Where the remaining paint is thick, feather all exposed edges. Conduct spot cleaning in a manner which will minimize damage to sound paint. Clean rust spots thoroughly, and scrape the edges of all old paint back to sound material.

Remove paint that curls or lifts after application of the spot or priming paint, and repaint the area.

560-14 Drying of Painted Steel.

Do not apply any coats of paint until the preceding coat has dried. Allow each coat of paint to dry a minimum of 48 hours before applying a succeeding coat of paint.

560-15 Method of Measurement.

The quantities to be paid for will be determined under one of the following conditions:

(a) When no pay item for painting structural steel is included in the proposal, the work specified in this Section will not be paid for directly but will be considered as subsidiary work pertaining to the various items of construction on which paint is applied.

(b) When a pay item for painting structural steel is included in the proposal, the work specified under this Section will be paid for at the Contract lump sum price, or the Contract price per ton [metric ton], for Painting Structural Steel. The quantity will be either (1) the lump sum quantity painted and accepted, or (2) the plan quantity, in tons [metric tons] of structural steel, actually painted and accepted.

560-16 Basis of Payment.

When no item for painting structural steel is included in the proposal, the work specified in this Section will be included in the payment for the applicable items under Section 460.

When an item for painting structural steel is included in the proposal, price and payment will be full compensation for all work specified in this Section, including painting of all ferrous metals and machinery and castings.

Payment will be made under:

Item No. 560- 1- Painting Structural Steel - lump sum.
Item No. 2560- 1- Painting Structural Steel - lump sum.
Item No. 560- 2- Painting Structural Steel - per ton.
Item No. 2560- 2- Painting Structural Steel - per metric ton.

SECTION 561

SELF-CURING INORGANIC ZINC COATING SYSTEMS

561-1 Description.

Perform the shop, field, and maintenance painting of structural steel surfaces in accordance with this Section, using proprietary inorganic zinc coating materials meeting the requirements of 971-16.

Also, meet the provisions of Section 560 not in conflict with this Section.

561-2 Classification.

The Department classifies self-curing inorganic zinc coating systems into two systems of application and locality of use as follows:

1. Self-Curing Inorganic Zinc Coating System (TWO COATS): For inland non-chemical exposure use.

2. Self-Curing Inorganic Zinc Coating System (THREE COATS): For coastal use, including brackish salt water areas, and other locations where the plans indicate the presence of a corrosive environment.

For the TWO COAT SYSTEM, apply a coat of self-curing inorganic zinc primer and a finish coat. For the THREE COAT SYSTEM, apply a coat of self-curing inorganic zinc primer, an intermediate tie coat, and a finish coat. Use the particular coating system (TWO or THREE COATS), as designated in 1 and 2 above.

Apply the intermediate coat and the finish coat in the "field". Do not apply intermediate coats and finish coats to contact surfaces of members to be joined by high strength bolts.

561-3 Application.

561-3.1 Shop Applied Self-Curing Inorganic Zinc Primer: Clean steel surfaces by either blast cleaning with silica sand or by centrifugal wheel blast cleaning with cast steel shot, cast steel grit, or appropriate mixtures of the shot and grit. Use cast steel abrasives meeting the general requirements of SAE Specification J827. The Engineer will allow the use of steel grit of higher hardness than specified in J827 (Rockwell "C" 40 to 50). Size the cast steel abrasives in accordance with SAE Specification J444.

Clean steel surfaces to a "Near White" condition as defined in SSPC-SP 10. Determine the "Near White" condition according to NACE Visual Standard No. 2, TM-01-70 for sand blast cleaned; or NACE Visual Standard No. 2, TM-01-75 for steel grit cleaning or NACE Visual Standard No. 2, TM-01-75 for steel shot blast cleaning for centrifugal wheel blast cleaned. After blast cleaning, ensure that the anchor pattern is from 1 to 3 mils [25 to 75 μm] deep in a dense and uniform pattern of depressions and ridges. Determine the anchor pattern depth by using a Testex Press-O-Film Tape and micrometer kit or equal approved by the Department.

The Engineer may approve other methods for surface preparation provided the Contractor can demonstrate that satisfactory surface cleaning and anchor patterns can be achieved.

Clean galvanized or electroplated zinc metal parts, used on the structure and required to be painted, with appropriate solvents to remove any oil, grease, or dirt prior to painting.

Mask-off surfaces within 1 inch [25 mm] of welded field connections at the time of shop painting.

For two component products, add the powder component to the liquid component with thorough stirring, and continue stirring until the powder is well dispersed. Strain the mixture through a 30-60 mesh [250 by 600 μm] sieve to remove large particles. Equip pressure pots containing the mixed powder and liquid with a mechanical agitator which will remain in motion throughout the application period. Keep the pressure pots at approximately the same elevation as the spray gun.

Apply the self curing inorganic zinc coating to the "Near White" blast cleaned surfaces as recommended by the manufacturer in a single application using multiple spray "passes" to achieve a dry film thickness of 3.5 to 5.5 mils [90 to 140 μm]. Determine the dry film thickness using an Inspector Magnetic Dry Film Thickness Gauge or equal approved by the Department. Prior to use, calibrate the Magnetic Dry Film Thickness Gauge according to NIST No. SRM 1362 certified coating thickness calibration standards. Ensure that the applied coating presents a dense and uniform appearance after curing.

The Department considers the applied inorganic zinc primer deficient in thickness for measured dry thickness values less than 3.5 mils [90 μm] dry. Where deficient primer coat thickness measurements are found, apply additional zinc primer to the immediate surface area (1 ft^2 [0.1 m^2] minimum) surrounding the particular measurement in accordance with the recommendations of the coating manufacturer so that the dry film thickness of the repaired area will range between 3.5 and 5.5 mils [90 and 140 μm]. If more than four deficient thickness values (one measurement per 25 ft^2 [2.25 m^2] of surface area) are found in any 200 ft^2 [20 m^2] of continuous metal section, blast clean the entire section to a "Near White" condition. Repaint the section with inorganic zinc primer to achieve a dry film coating thickness of 3.5 to 5.5 [90 to 140 μm].

Repair primed areas having excessive dry film coating thickness, coating "dry spray", visible coating "mudcracking", visible surface hackles, handling abrasions, and missed paint in bolt holes. Repair in accordance with the written recommendations of the paint manufacturer. Obtain the Engineer's approval for all repair recommendations. The repair recommendations should include current product data and application instructions sheets.

Seal all areas inaccessible for blast cleaning 2 inch [13 mm] wide or less, such as welded faying surfaces that do not have continuous welds, with a caulking compound approved for use by the Engineer.

After erection, spot repair damaged surfaces in accordance with the written recommendations of the paint manufacturer prior to applying any intermediate coats or finish coats.

Have the Engineer inspect and obtain his approval for each section of steel before painting it. Furnish and erect scaffolding to the satisfaction of the Engineer in order to facilitate a safe inspection of all cleaned areas and for checking paint thickness of individual coats.

The Contractor is responsible for faulty work that may show up or for maintenance work that may be necessary during the life of the Contract.

561-3.2 Field Applied Self-Curing Inorganic Zinc Coatings: Meet the appropriate requirements of 561-3.1, except as specified below.

During all cleaning and painting operations, isolate the work area with appropriate containment devices (canvasses, tarpaulins, screens, etc.) in order to prevent any generated debris from causing violations of current State air and water pollution regulations. Legally dispose of all debris collected by the containment devices. Clean steel surfaces by blast cleaning only. Obtain the Engineer's approval for the use of abrasives other than silica.

561-3.3 Intermediate Coat: Apply the intermediate coat as recommended by the manufacturer in a single application using multiple spray "passes" to achieve a dry film thickness of 1 to 2 mils [25 to 50 μm]. Determine the dry film thickness using a Tooke Gauge or equal approved by the Department. Ensure that the color of the intermediate coat contrasts with both the color of the self-curing inorganic zinc primer and the color of the finish coat.

561-3.4 Finish Coat: The Engineer will select the finish coat color using either the paint manufacturers' color chart or the Federal Standard No. 595B color designations. Apply the finish coat as recommended by the manufacturer in a single application using multiple spray "passes" to achieve a minimum dry film thickness of 3 mils [75 μm]. Determine the dry film thickness using a Tooke Gauge or equal approved by the Department. Apply additional thickness of coating, if required by the Engineer, to ensure that the finish coat is uniform in color and even in appearance. Ensure that the color of the finish coat contrasts with both the color of the self-curing inorganic zinc primer and the color of the intermediate coat.

561-3.5 Painting Conditions: Meet the requirements of 560-7.3.

561-3.6 Additional Requirements for Maintenance Contracts: If any structural steel member is found to be defective and in need of replacement or repairs during the cleaning operation, the Engineer will arrange to have repairs started within 24 hours. Cooperate with personnel making these repairs. After completing repairs, clean and paint the repaired sections at no additional expense to the Department.

Clean electric motors and any other items to which sand blasting and spray painting may be detrimental by wire wheel brushes or any other method satisfactory to the Department, and brush paint them.

Cover all motors, gears and electrical apparatus that may be damaged by sand from the sandblaster. Keep bridges free from sand buildups at all times.

Keep all moving parts of movable spans well greased in accordance with Department lubrication requirements and free of sand at all times.

561-4 Method of Measurement.

The quantities to be paid for will be as specified in 560-15.

561-5 Basis of Payment.

Prices and payments will be as specified in 560-16.

Payment shall be made under:

Item No. 561- 1- Painting Structural Steel (Inorganic Zinc) - lump sum.
Item No. 2561- 1- Painting Structural Steel (Inorganic Zinc) - lump sum.
Item No. 561- 2- Painting Structural Steel - per ton.
Item No. 2561- 2- Painting Structural Steel - per metric ton.

SECTION 562

ZINC PAINT COATING

562-1 Description.

Apply a zinc paint coating over welded areas of galvanized structural members and over areas of previously galvanized members on which the galvanizing has, in the opinion of the Engineer, become significantly damaged.

562-2 Materials.

For the paint coating, use a galvanizing compound as specified in 971-15.

562-3 Construction Methods.

Before applying the compound, ensure that the welded area or damaged spelter area is clean and free of grease. Thoroughly brush the area with a stiff wire brush to remove all dirt, loose galvanizing, welding slag, or other foreign material. If necessary, clean the area with an approved grease-removing solvent. After cleaning the area, apply two coats of the galvanizing compound to achieve a dry film thickness as annotated on the Qualified Products List. On rough or pitted surfaces, the Engineer may require more than the specified two coats, if necessary in his opinion, in order to obtain acceptable cover. Allow at least 12 hours drying time between coats. Brushing back over partly dried applications will not be permitted.

562-4 Basis of Payment.

No direct payment will be made for zinc paint coating of welded surfaces or for field repair of damaged spelter coating. Where the Contractor is required to perform these operations, the cost shall be included in the Contract price for the item which includes the member being so treated.

SECTION 563

ANTI-GRAFFITI COATING

563-1 Description.

Furnish and apply anti-graffiti coating to the surfaces indicated in the plans. Prepare the surface prior to application of the coating. Apply clear coatings, unless otherwise specified in the plans, or approved by the Engineer.

Use only products listed on the Qualified Products List.

563-2 Application.

563-2.1 Cleaning: Thoroughly clean all surfaces and allow them to dry, according to manufacturer's recommendations, before applying any coatings. Adopt cleaning procedures that will not damage the existing surface texture or coloring.

563-2.2 Surface Preparation: Prepare all surfaces, including primer application, according to manufacturer's recommendations.

563-2.3 Application Rates: Apply all cleaning, priming, and coating products according to manufacturer's recommendations, so that the finished product meets the requirements of 563-4.

563-3 Environmental Restrictions.

Use only products meeting Federal, State, and Local environmental restrictions. Do not use products containing Lead, Cadmium, or Chromium.

563-3.1 Volatile Organic Compounds (VOC): Do not use products with a VOC greater than 150 g/L.

563-3.2 Local Conditions: Ensure that the humidity and temperature are within acceptable ranges specified by the manufacturer.

563-3.3 Wind Velocity: Protect vehicles or other property from damage resulting from dispersion of the material. Suspend operations until conditions improve enough to permit work to continue without damage.

563-4 Construction.

Apply the product so that the completed product meets the following requirements:

Total product life	Five years
Removal delay period	Two months

Follow the application and cure time, specified by the manufacturer, to ensure that the coated surface is capable of withstanding graffiti application (spray paint), removal delay period, and cleaning without damage. Observe the proper cleaning procedures, as well as cleaning products, specified by the manufacturer. Use cleaning products that meet the requirements of 563-3. Ensure that the cleaned surface displays no sign of graffiti "shadows" or "ghosts".

Submit a copy of the Manufacturer=s cleaning procedures and recommended cleaning products to the Engineer, before applying any anti-graffiti coating.

563-5 Certification.

Furnish the Engineer with three copies of a test report certifying that the material meets all requirements specified above. The Engineer will consider any marked variation from original test values for a material or evidence of inadequate field performance of a material to be sufficient evidence that the properties of the material have changed and the material will be removed from the Qualified Products List.

563-6 Method of Measurement.

The quantity to be paid for will be the area, in square feet [square meters], completed and accepted.

563-7 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section, including furnishing and applying materials to complete the coating.

Payment shall be made under:

Item No. 563- 2- Anti-Graffiti Coating - per square foot.
Item No. 2563- 2- Anti-Graffiti Coating - per square meter.

SECTION 570

GRASSING (BY SEEDING)

570-1 Description.

Establish a stand of grass on slopes, shoulders and specified other areas, by seeding or by seeding and mulching. Perform seeding and mulching, fertilizing, and wildflower seed application as required, and maintain the grassed areas until the completion of the project.

The Engineer may eliminate at his discretion, any of the items of work covered by this Section.

570-2 Materials.

Meet the following requirements:

Grass Seed	981-1
Wildflower Seed	981-1
Mulch	981-3
Fertilizer, Type I	Section 982
Water	Section 983
Compost	Section 987

Prior to planting, furnish the Engineer a certification from the grower stating the age of all seed.

570-3 Construction Methods.

570-3.1 General: Do not seed or mulch when wind velocities exceed 15 mph [25 km/h]. Sow seed only when the soil is moist. Do not perform any seeding when the ground is frozen, unduly wet or otherwise not in a tillable condition.

Whenever a suitable length of roadway slopes or adjacent areas has been graded, prepare the area and perform grassing in accordance with the Contract Documents. Incorporate grassing into the project at the earliest practical time.

Complete all grassing on shoulder areas prior to the placement of the friction course on adjacent pavement, unless the friction course is to be placed directly on a non-asphalt base.

570-3.2 Sequence of Operations: Perform the operations in the following sequence: Apply finish soil layer materials in accordance with Section 162, prepare the area to be seeded, seed, spread and cut-in mulch and fertilize.

In preparing the ground for sowing of seeds, disk-harrow and thoroughly pulverize the soil to an average depth of 6 inches [150 mm]. Make the soil true to grade, not compacted and free of large clods, roots, and other material which will interfere with the work or subsequent mowing and maintenance operations. Do not begin subsequent operations until the Engineer has approved the condition of the prepared areas.

570-3.3 Seeding: While the soil is still loose, scatter the seed uniformly over the grassing area and immediately mix it into the seed bed to a depth of 3 inch [6 mm] using the specified seed.

Thoroughly dry-mix the separate types of seed immediately before sowing. Do not use wet seed.

The Engineer will allow the wildflower seed to be included in the grassing operation or performed separately from the grass seeding operation in areas shown in the plans.

Ensure that the wildflower seed is uniformly planted by drilling or placing the seed into the soil at an average depth of χ inch [3 mm], but not exceeding 3 inch [6 mm] into the designated area at the specified rate.

570-3.4 Mulching: When areas require mulch, as shown on the plans, apply approximately 2 inches [50 mm], loose thickness, of the mulch material uniformly over the seeded area, and cut the mulch material into the soil to produce a loose mulched thickness of 3 to 4 inches [75 to 100 mm]. Do not use harrows. The Contractor may use compost meeting the requirements of Section 987 in lieu of mulch.

When mulching on steep slopes, where the use of a machine for the cutting-in process is not practicable, secure the mulch after the seeding operation by either using an erosion control fabric, or; spread a string net over the mulch using stakes driven flush with the top of the mulch at 6 foot [1.8 m] centers and string parallel and perpendicular with diagonals in both directions.

570-3.5 Rolling: Immediately after seeding, roll the entire grassed or mulched area with a cultipacker, traffic roller or a horticultural roller. Make at least two passes over the entire area.

570-3.6 Watering: Provide a vehicle for applying water to the grassed areas equipped with either a calibrated tank or an approved metering device installed at such point on the vehicle to measure the water at time of application. Do not water newly seeded areas to force the seed germination. Do not apply more than 2 inches of water per acre [25 mm of water per hectare] per week for sustaining the grass growth. Use water only on vegetated areas when permitted by the Engineer.

570-3.7 Fertilizing: Spread the fertilizer over the grassed area four to five weeks after the grass seed germinates in one or more applications as specified below:

Spread an initial application of 265 lbs/acre [300 kg/ha] of 16-4-8.

If the project has not reached final acceptance in accordance with Article 5-11, spread subsequent applications of 135 lbs/acre [150 kg/ha] of 16-4-8 approximately 60 calendar days after the initial application without mixing into the soil.

The Contractor may spread the fertilizer by hand on steep slopes or other areas where machine-spreading may not be practicable.

570-4 Maintenance.

Maintain the planted areas as an acceptable stand of grass until final acceptance of the project at no expense to the Department. Include in such maintenance the filling, leveling, and repairing of any washed or eroded areas, as may be necessary.

An acceptable stand of grass is defined as a 1 by 1 foot [300 by 300 mm] area containing a minimum of 16 live, viable, healthy wildflower and/or grass seedlings.

The Department will pay for replanting as necessary due to factors determined to be beyond control of the Contractor.

Mow the planted grass areas to a height of 6 inches [150 mm] when competing vegetation height exceeds 20 inches [500 mm] in height. Do not mow wildflower areas until at least three weeks after the peak of the bloom period and do not mow lower than 6 inches [150 mm]. Do not use selective herbicides in wildflower areas.

570-5 Method of Measurement.

570-5.1 General: The quantities to be paid for will be for the following items, completed and accepted:

(1) The area, in square feet [square meters], of seeding.
(2) The area, in square feet [square meters], of seeding and mulching.
(3) The weight, in pounds [kilograms], of grass seed.
(4) The weight, in tons [metric tons], of mulch material.
(5) The weight, in tons [metric tons], of fertilizer.
(6) The volume, in thousand gallons [kiloliters], of water.
(7) The weight, in pounds [kilograms], of wildflower seed.
(8) The area, in acres [hectares], of mowing.

570-5.2 Area Quantities: For the quantities paid for on a square foot [square meter] basis, no deductions will be made for the areas occupied by turnouts in rural sections.

570-5.3 Seed: The quantity of grass or wildflower seed will be determined from packaged weights or by other appropriate methods.

570-5.4 Mulch Material: The quantity will be determined by weighing on truck scales, or by other appropriate methods. The Contractor shall advise the Engineer of the time and place of such weighing. Weighing will be done in the general vicinity of the project.

570-6 Basis of Payment.

570-6.1 General: Prices and payments will be full compensation for all work and materials specified in this Section.

570-6.2 Seeding: When mulching is not specified, price and payment will be full compensation for all work and materials not specifically included in the items of separate payment shown below. The item of Seeding will include specifically all preparations of the ground, the application of the seed, the rolling, tilling or other specified work.

570-6.3 Seeding and Mulching: When mulching is specified, price and payment will be full compensation for everything specified in 570-6.2 and, in addition, will include the cost of applying, cutting-in, rolling, and anchoring, where required, of the mulch material, but will not include the furnishing of the mulch material.

570-6.4 Seed: Price and payment for Grass Seed (Permanent Type) and, Grass Seed (Quick-Growing Type) will be full compensation for the furnishing of the seed, at the site of its use. Price and payment for Wildflower Seed will include furnishing, applying, and mixing the seed into the seed bed.

570-6.5 Mulch Material:

570-6.5.1 General: Price and payment will be full compensation for the furnishing and spreading of the mulch material, at the site of its use.

570-6.6 Water: The quantity of water, ordered at the specific time of its being applied and which is actually used, determined by the specific metering device or by calibrated tank, will be paid for at the Contract price per thousand gallons [kiloliters] of Water for Grassing. Such quantity will include all water authorized by the Engineer, which is used until the time of acceptance of the work.

570-6.7 Payment Items: Payment will be made under:

Item No. 104- 4- Mowing - per acre.
Item No. 2104- 4- Mowing - per hectare.
Item No. 570- 1- Seeding - per square foot.
Item No. 2570- 1- Seeding - per square meter.
Item No. 570- 2- Seeding and Mulching - per square foot.
Item No. 2570- 2- Seeding and Mulching - per square meter.
Item No. 570- 3- Grass Seed (Permanent Type) - per pound.
Item No. 2570- 3- Grass Seed (Permanent Type) - per kilogram.
Item No. 570- 4- Mulch Material - per ton.
Item No. 2570- 4- Mulch Material - per metric ton.
Item No. 570- 5- Fertilizer - per ton.
Item No. 2570- 5- Fertilizer - per metric ton.
Item No. 570- 9- Water for Grassing - per thousand gallons.
Item No. 2570- 9- Water for Grassing - per kiloliters.
Item No. 570- 10- Grass Seed (Quick-Growing Type) - per pound.
Item No. 2570- 10- Grass Seed (Quick-Growing Type) - per kilogram.
Item No. 570- 12- Wildflower Seed - per pound.
Item No. 2570- 12- Wildflower Seed - per kilogram.

SECTION 575

SODDING

575-1 Description.

Establish a stand of grass within the specified areas, by furnishing and placing sod, and rolling, fertilizing, watering, and maintaining the sodded areas to ensure a healthy stand of grass.

575-2 Materials.

Meet the following requirements:

Sod.. 981-2
Fertilizer, Type I..Section 982
Water ....Section 983

575-3 Construction Methods.

575-3.1 Preparation of Ground: Fertilize at the rate as shown in Section 570. Scarify or loosen the areas requiring sod to a depth of 6 inches [150 mm]. On areas where the soil is sufficiently loose, particularly on shoulders and fill slopes, the Engineer may authorize the elimination of the ground preparation. Limit preparation to those areas that can be sodded within 72 hours after preparation. Prior to sodding, thoroughly water areas and allow water to percolate into the soil. Allow surface moisture to dry before sodding to prevent a muddy soil condition.

575-3.2 Placing Sod: Place sod immediately after ground preparation. Do not use sod which has been cut for more than 72 hours. Stack all sod that is not planted within 24 hours after cutting and maintain proper moist condition.

Do not sod when weather and soil conditions are unsuitable for proper results. Pre-wet the area prior to placing sod. Do not place sod on eroded or washed out sites.

Place the sod on the prepared surface, with edges in close contact, and embed it firmly and smoothly by light tamping with appropriate tools.

Place the sod to the edge of all the paving and shrub areas and 1 inch [25 mm] below adjoining pavement with an even surface and edge. Place rolled sod parallel with the roadway and cut any exposed netting even with the sod edge.

Roll using a lightweight turf roller. Provide a true and even surface without any displacement of the sod or deformation.

Where sodding in drainage ditches, stagger the setting of the sod pieces to avoid a continuous seam along the line of flow. Ensure that the offsets of individual strips do not exceed 6 inches [150 mm]. Tamp the outer pieces of sod to produce a featheredge effect.

Peg sod at locations where the sod may slide. Drive pegs through sod blocks into firm earth, at intervals approved by the Engineer.

Remove any sod as directed by the Engineer.

575-3.3 Watering: Thoroughly water the sod immediately after placing. Do not water in excess of 2 inch per acre [25 mm per hectare] per week for establishment. Use watering equipment that will prevent damage to the finished sod surface. Keep the sod in a moist condition for the duration of the Contract period.

575-3.4 Maintenance: Maintain the sodded areas in a satisfactory condition until final acceptance of the project. Include in such maintenance the filling, leveling, and repairing of any washed or eroded areas, as may be necessary. The Department will pay for resodding necessary due to factors determined to be beyond the control of the Contractor.

Mow the sodded areas to a height of 6 inches [150 mm] when competing vegetation height exceeds 20 inches [500 mm] in height.

575-4 Method of Measurement.

The quantities to be paid for will be for the following items, completed and accepted:

(1) The area, in square yards [square meters], of sodding.
(2) The weight, in tons [metric tons], of fertilizer.
(3) The volume, in thousand gallons [kiloliters], of water.
(4) The area, in acres [hectares], of mowing.

575-5 Basis of Payment.

Prices and payments will be full compensation for all work and materials specified in this Section, and the satisfactory disposal of excavated material, except the furnishing of the fertilizer, and the furnishing and application of the water.

Fertilizer and water will be paid for as specified in 570-6.

The work and materials for pegging of sod, directed by the Engineer (as provided in 575-3.2), will be paid for as Unforeseeable Work.

Payment will be made under:

Item No. 104- 4-	Mowing - per acre.
Item No. 2104- 4-	Mowing - per hectare.
Item No. 570- 5-	Fertilizer - per ton.
Item No. 2570- 5-	Fertilizer - per metric ton.
Item No. 570- 9-	Water for Grassing - per thousand gallons.
Item No. 2570- 9-	Water for Grassing - per kiloliter.
Item No. 575- 1-	Sodding - per square yard.
Item No. 2575- 1-	Sodding - per square meter.

SECTION 577

REWORKING SHOULDERS

577-1 Description.

Prepare, build-up, and establish a stand of grass on existing shoulders where shown on the plans. Perform shoulder preparation, seeding, fertilizing, mulching, and watering as specified in this Section.

577-2 Materials.

Meet the following requirements:

Emulsified Asphalt (Grade SS-1)	916-4
Seed	981-1
Mulch	981-3
Fertilizer	982-1
Water	Section 983

577-3 Equipment.

577-3.1 Equipment for Mixing Shoulders: Provide equipment, that may include pulver mixer and rotovators with shovel-like cultivators, of a type that will mix the additional shoulder material with the existing turf to the required depth and which will leave the shoulder in a non-compacted condition.

577-3.2 Water-metering Devices: Provide devices as specified in 570-3.6.

577-4 Construction Methods.

577-4.1 Sequence of Construction: Proceed with the several operations involved in the work in the following sequence: blade shoulders if necessary, add and spread borrow material, and mix borrow material with the underlying turf. Apply hay mulch and/or emulsified asphalt if required by the Contract Documents, and water as specified.

Complete this work prior to the placement of the friction course on adjacent pavement.

577-4.2 Preparation of Shoulder to be Reworked: Blade the existing shoulder as necessary to achieve a reasonable uniform plane. Blade turf which has grown over the edge of existing pavement from the pavement for a width of not more than 18 inches [450 mm] from the pavement's edge. Disc the existing shoulders prior to placing additional material.

577-4.3 Additional Material: Add and spread borrow material to conform to the desired shoulder configuration. Do not place this added material on the shoulders earlier than seven calendar days before beginning mixing operations in that area.

577-4.4 Mixing: Mix the additional shoulder material with the existing turf with a pulver mixer or rotovator mixer to a depth such that the upper 4 inches [100 mm] of the existing turf becomes uniformly mixed with the added material. Add seed and fertilizer after the mixing operation, and incorporate them into the seed bed in an acceptable manner to an average depth of 2 inch [13 mm], prior to applying the mulch.

In those areas where the added borrow material exceeds 4 inches [100 mm] in depth, the Engineer will not require mixing of borrow material and turf. At these locations, mix the seed into a seed bed to an average depth of 2 inch [13 mm].

Immediately after the above operations, reshape the shoulder area to the required configuration, and lightly roll it.

577-4.5 Fertilizing and Seeding: The Contractor may add fertilizer and seed to the specified areas in the same operation. Place the fertilizer at the rate of 400 lbs/Ac [450 kg/ha] of 16-4-8, or its equivalent, to provide equal pounds [kilograms] of plant food per acre [hectare]. Provide 50% of the fertilizer's nitrogen from a slow release source.

The Engineer will not allow fertilizing and seeding operations when conditions prevent a uniform distribution of materials. Sow seed only when the soil is moist and in proper condition to induce growth. Do not seed when the ground is frozen, unduly wet, or otherwise in an untillable condition.

577-4.6 Mulch: When mulch is specified in the Contract Documents, apply it in accordance with 570-4.6, prior to the application of the emulsified asphalt.

577-4.7 Emulsified Asphalt Mulch: When asphalt mulch is specified in the Contract Documents, use emulsified asphalt diluted with water in a 1:1 ratio. Apply the asphalt mulch in accordance with 300-7.3 within 24 hours after completing the seeding and fertilizing operations. Apply the diluted emulsified asphalt at a rate of not less than 0.30 gal/yd^2 [1.4 L/m^2]. Depending upon the shoulder material, the Contractor may increase or decrease the diluted application rate as directed by the Engineer.

577-4.8 Watering: If, at the time of reworking the shoulder, the Engineer determines the soil is dry, apply water for a period of three weeks from the date of planting unless rainfall occurs providing adequate moisture. Add the water at a minimum rate of 2 inch [13 mm] per watering, twice a week. Perform watering in such a manner as to prevent washing of the newly built shoulders.

577-5 Method of Measurement.

577-5.1 General: The quantities to be paid for will be for the following items, completed and accepted.

(1) The area, in square yards [square meters], of reworking shoulders.
(2) The weight, in pounds [kilograms], of grass seed.
(3) The weight, in tons [metric tons], of fertilizer.
(4) The volume, in gallons [liters], of diluted emulsified asphalt.
(5) The weight, in tons [metric tons], of mulch material.
(6) The volume, in thousand gallons [kiloliters], of water.

577-5.2 Reworking Shoulders: The quantity will be determined as specified in 570-5.2.

577-5.3 Grass Seed: The quantity will be determined as specified in 570-5.3.

577-5.4 Fertilizer: The quantity will be determined as specified in 570-5.1, except the quantity to be paid for will be the equivalent weight of 16-4-8 fertilizer.

577-5.5 Emulsified Asphalt: The quantity will be determined as specified in 300-8, except the quantity to be paid for will be the volume after dilution.

577-5.6 Mulch Material: The quantity will be determined as specified in 570-5.4.

577-5.7 Water: The quantity of water will be as specified in 570-5.1.

577-5.8 Borrow Material: Borrow Material is not included for payment in this Section. Borrow material will be paid for by the cubic yard [cubic meter] truck measure as specified in 120-12.1.3.

577-6 Basis of Payment.

Prices and payments will be full compensation for all of work and materials specified in this Section, including all work and incidentals to complete the work.

Payment will be made under:

Item No. 300- 1- Bituminous Material - per gallon.
Item No. 2300- 1- Bituminous Material - per liter.
Item No. 570- 3- Grass Seed (Permanent Type) - per pound.

Item No. 2570- 3- Grass Seed (Permanent Type) - per kilogram.
Item No. 570- 4- Mulch Material - per ton.
Item No. 2570- 4- Mulch Material - per metric ton.
Item No. 570- 5- Fertilizer - per ton.
Item No. 2570- 5- Fertilizer - per metric ton.
Item No. 570- 9- Water for Grassing - per thousand gallons.
Item No. 2570- 9- Water for Grassing - per kiloliter.
Item No. 570- 10- Grass Seed (Quick-Growing Type) - per pound.
Item No. 2570- 10- Grass Seed (Quick-Growing Type) - per kilogram.
Item No. 577- 70- Reworking Shoulders - per square yard.
Item No. 2577- 70- Reworking Shoulders - per square meter.

SECTION 580

LANDSCAPE INSTALLATION

580-1 Description.

Plant trees and shrubs of the species, size, and quality indicated in the plans.

The Engineer reserves the right to adjust the number and location of any of the designated types and species to be used at any of the locations shown, in order to provide for any unanticipated effects which might become apparent after the substantial completion of other phases of the project, or for other causes.

580-2 Materials.

580-2.1 Plants:

580-2.1.1 Authority for Nomenclature; Species, etc.: For the designated authority in the identification of all plant material, refer to two publications of L.H. Bailey: "Hortus III" and "Manual of Cultivated Plants," and ensure that all specimens are true to type, name, etc., as described therein. For the standard nomenclature, refer to the publication of the American Joint Committee on Horticultural Nomenclature, "Standardized Plant Names."

580-2.1.2 Grade Standards and Conformity with Type and Species: Only use nursery grown plant material except where specified as Collected Material. Use nursery grown plant material that complies with all required inspection, grading standards, and plant regulations in accordance with the latest edition of the Florida Department of Agriculture's "Grades and Standards for Nursery Plants".

Except where a lesser grade might be specifically specified in the plans, ensure that the minimum grade for all trees and shrubs is Florida No. 1. Ensure that all plants are the proper size and grade at the time of delivery to the site, throughout the project construction period and during the plant establishment period.

Ensure that plant materials are true to type and species and that any plant materials not specifically covered in Florida Department of Agriculture's "Grades and Standards for Nursery Plants" conform in type and species with the standards and designations in general acceptance by Florida nurseries.

Ensure that plant materials are shipped with tags stating the botanical and common name of the plant.

580-2.1.3 Inspection and Transporting: Move nursery stock in accordance with all Federal and State regulations therefor, and accompany each shipment with the required inspection certificates for filing with the Engineer.

580-2.2 Water: Meet the requirements of Section 983.

580-3 Specific Requirements for the Various Plant Designations.

580-3.1 Balled-and-Burlapped Plants (B&B), and Wired Balled-and-Burlapped (WB & B):

580-3.1.1 General: Properly protect the root ball of these plants until planting them. The Engineer may reject any plant which shows evidence of having been mishandled.

Set the B&B and WB&B plants then remove the top β of all wire, rope, and binding surrounding the plant. Remove the burlap from the top 4 inches [100 mm] of the root ball. Do not disturb the root ball in any way. Bare root material is not allowed for substitution.

At least 90 days before digging out B & B and WB & B plants, root-prune those 12 inches [38 mm] or greater in diameter and certify such fact on accompanying invoices.

580-3.1.2 Provisions for Wiring: For plants grown in soil of a loose texture, which does not readily adhere to the root system (and especially in the case of large plants or trees), the Engineer may require WB & B plants. For WB & B plants, before removing the plant from the excavated hole, place sound hog wire around the burlapped ball, and loop and tension it until the tightened wire netting substantially packages the burlapped ball such as to prevent disturbing of the loose soil around the roots during handling.

580-3.2 Container-Grown Plants (CG): The Engineer will not accept any CG plants with roots which have become pot-bound or for which the top system is too large for the size of the container. Fully cut and open all containers in a manner that will not damage the root system. Do not remove CG plants from the container until immediately before planting to prevent damage to the root system.

580-3.3 Collected Plants (Trees and Shrubs) (C): Use C plants which have a root ball according to AFlorida Grades and Standards for Nursery Plants≅. Do not plant any C plant before the Engineer's inspection and acceptance at the planting site.

580-3.4 Collected Plants (Herbaceous) (HC): The root mass and vegetative portions of collected herbaceous plants shall be as large as the specified container-grown equivalent. Do not plant any collected plant before inspection and acceptance by the Engineer.

580-3.5 Specimen Plants (Special Grade): When Specimen (or Special Grade) plants are required, label them as such on the plant list, and tag the plant to be furnished.

580-3.6 Palms: Wrap the roots of all plants of the palm species before transporting, except if they are CG plants and ensure that they have an adequate root ball structure and mass for healthy transplantation as defined in AFlorida Grades and Standards for Nursery Plants≅.

The Engineer will not require burlapping if the palm is carefully dug from marl or heavy soil that adheres to the roots and retains its shape without crumbling. During transporting and after arrival, carefully protect root balls of palms from wind and exposure to the sun. Muck grown palms are not allowed. After delivery to the job site, if not planting the palm within 24 hours, cover the root ball with a moist material. Plant all palms within 48 hours of delivery to the site.

Move sabal and coconut palms in accordance with the "Florida Grades and Standards for Nursery Plants."

580-3.7 Substitution of Container-Grown (CG) Plants: With the Engineer's approval, the Contractor may substitute CG plants for any other root classification types, if he has met all other requirements of the Contract Documents.

580-4 Planting Requirements.

580-4.1 Layout: Prior to any excavation or planting, mark all planting beds and individual locations of palms, trees, large shrubs and proposed art and architectural structures, as shown in the plans, on the ground with a common bright orange colored spray paint, or with other approved methods, within the project limits. Obtain the Engineer=s approval and make necessary utility clearance requests.

580-4.2 Excavation of Plant Holes: Excavate plant holes after an area around the plant three times the size of the root ball has been tilled to a depth of the root ball. Ensure that the plant hole is made in the center of the tilled area only to the depth of the plant root ball.

Where excess material has been excavated from the plant hole, use the excavated material to backfill to proper level.

580-4.3 Setting of Plants: Center plants in the hole. Lower the plant into the hole so that it rests on a prepared hole bottom such that the roots are level with, or slightly above, the level of their previous growth and so oriented such as to present the best appearance.

Backfill with native soil, unless otherwise specified on the plans. Firmly rod and water-in the backfill so that no air pockets remain. Apply a sufficient quantity of water immediately upon planting to thoroughly moisten all of the backfilled earth. Keep plants in a moistened condition for the duration of the planting period.

When so directed, form a water ring 6 inches [150 mm] in width to make a water collecting basin with an inside diameter equal to the diameter of the excavated hole. Maintain the water ring in an acceptable condition.

580-4.4 Special Bed Preparation: Where multiple or mass plantings are to be made in extended bedding areas, and the plans specify Special Bed Preparation, prepare the planting beds as follows:

Remove all vegetation from within the area of the planting bed and excavate the surface soil to a depth of 6 inches [150 mm]. Backfill the excavated area with peat, sand, finish soil layer material or other material to the elevation of the original surface. Till the entire area to provide a loose, friable mixture to a depth of at least 8 inches [200 mm]. Level the bed only slightly above the adjacent ground level. Then mulch the entire bedding area, in accordance with 580-8.

580-5 Staking and Guying.

580-5.1 General: When specified in the plans, or as directed by the Engineer, stake plants in accordance with the following.

Use wide plastic, rubber or other flexible strapping materials to support the tree to stakes or ground anchors that will give as the tree moves in any direction up to 30 degrees. Do not use rope or wire through a hose. Use guy chords, hose or any other thin bracing or anchorage material which has a minimum 12 inches [300 mm] length of high visibility flagging tape secured to guys, midway between the tree and stakes for safety.

Stake trees larger than 1 inch [25 mm] diameter and smaller than 2 inches [50 mm] diameter with a 2 by 2 inch [50 by 50 mm] stake, set at least 2 feet [0.6 m] in the ground and extending to the crown of the plant. Firmly fasten the plant to the stake with flexible strapping materials as noted above.

580-5.2 Trees of 2 to 32 inches [50 to 90 mm] Caliper: Stake all trees, other than palm trees, larger than 2 inches [50 mm] caliper and smaller than 32 inches [90 mm] caliper with two 2 by 4 inch [50 by 100 mm] stakes, 8 feet [2.4 m] long, set 2 feet [0.6 m] in the ground. Place the tree midway between the stakes and hold it firmly in place by flexible strapping materials as noted above.

580-5.3 Large Trees: Guy all trees, other than palm trees, larger than 32 inches [90 mm] caliper, from at least three points, with flexible strapping materials as noted above.

Anchor flexible strapping to 2 by 4 by 24 inch [50 by 100 by 600 mm] stakes, driven into the ground such that the top of the stake is at least 3 inches [75 mm] below the finished ground.

580-5.4 Special Requirements for Palm Trees: Brace palms which are to be staked with three 2 by 4 inch [50 by 100 mm] wood braces, toe-nailed to cleats which are securely banded at two points to the palm, at a point one third the height of the trunk. Pad the trunk with five layers of burlap under the cleats. Place braces approximately 120 degrees apart and secure them underground by 2 by 4 by 12 inch [50 by 100 by 300 mm] stake pads.

580-6 Tree Protection and Root Barriers.

Install tree barricades when called for in the Contract Documents or by the Engineer to protect existing trees from damage during project construction. Place barricades at the drip line of the tree foliage or as far from the base of the tree trunk as possible. Barricades shall be able to withstand bumps by heavy equipment and trucks. Maintain barricades in good condition.

When called for in the Contract Documents, install root barriers or fabrics in accordance with the details shown.

580-7 Pruning.

Prune all broken or damaged roots and limbs in accordance with established arborculture practices. When pruning is completed ensure that all remaining wood is alive. Do not reduce the size or quality of the plant below the minimum specified.

580-8 Mulching.

Uniformly apply mulch material, consisting of wood chips (no Cypress Mulch is allowed), pine straw, compost, or other suitable material approved by the Engineer, to a minimum loose thickness of 3 inches [75 mm] over the entire area of the backfilled hole or bed within two days after the planting. Compost used for mulch shall meet the requirements of Section 987. Maintain the mulch continuously in place until the time of final inspection.

580-9 Disposal of Surplus Materials and Debris.

Dispose of surplus excavated material from plant holes by scattering or otherwise as might be directed so that it is not readily visible or conspicuous to the passing motorist or pedestrian. Remove all debris and other objectionable material from the site and clean up the entire area and leave it in neat condition.

580-10 Contractor's Responsibility for Condition of the Plantings.

Ensure that the plants are kept watered, that the staking and guying is kept adjusted as necessary, that all planting areas and beds are kept free of weeds and undesirable plant growth and that the plants are maintained so that they are healthy, vigorous, and undamaged at the time of acceptance.

580-11 Plant Establishment Period and Contractor=s Warranty.

Assume responsibility for the proper maintenance, survival and condition of all landscape items for a period of one year after the final acceptance of all work under the Contract in accordance with 5-11. Provide a Warranty/Maintenance Bond to the Department in the amount of the total sums bid for all landscape items as evidence of warranty during this plant establishment period. The costs of the bond will not be paid separately, but will be included in the costs of other bid items.

In addition to satisfying the provisions of Section 287.0935, Florida Statutes, the bonding company is required to have a A.M. Best rating of AA≅ or better. If the bonding company drops below the AA≅ rating during the one year Warranty/Maintenance Bond period, provide a new Warranty/Maintenance Bond for the balance of the one year period from a bonding company with an AA≅ or better rating. In such event, all costs of the premium for the new Warranty/Maintenance Bond shall be at the Contractor=s expense.

Take responsibility to apply water as necessary during this period and include the cost in the various landscape items. No separate measurement or payment will be made for water during the plant establishment period.

The Engineer will conduct interim inspections of all landscape items 90 days, 180 days and 270 days into the plant establishment period, as well as at the end of the plant establishment period. As part of the warranty to the Department, and at no cost to the Department, immediately replace all landscape items found not to meet minimum specifications as shown in 580-2.1.2 after each inspection.

At the end of the one year warranty period, the Engineer will release the Contractor from further warranty work and responsibility, provided all landscape items are established and all previous warranty and remedial work, if any, has been completed.

580-12 Method of Measurement.

The quantities to be paid for will be the items shown in the plans, completed and accepted.

580-13 Basis of Payment.

Prices and payments will be full compensation for all work specified in this Section, including furnishing and planting the designated plant types, the furnishing and placing of the plant backfill, fertilizer and mulch, (except where such are shown to be paid for under a separate item), the application of water, the maintenance, care, etc., and all costs of any required replacing of plantings or restoring of damaged areas.

TRAFFIC CONTROL DEVICES

SECTION 603

GENERAL REQUIREMENTS FOR THE INSTALLATION AND EVALUATION OF TRAFFIC CONTROL SIGNAL EQUIPMENT AND MATERIALS

603-1 Description.

The provisions contained in this Section include general requirements for all traffic control signal equipment and materials used in the construction of signalized intersections.

603-2 Equipment and Materials.

603-2.1 General: Except as provided in 603-2.2, only use traffic control signal devices meeting the requirements of the Minimum Specifications for Traffic Control Signal Devices (MSTCSD) and listed on the Department=s Approved Product List (APL).

Only use new equipment and materials, except as specified in the Contract Documents.

603-2.2 Exceptions: The Department may grant exceptions to the requirements of 603-2.1 by Temporary Permit to take advantage of "state of the art" equipment advances or other circumstances that are found to be in the public interest.

603-2.3 Uniformity: Only use compatible units of any one item of equipment, such as signal heads, detectors, controllers, cabinets, poles, signal system or interconnection equipment etc., for use at an intersection.

603-2.4 Hardware and Fittings: Ensure that all bolts and nuts less than ε inch [16 mm] in diameter are passivated stainless steel, Type 316 or Type 304 and meet the requirements of ASTM F 593 and ASTM F 594 for corrosion resistance, unless otherwise specified in the Contract Documents. Provide documentation to the Engineer certifying that the materials meet all requirements specified.

Ensure that all bolts and nuts ε inch [16 mm] and over in diameter are galvanized and meet the requirements of ASTM A 307.

Use high-strength steel anchor bolts and U-bolts, having a minimum yield strength of 55,000 psi [380 MPa] and a minimum ultimate strength of 90,000 psi

[620 MPa].

603-2.5 Galvanizing: Meet the requirements of Section 962 when galvanizing for fittings and appurtenances for all structural steel (including steel poles).

603-3 Definitions.

Traffic Control Signal Devices: Any device, either manually, electrically or mechanically operated, by which traffic is alternately directed to stop and permitted to proceed or controlled in any manner. These include, but are not limited to, controller assemblies (controller cabinets and their contents); signal heads including their hanging or mounting devices; vehicle detection systems (loops, sealant, amplifier, lead-in wire, or cable); and pedestrian detection systems (push button, push button housing, lead-in wires, and signal).

Minimum Specifications for Traffic Control Signal Devices: The current edition of the MSTCSD, maintained by the State Traffic Engineering Office, which provides standards and specific technical requirements for electronic equipment and materials for the evaluation of traffic control signal devices.

Approved Products List (APL): A listing of certified or approved traffic control signal devices or hardware, compiled and maintained by the State Traffic Engineering Office.

Temporary Permit: A permit issued by the State Traffic Engineering Office for a specified time period at a specific location for new products or technology introduced by manufacturers requiring approval by the Department. This permit allows for a trial use of such products and field evaluation before the Department issues a formal approval. The State Traffic Engineering Office maintains the list of temporarily permitted traffic control signal devices.

603-4 Systems Approval Requirement.

The Engineer will review and approve any system design plan of traffic control signal devices, that is controlled and/or operated from a remote location by electronic computers or similar devices, and which affects the movement of traffic on any portion of the State Highway System, prior to installation. Within such system, only use traffic control signal devices that meet all certification or approval requirements contained herein.

603-5 Device Approval Process.

The traffic control signal devices approval process is described in detail in Section A601 of the MSTCSD.

603-6 Marking of Approved Equipment.

603-6.1 Manufacturer=s Identification: Ensure that all traffic control signal devices, furnished and/or installed, are marked by the manufacturer with a permanently affixed ID plate or stamp, bearing the name or trademark of the manufacturer and the part number.

603-6.2 Certification Number: Ensure that the Florida Department of Transportation certification number is permanently affixed.

1. For electrical/electronic devices such as controllers and accessories and

vehicle detectors, the manufacturer, vendor, supplier, or Contractor shall permanently affix the certification number on the top front center of the electrical/electronic device with a tamper proof, water resistant label.

2. For vehicular and pedestrian traffic signals, electro-mechanical signs, disconnect hangers and pedestrian detectors, the certification number shall be permanently affixed inside the housing near the terminal block by the manufacturer, vendor, supplier, or Contractor.

3. For controller cabinets, the certification number shall be permanently affixed on the inside of the main cabinet door by the manufacturer, vendor, supplier, or Contractor.

603-7 Submittal Data Requirements.

Prior to the installation of signal equipment and within 30 days after the preconstruction conference, submit a completed Form 724-10, listing all traffic devices or hardware with certification number(s) to the Engineer for approval. On all non-structural equipment or materials that do not have a Florida Department of Transportation Certification Number, submit one copy of the manufacturer's descriptive literature and technical data fully describing the types of signal equipment that will be used to the Engineer.

Develop shop drawings for all structural support materials and other special designs, such as non-electrical, non-mechanical, or other fabricated items, which may not be specifically detailed in the plans. Have the Specialty Engineer approve all shop drawings. Do not submit shop drawings for those items that have been previously evaluated and approved. Meet the requirements of 5-1.4 for shop drawings. Send two copies of the shop drawings signed and sealed by the Specialty Engineer to the Engineer.

The Engineer will approve submittal data for devices having a Florida Department of Transportation Certification Number.

The Department is not liable for any equipment or material purchased, work done, or delay incurred prior to such approval.

Provide a complete operable signal installation as specified in the Contract regardless of any failure of the Department to discover or note any unsatisfactory material. Meet the requirements of Section 608.

603-8 Documentation for Electronic Equipment.

Prior to final acceptance, furnish the Engineer with two copies of the following documentary items obtained from the manufacturer for the electronic equipment listed below:

1. Manual describing the theory of operation
2. Manual for troubleshooting
3. Electronic schematics of circuit boards
4. Pictorial layout of components of circuit boards
5. Parts list, including the location
6. Diagram of the field installation wiring (not applicable to the detectors)

Furnish documentary items for the following equipment:

1. Controllers
2. Vehicle detectors

3. Coordinating units
4. Load switches
5. Flasher units
6. Preemption units
7. Conflict monitors
8. Special sequence relays
9. Any other equipment which has a logic, timing, or communications function
10. Other equipment documentation specified in the Contract Documents

603-9 Department-Furnished Equipment Installed By Contractor.

Where the Contract includes installation of Department-furnished equipment, the Department will turn over such equipment to the Contractor when the construction progress allows or as designated in the Contract Documents. The Department will test and certify the equipment to be in proper condition and ready to use and will bear the costs of correcting any defects in the equipment prior to pick-up by the Contractor. The Engineer will coordinate the pick-up and installation of the equipment. Maintain the equipment in proper operational condition after pick-up at no cost to the Department, until either final acceptance or the equipment is returned to the Department.

SECTION 608

GUARANTIES

608-1 Description.

This Section sets forth traffic signal equipment guaranty requirements for Department contracts. The Department will consider manufacturer and Contractor costs associated with providing and delivering equipment guaranties, requirements, terms, and conditions incidental to the payment for equipment or construction feature utilizing the equipment.

608-2 Guaranty Provisions.

608-2.1 Contractor's Responsibility: Secure all guaranties that are customarily issued by the signal equipment manufacturers for the specific signal equipment included in the Contract. The Contractor shall ensure that the form in which such guaranties are delivered to the Contractor includes the provision that they are subject to transfer to the maintaining agency as named by the Department, and is accompanied by proper validation of such fact. Transfer guaranties at final acceptance of the work (or equipment) by the Department.

608-2.2 Terms: Ensure that the manufacturers of traffic signal equipment stipulate the terms of guaranties when submitting a request to the Department for certification and for equipment submittals for construction projects. Include terms for a specified service performance with provisions for repair parts and labor, or for replacement. Provisions shall define the equipment "installation date" as the date for such guaranty to be in effect. For construction projects, the "installation date" is the first day of equipment "burn-in". For warehouse purchases, the "installation date" is the date of visual inspection approval, not to exceed ten days after delivery date.

608-2.3 Conditions: When guaranty is available, ensure that a written and signed guaranty accompanies the manufacturer's billing invoice. The Engineer will sign and retain the original and provide a copy to the maintaining agency and to the manufacturer. If the Contractor does not comply with the terms of the guaranty, the Department may suspend the certification. Comply with additional terms and conditions as stated in purchasing agreements.

SECTION 611

ACCEPTANCE PROCEDURES

611-1 Description.

This Section sets forth Contract acceptance procedures for signalization installations and for equipment purchase contracts.

611-2 Acceptance of Signal Installations.

611-2.1 Partial Acceptance: The Engineer may make inspection for partial acceptance under the Contract in accordance with 5-10 of a complete installation of a signalization control system upon its completion in accordance with the Contract Documents and at such time that other parts of the total Contract are at a stage of completion that either require or allow the installation to operate in a manner which is in accordance with the Contract Documents. Before inspection for partial acceptance, the Engineer will require the satisfactory completion of all field tests of completed installations in accordance with the requirements of 611-4. The Engineer will make inspection for partial acceptance in accordance with 5-10 in company with a Contractor's representative and, when applicable, a representative of the agency designated to accept maintenance responsibility.

611-2.2 Final Acceptance: The Engineer will make inspection for final acceptance of signal installations as part of all work under the Contract in accordance with 5-11, only after satisfactory completion of all field tests of completed installations in accordance with the requirements of 611-4 and on the basis of a comprehensive final field inspection of all traffic signal installations. The Engineer will make the final inspection of all signal installations with a Contractor's representative and, when applicable, a representative of the agency designated to accept maintenance responsibility. Transfer to the Department any guarantees on equipment or materials furnished by the manufacturer and ensure that the manufacturer includes with such guarantees the provision that they are subject to such transfer, and proper validation of such fact. In addition, as a condition precedent to final acceptance in accordance with 5-11, provide a Warranty/Maintenance Bond in accordance with the requirements of 611-5.

611-3 Signal Timing.

Set the timing of a traffic signal or system of traffic control devices in accordance with the Contract Documents, unless approved otherwise in writing by the Engineer.

611-4 Field Tests of Signal Installations.

Perform the following tests on all traffic signal installations in the presence of the Engineer and, when applicable, a representative of the agency designated to accept maintenance responsibility.

Continuity: Test each signal head circuit, pedestrian detector circuit, vehicle detector loop circuit, and interconnect signal circuit for continuity.

Functional: Perform a functional test that demonstrates that each and every part of the signal installation functions as specified.

Induced Voltage: Measure the voltage between each signal head indication field terminal and the AC neutral circuit in the controller cabinet during the off (dark) state of each signal head indication. Ensure that the voltage does not exceed 2 $V_{AC, RMS}$. If this value is exceeded, take the following action to reduce the value to 2 $V_{AC, RMS}$:

(1) Check for loose or broken connections in the signal head circuit from the controller cabinet to the signal heads.

(2) If (1) above does not correct the problem, connect additional neutral circuits between the signal head and the controller cabinet.

Inductive Loop Assembly: An inductive loop assembly is defined as a loop plus the lead-in cable. Measure and record the series resistance of each inductive loop assembly. Ensure that the resistance does not exceed 10 Ω. Perform an insulation resistance megger test, at 500 V_{DC}, for each inductive loop assembly at the cabinet in which the inductive loop assembly is terminated. Do not connect the inductive loop assembly to the cabinet terminal strips during the test, except for the drain wire of a shielded lead-in cable. Insulation resistance is defined as the resistance between one wire of the lead-in cable and a ground rod or bussbar. Record the insulation resistance of each inductive loop assembly. Ensure that the resistance is equal to or greater than 100 MΩ.

Perform the 48 hour test only after achieving acceptable results from the other tests listed in 611-4.

Forty-Eight Hour Test:

(a) Before beginning the 48 hour test, place all new signal installations (no existing signals) in flash for 48 to 336 hours. The length of the flash period will be determined by the Engineer.

(b) Continuously operate each new or modified traffic signal installation or system for not less than 48 hours. If unsatisfactory performance of the system develops, correct the condition, and repeat the test until obtaining 48 hours of satisfactory continuous operation.

(c) During the 48 hour test period, the Contractor is fully responsible for the signal or signal systems. Provide a responsible representative (technically qualified) who can monitor signal operation and troubleshoot any malfunctions within a one hour period.

When coordination is specified in the Contract Documents, provide a two hour training session on the operation and programming of the coordination features of the controller units during the 48 hour test. Arrange the time and place of the training session with the Engineer.

(d) Perform a 48 hour test for flashing beacon installations in the same manner as for traffic signal installations.

(e) Start the 48 hour test on a Monday, Tuesday, or Wednesday. However, do not start the 48 hour test on the day preceding a holiday.

(f) Start the 48 hour test between 9:00 AM and 2:00 PM.

(g) Before the 48 hour test, install and have standing by all equipment specified in the Contract Documents.

611-5 Contractor=s Warranty Period for Signal Installations.

611-5.1 General Requirements: After satisfactory completion of all field tests in accordance with 611-4 and as a condition precedent to final acceptance of all work under the Contract in accordance with 5-11, provide a Warranty/Maintenance Bond for the repair or replacement of any defective components of the signal installations which shall be in effect for a 90 day period after final acceptance in accordance with 5-11. Include the costs of the bond in the costs of other bid items.

In addition to satisfying the provisions of Section 287.0935, Florida Statutes, the bonding company is required to have a A.M. Best rating of AA≅ or better. If the bonding company drops below the AA≅ rating during the 90 day Warranty/Maintenance Bond period, provide a new Warranty/Maintenance Bond for the balance of the 90 day period from a bonding company with an AA≅ or better rating. In such event, all costs of the premium for the new Maintenance Bond will be at the Contractor=s expense.

The Warranty/Maintenance Bond shall be written and issued in the amount of the total sums bid for all electrical or electronic equipment furnished and installed as part of any traffic signal installation or system of traffic control devices.

At the end of the 90 day warranty period, the Contractor will be released by the Engineer from further warranty work and responsibility, provided all previous warranty work and remedial work, if any, has been completed satisfactorily.

611-5.2 Contractor's Responsibilities: During the warranty period, the Contractor is responsible for the following:

(a) Repair or replacement of equipment that fails to function properly due to defective materials or workmanship.

(b) Upon notification by the Engineer of a malfunction, restore the equipment to proper operating condition within 12 hours after notification by the Engineer.

If the Contractor fails to restore the equipment to proper operating condition within 12 hours after notification, the Engineer has the authority to have the remedial work performed by other forces. The Contractor is responsible for all incurred costs of the work performed by other forces. Remedial work performed by other forces does not alter any of the requirements, responsibilities or obligations of this warranty.

(c) In the event that the equipment does not function or malfunctions due to defective materials or workmanship, the Contractor is liable for any impairment to the safety of pedestrian and vehicular traffic resulting from such malfunction.

611-5.3 Department's Responsibilities: During the warranty period, the

Department is responsible for the following:

(a) Electrical energy costs which are paid for by the local maintaining agency.

(b) All adjustments, such as timing, necessary for the normal operations of equipment.

(c) Documentation of the individuals involved and the time of Contractor notification upon failure or malfunction of equipment.

(d) Repair or replacement of any part of the installation damaged as a result of natural causes or those resulting from vehicular or pedestrian traffic not associated with Contractor activities.

611-6 Manufacturer's Tests and Certifications.

For materials which may not require formal testing, the Engineer reserves the right to require certifications from the manufacturer of such equipment and material, to the effect that they meet all Specification requirements, and, in the event of questionable equipment or material, to require that such material or equipment be tested at no expense to the Department.

The Engineer reserves the right to withhold any payments which may be due, if the Engineer determines that the equipment does not meet the Specifications or evaluation criteria.

611-7 Contracts for Purchase of Equipment.

611-7.1 Acceptance Tests Required: For each unit of equipment furnished under purchase contracts (furnish only), the Engineer will perform the following tests:

(a) Visual inspection within five days after delivery.

(b) Operational tests which determine whether the equipment performs in accordance with the requirements of the Contract Documents. The Engineer will complete such tests within 15 days after delivery.

611-7.2 Eligibility for Payment:

(a) The Department will base payment for equipment furnished under purchase contracts on satisfactory completion of the visual inspection and operational tests required by 611-7.1.

(b) Before any payment will be made for each functional group, deliver to the Engineer and receive from the Engineer acceptance of all units of each functional group of equipment required to be furnished by the Contract Documents. The Department will make separate payment for a staged delivery of each functional group of equipment only when staged delivery is specified in the Contract Documents.

611-7.3 Equipment Failing to Pass Acceptance Tests:

(a) When any unit of equipment fails to pass the acceptance tests, correct the deficiencies (by repair or replacement), at no expense (including all freight costs) to the Department, to attain compliance. If the original Contract Time has expired, the Department will charge and continue to assess liquidated damages in accordance with 8-10 until final acceptance of the equipment. Upon compliance with such correction requirements, the Engineer will perform tests on the equipment as specified above and will determine their eligibility for payment.

(b) The Department will not assess liquidated damages during the acceptance test period in 611-7.1. The Department will allow only one acceptance test exclusion with regard to liquidated damages assessment per lot of units required to be delivered.

SECTION 620

SIGNAL INSTALLATION GROUNDING

620-1 Description.

Install grounding for traffic signal installations to provide personnel and equipment protection against faults, surge currents and lightning transients.

620-2 Materials.

Use materials meeting the requirements of Section A620 of the current Minimum Specifications for Traffic Control Signal Devices (MSTCSD), except as provided in 603-2.2.

620-3 Requirements for Grounding.

620-3.1 General: Meet all local electrical codes which exceed these Specifications. Install all grounding electrodes 18 inches [450 mm] below finished grade. Accomplish grounding for any element of a traffic signal installation by installing either a grounding electrode assembly or a grounding electrode array, unless otherwise specified in the Contract Documents.

Use solid No. 6 AWG copper insulated (green) conductor for electrical or lightning protection ground from the system ground bus or barrier plate(s) to the grounding electrodes and from grounding electrode to grounding electrode. Use either solid or stranded No. 6 AWG copper insulated (green) conductor for all other applications.

Bond all grounding electrode assemblies and arrays together and place in a location that minimizes the length of the grounding conductor between the assembly or array and the element being grounded.

Attain a resistance to ground measurement of 25 Ω or less, in accordance with 620-3.4 for each of the following elements by either installing a grounding electrode assembly or array, unless otherwise approved by the Engineer:

(a) Electric power service
(b) Pole with electrical power service installed
(c) Pole mounted cabinet with electrical power service installed

Install an array when conditions require the driving of more that 20 feet [6 m] of grounding electrode to attain the required resistance to ground measurement of 25 Ω or less.

Install 20 feet [6 m] of ground assembly or array for each of the following elements:

(a) Controller or detector cabinet
(b) Pole

(c) Pedestals for pedestrian signals

(d) Metal cover used with pull boxes

Ensure that all separately grounded elements at an intersection are bonded together to form an intersection grounding network.

For span wire assemblies, use the span wire to connect the grounding electrode assemblies or arrays of the poles.

Do not install a grounding electrode assembly or array for a base mounted cabinet within 6 feet [1.8 m] of a grounding electrode assembly or array installed for a pole.

Make all bonds between ground wires and grounding electrode assemblies or arrays with an exothermic bond With the following exception: do not exothermically bond grounding electrode to grounding electrode connections or the system ground bussbar or barrier plate connections located within a cabinet. Use exothermic materials from the same source to make all the exothermic bonds at an intersection, meeting the requirements of the IEEE standards 80 and 837.

620-3.2 Grounding Electrode Assembly: Provide a grounding electrode assembly consisting of one or more grounding electrodes coupled together, such that the total length of the electrodes in the assembly is a minimum of 20 feet [6 m], driven into the earth at a single point, without disrupting the electrical continuity of the assembly.

Use a coupling device for grounding electrode to grounding electrode connections approved by the Engineer.

Obtain Department of Transportation Traffic Signal Resistance Measurement Data Sheets from the District Traffic Operations Office. Measure the grounding electrode resistance to ground in accordance with 620-3.4 at 10 feet [3 m] intervals, during the driving of grounding electrodes and record the readings on the Data Sheets. After completing the Data Sheets, submit them to the Engineer. Leave a copy of the Data Sheets in the controller cabinet.

Install the grounding electrode assembly so that the final elevation at the top is 6 inches [150 mm] below finished earth grade. Mark the location of the assembly with a stake and keep uncovered until the Engineer performs a final inspection of the installation.

620-3.3 Grounding Electrode Array: Provide a grounding electrode array consisting of two or more grounding electrode assemblies, bonded together, separated by a distance equal to the length of the longer grounding electrode assembly.

620-3.4 Ground Resistance: Measure all resistance, in the presence of the Engineer with a null balanced earth ground megger utilizing the three point measure technique. Obtain the Engineer=s approval prior to using a ground impedance impulse tester.

620-3.5 Grounding Poles: Ground all metal poles, including pedestals for pedestrian signals, in accordance with the details for grounding and connections shown in the Roadway and Traffic Design Standards, Index No. 17727.

For non-metallic poles, including pedestals for pedestrian signals, accommodate the ground connection from signal heads and span wires to the ground electrode assembly or array located at the pole base in accordance with the details in the Roadway and Traffic Design Standards, Index No. 17727.

When erecting new metal poles within 10 feet [3 m] of existing metal poles or structures, bond the new and existing poles or structures together.

620-3.6 Grounding Electric Power Service: Ground all electric power services in accordance with the details for grounding and connections shown in the Roadway and Traffic Design Standards, Index No. 17736.

620-3.7 Grounding Controller or Detector Cabinets: Ground controller or detector cabinets to the bussbar located in the cabinet. Place the grounding electrode assembly or array as close to the cabinet as possible.

620-3.8 Grounding Span Wire Mounted Signal Heads and Electrically Powered Signs: Ground span wire mounted signal heads and electrically powered signs through the span wire assembly in accordance with the details shown in the Roadway and Traffic Design Standards, Index No. 17727.

Do not use guy wires for grounding purposes, however bond any guy wire to the span wire as part of the intersection grounding network.

620-4 Method of Measurement.

620-4.1 General: Measurement for payment will be in accordance with the following work tasks.

620-4.2 Furnish and Install: The Contract unit price per foot [meter] of Grounding Electrode, furnished and installed, will include the grounding electrode, coupling devices, grounding conductors, and connecting devices as specified in the Contract Documents, and all labor, equipment, and miscellaneous materials necessary for a complete and accepted installation.

620-4.3 Furnish: The Contract unit price per foot [meter] of Grounding Electrode, furnished, will include the cost of the grounding electrode, coupling devices, grounding conductors, and connecting devices as specified in the Contract Documents, plus all shipping and handling costs involved in delivery as specified in the Contract Documents.

620-4.4 Install: The Contract unit price per foot [meter] of Grounding Electrode, installed, will include the cost of all labor, equipment, and miscellaneous materials used to install grounding electrode assemblies or arrays at all locations required by the Contract Documents.

The Engineer will supply the grounding electrode(s), coupling devices, grounding conductors, and connecting devices.

620-5 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section.

Payment will be made under:

Item No. 620- 1- Grounding Electrode - per foot.
Item No. 2620- 1- Grounding Electrode - per meter.

SECTION 630

CONDUIT

630-1 Description.

Install conduit for traffic signals and other electrically powered or operated traffic control devices as shown in the plans and Roadway and Traffic Design Standards, Index No. 17721.

630-2 Materials.

Use materials meeting the requirements of Section A630 of the current Minimum Specifications for Traffic Control Signal Devices (MSTCSD), except as provided in 603-2.2.

630-3 Installation Requirements.

630-3.1 General: Consider the locations of conduit as shown on the plans as approximate. Construct conduit runs as straight as possible, and obtain the Engineer's approval of all major deviations in conduit locations from those shown on the plans.

Do not place more than the equivalent of four quarter bends or 360 degree of bends, including the termination bends, between the two points of termination in the conduit, without a pullbox. Obtain the Engineer=s approval to use corrugated flexible conduits for short runs 6 feet [1.8 m] or less.

Use only intermediate metal conduit, rigid galvanized conduit, rigid aluminum conduit or PVC coated intermediate metal conduit for above-ground or underground electrical power service installations. Meet the requirements of Section 562 for coating all field cut and threaded galvanized pipe.

Use either schedule 80 PVC or fiberglass reinforced epoxy conduit for installations on bridge decks.

Use either schedule 40 PVC or fiberglass reinforced epoxy, conduit for underground and under pavement installations, except for electrical power service.

When the installation of a conduit requires jacking under paved surfaces, railroads, etc., use an intermediate metal conduit as the sleeve for the underground conduit. Install the underground conduit as shown in the Roadway and Traffic Design Standards, Index No. 17721.

When a conduit installation changes from underground to above-ground, make the change a minimum of 6 inches [150 mm] below finished grade.

Install a No. 12 AWG pull wire or polypropylene cord the full length of all conduits that are designated for future use. Ensure that a minimum of 24 inches [600 mm] of pull line approved by the Engineer is accessible at each conduit termination.

Install an expansion fitting when conduit crosses an expansion joint of a structure.

Use couplings and expansion joints made of the same material as the conduit.

Ensure that all joints are made as specified by the manufacturer and are waterproof.

For installations not specifically shown, install the conduit in accordance with NEC and/or National Electrical Safety Code requirements.

When earth backfill and tamping is required, place backfill material as per

Section 120 in layers approximately 12 inches [300 mm] thick, and tamp each layer to a density equal to or greater than the adjacent soil.

When trenching, saw cut and repair all pavement and sidewalks encountered.

When backfilling trenches in existing pavement, use a commercially available sand-cement (approximately 10:1 mix ratio).

Provide a standard clearance between underground control cable and electrical service cable or another parallel underground electrical service cable that meets National Electrical Safety Code requirements.

630-3.2 Conduit Sizes: Size the conduit to be used on all installations, unless otherwise shown in the Contract Documents. Use conduit of sufficient size to allow the conductor to be installed without any damage and meeting NEC requirements. Use conduit that is at least 1 inch [25 mm] in diameter, except for the conduit protecting the ground wire on the side of a pole, use conduit that is at least 2 inch [13 mm] in diameter.

630-3.3 Conduit Joints: Make conduit joints using materials as specified by the manufacturer. As an exception to the threaded coupling for intermediate metal conduit, at locations where it is not possible to screw the threaded coupling properly, the Contractor may use a waterproof slip-joint coupling approved by the Engineer. Secure the joint, and tighten threaded connections.

Prior to insertion into the coupling, clean, prime and coat the ends of PVC conduit with a solvent-type cement as specified by the manufacturer.

630-3.4 PVC Coating: Apply the PVC coating to the entire surface of the conduit, except for the threads, to attain a nominal thickness of 40 mils [1.02 mm]. Ensure that the coating is free of sags and/or drips. Ensure that the bond between the PVC coating and the conduit is greater than the tensile strength of the PVC coating.

Attach the coupling to the conduit prior to the application of the coating for conduit of 1 inch [25 mm] diameter or less.

Use a coupling with sleeve extensions on conduit larger than 1 inch [25 mm]. Ensure that the sleeve extensions on all threaded female openings have a length equal to the diameter of the conduit up to and including size number 53.

630-3.5 Conduit Terminations: Fit the terminating ends of all metal conduit and metal conduit sleeves with an appropriate bushing.

For conduit to be encased in concrete, wrap with tape or otherwise protect all terminations to prevent the entrance of concrete.

Connect new underground conduit(s) to existing underground conduit(s) with a pull box.

Install conduit terminating in a concrete strain pole through the cable entry hole and up the center of the pole to a location approximately 6 inches [150 mm] below the handhole.

Seal conduits terminating in a controller base, pole, pull box, junction box, or pedestal base with Appleton Duct Seal, Permagum Duct Seal, GB Duct Seal, or an equivalent moisture resistant sealant approved by the Engineer.

For a controller base, pole or pedestal base, and junction boxes, terminate conduit runs into the center of the base or box at least 2 inches [50 mm] above the surface of the base.

630-3.6 Existing Underground Facilities: Coordinate with any potential conflicting underground utilities prior to starting all excavating or jacking operations at the project site.

630-3.7 Restoration of Trench Areas: Restore the conduit trench construction area to an acceptable condition. Such work includes replacement of all pavement areas, sidewalks, curbs, structures, or grass areas disturbed by the conduit trench.

630-3.8 Jacking Conduit: Use either intermediate metal conduit or rigid galvanized conduit as the sleeve when installation of a conduit requires jacking under paved surfaces, railroads, etc., with either polyvinyl chloride or fiberglass reinforced epoxy conduit installed in the jacked sleeve. Do not disturb any pavement without the approval of the Engineer.

630-3.9 Above-Ground Installation: Securely attach above-ground conduit installations to the surface of the supporting structure using conduit straps. As a minimum, use conduit straps located on 5 feet [1.5 m] centers. Use galvanized metal conduit straps when installing intermediate metal conduit, fiberglass reinforced epoxy conduit, rigid galvanized conduit, rigid aluminum conduit or PVC coated intermediate metal conduit above ground.

Use the same PVC coating for the metal straps as the conduit, when using PVC coated intermediate metal conduit.

630-3.10 Elbows: Use only preformed or field constructed conduit elbows. The radius of curvature of the inner edge of any bend shall not be less than shown below:

Size	Standard Radius
2 inch [13 mm]	4 inches [100 mm]
: inch [19 mm]	42 inches [115 mm]
1 inch [25 mm]	52 inches [145 mm]
13 inches [32 mm]	73 inches [185 mm]
12 inches [38 mm]	83 inches [210 mm]
2 inches [50 mm]	92 inches [240 mm]
22 inches [63 mm]	102 inches [265 mm]
3 inches [75 mm]	13 inches [330 mm]
32 inches [90 mm]	15 inches [380 mm]
4 inches [100 mm]	16 inches [405 mm]
5 inches [125 mm]	24 inches [610 mm]
6 inches [150 mm]	30 inches [760 mm]

630-4 Method of Measurement.

630-4.1 General: Measurement for payment will be in accordance with the following work tasks.

630-4.2 Furnish and Install: The Contract unit price per foot [meter] of Conduit, furnished and installed, will include furnishing all hardware and materials as specified in the Contract Documents, and all labor, trenching, backfilling, and restoration materials necessary for a complete and accepted installation.

Payment for conduit placed in the ground or used on bridge decks will be based on the horizontal path of the installed conduit as measured in a straight line between the centers of pull boxes, cabinets, poles, etc. No allowance will be made for sweeps or vertical distances above or below the ground or the bridge deck.

Due to conditions which may exist on the project site, the Contractor may furnish conduit in variable lengths.

630-4.3 Furnish: The Contract unit price per foot [meter] of Conduit, furnished, will include the cost of materials, and hardware as specified in the Contract Documents, plus all shipping and handling cost involved in delivery as specified in the Contract Documents.

The Contractor shall furnish conduit in 20 foot [6 m] sections with one coupling per section.

630-4.4 Install: The Contract unit price per foot [meter] of Conduit, installed, will include all miscellaneous hardware and materials, labor, trenching, backfilling, and restoration materials necessary for a complete and accepted installation.

The Engineer will supply conduit in sections with one coupling per section and elbows as required.

Payment for conduit placed in the ground or used on bridge decks will be based on the horizontal path of the installed conduit as measured in a straight line between the centers of pull boxes, cabinets, poles, etc. No allowance will be made for sweeps or vertical distances above or below the ground or the bridge deck.

630-5 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section.

Payment will be made under:

Item No. 630- 1- Conduit - per foot.

Item No. 2630- 1- Conduit - per meter.

SECTION 632

SIGNAL AND INTERCONNECT CABLE

632-1 Description.

Install underground and aerial signal and interconnect cable.

632-2 Materials.

Use materials meeting the requirements of Section A632 of the current Minimum Specifications for Traffic Control Signal Devices (MSTCSD), except as provided in 603-2.2.

632-3 Installation Requirements.

632-3.1 Number of Conductors: Determine the number of conductors required for each signal and interconnect cable unless otherwise specified in the Contract Documents.

Provide two spare conductors within the interconnect cable. Terminate conductors within controller cabinets as specified below.

Provide three spare conductors for each signal cable used at all signal installations. Install the three spare conductors from the controller cabinet through each signal head disconnect hanger to the furthermost disconnect hanger. For non-span wire installations, install the three spare conductors from the controller cabinet through each signal to the furthermost signal.

Ground spare signal cable conductors in the controller cabinet. In the disconnect hanger, terminate spare wires at the terminal strip. Individually cap or tape any additional spares in the disconnect hanger.

Identify all spare conductors in a controller cabinet as spare signal conductors or spare interconnect conductors, and ground them to the controller cabinet ground bussbar. Provide spare conductors within the controller cabinet of sufficient length to reach the furthermost field wiring terminals in the cabinet.

632-3.2 Number of Cables: Do not install more than four separate cables at any point on a single support wire.

632-3.3 Installation in Conduit: Install cable to be drawn through conduit, ducts, or support structures in such a manner as to prevent damage to conductors or insulation.

632-3.4 Cable Terminations: Terminate separate lengths of cable by either of the following two methods:

1. Crimping an insulated fork or ring terminal to the bared conductor using a calibrated ratchet crimping tool and connecting the fork or ring terminal to the terminal block by tightening the appropriate screw.

2. Inserting the bared conductor into a compression type terminal block by tightening the appropriate screw.

Neatly form and tie wrap all cable terminations.

Do not splice cable conductors.

632-4 Signal Cable.

Install underground and aerial signal cable in accordance with the Roadway and Traffic Design Standards, Index No. 17727. Install signal cable in continuous lengths between the traffic signal controller cabinets, disconnect hangers, (or signal heads for non-span wire installations) pedestrian signal heads, and pedestrian detectors.

Do not use the neutral return conductor for pedestrian detectors as a neutral return for any other device.

632-5 Interconnect Cable.

Install underground and aerial interconnect cable in accordance with the Roadway and Traffic Design Standards, Index Nos. 17733 and 17841.

Install aerial interconnect cable in continuous lengths to and between traffic signal controller cabinets and aerial junction boxes.

Install underground interconnect cable in continuous lengths to and between traffic signal controller cabinets and above-ground junction boxes. Install terminations between controller cabinets at above-ground interconnect junction boxes. The Contractor may install terminations at intervals less than shown on the plans; however, the Contractor must provide the above-ground junction box, materials, and labor for these terminations at no expense to the Department. Obtain the Engineer's approval of the location of additional junction boxes.

632-6 Method of Measurement.

632-6.1 General: Measurement for payment will be in accordance with the following work tasks.

632-6.2 Furnish and Install: The Contract unit price per intersection for Cable (Signal) and per foot [meter] for Cable (Interconnect), furnished and installed, will include furnishing all material, hardware, support wire, cable ties, cable clamps, lashing wire, terminal connectors, cable grounding and labor necessary for a complete and accepted installation.

Payment for Cable (Signal) will be based on the number of intersections at which signal cable is furnished and installed.

Payment for Cable (Interconnect) will be based upon the length installed between cable terminations, as determined by the manufacturer's sequential markings printed on the cable jacket, recorded to the nearest foot [meter].

632-6.3 Furnish: The Contract unit price of Cable, furnished, will include the cost of the required cable as specified in the Contract Documents, plus all shipping and handling costs involved in delivery as specified in the Contract Documents.

632-6.4 Install: The Contract unit price per intersection for Cable (Signal) and per foot [meter] for Cable (Interconnect), installed, will include all labor, cable ties, cable clamps, lashing wire, and cable grounding necessary for a complete and accepted installation. The Engineer will supply all cable.

Payment for Cable (Signal) will be based on the number of intersections at which signal cable is installed.

Payment for Cable (Interconnect) will be based upon the length installed between cable terminations, as determined by the manufacturer's sequential markings printed on the cable jacket, recorded to the nearest foot [meter].

632-7 Basis of Payment.

Prices and payments will be full compensation for all work specified in this Section.

Payment will be made under:

Item No. 632- 7- Cable (Signal) - per intersection.
Item No. 2632- 7- Cable (Signal) - per intersection.
Item No. 632- 8- Cable (Interconnect) - per foot.
Item No. 2632- 8- Cable (Interconnect) - per meter.

SECTION 634

SPAN WIRE ASSEMBLY

634-1 Description.

Install a span wire assembly for supporting traffic signals, signs, and/or other traffic control devices. Provide fiberglass insulators when required.

634-2 Materials.

634-2.1 General Requirements: The specific components of a span wire assembly are a catenary wire, a messenger wire, and, when required, a tether wire. Use catenary wire to support the imposed dead and wind loads from the attached signs and traffic signals. For a single point attachment, use messenger wire to support the signal conductor cables and interconnect cables, and to stabilize signal heads, signs and other traffic control devices.

For a two point attachment, use messenger wire to resist a significant portion of the imposed wind load in addition to the loads the wire supports in a single point attachment.

Use tether wire for maintaining the alignment of optically programmed signal heads when installed on the span wire assembly or when specified in the plans for overhead signs.

634-2.2 Wires: For span wire assemblies, only use wire cables of seven wire strands manufactured and provided with a Class A zinc coating in accordance with ASTM A 475.

Provide Utility Grade catenary wires.

Provide Utility Grade messenger wires. The Contractor may use Siemens-Martin Grade only for single point attachments. Use Siemens-Martin Grade tether wires. Meet the following additional requirements for span wire assembly strands:

Span Wire Assembly Strand Type	Nominal Diameter Inch [mm]	Required Minimum Breaking Strength Pounds [kN]
Catenary Wire *	δ [9.52] $^7/_{16}$ [11.1]	11,500 [51] 18,000 [80]
Messenger Wire **	3 [6.35] δ [9.52] $^7/_{16}$ [11.1] 2 [12.7]	3,150 [14] 11,500 [51] 18,000 [80] 25,000 [111]
Tether Wire	3/16 [4.76]	1,900 [8.5]

*Supply catenary wire of the nominal diameter specified in the plans. Use the diameters shown as the standard diameters.

** Use messenger wire having a nominal diameter of 3 inch [6.35 mm] for single point attachments and use messenger wire of the diameter specified on the plans for two point attachments.

634-2.3 Hardware and Fittings: For Utility or Siemens-Martin Grade wires, use the connection hardware as specified herein and in 634-3.4(f). For installations that use other grades of wire, provide the hardware and fittings indicated on the plans. Provide only hardware and fittings made of galvanized steel or non-corrosive metal unless the fiberglass insulators specified in 634-2.4 are also required. Provide hardware and fittings of sufficient strength to resist the breaking strength of the wire with which they are used.

Connect the automatic compression dead-end clamps of the catenary wire (or wires) to the strain poles with : inch [19 mm] diameter oval eye bolts, except as noted in 634-3.3(f). For single point attachments, attach the automatic compression dead-end clamp of the messenger wire to the same oval eye bolt as the catenary wire. For two point attachments, connect the messenger wire to : inch [19 mm] diameter oval eye bolts at the lower attachment location, except as noted in 634-3.4(f). Do not use thimbleye bolts for these connections.

Only use thimbleye and oval eye bolts, : inch [19 mm] in diameter, minimum, to connect the automatic compression dead-end clamps of tether wires to strain poles.

Only use "S" hooks, 5/16 inch [7.94 mm] in diameter, minimum, when connecting the tether wire to all poles.

Ensure that other hardware and fittings, as required for the attachment of a span wire assembly to support poles or structures, are in accordance with the details shown in the Roadway and Traffic Design Standards.

634-2.4 Fiberglass Insulators: Install fiberglass insulators of the length specified in the plans on span wire assemblies located within 6 feet [1.8 m] of overhead electric power lines.

Use a fiberglass insulator of a cylindrical shape, fabricated from epoxy-resin impregnated fiberglass strands and having a breaking strength 50% greater than that of the structural support wire to which it is to be attached. Equip the insulator with thimbleye fittings on each end for attachment of the wire. Furnish all fittings and hardware necessary for the complete installation with the insulator and ensure that such fittings and hardware are of at least equal strength to the insulator.

634-3 Installation Requirements.

634-3.1 Span Wire Assembly Types: Use span wire assemblies of the following types:

(a) Two Wire Assembly: This type assembly requires a catenary wire and a messenger wire.

(b) Three Wire Assembly: This type assembly requires a catenary wire, a messenger wire, and a tether wire.

The Contractor may supply either of these types for single or two point attachments.

634-3.2 Span Types: Install span wire assemblies on the following span types:

(a) Perpendicular Span: Use this type span at an intersection to support a single span wire assembly upon which traffic signals, signs, and/or other traffic control devices are attached. Attach the span wire assembly to two support poles or structures, located on opposite sides of the roadway, and extend the assembly across the roadway at an angle of approximately 90 degrees to the roadway approach.

(b) Diagonal Span: Use this span type at an intersection to support a single span wire assembly upon which traffic signals, signs, and/or other traffic control devices are attached. Attach the span wire assembly to two poles, located in opposite quadrants of the intersection, and extend the assembly across the intersection at an angle of approximately 45 degrees to the approach lanes of the intersection. Locate traffic control devices for all approaches at appropriate locations on the span wire assembly.

(c) Box Span: Use this span type at an intersection to support a perimeter system of four span wire assemblies upon which traffic signals, signs and/or other traffic control devices for each approach to the intersection are attached. Attach the span wire assemblies to four poles, one located in each quadrant of the intersection, and extend each span wire assembly between two poles at an angle of approximately 90 degrees to the roadway approaches. Place traffic control devices for an approach on the span wire assembly on the far side of the intersection.

(d) Special Design Span: Use this span type to support two or more span wire assemblies upon which traffic signals, signs and other traffic control devices for one or more roadway approaches are attached. Attach the span wire assemblies to three or more poles.

634-3.3 General Requirements:

(a) Provide a span wire assembly with catenary messenger and tether wires of one continuous length of wire cable with no splices except when an insulator is required by 634-2.4. Connect the insulator, if required, to the cable with automatic compression dead-end clamps.

(b) Attach the span wire assemblies to the support poles or structures by means of automatic compression clamps and accessory hardware.

(c) Assemble the washer and nut on the oval eye bolt with the flat washer next to the pole. Tighten the nut sufficiently to prevent the oval eye bolt from rotating.

(d) For single point attachment, supply tension to the messenger wire with the signal conductor cables attached to eliminate any appreciable sag.

For two point attachments, install the messenger wire with the following tensions per 100 feet [30 m]. Linearly prorate cable tensions for other lengths from these values:

Cable Size Inch [mm]	Wire Tension Lbs. [kN]
δ [9.52]	340.0 [1.5]
$^{7}/_{16}$ [11.1]	500.0 [2.2]
2 [12.7]	645.0 [2.9]

(e) Install the catenary wire to the following initial wire tensions:

For δ inch [9.52 mm] diameter:

Span Feet [m]	Initial Wire Tension Lbs. [N]
0 to 100 [0 to 30]	50.0 [222]
101 to 125 [31 to 38]	75.0 [334]
126 to 150 [39 to 45]	85.0 [378]
151 to 175 [46 to 53]	100.0 [445]
176 to 200 [54 to 61]	115.0 [512]

201 to 225 [62 to 68]	125.0 [556]
226 to 250 [69 to 76]	140.0 [623]
251 to 275 [77 to 83]	150.0 [667]
276 to 300 [84 to 91]	175.0 [778]
over 300 [over 91]	200.0 [890]

For $^{7}/_{16}$ inch [11.1 mm] diameter:

Span Feet [m]	Initial Wire Tension Lbs. [N]
0 to 100 [0 to 30]	75.0 [334]
101 to 125 [31 to 38]	100.0 [445]
126 to 150 [39 to 45]	125.0 [556]
151 to 175 [46 to 53]	150.0 [667]
176 to 200 [54 to 61]	175.0 [778]
201 to 225 [62 to 68]	175.0 [778]
226 to 250 [69 to 76]	200.0 [890]
251 to 275 [77 to 83]	225.0 [1000]
276 to 300 [84 to 91]	250.0 [1112]
over 300 [over 91]	275.0 [1223]

(f) Connect a maximum of two δ inch [9.52 mm] diameter catenary wires to a strain pole with one : inch [19 mm] diameter oval eye bolt. Connect a maximum of one 7/16 inch [11.1 mm] diameter catenary wire to a strain pole with one : inch [19 mm] diameter oval eye bolt.

Use a : inch [19 mm] diameter alloy steel eyebolt (ASTM F 541, Type 2) and a : inch [19 mm] heavy hex nut ASTM A 563 [ASTM A 563M], Grade C or D), both zinc coated in accordance with ASTM A 153 [ASTM A 153M], Class C, to connect more than one 7/16 inch [11.1 mm] diameter catenary wire or one 2 inch [12.7 mm] diameter messenger or catenary wire to a single strain pole. Alternatively, the Engineer may design a special connection for this case.

(g) Install the span wire assemblies in accordance with the Roadway and Traffic Design Standards, Index No. 17727, and at a height on the support poles which will provide a clearance from the roadway to the bottom of the signal head assemblies as specified in 650-4.

(h) Connect all span wires to the pole grounding system in accordance with Section 620.

(i) Obtain and meet all provisions of the National Electric Safety Code (ANSI-C2) regarding clearance from electric lines, contacting of utility owners, and safety requirements prior to span wire installation.

(j) Prior to installation of the span wire assembly, submit the method of providing the required tension in the catenary wire and the messenger wire in two point attachments to the Engineer for approval.

634-4 Method of Measurement.

634-4.1 General: Measurement for payment will be in accordance with the following work tasks.

634-4.2 Furnish and Install: The Contract unit price per intersection for Span Wire Assembly and per foot [meter] of Fiberglass Insulator, furnished and installed, between supporting poles and structures will include furnishing all materials and hardware as required in 634-2, and all labor, equipment, and miscellaneous materials necessary for a complete and accepted installation.

634-4.3 Furnish: The Contract unit price per intersection for Span Wire Assembly and per foot [meter] of Fiberglass Insulator, furnished, will include the cost of the required materials and hardware as required in 634-2, and all handling and delivery of these items to the site designated by the Department in the Contract Documents.

634-4.4 Install: The Contract unit price per intersection for Span Wire Assembly and per foot [meter] of Fiberglass Insulator, installed, will include all labor, equipment, and miscellaneous materials necessary for a complete and accepted installation.

The Engineer will supply all materials and hardware as required in 634-2 for the span wire assembly.

634-5 Basis of Payment.

Prices and payments will be full compensation for all work specified in this Section.

Payment will be made under:

Item No. 634- 4- Span Wire Assembly - per intersection.
Item No. 2634- 4- Span Wire Assembly - per intersection.
Item No. 634- 5- Fiberglass Insulator - per foot.
Item No. 2634- 5- Fiberglass Insulator - per meter.

SECTION 635

PULL AND JUNCTION BOXES

635-1 Description.

Install pull and junction boxes for traffic signals.

635-2 Materials.

Use Pull and Junction Boxes listed on the Department=s Approved Product List (APL). Ensure that all Pull and Junction Boxes are marked in accordance with Section 603 and the markings are visible after installation.

635-3 Pull Boxes Installation.

Install pull boxes in accordance with the Roadway and Traffic Design Standards, Index No. 17721. Ensure that the pull box cover is flush with the finished grade or sidewalk. Do not install pull boxes in roadways, driveways, parking areas, ditches or public sidewalk curb ramps.

635-4 Junction Boxes Installation.

635-4.1 Aerial Junction Boxes: Install aerial junction boxes in accordance with the Roadway and Traffic Design Standards, Index No. 17733.

635-4.2 Mounted Junction Boxes: Install mounted junction boxes in accordance with the Roadway and Traffic Design Standards, Index No. 17841. Ensure that the bottom surface of pole mounted junction boxes is a minimum of 4 feet [1.2 m] above the finished grade.

635-4.3 Cable Terminations: Make cable terminations in junction boxes in accordance with Section 632. Rout and form the cable to allow access to the terminal screws. Do not cover the terminal identification numbers with the cable.

635-5 General Requirements.

Do not pull signal or interconnect cable through a pull box used for loop termination. Use separate pull boxes for signal and interconnect cables.

Use embedded junction boxes that include junction boxes, conduit, conduit expansion couplings, and miscellaneous hardware to make a complete and accepted installation.

Ground all metal covers in accordance with Section 620.

When specified in the Contract Documents, disregard the grounding requirements for metal covers for pull and junction boxes powered strictly by battery or a combination of battery and solar energy or used exclusively for vehicle loop wires where signal or 120V interconnect power is not present.

635-6 Method of Measurement.

635-6.1 General: Measurement for payment will be in accordance with the following work tasks:

635-6.2 Furnish and Install: The Contract unit price each for Pull and Junction Boxes, furnished and installed, will consist of the pull and junction boxes including all required hardware for the type of box and location as specified in the Contract Documents, and all labor and materials necessary for a complete and accepted installation.

635-6.3 Furnish: The Contract unit price each for Pull and Junction Box, furnished, will include the cost of the pull and junction box including covers, doors, locks and keys, and any necessary miscellaneous hardware specified in the Contract Documents, plus all shipping and handling costs involved in delivery as specified in the Contract Documents

635-6.4 Install: The Contract unit price each for Pull and Junction Box, installed, will include the cost of all labor, equipment, miscellaneous hardware and materials necessary to make a complete and accepted installation of the type box and at locations as shown on the plans. The Engineer will supply a complete box as specified in the Contract Documents.

635-7 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section, except grounding. Payment for embedded junction boxes will not be made separately.

The Contractor shall include the cost of embedded junction boxes in the Contract unit price for the concrete substructure or superstructure items.

Payment will be made under:

Item No. 635- 1- Pull and Junction Boxes - each.
Item No. 2635- 1- Pull and Junction Boxes - each.

SECTION 639

ELECTRICAL POWER SERVICE ASSEMBLIES

639-1 Description.

Install electrical power service assemblies for either overhead service or underground service in accordance with the details shown in the Roadway and Traffic Design Standards, Index No. 17736.

639-2 Definitions.

(a) Overhead Service: A service assembly which is supplied electrical power from an overhead power company source. Include with an overhead electrical power service assembly the following components:

(1) Weatherhead
(2) Conduit
(3) Service wire
(4) Meter base (when required)
(5) Service disconnect assembly
(6) Transient Protection Device

(b) Underground Service: A service assembly which is supplied electrical power from an underground power company source. Include with an underground electrical power service assembly the following components:

(1) Conduit
(2) Service wire
(3) Meter base (when required)
(4) Service disconnect assembly
(5) Transient Protection Device

639-3 Materials.

Use materials meeting the requirements of Section A639 of the current Minimum Specifications for Traffic Control Signal Devices (MSTCSD), except as provided in 603-2.2.

639-4 Installation Requirements.

639-4.1 General: Meet the following requirements for the installation of individual components of the electrical power service assembly:

Use extreme care and caution in the installation of all components of the electrical power service assembly.

Follow installation procedures recommended by NEC and National Electrical Safety Code (NESC).

Consider the location of electrical power service assemblies as shown in the plans to be approximate, and coordinate with the appropriate electrical power company authority to determine the exact locations of each assembly.

639-4.2 Weatherhead: Securely attach the weatherhead to the upper end of the conduit which extends upward from the meter base (or service disconnect if a meter base is not required) to a minimum height of 22 feet [7 m] above grade.

639-4.3 Conduit: Securely attach all conduit to the pole or cabinet with a maximum distance of 5 feet [1.5 m] between conduit attachment hardware.

639-4.4 Electrical Service Wire: Install the electrical service wire in a manner which will ensure that damage to the installation will not occur.

Ensure that the service wire is of sufficient length after installation in the conduit to provide for attachment to the power company service and for termination within the cabinet for which power is required.

639-4.5 Meter Base: When a meter base is required, securely fasten the meter base to the pole or cabinet. Install pole mounted meter bases at a minimum height of 52 feet [2 m] above grade when measured from the center of the meter base or meet the local electric power company requirement, whichever is greater.

639-4.6 Service Disconnect: Securely fasten the service disconnect to the pole (or cabinet with the Engineers approval), and electrically position the service disconnect between the service meter and the traffic control device cabinet to which electrical service is being supplied. Install pole mounted service disconnects a minimum of 4 feet [1.2 m] above grade when measured from the bottom of the disconnect. For cabinet installations, mount the service disconnect at a height approved by the Engineer or as shown in the plans.

639-5 Method of Measurement.

639-5.1 General: Measurement for payment will be in accordance with the following work tasks.

639-5.2 Furnish and Install: The Contract unit price per foot [meter] of Electrical Service Wire, or the Contract unit price each for Electrical Service Disconnect, furnished and installed, will include furnishing all materials and hardware as specified in the Contract Documents, and all labor, equipment, and miscellaneous materials necessary for a complete and accepted installation.

639-5.3 Furnish: The Contract unit price per foot [meter] of Electrical Service Wire, or the Contract unit price each, for Electrical Service Disconnect, furnished, will include the cost of the required materials and hardware as specified in the Contract Documents, plus all shipping and handling costs involved in delivery as specified in the Contract Documents.

639-5.4 Install: The Contract unit price per foot [meter] of Electrical Service Wire, or the Contract unit price each, for Electrical Service Disconnect, installed, will include all labor, equipment, and miscellaneous materials necessary for a complete and accepted installation. The Engineer will supply electrical service wire or electrical service disconnect.

639-5.5 Electrical Power Service: The Contract unit price per assembly for Electrical Power Service will include furnishing and installing all material and hardware as specified in the Contract Documents, and all labor and equipment necessary to make a complete and accepted installation.

Payment for conduit and electrical service wire as part of the electrical power service assembly will include only the conduit and service wire which is vertically attached to the assembly. Horizontal lengths of conduit and conductors required beyond the electrical power service assembly will be paid for under another pay item.

639-6 Basis of Payment.

Prices and payments will be full compensation for all work specified in this Section.

Payment will be made under:

Item No. 639- 1- Electrical Power Service - per assembly.
Item No. 2639- 1- Electrical Power Service - per assembly.
Item No. 639- 2- Electrical Service Wire - per foot.
Item No. 2639- 2- Electrical Service Wire - per meter.
Item No. 639- 3- Electrical Service Disconnect - each.
Item No. 2639- 3- Electrical Service Disconnect - each.

SECTION 641

PRESTRESSED CONCRETE POLES

641-1 Description.

Furnish and install prestressed concrete poles for service pole applications (Type N-II), luminaire support (Type N-III), and strain poles for span wire support of traffic signals, signs, and other devices (Types N-IV, N-V, N-VI, and N-VII).

641-2 Materials.

Only use poles listed on the Qualified Products List.

641-3 Installation Requirements.

641-3.1 General: Furnish poles of the type and length shown on the plans. Provide catenary cable of the size shown on the plans. Ground poles in accordance with Section 620. Install span wire assemblies in accordance with Section 634.

Do not consider the poles acceptable for use if the camber of the pole, measured as the maximum deviation between the centerline of the pole and a straight line connecting the centroids of the cross-sections at each end of the pole, is greater than the total pole length in millimeters divided by 140.

641-3.2 Footings: Provide footings 3 feet 6 inches [1 m] in diameter and of the depth specified in the plans for strain poles used for span wire support of traffic signals (Types N-IV through N-VII). Provide footings for all other pole applications as specified in the plans. Construct the footings with Class I concrete as specified in Section 347.

For the excavation and backfill of the footing, meet the requirements specified in 125-4 and 125-8.2 with the exception of the backfill density. In lieu of the requirements for obtaining the specified density, the Contractor may hand tamp the backfill in 4 inches [100 mm] maximum layers or machine tamp the backfill in 6 inches [150 mm] maximum layers. When performing such operations, ensure that the material is neither dry nor saturated. The Contractor may backfill with concrete.

Use forms, when required, meeting the requirements of 700-8.3. If the footing is cast in an oversize hole, place the concrete in the top 6 inches [150 mm] in a form. Trowel all exposed surfaces to a smooth finish.

641-3.3 Orientation of Poles: For poles supporting one catenary wire, orient the pole so that the load face is perpendicular to the catenary wire. For poles supporting two catenary wires, orient the pole so that the load face is perpendicular to a line bisecting the angle between the two catenary wires.

641-4 Method of Measurement.

641-4.1 General: Measurement for payment will be in accordance with the following work tasks.

641-4.2 Furnish and Install: The Contract unit price for Prestressed Concrete Poles, Furnish and Install, will consist of the pole plus all labor, concrete for the foundation and other materials necessary for a complete and accepted installation as specified in the Contract Documents.

641-4.3 Furnish: The Contract unit price for Prestressed Concrete Poles, Furnish, will include the cost of the pole and shipping, handling, and delivery of the pole to the site designated in the Contract Documents.

641-4.4 Install: The Contract unit price for Prestressed Concrete Poles, Install, will include all labor, concrete for the foundation and other materials necessary for a complete and accepted installation as specified in the Contract Documents. The Engineer will supply the poles.

641-5 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section.

Payment will be made under:

Item No. 641- Prestressed Concrete Poles - each.
Item No. 2641- Prestressed Concrete Poles - each.

SECTION 650

VEHICULAR SIGNAL ASSEMBLIES

650-1 Description.

Install vehicular traffic signal assemblies. For additional requirements related to the installation of the signals, refer to the appropriate Sections for the installation of related elements of the overall traffic signal system.

650-2 Materials.

Use signal and signal lamps currently listed on the Department=s Approved Product List (APL). Ensure that all equipment is marked in accordance with Section 603.

650-3 Installation.

650-3.1 Preassembly: Pre-assemble the signal heads when more than one signal section is required prior to installation at the site. Furnish signal heads with the signal lamps firmly seated in the lamp receptacle. Rotate the lamp receptacle (or the reflector holder) so that the opening between the filament ends is up.

650-3.2 Positioning of Signals: Consider the locations of the installed signals as shown on the plans as sufficiently flexible as to allow for unanticipated field conditions at the site. The Engineer will direct any variations from the locations shown. Position adjacent signal faces no closer than 8 feet [2.5 m] apart measured horizontally at 90 degrees to the traffic flow between centers of faces.

Regardless of the results of any scaled dimensions, consider the location shown on the plans to be approximate. Position a signal face mounted on a span wire or mast arm as near as practical to the line of the driver's normal view.

Ensure that all sections are of the same manufacturer and the section assemblies are uniform in appearance and alignment.

650-3.3 Clearances: Unless directed otherwise by the Engineer for unusual circumstances at the site, provide a vertical clearance of not less than 172 feet [5.35 m] and not more than 19 feet [5.8 m] for traffic signals placed over the roadway. Measure such clearance for each span directly under the most critical signal assembly (in regards to clearance) for that span. Place signal assemblies on each span as near as practical to the same elevation as the critical signal assembly.

Ensure that the lowest point on pedestal-mounted and side-mounted signal heads is 12 feet [3.7 m] above finished grade at the point of their installation.

650-3.4 Aiming of Signal Indication: For proper lateral orientation, aim signals after installing and before locking them in position.

650-3.5 Wiring Connections: Do not splice signal cable. Connect the proper signal cable to the terminals in each signal head in order to provide the proper signal indication display when the cables are connected to the controllers. Wire a separate neutral circuit and return it to the controller cabinet from each vehicular movement as shown in the Contract Documents.

650-3.6 Special Installation Requirements for Optically Programmed Signals: Install, direct (aim), and conceal optically programmed signals in strict accordance with the instructions of the manufacturer, using the materials furnished by the signal manufacturer with the signals, and with the directions of the Engineer.

Position the signals for maximum performance in accordance with the requirements shown on the plans, and install them with rigidly firm mounts, using elbows and plumbizers of such type as will provide for stability of the position of the signals. Do not use clevises in the supporting attachments.

Seal the cable routing to the signals to provide permanent water tightness.

650-3.7 Vertically Mounted Polycarbonate (Light-Weight) Signal Head Assemblies: Ensure that when mounted in a vertical position and suspended from the top section all polycarbonate signal head assemblies have a die cast aluminum top section. Ensure that all sections of the assembly are from the same manufacturer.

Single section polycarbonate assemblies may be used without a die cast aluminum top section.

650-3.8 Sealing Installed Signal Head Assembly: Ensure that the installed signal head assembly is sealed to exclude dust and moisture. Drill two 3 inch [6.35 mm] drain holes in the bottom of the installed signal head assembly.

650-3.9 Concealing Signals Not in Use: Where traffic signals are installed and not put into service immediately, conceal the signal head assembly by placing burlap bags or other covering approved by the Engineer over a weather resistant covering of non-transparent material open at the bottom to prevent condensation buildup.

650-3.10 Installation Sequence: Install all traffic signal assemblies at any intersection as a single operation unless a staged operation is approved by the Engineer.

650-4 Method of Measurement.

650-4.1 General: Measurement for payment will be in accordance with the following work tasks.

650-4.2 Furnish and Install: The Contract unit price per assembly for Traffic Signal, furnished and installed, will consist of the traffic signal assembly, including all hardware, labor, and materials necessary for a complete and accepted installation.

650-4.3 Furnish: The Contract unit price per assembly for Traffic Signal, furnished, will include the cost of all components of a traffic signal assembly plus all shipping and handling cost involved in delivery as specified in the Contract Documents.

The Contractor shall deliver the assembly in an unassembled state, with the following exception, deliver signal sections assembled in the required number of sections for one direction so that with minimum effort they may be combined into a multiple direction assembly as specified in the Contract Documents. The Contractor shall include all hardware specified in this Section in the components of the assembly which are to be furnished and used in the installation of the assembly. The Contractor shall package and ship component parts of the assembly in accordance with manufacturer's instructions in order to minimize the potential for damage during shipment.

650-4.4 Install: The Contract unit price per assembly for Traffic Signal, installed, will consist of all labor necessary to assemble all traffic signal components for a complete and accepted installation.

The Engineer will supply all traffic signal assembly components. The Contractor shall furnish any required minor miscellaneous standard hardware items, such as nuts and bolts, as part of the installation task.

650-5 Basis of Payment.

Prices and payments will be full compensation for all work specified in this Section, including all hardware necessary to make a complete unit with proper lens indications, mounting hardware, brackets, drop-pipe, disconnect hangers, bulbs, and any other materials or equipment to make a complete installation.

Payment will be made under:

Item No. 650- 1- Traffic Signal, 12 inch Std. - per assembly.
Item No. 2650- 1- Traffic Signal, 305 mm Std. - per assembly.

Item No. 650- 2-	Traffic Signal, 12 inch Opt. Prog - per assembly.
Item No. 2650- 2-	Traffic Signal, 305 mm Opt. Prog. - per assembly.
Item No. 650- 3-	Traffic Signal, 12 inch Lightweight - per assembly.
Item No. 2650- 3-	Traffic Signal, 305 mm Lightweight - per assembly.
Item No. 650- 4-	Traffic Signal, 8 inch Std. - per assembly.
Item No. 2650- 4-	Traffic Signal, 205 mm Std. - per assembly.
Item No. 650- 8-	Traffic Signal, 12 inch Lightweight - per assembly.
Item No. 2650- 8-	Traffic Signal, 305 mm Lightweight - per assembly.
Item No. 650- 9-	Traffic Signal, 12 inch Std. - per assembly.
Item No. 2650- 9-	Traffic Signal, 305 mm Std.- per assembly.

SECTION 653

PEDESTRIAN SIGNAL ASSEMBLIES

653-1 Description.

Install pedestrian signal assemblies as shown in the plans and Roadway and Traffic Design Standards, Index No. 17764.

653-2 Materials.

Use only pedestrian signals currently listed on the Department=s Approved Product List (APL). Ensure that all equipment is marked in accordance with Section 603.

653-3 Installation.

653-3.1 General: Use pedestrian signal assemblies capable of being maintained, adjusted, or disassembled with ordinary hand tools. Pre-assemble the pedestrian signal (not mounting hardware) prior to installation at the site. Connect the proper signal cable wires to the proper connections in the pedestrian housing in order to provide the proper signal indication display. Conceal all conductors. Construct the pedestrian signal assembly (including the mounting hardware) to be a weathertight unit.

653-3.2 Placement: Install the pedestrian signals at a location and mount them in the manner as shown on the plans. Consider the plans to be sufficiently flexible as to allow for unanticipated field conditions at the site. The Engineer will direct all variation from the locations shown. Mount pedestrian signals with bottom of housing not less than 8 feet [2.5 m] (standard) or more than 10 feet [3 m] above the sidewalk level. Position pedestrian signals and all mounting assembly members as either plumb or level, and symmetrically arranged. Properly aim the signals in the line of the pedestrian's vision for the crosswalk being used.

653-3.3 Installation Sequence: Install all pedestrian signal assemblies at any intersection as a single operation unless a staged operation is approved by the Engineer. Do not install signals at any intersection until all other signal equipment, including the controller, and pedestrian detectors, are in place and ready for operation, unless completely covered, in accordance with 650-3.8. Ensure that the cover remains in place until the pedestrian signal is placed into operation.

653-4 Method of Measurement.

653-4.1 General: Pedestrian signal assemblies will include any hardware necessary to make a complete installation and may include one or more pedestrian signals, as specified in the Contract Documents, including the appropriate mounting hardware.

Measurement for payment will be in accordance with the following work tasks.

653-4.2 Furnish and Install: The Contract unit price per assembly for Pedestrian Signal, furnished and installed, (including mounting hardware but not including pedestals) will include all materials and equipment as specified in the Contract Documents, and all labor and materials necessary for a complete and accepted installation.

653-4.3 Furnish: The Contract unit price per assembly for Pedestrian Signal, furnished, will include the cost of the assembly including all mounting hardware as specified in the Contract Documents, plus all shipping and handling costs involved in delivery as specified in the Contract Documents.

The Contractor shall deliver the pedestrian signal assembly in a pre-assembled state. The Contractor shall package and ship component parts of the assembly in accordance with the manufacturer's instructions to minimize the potential for damage during shipment.

653-4.4 Install: The Contract unit price per assembly for Pedestrian Signal, installed, will consist of all labor necessary to assemble all components for complete and accepted installation. The Engineer will supply pedestrian signal assembly (including all mounting hardware) as specified in the Contract Documents. The Contractor shall furnish all conduit, risers, lead-in-wires, posts or miscellaneous materials needed to complete the installation as specified in the Contract Documents.

653-5 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section.

Payment will be made under:

Item No. 653- Pedestrian Signals - per assembly.
Item No. 2653- Pedestrian Signals - per assembly.

SECTION 660

INDUCTIVE LOOP DETECTORS

660-1 Description.

Install inductive loop detectors, harnesses, and loop assemblies.

660-2 Materials.

Use inductive loop detectors, pre-formed loop assemblies and loop sealant currently listed on the Department=s Approved Products List (APL). Ensure that all loop detectors are marked in accordance with Section 603 and the markings are visible after installation.

660-3 Installation Requirements.

660-3.1 Inductive Loop-Detector Units: Install inductive loop detector units and cable harnesses in accordance with the manufacturer's instructions and the Roadway and Traffic Design Standards, Index No. 17781. Adjust the operating frequency of each detector unit, if required, to prevent crosstalk of the units.

660-3.2 Saw Cuts: Use a chalk line or equivalent method to outline the perimeter of the loop on the pavement and routes for lead-in cables. Do not allow the saw cut in the pavement to deviate by more than 1 inch [25 mm] from the chalked line. Ensure that all saw cuts are free of any dust, dirt or other debris and completely dry prior to the installation of the loop wire, loop wire twisted pair lead or lead-in cable.

Make saw cuts in accordance with the Roadway and Traffic Design Standards, Index No. 17781. Ensure that the top conductor of the loop wire or lead-in cable is a minimum of 1 inch [25 mm] below the final surface of the roadway.

660-3.3 Loop Wire: Ensure that all loops are wound in a clockwise manner and the first turn of the loop wire is placed in the bottom of the saw cut, with each subsequent turn placed on top of the preceding turn. Push the loop wire to the bottom of the saw cut with a non-metallic tool which will not damage the insulation.

Tag and identify the clockwise "lead" of each loop.

Use alternate polarity on adjacent loops.

Ensure that the hold down material is non-metallic and is not longer than 1 inch [25 mm] and that the distance from the top of the hold down material to the final surface of the roadway is not less than : inch [19 mm].

Twist the loop wire a minimum of five turns per 1 foot [300 mm] to form a loop wire twisted pair lead from the edge of the loop to the pull box.

Splice the loop wire twisted pair lead to the lead-in cable in the pull box. Place only one loop wire twisted pair lead in a saw cut.

Ensure that the distance between a twisted loop wire pair lead within the roadway is a minimum of 6 inches [150 mm] from any other twisted loop wire pair lead or loop, until they are within 1 foot [300 mm] of the edge of pavement or curb, at which point they may be placed closer together.

Prepare and apply the loop sealant in accordance with the manufacturer=s instructions. Ensure that the loop sealant has cured completely before allowing vehicular traffic to travel over the sealant.

660-3.4 Lead-In Cable: Place the lead-in cable in the bottom of the saw cut. Do not damage the insulation.

Install no more than four lead-in cables in a saw cut. Ensure that the hold down material is not longer than 1 inch [25 mm] and that the distance from the top of the hold down material to the final surface of the roadway is not less than : inch [19 mm].

Prepare and apply the loop sealant in accordance with the manufacturer=s instructions. Ensure that the loop sealant has cured completely before allowing vehicular traffic to travel over the sealant.

660-4 Splicing And Termination Requirements.

660-4.1 Splicing: Splice lead-in cable to the loop wire in accordance with Roadway and Traffic Design Standards, Index No. 17781. Perform the splicing in a pull box located off the roadway, not in the roadway itself.

Splice the black conductor of the lead-in cable to the clockwise "lead" of the loop.

Ensure that the ends of the cable jackets, twisted pair and lead-in, are encased in the loop splice material.

Ensure that each loop has an individual return to the cabinet and series splicing is performed on a separate terminal block in the cabinet.

660-4.2 Terminations: Using insulated terminal lugs, terminate lead-in cables or twisted pair loop wire on a terminal strip which is located in the controller or detector cabinet. Use a calibrated ratchet type crimping tool to attach the lugs to the conductors of the lead-in cable or twisted loop wire.

660-5 Loop Assembly Identification.

Identify and tag each loop assembly in the controller or detector cabinet by lane and movement number.

Example: Outside lane- Movement 6
Center lane- Movement 6
Inside lane- Movement 6

660-6 Testing Requirements.

660-6.1 Series Resistance: Obtain Department of Transportation Traffic Signal Resistance Measurement Data Sheets from the Engineer. Measure and record the series resistance of each loop assembly on these Data Sheets. Leave a copy in the controller cabinet.

If the series resistance of a loop assembly is greater than 10 Ω, inspect the loop assembly to find the cause of the excessive resistance. Correct the cause of the excessive resistance at no additional cost to the Department.

660-6.2 Insulation Resistance: Measure and record the insulation resistance of each loop assembly, and verify that the resistance is greater than 100 MΩ. Use a 500 V_{DC} insulation megger to measure the resistance. Reference all measurements to a good earth ground (ground rod, metallic water pipe, etc.), with a resistance to ground of less than 25 Ω. Disconnect the transient suppression devices from the loop assemblies before taking any measurements. If the insulation resistance is less than 100 MΩ, determine if the lead-in cable or the loop wire is causing the problem, and replace the defective cable or loop wire at no additional cost to the Department.

660-7 Turn On Requirements.

Connect the loop assemblies to the appropriate inductive loop vehicle detectors and tune the detectors in accordance with the manufacturer's instructions. Separate the operating frequencies of vehicle detectors, in adjacent lanes, by at least 2 kHz.

660-8 Method of Measurement.

660-8.1 General: Measurement for payment will be in accordance with the following tasks.

660-8.2 Furnish and Install: The Contract unit price each for Inductive Loop Detector and per assembly for Loop Assembly, furnished and installed, will include all equipment, materials as specified in the Contract Documents and all labor, equipment, and miscellaneous materials necessary for a complete and accepted installation.

660-8.3 Furnish: The Contract unit price each for Inductive Loop Detector, per assembly for Loop Assembly, per gallon [liter] for Loop Sealant, per foot [meter] for Loop Material and for each Inductive Loop Detector Accessories, furnished, will include all equipment and materials as specified in the Contract Documents, plus all shipping and handling costs involved in delivery as specified in the Contract Documents.

660-8.4 Install: The Contract unit price each for Inductive Loop Detector and per assembly for Loop Assembly, installed, will include all loop sealant, miscellaneous materials, labor, and equipment necessary for a complete and accepted installation.

The Engineer will supply the inductive loop detector, harness, lead-in cable, and loop wire.

660-8.5 Modify: The Contract unit price per assembly for Loop Assembly, modified, will include all lead-in cable, saw cuts, miscellaneous materials as specified in the Contract Documents, connecting new lead-in cable to an existing loop and installing and terminating the lead-in cable to the location designated in the Contract Documents, and all labor and equipment necessary for a complete and accepted installation.

660-9 Basis of Payment.

660-9.1 Inductive Loop Detector: Price and payment will be full compensation for all work specified in this Section.

Payment will be made under:

Item No. 660- 1- Inductive Loop Detector - each.
Item No. 2660- 1- Inductive Loop Detector - each.

660-9.2 Loop Assembly: Price and payment will be full compensation for all work specified in this Section.

Payment will be made under:

Item No. 660- 2- Loop Assembly - per assembly.

Item No. 2660- 2- Loop Assembly - per assembly.

SECTION 665

PEDESTRIAN DETECTOR ASSEMBLY

665-1 Description.

Install pedestrian detector assembly.

665-2 Materials.

Use only an ADA (Americans With Disabilities Act) compliant pedestrian detector assembly listed on the Department=s Approved Product List (APL). Ensure that all pedestrian detectors are marked in accordance with Section 603 and the markings are visible after installation.

665-3 Installation.

Meet the requirements of 653-3.1, except as follows. Connect the lead-in wires to the detector in order to provide proper operation when connected to the controller.

Install the pedestrian detector assembly at the location and mounted in a manner as shown on the plans and Roadway and Traffic Design Standards, Index No. 17784 (Pedestrian Detector Assembly). Ensure that all detectors used are of the manufacturer and model.

Consider the plans to be sufficiently flexible as to allow for unanticipated field conditions at the site. The Engineer will direct any variation from the locations shown. Mount the pedestrian detector assembly at the height (center of push-button) of 32 to 4 feet [1.1 to 1.2 m] above the sidewalk. When mounting, place the detector housing or saddle in complete contact with the pole or controller cabinet. Orient the pedestrian detector assembly and sign to point in the same direction as the corresponding crosswalk. When a post is required in the installation of the pedestrian detector assembly, restore the area around the post to its original condition or as required by the plans.

665-4 Method of Measurement.

665-4.1 General: Measurement for payment will be in accordance with the following tasks.

665-4.2 Furnish and Install: The Contract unit price each for Pedestrian Detector Assembly, furnished and installed, will include all mounting hardware, lead-in wires, materials and equipment, as specified in the Contract Documents, and all labor and miscellaneous materials necessary for a complete and accepted installation.

665-4.3 Furnish: The Contract unit price each for Pedestrian Detector Assembly, furnished, will include the cost of the assembly (including all mounting hardware) plus all shipping and handling costs involved in delivery as specified in the Contract Documents.

Risers, lead-in wires, or posts are not included in furnish items.

The Contractor shall deliver the pedestrian detector assembly in a pre-assembled state. The Contractor shall package and ship component parts of the assembly in accordance with the manufacturer's instructions in order to minimize the potential for damage during shipment.

665-4.4 Install: The Contract unit price each for Pedestrian Detector Assembly, installed, will include all materials, equipment, labor and miscellaneous materials necessary to assemble and install all components for a complete and accepted installation. The Engineer will supply the pedestrian detector assembly, including mounting hardware.

665-5 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section.

Payment will be made under:

Item No. 665- Pedestrian Detector - each.
Item No. 2665 - Pedestrian Detector - each.

SECTION 670

TRAFFIC CONTROLLER ASSEMBLY

670-1 Description.

Install traffic controller assembly or flashing beacon controller assembly.

670-2 Materials.

Use a traffic controller assembly or flashing beacon controller assembly listed on the Department=s Approved Product List (APL). Ensure that the traffic controller assembly or flashing beacon controller assembly is marked in accordance with Section 603 and the markings are visible after installation.

670-3 Installation Requirements.

670-3.1 Controller Cabinets: Meet the requirements of Section 676.

670-3.2 Field Wiring: Meet the requirements of Sections 632 and 676.

670-3.3 Grounding: Meet the requirements of Sections 620 and 676.

670-3.4 Equipment Placement: Install all equipment in the cabinet in accordance with the manufacturer's recommendations.

670-4 Method of Measurement.

670-4.1 General: Measurement for payment will be in accordance with the following work tasks.

670-4.2 Furnish and Install: The Contract unit price per assembly for Traffic Controller Assembly or Flashing Beacon Controller Assembly, furnished and installed, will include all equipment specified in the Contract Documents, and all labor, equipment, and miscellaneous materials necessary for a complete and accepted installation.

670-4.3 Furnish: The Contract unit price per assembly for Traffic Controller Assembly or Flashing Beacon Controller Assembly, furnished, will include all equipment specified in the Contract Documents, plus all shipping and handling costs involved in delivery as specified in the Contract Documents.

670-4.4 Install: The Contract unit price per assembly for Traffic Controller Assembly or Flashing Beacon Controller Assembly, installed, will include all labor, equipment, and miscellaneous materials necessary for a complete and acceptable installation. The Engineer will supply the equipment specified in the Contract Documents.

670-5 Basis of Payment.

Prices and payments will be full compensation for all work specified in this Section.

Payment will be made under:

Item No. 670- 5 - Traffic Controller Assembly - per assembly.
Item No. 2670- 5 - Traffic Controller Assembly - per assembly.

SECTION 671

TRAFFIC CONTROLLERS

671-1 Description.

This Section specifies the provisions for the measurement and payment for NEMA Types D4-4, and D8 and Model 170 controller units.

671-2 Materials.

Use Traffic Controllers listed on the Department=s Approved Product List (APL). Ensure that all Traffic Controllers are marked in accordance with Section 603 and the markings are visible after installation.

671-3 Method of Measurement.

671-3.1 General: Measurement for payment will be in accordance with the following work tasks.

671-3.2 Furnish and Install: The Contract unit price each for Traffic Controller Unit, furnished and installed, will include furnishing a controller unit and harness cable as specified in the Contract Documents, and all labor and miscellaneous materials necessary for a complete and accepted installation.

671-3.3 Furnish: The Contract unit price each for Traffic Controller Unit, furnished, will include the controller unit and harness cable as specified in the Contract Documents, plus all shipping and handling costs involved in delivery as specified in the Contract Documents.

671-3.4 Install: The Contract unit price each for Traffic Controller Units, installed, will include all labor, equipment, and miscellaneous materials necessary for a complete and accepted installation. The Engineer will supply all materials as specified in the Contract Documents.

671-3.5 Modify: The Contract unit price each for Traffic Controller Units, modified, as specified in the Contract Documents, will include all labor, equipment, and miscellaneous materials necessary for a complete and accepted installation.

671-4 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section.

Payment will be made under:

Item No. 671- 2- Traffic Controller - each.
Item No. 2671- 2- Traffic Controller - each.

SECTION 676

CONTROLLER CABINETS

676-1 Description.

Install NEMA cabinets types 1, 2, 3, 4, 5, and cabinets types used for Model 170 controller assemblies.

676-2 Materials.

Use Controller Cabinets listed on the Department=s Approved Product List (APL). Ensure that all Controller Cabinets are marked in accordance with Section 603 and the markings are visible after installation.

676-3 Installation Requirements.

676-3.1 General: Install controller cabinets in accordance with the Roadway and Traffic Design Standards, Index No. 17841. Ensure that all conduit entrance holes or other holes which are field drilled are reamed and free of burrs. Make all conduit connections to the cabinet watertight by the use of clear silicone rubber sealant.

676-3.2 Pole Mounted Cabinets (Types 1, 2, 3, and 4):

(a) Fasten the pole mounted hardware which is furnished with the cabinet to the cabinet, making all connections watertight.

(b) Use stainless steel bands for mounting cabinets onto steel strain poles.

(c) Use stainless steel bands or lead anchors (or equivalent) for mounting cabinets onto concrete strain poles.

(d) Use stainless steel bands or lag bolts for mounting cabinets onto wood poles.

676-3.3 Base Mounted Cabinets (Types 4, 5, and types used for Model 170 controller assemblies):

(a) Use anchor bolts to fasten base mounted cabinets to the concrete base.

(b) Seal the joint between the bottom of the cabinet and the concrete base (inside and outside of cabinet) with a clear silicone rubber sealant.

(c) Construct the base for the cabinets with Class I Concrete in accordance with Section 347. Make the concrete base for the cabinet level, free of honeycombs and as smooth as possible. Temporarily seal the end of conduit risers located in the base before placing the concrete. Position the end of the conduit risers a minimum of 2 inches [50 mm] above the finished surface of the concrete base.

676-3.4 Field Wiring:

(a) Terminate signal cable, interconnect cable, and loop lead-in wires on the appropriate terminal strips in the controller cabinet with insulated terminal lugs. Use a calibrated ratchet type crimping tool to install the insulated terminal lugs onto the field wires.

(b) Label spare circuits of the signal and interconnect cables and connect them to the cabinet ground bussbar.

(c) Neatly bundle and identify all field wiring cables in the controller cabinet.

676-3.5 Grounding: Ground all controller cabinets in accordance with the requirements of Section 620. Keep the ground wire from the controller cabinet ground bussbar to the ground rod assembly or array as short as possible. Ensure the ground wire is not in contact with any other part of the cabinet.

676-4 Method of Measurement.

676-4.1 General: Measurement for payment will be in accordance with the following work tasks.

676-4.2 Furnish and Install: The Contract unit price each for Controller Cabinet, furnished and installed, will include all materials specified in the Contract Documents, and all labor, equipment, and miscellaneous materials necessary for a complete and acceptable installation.

676-4.3 Furnish: The Contract unit price each for Controller Cabinet, furnished, will include all materials and all shipping and handling costs involved in delivery as specified in the Contract Documents.

676-4.4 Install: The Contract unit price each for Controller Cabinet, installed, will include all labor, equipment, and miscellaneous materials necessary for a complete and acceptable installation. The Engineer will supply all materials as specified in the Contract Documents.

676-4.5 Modify: The Contract unit price each for Controller Cabinet, modified, as specified in the Contract Documents, will include all labor, equipment, and miscellaneous materials necessary for a complete and acceptable installation.

676-5 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section.

Payment will be made under:

Item No. 676- 1 - Controller Cabinet - each.
Item No. 2676- 1 - Controller Cabinet - each.

SECTION 678

CONTROLLER ACCESSORIES

678-1 Description.

Install Controller Accessories.

678-2 Materials.

Use Traffic Controller Accessories listed on the Department=s Approved Product List (APL). Ensure that all Traffic Controller Accessories are marked in accordance with Section 603 and the markings are visible after installation.

678-3 Time Switch.

Mount time switches on the inside wall of the controller cabinet in such a manner as to allow easy access for programming the switch. Ensure that the load current on the output circuit(s) of the time switch does not exceed 3 A at 115 $V_{AC.}$ Whenever time switches are used for transferring a controller assembly to and from flashing operation, wire the controller cabinet for uniform code flashing as specified in the Contract Documents.

678-4 Method of Measurement.

678-4.1 General: Measurement for payment will be in accordance with the following work tasks.

678-4.2 Furnish and Install: The Contract unit price each for Controller Accessory, furnished and installed, will include furnishing all materials, equipment, and hardware specified in the Contract Documents, and all labor and miscellaneous materials necessary for a complete and acceptable installation.

678-4.3 Furnish: The Contract unit price each for Controller Accessory, furnished, will include the cost of the equipment and materials and all shipping and handling costs involved in delivery as specified in the Contract Documents.

678-4.4 Install: The Contract unit price each for Controller Accessory, installed, will include all labor, equipment, and miscellaneous materials necessary for a complete and acceptable installation. The Engineer will supply all materials as specified in the Contract Documents.

678-5 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section.

Payment will be made under:

Item No. 678- 1 - Controller Accessories - each.
Item No. 2678- 1 - Controller Accessories - each.

SECTION 690

REMOVAL OF EXISTING TRAFFIC SIGNAL EQUIPMENT

690-1 Description.

Remove existing traffic signal equipment including electrical and electronic equipment, supporting hardware and structures, electrical wiring conduit, and all other elements specified and required to clear the areas of concern for new installations.

When removing existing traffic signal equipment, salvage and protect all equipment and materials designated for removal in the Contract Documents.

690-2 Ownership.

The Department retains ownership of the equipment removed unless otherwise stated in the Contract Documents.

690-3 General Removal Operations.

Remove and salvage all equipment, appurtenances, and materials designated on the plans to remain the property of the Department or other owner.

Where the removals require excavation, backfill, compact, and level the excavated areas (unless to be used as areas for other installations) so as to form a smooth contour, uniform in density with adjacent ground areas.

Where the removal operations require the removal or disturbance of overlying pavement, curb, grass, or sidewalk, remove such pavement and subsequently replace it in kind (or equivalent).

Remove, handle, and transport electronic equipment to be removed with all due care. Correct any damage to such equipment caused by negligence at no expense to the Department regardless of whether the damage occurs before or after removal of the equipment.

When removing all electronic equipment, also remove all attaching devices and all other devices and auxiliaries related to the electronic unit which the Department does not require to remain in place for use with replacing equipment.

Perform all removals in such a manner as to not damage or disturb adjacent property, utilities, or other equipment.

Where replacing existing functioning installations by new installations, do not remove the existing installations until the new installations are in place and operating or until temporary traffic control approved by the Engineer is in place.

Notify the proper authorities or the owners of affected adjacent installations at least 24 hours in advance of any removal operations which might endanger or otherwise affect the operations of their facilities.

Where the Contract Documents indicate that owners will remove their own poles (or others), carefully remove and handle all signal equipment from such poles prior to such removal of the poles.

690-4 Specific Removal Operations.

690-4.1 Removal of Poles and Pedestals: When removing poles and pedestals, also remove their foundations and any pole keys or dead men, guying apparatus, and other accessories or attachments thereto as may be encountered.

Accomplish the removal process of poles and pedestals in such a manner as not to result in a safety hazard to motorists or adjacent property or damage to existing utilities. Ensure that all utilities have been located prior to removal. Obtain the Engineer's approval for the removal process in advance.

If the Engineer allows partial removal of the foundation, ensure that the remaining foundation and any protrusions, such as conduit, anchor bolts, or reinforcing steel, are removed a minimum of 3 feet [1 m] below final grade.

Do not remove or disturb utility poles located within the right-of-way.

690-4.2 Controller Assembly: When removing controller assemblies, also remove the cabinet. For base mounted cabinets, completely remove the concrete base and technician pad.

Prior to removal, conduct an inventory of all controller assembly parts, cabinets, and related equipment using an appropriate list, as determined by the Engineer, including identification of the model number and serial numbers of each item. Turn over the controller assembly inventory list to the Engineer for retention by the Department or transfer the list to the equipment owner.

690-4.3 Signal Head Assembly (Vehicular and Pedestrian): Remove all signal head assemblies in such a manner as to avoid unnecessary damage. Also remove the signal head, disconnect hanger and adjustable hanger, saddle clamp, drop pipe, and all miscellaneous attachment hardware before dropping spanwire.

690-4.4 Detector Assembly (Vehicular and Pedestrian): Divide the removal of detector assemblies into the following categories:

(a) Vehicular Detector Assemblies: When the removal of vehicular detector assemblies is specified in the Contract Documents, remove the amplifier from the controller cabinet, the loop, and the lead-in wiring that is in the conduit and pull boxes.

When removing pressure type vehicular detector assemblies, remove the amplifier and the detector pad and its framework from the roadway pavement. After removing such detector assemblies, repair the roadway areas by backfilling and tamping with an approved asphaltic concrete mix or concrete pavement mix so as to restore the roadway to the satisfaction of the Engineer.

(b) Pedestrian Detector Assemblies: Include in the removal of pedestrian detector assemblies the removal of the push button detector, sign, and all mounting hardware, including the supporting post and foundation.

690-4.5 Mast Arm Assembly: Disconnect the mast arms carefully at the pole, and salvage all usable hardware and attachment devices as determined by the Engineer. Remove all devices supported by the mast arm and the wiring in the mast arm prior to the removal of the mast arm.

For integrally installed mast arms and mast arm poles, remove the pole and mast arm combination as a unit after removing the devices supported by the mast arms.

690-4.6 Cabling and Conduit: After removing the conductor cable and conduit, carefully stub, or protect with other appropriate procedures, the remaining conductor cable and conduit at the point of removal.

If the removal of any cables and conduit requires excavation, restore disturbed areas compatible with adjacent ground areas.

690-5 Transporting and Storing Removed Signal Equipment.

When the Contract Documents specify special handling, deliver equipment and materials that are not stipulated to be reused in the new installations to the location(s) designated in the Contract. When the Contract Documents note no special handling, stockpile or dispose of the removed materials as approved by the Engineer. The Engineer will determine ownership of removed equipment and will approve of the removal of any salvaged equipment from the project in advance.

Provide disposal areas, and dispose of removed concrete strain poles in such areas.

690-6 Method of Measurement.

The quantities to be paid for will be measured in accordance with the different work tasks required in this Section. The Contract unit price for each different work task as specified in the Contract Documents will include all labor and equipment required to remove the specified items specified by the Pay Item Numbers listed below.

690-7 Basis of Payment.

Prices and payments will be full compensation for all work specified in this Section.

Payment will be made under:

Item No. 690- 10- Remove Traffic Signal Head Assembly - each.
Item No. 2690- 10- Remove Traffic Signal Head Assembly - each.
Item No. 690- 20- Remove Pedestrian Signal Assembly - each.
Item No. 2690- 20- Remove Pedestrian Signal Assembly - each.
Item No. 690- 30- Remove Poles - each.
Item No. 2690- 30- Remove Poles - each.
Item No. 690- 31- Remove Signal Pedestal - each.
Item No. 2690- 31- Remove Signal Pedestal - each.
Item No. 690- 40- Remove Mast Arm Assembly - each.
Item No. 2690- 40- Remove Mast Arm Assembly - each.
Item No. 690- 50- Remove Controller Assembly - each.
Item No. 2690- 50- Remove Controller Assembly - each.
Item No. 690- 60- Remove Vehicular Detector Assembly - each.
Item No. 2690- 60- Remove Vehicular Detector Assembly - each.
Item No. 690- 70- Remove Pedestrian Detector Assembly - each.
Item No. 2690- 70- Remove Pedestrian Detector Assembly - each.
Item No. 690- 80- Remove Span Wire Assembly - each.
Item No. 2690- 80- Remove Span Wire Assembly - each.
Item No. 690- 90- Remove Cabling and Conduit - per intersection.
Item No. 2690- 90- Remove Cabling and Conduit - per intersection.
Item No. 690-100- Remove Miscellaneous Signal Equipment - per intersection.
Item No.2690-100- Remove Miscellaneous Signal Equipment - per intersection.

TRAFFIC CONTROL

SECTION 700

HIGHWAY SIGNING

700-1 Description.

Furnish and erect aluminum or steel roadway signs, with supporting posts or columns, at the locations shown in the plans, in accordance with the details shown in the plans. Reflectorize all signs, and, when so specified in the plans, provide overhead signs with lighting.

Include in the designation Roadside Traffic Signs all signs erected on the shoulders, slopes, or medians, but not extending over the traveled roadway.

The Department designates signs erected partially or completely over the traveled roadway or mounted on bridges as Overhead Traffic Signs, and may further classify some of these signs as Overhead Cantilever Traffic Signs.

700-2 Sign Assembly Design Requirements.

700-2.1 General: Sign assemblies as specified in the plans fall into three general categories: frangible support ground sign assemblies, breakaway support ground sign assemblies, and overhead sign assemblies.

Use any combination of sign materials described below. The Contractor may utilize different combinations for each type of sign assembly. However, ensure that the material combination used for each type is the same within the Contract.

700-2.2 Sign Panels: Use either aluminum or galvanized steel for any sign panel shown in the plans, regardless of its mounting type.

If using galvanized steel for the sign panels, provide the same dimensions, including the thickness, as those shown in the plans for aluminum.

Fabricate standard sign panel messages in accordance with details included in the Standard Highway Signs Manual published by the U.S. Department of Transportation. The Engineer will not require the submittal of shop drawings for these signs or for non-standard sign panels and messages fabricated in accordance with details shown in the plans. Submit seven copies of shop drawings indicating detailed layout of the sign legend, spacing, and border for all other signs to the Engineer of Record prior to fabrication.

If the size of a sign is not specified in the plans, provide the standard size sign as shown in the Standard Highway Signs Manual.

When the plans allow the use of porcelain enamel for lighted overhead signs, use only one type (reflectorized or porcelain enamel) throughout the Contract.

For panels 16 ft^2 [1.5 m^2] or less and sign panel overlays, the Contractor may use fiberglass reinforced plastic.

Provide fiberglass reinforced plastic panels in accordance with ASTM D 3841 and the following requirements and properties:

Use fiberglass reinforced plastic sign panels and overlay panels of a fiberglass reinforced thermoset polyester laminate. Use acrylic modified panels stabilized to withstand ultraviolet attack for outdoor weatherability.

Stabilize the panels so as not to release migrating constituents such as solvents, monomers, etc. Keep the surface of the laminate free from any residue release agents that will interfere with any subsequent bonding operations.

Do not use any panels containing visual cracks, pinholes, foreign inclusions, or surface wrinkles that would affect implied performance, alter the specific dimensions of the panels, or otherwise affect their serviceability.

Measure the mechanical properties in both the line direction of the panels and at 90 degrees to the line as noted in the appropriate test referenced below:

Mechanical Property	Minimum Requirement PSI [MPa]	Test
Tensile Strength	10,000 [70]	ASTM D 638 [ASTM D 638M]
Tensile Modulus	1,200,000 [8,300]	ASTM D 638 [ASTM D 638M]
Flexural Strength	20,000 [140]	ASTM D 790 [ASTM D 790M]
Flexural Modulus	1,200,000 [8,300]	ASTM D 790 [ASTM D 790M]
Compression Strength	32,000 [220]	ASTM D 695 [ASTM D 695M]
Compression Modulus	1,400,000 [9,700]	ASTM D 695 [ASTM D 695M]
Punch Shear	13,000 [90]	ASTM D 732 [ASTM D 732]

Provide panels with the following physical properties:

1. Panel Thickness:
    a. Sign Panel: 0.135 inch [3.43 mm] (tolerance ∀ 0.005 inch [∀0.13 mm])
    b. Overlay Panel: 0.075 inch [1.91 mm] (tolerance ∀ 0.005 inch [∀0.13 mm])
2. Panel Width and Length:
    a. Sign Panel: Tolerance to ∀0.09% of length when measured in accordance with ASTM D 3841.
    b. Overlay Panel: Tolerance to ∀ 0.1% of length or 0.3% of width when measured in accordance with ASTM D 3841.
3. Panel Squareness: Sign Panel and Overlay Panel - tolerance to ∀ 0.09% of length when measured in accordance with ASTM D 3841.
4. Panel Smoothness: Ensure that smoothness does not adversely affect the adhesion of the reflective sheeting or the legibility of a sign when fabricated from the panel.
5. Color: Apply a visually uniform Department green pigment to the panels.
6. Coefficient of Thermal Expansion: A maximum of 0.000018 in/in/EF [0.000032 mm/mm/EC)] when tested in accordance with ASTM D 696.
7. Weatherability: Classify the panel as to a minimum Grade II (weather resistant) panel as specified in ASTM D 3841 following a 3000 ∀ 100-hour weatherometer test.
8. Fire Resistance: Ensure that the extent of burning does not exceed 1 inch [25 mm] when tested in accordance with ASTM D 635.
9. Panel Flatness: Provide five 30 by 30 inch [760 by 760 mm] fiber

reinforced plastic panels for this test. Measure initial warpage in four directions: 0 degree, 45 degrees, 90 degrees and 135 degrees. To measure warpage, freely suspend the panel at one corner, and place a straight edge along the panel so that the edges of the panel touch the straight edge. Exercise care to avoid disturbing the dimensional characteristics of the panel. Use a rule graduated in inches [millimeters] to measure the distance from the center of the panel face to the straight edge. Measure that distance to the nearest 1/32 inch [1 mm] in all four directions. Ensure that the maximum deflection does not exceed 15/32 inch [12 mm].

Then, freely suspend the panels diagonally in an oven for 48 hours at 180EF [82EC]. After 48 hours in the oven, remove the panels and allow them to cool to room temperature freely suspended. Again, record the warpage measurements and corresponding direction as described above. Ensure that the maximum deflection does not exceed 15/32 inch [12 mm].

10. Thermal Stability: Do not allow temperatures ranging from -65 to 212EF [-54 to 100EC] to appreciably affect the strength and impact resistance qualities of the panels. Determine the coefficient of linear thermal expansion in accordance with ASTM D 696.

11. Impact Resistance:

a. Sign Panel: Use a 1.18-pound [0.535 kg] falling ball test in accordance with ASTM D 3841 to ensure that the panel resists an impact of the ball dropped at 60 feet [18 m].

b. Overlay Panel: Use a 5.0-pound [2.27 kg] falling ball test in accordance with ASTM D 3841, to ensure that the panel resists an impact of the ball dropped at 4 feet [1.2 m].

12. Certification Requirements: Furnish to the Engineer six certified copies of a statement from the producer certifying that the materials described above meet all the requirements herein and they have passed all the stipulated tests.

700-2.3 Roadside Sign Supports:

700-2.3.1 Frangible Supports: Provide posts for all frangible sign assemblies consisting of aluminum tubes up to 32 inches [90 mm] outside diameter with 3/16 inch [4.76 mm] wall thickness, or galvanized steel U-Channel up to 3 lb/ft [4.5 kg/m] as listed on the Qualified Products List, and in accordance with Roadway and Traffic Design Standards, Index Nos. 11860 through 11865 for frangible sign supports.

Provide all single column signs mounted on a tubular post, not requiring a foundation, with a standard extruded aluminum sign bracket clamped on the post 12 inches [300 mm] below grade. Match bracket size with the post diameter.

700-2.3.2 Breakaway Supports: For posts for breakaway sign assemblies, the Contractor may use either aluminum or galvanized steel in accordance with the requirements for breakaway signs in the Roadway and Traffic Design Standards.

The Engineer will accept breakaway sign assemblies utilizing load concentrating couplers as an alternate to the slip base. Supply erection drawings with the assemblies. Supply evidence that the proposed couplers meet the breakaway requirements of the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals, prior to use on a project.

The Department lists alternate proprietary and non-proprietary breakaway assemblies on the Qualified Products List. For an acceptable non-proprietary breakaway lap splice for U-Channel steel posts, refer to the U-Channel Lap Splice Detail. The Engineer may accept other alternate breakaway designs if satisfactorily tested in accordance with the current AASHTO requirements.

700-2.3.3 Steel Posts: When using steel posts as the structural member in a full length support or breakaway base installation for a small roadway sign, provide steel flanged U-channel consisting of rerolled rail steel or an equivalent billet steel, meeting the mechanical requirements of ASTM A 499, Grade 60, and meeting the chemical requirements of ASTM A 1. For each U-channel, punch or drill δ inch [9.5 mm] diameter holes on 1 inch [25 mm] centers through the center of the post, starting approximately 1 inch [25 mm] from the top and extending the full length of the U-post. Ensure that the weight per foot [meter] of a particular manufacturer's U-channel size does not vary more than ∀32% of its specified weight per foot [meter]. Taper the bottom end of the U-channel post for easier installation. Machine straighten the U-channel to a tolerance of 0.4% of the length. Ensure that post configuration generally complies with the dimensions for Type F or Type M flanged U-channel, as shown on Roadway and Traffic Design Standards, Index No. 11865.

Only provide steel components that have been galvanized after fabrication in accordance with ASTM A 123 [ASTM A 123M] and have a smooth uniform finish free from defects affecting strength, durability, and appearance.

Attach the sign to the structural member using hardware meeting the manufacturer's recommendations and as specified in the Roadway and Traffic Design Standards. Only use attachment hardware (nuts, bolts, clamps, brackets, braces, etc.) of a non-corrosive metal, aluminum, or galvanized steel, meeting the requirements specified on the Roadway and Traffic Design Standards, Index Nos. 11860 through 11865.

700-2.4 Overhead Sign Structures:

700-2.4.1 Department's Design: When the overhead sign structure is detailed in the plans, submit shop drawings to the Department for approval as specified in Section 5. Prior to the submittal of the shop drawings, determine the actual length of support columns for all sign structures on the basis of existing field conditions and include these lengths on the shop drawings.

700-2.4.2 Contractor's Design: When the overhead sign structure is not detailed in the plans, submit to the Department a sign structure design utilizing steel structural members. Meet the requirements of this Section and the AASHTO Specification for the Design and Construction of Structural Supports for Highway Signs, Luminaires and Traffic Signals.

Use a design wind speed as shown on the Contract drawings. When a sign structure is attached to a bridge or wall structure, ensure that the loads from the sign structure applied to the bridge or wall structure are equal to or less than those shown on the Contract drawings. When the sign support is not on a structure, the Contractor is responsible for the design of the foundation.

Have designs and shop drawings prepared by a Specialty Engineer, and submit them to the Department for review and approval in accordance with Section 5.

Determine the actual length of support columns for all sign structures on the basis of existing field conditions, and include these lengths in the shop drawings and calculations.

700-2.5 Sign Background: Use Type III-A, III-B, or III-C sheeting for background sheeting and white legends, borders, and shields on all signs, excluding STOP, DO NOT ENTER, and WRONG WAY. Use Type III-D sheeting for STOP, DO NOT ENTER, and WRONG WAY signs.

700-3 Materials.

700-3.1 General: Meet the materials requirements shown below and any additional requirements which the plans might show.

700-3.2 Concrete: For footings, use Class II concrete meeting the requirements of Section 346.

700-3.3 Reinforcing Steel: For reinforcing steel in footings, meet the requirements of Section 415.

700-3.4 Aluminum Materials:

700-3.4.1 General: For aluminum materials, meet the general provisions of 965-1.

700-3.4.2 Sheets and Plates: For aluminum sheets and plates for sign panels, meet the requirements of ASTM B 209, [ASTM B 209M], Aluminum Association Alloy 6061-T6, 5154-H38 or 5052-H38 and those shown in the plans.

700-3.4.3 Extruded Tubing: For extruded aluminum tubing, meet the requirements shown in the plans.

700-3.4.4 Castings: Provide aluminum castings of the alloys shown in the plans. For aluminum alternates the Engineer will allow a cast base, provided the Contractor submits test reports are submitted giving evidence that the base to be used for each pole size is as strong as the pole with which it is to be used. Perform physical tests and submit certified reports for one base to be used with each pole size. Use Alloy A 356-T6 for the castings. Use aluminum bolts for connecting parts of the cast base.

700-3.4.5 Channels: For aluminum channels, meet the requirements of ASTM B 308 [ASTM B 308M] for the alloys shown in the plans.

700-3.4.6 Bolts, Nuts, and Lockwashers: For aluminum bolts, nuts, and lockwashers, meet the requirements shown in the plans. Ensure that finished bolts and washers are given an anodic coating of at least 0.0002 inch [5 μm] in thickness and are chromate-sealed.

700-3.5 Steel:

700-3.5.1 General: Only use structural steel, including bolts, nuts, and washers, that have been hot dip galvanized or metalized after fabrication. Perform hot dip galvanizing in accordance with ASTM A 123 [ASTM A 123M] or ASTM A 153 [ASTM A 153M] and metalizing in accordance with Section 562. For galvanized steel members, except plate for sign panels, meet the general requirements of Section 962 and the specific requirements of 962-7. For steel plate for use as sign panels, meet the requirements of ASTM A 283 [ASTM A 283M] for either Grade C or Grade D.

700-3.5.2 Specific Uses of Aluminum and Galvanized Steel: Use aluminum bolts, nuts, and hardware to connect parts of the cast base.

Use galvanized steel anchor bolts for anchoring base plates to concrete bases and for the nuts and washers therefor.

For all other metal parts, the Engineer will allow galvanized steel as an alternate to aluminum.

700-3.6 Bearing Pads: For bearing pads, meet the requirements of 932-2.

700-3.7 Reflective Sheeting: Meet the reflective sheeting requirements of Section 994.

700-3.8 Process Colors: Use transparent and black opaque process colors meeting the requirements of 994-5 on reflective sheeting.

700-3.9 Demountable Sign Face Materials: For demountable sign face materials, meet the requirements of Section 995.

700-3.10 Porcelain Enamel Background: For porcelain enamel background material, meet the requirements of Section 996.

700-4 Preparation of Sign Blanks.

700-4.1 De-greasing and Etching for Aluminum Sign Blanks:

700-4.1.1 General: Prior to the application of reflective sheeting, use any of the methods shown below to de-grease and etch the aluminum sign blanks.

700-4.1.2 Hand Method: Under this method, de-grease and etch the blanks in one operation, using steel wool (medium grade) with any of the following combinations of materials:

(1) An abrasive cleanser of a commercial grade kitchen scouring powder.

(2) Acid and a suitable detergent solution.

(3) An alkaline solution.

Thoroughly rinse the blanks with clean water following all hand de-greasing operations.

700-4.1.3 Power-Washer Method: Under this method, de-grease the blanks with an inhibited alkaline cleanser, by spraying for 90 seconds with the solution between 135 and 249EF [57 and 120EC], the exact temperature to be as recommended by the manufacturer of the cleanser. After the spraying, rinse the blanks with clean water. Then etch the blanks by immersing them in a 6 to 8% solution of phosphoric acid at a temperature of 100 to 180EF [38 to 82EC] for 60 seconds. After immersion, rinse the blanks in clean water.

700-4.1.4 Immersion Method: Under this method, de-grease the blanks by immersing them in a solution of inhibited alkaline cleanser at a temperature between 160 and 180EF [71 and 82EC] for three to five minutes, and then rinsing with clean water. Then etch blanks by immersing them in a 6 to 8% solution of phosphoric acid at a temperature of 100EF [38EC] for three minutes. After immersion, rinse the blanks in clean water.

700-4.1.5 Vapor De-greasing Method: Under this method, de-grease the blanks by totally immersing them in a saturated vapor of trichloroethylene. Remove trademark printing with lacquer thinner or a controlled alkaline cleaning system.

700-4.1.6 Alkaline De-greasing Method: De-grease the blanks by totally immersing them in a tank containing an alkaline solution, controlled and titrated in accordance with the solution manufacturer's directions. Adapt immersion time to the amount of soil present and the thickness of the metal. After immersion, thoroughly rinse the blanks with running water.

700-4.1.7 Etching Method when De-greasing is Separate Operation: If using either of the de-greasing methods described under 700-4.1.5 and 700-4.1.6, accomplish etching by one of the following alternate methods:

(1) Acid Etch: Etch well in a 6 to 8% phosphoric acid solution at 100EF [38EC], or in a proprietary acid etching solution. Rinse thoroughly with running cold water, which may be followed by a hot water rinse.

(2) Alkaline Etch: Etch aluminum surfaces in an alkaline etching material that is controlled by titration. Meet the time, temperature, and concentration requirements specified by the solution manufacturer. After completing etching is complete, rinse the panel thoroughly.

700-4.2 Preparation of Surface for Steel Sign Blanks: Clean and prepare galvanized steel sign blanks for painting or for application of reflective sheeting in accordance with the recommendations of the manufacturer of the material to be applied to the sign blanks.

700-4.3 Drying: Dry the panels using a forced-air drier. Use a device or clean canvas gloves, to handle the material between all cleaning and etching operations and the application of reflective sheeting. Do not allow the metal to come in contact with greases, oils or other contaminants prior to the application of reflective sheeting.

700-4.4 Fabrication of Sign Blanks: Fabricate all metal parts to ensure a proper fit of all sign components. Complete all fabrication, with the exception of cutting and punching of holes, prior to metal de-greasing and applying the reflective sheeting. Cut metal panels to size and shape and keep free of buckles, warp, dents, burrs, and defects resulting from fabrication. Provide all sign panels with a flat surface. Where signs are to be fabricated from galvanized steel, cut the plates to the required size and drill prior to galvanizing.

700-5 Fabrication of Reflectorized Sign Faces.

700-5.1 Application of Sheeting: Apply reflective sheeting to the base panels with mechanical equipment in a manner specified for the manufacture of traffic control signs by the sheeting manufacturer. Ensure that sheeting applied to extruded aluminum sections adheres over and around the side legs of all panels to a minimum distance of 1/16 inch [1.5 mm] beyond the radius of top edge.

Match sign faces comprising two or more pieces of reflective sheeting for color and reflectivity at the time of sign fabrication. Reverse and apply consecutively alternate successive width sections of either sheeting or panels to ensure that corresponding edges of sheeting lie adjacent on the finished sign. The Engineer will not accept nonconformance that may result in nonuniform shading and an undesirable contrast between adjacent widths of applied sheeting.

700-5.2 Finish: Seal reflective sheeting splices and sign edges with materials the sheeting manufacturer supplies in a manner the sheeting manufacturer specifies for traffic control signs.

700-5.3 Screening-on Message: Screen message and borders on reflective sheeting in accordance with the recommendations of the paint manufacturer. Process either before or after applying the sheeting to the base panels.

700-5.4 Finished Sign Face: Provide finished signs with clean cut and sharp messages and borders. Ensure that finished background panels are essentially a plane surface.

700-5.5 Stenciling: Permanently mark the back of all finished panels at the bottom edge with "FDOT", the date of fabrication, the date of installation, and the fabricator's initials. Make the markings unobtrusive, but legible enough to be easily read by an observer on the ground when the sign is in its final position. Apply the markings in a manner that is at least as durable as the sign face.

700-5.6 Product Changes: If changes in the formulation of the sheeting occur, submit new samples for re-evaluation for continued approval.

700-6 Painting Panels for Nonreflectorized Background.

When specified in the Contract Documents, provide all Type A and Type B signs, all GORE EXIT signs, and all REST AREA signs with a nonreflectorized background, composed of one spray coat of primer and two finish coats of baked enamel, as specified below. Make the REST AREA signs blue and all others green.

After the cleaning and etching, give these sign faces one spray coat of primer of the type the manufacturer of the finish coats recommends. Allow this prime coat to dry for at least 12 hours and until dry, after which, give the sign faces two coats of finish paint meeting the following requirements.

Provide finish coats of baked alkyd resin enamels meeting Federal Specifications TT-E-529A, Class B, of a composition which effects on the finished background surface, when thoroughly dry, colors matching those described in the current Highway Blue Color Tolerance Chart, PR Color No. 3, or in Highway Green Color Tolerance Chart, PR Color No. 4, published by the U.S. Department of Commerce, Bureau of Public Roads (now designated as the U.S. Department of Transportation, FHWA, Washington, D.C. 20590), as specified for the particular application. The Department will judge the color match visually per the Chart directions but the Department may use instrumental methods in the case of questionable visual matches.

Revise the package viscosity requirement on the opaque paints, as specified in Federal Specifications TT-E-529A, as follows: change the maximum requirement for Viscosity (Package), No. 4 Ford Cup, for Class B, from 110 seconds as shown to 150 seconds.

Ensure that the manufacturer of the enamel paints furnishes the Engineer with six copies of a certified test report indicating that the paint furnished meets the above requirements. Identify the pigmentation by the appropriate color number in Table I, and show the manufacturer's test results for compliance with the requirements of 3.3.1, 3.3.2.2, 3.4.1, and 3.4.2 of Federal Specifications TT-E-529A.

Notwithstanding the certification required, the Department reserves the right to test this paint. Submit samples to the Engineer in accordance with 6-5.

700-7 Acceptance of Signs.

700-7.1 Manufacturer's Certification and Recommendations: Ensure that the sign manufacturer provides producer's certifications of materials incorporated into the signs. Ensure that the sign manufacturer certifies that the delivered signs conform to this Section and provides recommendations for storing and repairing signs.

700-7.2 Packaging and Shipping: Have the manufacturer package and ship the signs in a manner which will minimize possible damage.

700-7.3 Storage of Signs: If signs are stored prior to installation, store them in accordance with the manufacturer's recommendations.

700-7.4 Sign Inspection: Do not install signs until the Engineer inspects them for conformance with this Section. Provide all manufacturer certifications and recommendations prior to the Engineer's inspection. The Engineer will inspect the signs upon delivery to the storage or project site and again at the final construction inspection. Repair and replace signs deemed unacceptable by the Engineer at no expense to the Department.

700-7.5 Imperfections and Repairs: Repair and replace signs containing imperfections or damage regardless of the kind, type, or cause of the imperfections or damage. Make repairs according to the manufacturer's recommendations and to the satisfaction of the Engineer. Ensure that completed repairs provide a level of quality necessary to maintain the service life warranty of the sign and are satisfactory in appearance to the Engineer.

700-8 Footings for Signs, Posts and Supports.

700-8.1 Excavation and Backfilling: Perform excavation and backfilling for the footings in accordance with Section 125, with the exceptions that no specific density is required and that the backfill may be tamped in 4 inches [100 mm] maximum layers. Use material that is at near optimum moisture and neither dry or saturated, and tamp to the extent directed by the Engineer. The Department may require that the backfilling be done with poured concrete.

Install spread footings which support sign structures overhanging the roadway as required in 455-25 through 455-37.

700-8.2 Mixing and Placing Concrete: For batching and mixing of concrete for footings, meet the requirements of Section 346, except that the Engineer will allow hand mixing by approved methods where the quantity to be mixed does not exceed 2 yd^3 [0.4 m^3]. Use cast-in-place or precast concrete for the footings.

700-8.3 Forms: The Engineer will not require forms when the ground is sufficiently firm, in which case, sufficiently moisten the adjacent earth to prevent it from absorbing the moisture from the concrete. Where forms are required and the soil is not moist, place sufficient water, as directed by the Engineer, in the hole, and pour the concrete as soon as the water has been absorbed. Place at least 4 inches [100 mm] of loose earth, free from clods or gravel, over the top of the footing to effect curing.

700-8.4 Finishing Concrete: Trowel the top of the concrete to a smooth finish.

700-8.5 Removal of Footing: When the plans call for existing ground-mounted signs to be modified or removed, immediately remove supports and footings that project more than 6 inches [150 mm] above the ground surface after removing the sign panel from the assembly. Remove existing footings to a depth at least 12 inches [300 mm] below the ground surface. The costs will be included in the Contract unit price of the item to which it is incidental.

700-9 Erection of Signs and Sign Supports.

Do not erect overhead sign supports until the concrete in the support footing has cured for at least seven days. The Engineer may allow sign support erections prior to seven days provided the footing concrete strength is at least 2,500 psi [17 MPa]. Determine concrete strength from tests on a minimum of two test cylinders, tested in accordance with Section 346.

Erect the signs and sign structures in accordance with the details shown in the plans. The Contractor may fabricate the structural steel sign trusses in sections that will fit into available galvanizing vats. Prior to galvanizing, weld the joints as specified in 460-6 and in accordance with the details shown in the plans. Metalize damaged parts as specified in Section 562.

Weld aluminum structures in accordance with 965-3.

700-10 Method of Measurement.

The quantities to be paid for will be:

(1) The number of roadside traffic signs of each designated class of assembly, complete.

(2) The number of overhead traffic signs of each designated class of assembly, complete.

(3) The number of lighted overhead traffic signs of each designated class of assembly, complete.

(4) The number of existing signs removed, relocated, modified, lighted, placed on breakaway or nonbreakaway supports, of each designated class of assembly, complete.

(5) The number of each existing sign refurbished, existing sign panel removed, pole installed, exit numbering panel, and mile post, complete.

(6) The number of overhead signs span wire mounted, bridge mounted, and lighted sequential, of each designated class of assembly, complete.

(7) The number of lighted roadside signs of each designated class of assembly, complete.

For the purpose of payment, a sign assembly consists of all the signs mounted on a single structure (one, two or three posts, or overhead structure) or all the signs on a bridge mounted sign structure and the sign structure.

700-11 Basis of Payment.

Price and payment will be full compensation for furnishing and installation of all materials necessary to complete the signs in accordance with the details shown in the plans; including sign panels complete with sheeting, painting, and message; sign posts and supports, footings, excavation, etc.; for the lighted signs, all costs of the electrical installation for lighting, up to the point of connection by others; and all other work specified in this Section, including all incidentals necessary for the complete item.

SECTION 701

RAISED RIB SHOULDER WARNING DEVICES

701-1 Description.

Place raised rib shoulder warning devices in accordance with the Contract Documents and remove raised rib shoulder warning devices as required.

701-2 Materials.

701-2.1 Thermoplastic Material: Use only thermoplastic material listed on the Qualified Products List (QPL), meeting the requirements of 971-1 and 971-21. The Engineer will take random samples of the materials in accordance with the Department=s Sampling, Testing and Reporting Guide schedule.

701-2.2 Glass Spheres: Use only glass spheres listed on the Qualified Products List (QPL), meeting the requirements of 971-1 and 971-14. The Engineer will take random samples of the glass spheres in accordance with FM 3D-1155 and the Department=s Sampling, Testing and Reporting Guide schedule.

701-3 Equipment.

Use equipment capable of providing continuous, uniform heating of the material to temperatures exceeding 390EF [200EC], mixing and agitating the material in the reservoir to prevent accumulation and clogging of dispensing devices and maintain the material in a plastic state until applied. Provide easy access for cleaning and maintenance of all parts of the equipment which contact the material. Use equipment which has a screed extrusion die capable of simultaneously applying line widths up to a 12 inches [305 mm] with two or three ribs extending over 80% of the line width in the configuration shown on the plans. Do not use of pans, aprons or similar appliances which the dispenser overruns. Additionally, use equipment that meets the following requirements:

(a) capable of traveling at a uniform rate of speed, both uphill and downhill, to produce a uniform application of thermoplastic material and capable of following straight lines and making normal curves in true arcs.

(b) capable of applying glass spheres to the surface of the completed stripe by an automatic sphere dispenser attached to the striping machine such that the glass spheres are dispensed closely behind the installed line. Use a glass spheres dispenser equipped with an automatic cut-off control synchronized with the cut-off of the thermoplastic material and applies the glass spheres in a manner such that the spheres appear uniform on the entire traffic stripes and markings surface with, 50 to 60% embedment.

(c) equipped with a special kettle with an automatic temperature control device, and material thermometer for positive temperature control for uniformly melting and heating and to prevent overheating or scorching of the thermoplastic material.

(d) meets the requirements of the National Fire Protection Association, state, and local authorities.

701-4 Application.

701-4.1 General: Apply raised rib shoulder warning devices to the pavement using screed extrusion equipment. The Engineer will conduct field tests in accordance with FM 5-541. Remove and replace raised rib shoulder warning devices not meeting the requirements of this Section at no additional cost to the Department.

Ensure that existing pavement markings are removed, such that scars or traces of removed markings will not conflict with new stripes and markings by a method approved by the Engineer.

Prior to applying pavement stripes and markings, remove any material that would adversely affect the bond of the pavement stripes and markings by a method approved by the Engineer.

Apply traffic stripes or markings only to dry surfaces, and when the ambient air and surface temperature is at least 55EF [13°C] and rising. Follow the manufacturer=s recommendations for application temperature.

Offset longitudinal lines at least 2 inches [50 mm] from construction joints of portland cement concrete pavement.

Prior to installation of the raised rib thermoplastic material, apply a 2-part epoxy primer sealer recommended by the manufacturer, on all portland cement concrete surfaces.

Apply traffic stripes or markings, having well defined edges, over existing pavement markings such that not more than 2 inches [50 mm] on either end and not more than 1 inch [25 mm] on either side is visible.

Apply raised rib shoulder warning devices 6 inches [150 mm] wide with one drainage channel and raised rib shoulder warning devices 8 inches [200 mm] or greater with two drainage channels. The transverse width of each rib segment will not be less than 33 inches [80 mm]; the width of each drainage channel will not exceed 2 inch [13 mm].

Apply all final pavement markings prior to opening the road to traffic.

701-4.2 Corrections for Deficiencies to Raised Rib Shoulder Warning Devices: Remove and reapply a 1.0 mile [1.0 kilometer] LOT centered around any deficiency, at no additional cost to the Department.

701-4.3 Thickness: Construct raised rib shoulder warning devices that after application of drop-on glass spheres (AASHTO M 247 Type I), will have a thickness of 0.6 to 0.7 inch [15 to 18 mm], including the base line, when measured above pavement surface at the edge of the raised rib shoulder warning devices.

Construct base lines having a thickness of 0.079 to 0.085 inch [2 mm to 2.2 mm], exclusive of the raised ribs, when measured above pavement surface at the edge of the base line.

The Engineer will measure raised rib shoulder warning device thickness using one of the following devices: Micrometer, Vernier Calipers or a Starrett No. 270 Taper Gage.

When using a micrometer or vernier calipers, the Engineer will place black tapes or metal plates of known uniform thickness in the area where the raised rib shoulder warning devices are to be placed; after placement of the raised rib shoulder warning devices, the sample is removed from the pavement and measured for thickness with a proper correction for the film base.

When using a Starrett No. 270 Taper Gage, the Engineer will place a metal straight edge lengthwise across the raised rib shoulder warning devices and sliding a taper thickness gage underneath the metal straight edge until contact is made.

701-4.4 Audible Requirements: Construct raised rib shoulder warning devices meeting the following minimum requirements when tested by the Engineer, in accordance with FM 5-541:

In a car at 50 MPH [80 KPH]	Equal to 80 dB
In a car at 60 MPH [97 KPH]	Equal to 90 dB

701-4.5 Glass Spheres: Apply reflective glass spheres to all raised rib shoulder warning devices, at the rate of 0.10 lb/ft^2 [0.5 kg/m^2] of material with, 50 to 60% embedment.

701-4.6 Retroreflectivity: Construct white and yellow raised rib shoulder warning devices that will attain an initial retroreflectance of not less than 300 cd/fcAft5 [300 mcd/lxAm5] and not less than 250 cd/fcAft5 [250 mcd/lxAm5], respectively. Ensure that the intermittent and final retroreflectance of white and yellow pavement markings are not less than 150 cd/fcAft5 [150 mcd/lxAm5].

701-4.7 Color: Use white thermoplastic material that is pure white, free from any tint and showing no deviations from magnesium oxide color standard greater than the following:

Scale Definition	Magnesium Oxide Standard	Sample
RD	100	75% minimum
Reflectance		
a. Red-Green	0	-5 to +5
b. Yellow-Blue	0	-10 to +10

Use yellow thermoplastic material which visually matches Federal Test Standard Number 595-color 33538, and meet the following criteria for chromaticity coordinates (x,y):

x	0.455	0.510	0.472	0.530
y	0.444	0.485	0.400	0.456

701-4.8 Durability: Durability will be measured as the percent of thermoplastic material completely removed from the pavement. The thermoplastic material line loss shall not exceed 5.0%.

701-5 Contractor's Responsibility for Notification.

Notify the Engineer prior to the placement of raised rib shoulder warning devices. Furnish the Engineer with the manufacturer=s name and LOT numbers of the thermoplastic materials and glass spheres to be used. Ensure that the approved LOT numbers appear on the thermoplastic materials and glass spheres packages. Submit a certified test report to the Engineer indicating that the materials meet all requirements specified.

701-6 Protection of Newly Applied Raised Rib Shoulder Warning Devices.

Do not allow traffic onto newly applied pavement markings until they are sufficiently dry to permit vehicles to cross them without damage. Remove and replace any portion of the pavement markings damaged by passing traffic or from any other cause, at no additional cost to the Department.

701-7 Method of Measurement.

The quantities to be paid for under this Section will be the length, in net miles [kilometers], of raised rib shoulder warning devices, authorized and acceptably applied.

701-8 Basis of Payment.

Prices and payments will be full compensation for all work specified in this Section, including, all cleaning and preparing of surfaces, furnishing of all materials, application, curing and protection of all items, protection of traffic, furnishing of all tools, machines and equipment, and all incidentals necessary to complete the work. Final payment will be withheld until all deficiencies are corrected. Removal of raised rib shoulder warning devices shall be paid for under Pay Item 711-7 [Pay Item 2711-7].

Payment will be made under:

Item No. 701-1 - Solid Raised Rib Shoulder Warning Device - 6 inch.
Item No. 2701-1 - Solid Raised Rib Shoulder Warning Device - 150 mm.
Item No. 701-2 - Solid Raised Rib Shoulder Warning Device - 8 inch.
Item No. 2701-2 - Solid Raised Rib Shoulder Warning Device - 200 mm.
Item No. 701-3 - Solid Raised Rib Shoulder Warning Device - 10 inch.
Item No. 2701-3 - Solid Raised Rib Shoulder Warning Device - 250 mm.
Item No. 701-4 - Solid Raised Rib Shoulder Warning Device - 12 inch.
Item No. 2701-4 - Solid Raised Rib Shoulder Warning Device - 300 mm.

SECTION 705

HIGHWAY DELINEATORS

705-1 Description.

Furnish and install object markers and highway delineators, with supporting posts, of the types and at the locations called for in the plans. Highway delineators consist of a reflector, or reflective sheeting permanently adhered to sheet aluminum, mounted to delineator post. Use only delineator posts, reflectors and reflective sheeting listed on the Qualified Products List.

705-2 Materials.

705-2.1 Delineator Assembly: Meet the requirements of Sections 993 and 994.

705-2.2 Object Markers: Meet the arrangement and design requirements of Section 3C of the MUTCD, with the following additions:

(1) Use 0.080 inch [2.0 mm] aluminum sheets and plates and conform to ASTM B 209 [ASTM B 209M], Aluminum Association Alloy 6061-T6 or

5052-H38, or Fiberglass Reinforced Plastic Sign Panels conforming to 700-2.2.

(2) Obtain the Engineer=s approval of the object marker bracket and attachment.

705-2.3 Metal Delineator Posts: Meet the requirements of Section 993.

705-2.4 Flexible Delineator Posts: Meet the requirements of Section 972.

705-2.5 Reflective Sheeting for Delineator Posts: Use Types III-A, III-B, III-C, or III-D reflective sheeting meeting the requirements of Section 994.

705-3 Installation Requirements.

Install the posts and mount the delineator assemblies or object markers to the top of the posts in accordance with the manufacturer=s instructions. Install surface mounted posts to a height of 36 inches [1 m] from the existing surface to the top of the posts. Install ground mounted posts to a height of 48 inches [1.2 m] from the existing ground to the top of the posts.

Where reflective sheeting is a part of the delineator assembly, provide an assembly having a minimum of 4 by 8 inches [100 by 200 mm] of reflective sheeting, free of physical damage prior to and after installation. Mount the reflective sheeting using pressure sensitive adhesive in accordance with sheeting manufacturer=s requirements, to prevent disbonding of the sheeting during the life of the post.

705-4 Method of Measurement.

The quantity to be paid for will be the number of delineators or object markers furnished, installed and accepted.

705-5 Basis of Payment.

Prices and payments will be full compensation for work specified in this Section, including the cost of labor, materials, and incidental items required to complete the work.

Payment will be made under:

Item No. 705- 1- Delineator, Single Unit - each.
Item No. 2705- 1- Delineator, Single Unit - each.
Item No. 705- 2- Delineator, Double Unit - each.
Item No. 2705- 2- Delineator, Double Unit - each.
Item No. 705- 3- Delineator, Triple Unit - each.
Item No. 2705- 3- Delineator, Triple Unit - each.
Item No. 705- 10- Object Marker - each.
Item No. 2705- 10- Object Marker - each.
Item No. 705- 71- Tubular Delineator (Flexible) - each.
Item No. 2705- 71- Tubular Delineator (Flexible) - each.

SECTION 706

RAISED RETRO-REFLECTIVE PAVEMENT MARKERS AND

BITUMINOUS ADHESIVE

706-1 Description.

Place raised Retro-Reflective Pavement Markers (RPMs) and adhesive, which upon installation produces a positive guidance system to supplement other reflective pavement markings.

706-2 Materials.

Use only RPM materials and bituminous adhesives listed on the Qualified Products List (QPL). Meet the material requirements of Section 970. The Engineer will take random samples of the RPMs in accordance with the Department=s Sampling, Testing and Reporting Guide schedule.

Use only Class B markers unless otherwise shown in the plans.

706-3 Equipment.

Use equipment having either thermostatically controlled double boiler type units utilizing heat transfer oil or thermostatically controlled electric heating pots to install hot applied bituminous adhesive. Do not use direct flame melting units with flexible adhesives; however, this type of unit may be used with standard adhesive in accordance with manufacturer's recommendations. Use a melter/applicator unit suited for both melting and pumping the adhesive through heated applicator hoses.

Heat the adhesive to between 375 and 425EF [190 and 220EC] and apply directly to the bonding surface from the melter/applicator by either pumping or pouring. Maintain the application temperature between 375 and 425EF [190 and 220EC]. The adhesive may be reheated. However, do not exceed the manufacturer=s recommendations for pot life at application temperatures.

706-4 Application.

Apply RPMs to the bonding surface using bituminous adhesives only. The Engineer will conduct field testing in accordance with FM 5-566. Correct RPMs not applied in accordance with these requirements at no cost to the Department.

Prior to application of adhesive, clean the portion of the bonding surface of any material which would adversely affect the adhesive.

Apply the adhesive to the bonding surface (not the marker) so that 100% of the bonding area of the marker will be covered, in accordance with adhesive manufacturer=s recommendations. Apply sufficient adhesive to ensure, that when the marker is pressed downward into the adhesive, adhesive will be forced out around the entire perimeter of the marker.

Immediately remove excess adhesive from the bonding surface and exposed surfaces of the RPMs. Soft rags moistened with mineral spirits meeting Federal Specifications TT-T-291 or kerosene may be used to remove adhesive from exposed faces of the RPMs. Do not use any other solvent. If any adhesive, pavement marking materials or other foreign matter adheres to the reflective face of the marker, replace the marker at no cost to the Department.

Install RPMs with the reflective face of the RPM perpendicular to a line parallel to the roadway centerline. Do not install RPMs over longitudinal or transverse joints of the bonding surface.

Ensure that all final RPMs are in place prior to opening the road to traffic.

If more than 2% of the RPMs fail in adhesion or alignment within the first 45 days under traffic, replace all failed markers at no expense to the Department. If more than 5% of the markers fail in adhesion and or alignment during the initial 45 day period, the Engineer will extend the replacement period an additional 45 days from the date that all replacement markers have been installed. If, at the end of the additional 45 day period, more than 2% of all markers (initial installation and 45 day replacements combined) fail in adhesion or alignment, replace all failed markers at no expense to the Department.

706-5 Contractor=s Responsibility for Notification.

Notify the Engineer prior to the placement of RPMs. At the time of notification, indicate the manufacturer and the LOT numbers of RPMs and bituminous adhesive that are intended for use. Verify that the approved LOT numbers appear on the material packages. Furnish a test report to the Engineer certifying that the materials meet all requirements specified.

706-6 Method of Measurement.

The quantities to be paid for will be the number of RPMs, furnished and installed, completed and accepted.

706-7 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section.

Payment will be made under:

Item No. 706- 3- Retro-Reflective Pavement Markers - each.
Item No. 2706- 3- Retro-Reflective Pavement Markers - each.

SECTION 709

TRAFFIC STRIPES AND MARKINGS -

TWO REACTIVE COMPONENTS

709-1 Description.

Apply Two Reactive Component traffic stripes and markings in accordance with the details shown in the Contract documents and remove traffic stripes and markings when required.

709-2 Materials.

709-2.1 Two Reactive Components: Use only Two Reactive Component materials listed on the Qualified Products List (QPL), and meet the requirements of 971-1 and 971-12. The Engineer will take random samples of the materials in accordance with the Department=s Sampling, Testing and Reporting Guide schedule.

709-2.2 Glass Spheres: Use only glass spheres listed on the Qualified Products List (QPL), and meet the requirements of 971-1 and 971-14. The Engineer will take random samples of the glass spheres in accordance with FM 3D-1155 and the Department=s Sampling, Testing and Reporting Guide schedule.

709-3 Equipment.

Apply the Two Reactive Component material to the pavement utilizing equipment that will produce continuously uniform dimensions of the stripe, of varying widths and meet the following requirements:

(a) capable of traveling at a uniform rate of speed, both uphill and downhill, to produce a uniform application of the Two Reactive Component material and capable of following straight lines and making normal curves in true arcs.

(b) capable of applying glass spheres to the surface of the completed stripe by an automatic sphere dispenser attached to the striping machine such that the glass spheres are dispensed closely behind the installed line. Use a glass spheres dispenser equipped with an automatic cut-off control synchronized with the cut-off of the thermoplastic material and applies the glass spheres in a manner such that the spheres appear uniform on the entire traffic stripes and markings surface with, 50 to 60% embedment. Provide each nozzle with suitable line guides, either metallic shrouds or air blasts.

(c) capable of providing the manufacture=s recommended mixing ratio between the components in a through and consistent manner.

709-4 Application.

709-4.1 General: Apply the Two Reactive Component product to the pavement in accordance with the manufacturer's instructions or as directed by the Engineer. The Engineer will conduct field tests in accordance with FM 5-541. Remove and replace traffic stripes and markings not meeting the requirements of this Section at no additional cost to the Department.

Ensure that existing pavement markings are removed, such that scars or traces of removed markings will not conflict with new stripes and markings by a method approved by the Engineer.

Prior to applying pavement stripes and markings, remove any material that would adversely affect the bond of the pavement stripes and markings by a method approved by the Engineer.

Apply traffic stripes or markings only to dry surfaces, and when the ambient air and surface temperature is at least 40EF [5°C] and rising. Follow the manufacturer=s recommendations for application temperature. Do not apply pavement markings when winds are sufficient to cause spray dust.

Offset longitudinal lines at least 2 inches [50 mm] from construction joints of portland cement concrete pavement.

Apply traffic stripes or markings, having well defined edges, over existing pavement markings such that not more than 2 inches [50 mm] on either end and not more than 1 inch [25 mm] on either side is visible.

Apply all final pavement markings prior to opening the road to traffic.

709-4.2 Corrections for Deficiencies: Remove and reapply a 1.0 mile

[1.0 kilometer] LOT centered around any deficiency, as determined by the Engineer, at no additional cost to the Department.

709-4.3 Thickness: Apply traffic stripes or markings such that, after application of drop-on glass spheres (AASHTO M 247 Type I), the stripes or markings will have a thickness above the pavement surface as designated on the Qualified Products List for the particular product used.

709-4.4 Glass Spheres: Apply reflective glass spheres to all white and yellow traffic stripes or markings, at the rate of 0.1 lb/ft^2 [0.5 kg/m^2] of Two Reactive Component material with 50 to 60% embedment.

Apply a mixture consisting of 50% glass spheres and 50% sharp silica sand to all transverse lines, bike lane symbols and longitudinal lines adjacent to or in a proposed bike lane, at a rate of 0.1 lb/ft^2 [0.5 kg/m^2] of Two Reactive Component material.

709-4.5 Retroreflectivity: Apply white and yellow pavement markings that will attain an initial retroreflectance of not less than 300 mcd/lxAm5 and not less than 250 mcd/lxAm5, respectively. Ensure that the intermittent and final retroreflectance of white and yellow pavement markings are not less than 150 mcd/lxAm5. This does not apply to transverse lines, bike lane symbols and longitudinal lines adjacent to or in a proposed bike lane.

709-4.6 Color: Use white two reactive component material that is pure white, free from any tint and showing no deviations from magnesium oxide color standard greater than the following:

Scale Definition	Magnesium Oxide Standard	Sample
RD	100	75% minimum
Reflectance		
a. Red-Green	0	-5 to +5
b. Yellow-Blue	0	-10 to +10

Use yellow Two Reactive Component material which visually matches Federal Test Standard Number 595-color 33538, and meet the following criteria for chromaticity coordinates (x,y):

x	0.455	0.510	0.472	0.530
y	0.444	0.485	0.400	0.456

709-4.7 Durability: Durability is the measured percent of Two Reactive Component material completely removed from the pavement. The Two Reactive Component material line loss must not exceed 5.0%.

709-5 Contractor's Responsibility for Notification.

Notify the Engineer prior to the placement of the materials. Furnish the Engineer with the manufacturer=s name and LOT numbers of the materials and glass spheres to be used. Ensure that the approved LOT numbers appear on the materials and glass spheres packages. Submit a certified test report to the Engineer indicating that the materials meet all requirements specified.

709-6 Protection of Newly Applied Traffic Stripes and Markings.

Do not allow traffic onto newly applied traffic stripes and markings until they are sufficiently dry to permit vehicles to cross them without damage. Remove and replace any portion of the traffic stripes and markings damaged by passing traffic or from any other cause, at no additional cost to the Department.

709-7 Method of Measurement.

The quantities to be paid for under this Section will be as follows:

(a) The net length, in feet [meters], of each of the various types of lines, stripes and bands, authorized and acceptably applied.

(b) The number of pavement messages and directional arrows, authorized and acceptably applied.

(c) The total traversed distance in gross miles [kilometers] of skip line. The actual applied line is 25% of the traverse distance for 1:3 ratio. This equates to 1,320 feet [250 m] of marking per mile [kilometer] of single line.

(d) The area, in square feet [square meters], of Remove Existing Pavement Markings, acceptably removed.

(e) The length, in net miles [kilometers], of Solid Traffic Stripe, authorized and acceptably applied.

(f) The length, in gross miles [kilometers], of Alternating Skip Traffic Stripe, authorized and acceptable applied.

709-8 Basis of Payment.

Prices and payments will be full compensation for all work specified in this Section, including, all cleaning and preparing of surfaces, furnishing of all materials, application, curing and protection of all items, protection of traffic, furnishing of all tools, machines and equipment, and all incidentals necessary to complete the work. Final payment will be withheld until all deficiencies are corrected.

Payment will be made under:

Item No. 709- 11-	Skip Traffic Stripe, Two Reactive Component (White/Black) - per gross mile.
Item No. 2709- 11-	Skip Traffic Stripe, Two Reactive Component (White/Black) - per gross kilometer.
Item No. 709- 12-	Skip Traffic Stripe, Two Reactive Component (Yellow) - per gross mile.
Item No. 2709- 12-	Skip Traffic Stripe, Two Reactive Component (Yellow) - per gross kilometer.
Item No. 709- 21-	Solid Traffic Stripe, Two Reactive Component (White/Black) - per foot.
Item No. 2709- 21-	Solid Traffic Stripe, Two Reactive Component (White/Black) - per meter.
Item No. 709- 22-	Solid Traffic Stripe, Two Reactive Component (Yellow) - per foot.
Item No. 2709-22-	Solid Traffic Stripe, Two Reactive Component (Yellow) - per meter.

Item No. 709- 3- Pavement Messages, Two Reactive Component - each.
Item No. 2709- 3- Pavement Messages, Two Reactive Component - each.
Item No. 709- 31- Solid Traffic Stripe, Two Reactive Component (White/Black) - per net mile.
Item No. 2709- 31- Solid Traffic Stripe, Two Reactive Component (White/Black) - per net kilometer.
Item No. 709- 32- Solid Traffic Stripe, Two Reactive Component (Yellow) - per net mile.
Item No. 2709- 32- Solid Traffic Stripe, Two Reactive Component (Yellow) - per net kilometer.
Item No. 709- 4 - Directional Arrows, Two Reactive Component - each.
Item No. 2709- 4 - Directional Arrows, Two Reactive Component - each.
Item No. 709- 41- Alternating Skip Traffic Stripe, Two Reactive Component (white/Black) - per gross mile.
Item No. 2709- 41- Alternating Skip Traffic Stripe, Two Reactive Component (white/Black) - per gross kilometer.
Item No. 709- 5 - Guide Lines, Two Reactive Component (Dotted) - per foot.
Item No. 2709- 5 - Guide Lines, Two Reactive Component (Dotted) - per meter.
Item No. 709- 7 - Remove Existing Pavement Markings - per square foot.
Item No. 2709- 7 - Remove Existing Pavement Markings - per square meter.

SECTION 710

PAINTING TRAFFIC STRIPES

710-1 Description.

Apply Paint Traffic Stripes and Markings in accordance with the details shown in the Contract Documents, and remove traffic stripes and markings when required.

710-2 Materials.

710-2.1 Paint Materials: Use only paint materials listed on the Qualified Products List (QPL), and meet the requirements of 971-1 and 971-19. The Engineer will take random samples of the paint materials in accordance with the Department=s Sampling, Testing and Reporting Guide schedule.

710-2.2 Glass Spheres: Use only glass spheres listed on the Qualified Products List (QPL), and meet the requirements of 971-1 and 971-14. The Engineer will take random samples of the glass spheres in accordance with FM 3D-1155 and the Department=s Sampling, Testing and Reporting Guide schedule.

710-3 Equipment.

Use equipment that will produce continuously uniform dimensions of traffic stripes and markings of varying widths and meet the following requirements:

(a) capable of traveling at a uniform, predetermined rate of speed, both uphill and downhill, in order to produce a uniform application of paint and capable of following straight lines and making normal curves in true arcs.

(b) capable of applying glass spheres to the surface of the completed stripe by an automatic sphere dispenser attached to the striping machine such that the glass spheres are dispensed closely behind the installed line. Use a glass spheres dispenser equipped with an automatic cut-off control synchronized with the cut-off of the traffic paint and applies the glass spheres in a manner such that the spheres appear uniform on the entire traffic stripes and markings surface with, 50 to 60% embedment.

(c) capable of spraying the paint to the required thickness and width without thinning of the paint. Equip the paint tank with a mechanical agitator and nozzles equipped with cut-off valves which will apply broken or skip lines automatically. Provide each nozzle with suitable line guides, either metallic shrouds or air blasts.

710-4 Application:

710-4.1 General: Mix the paint thoroughly prior to pouring into the painting machine. Apply paint to the pavement by spray or other means approved by the Engineer. The Engineer will conduct field testing in accordance with FM 5-541. Remove and replace traffic stripes and markings not meeting the requirements of this Section at no additional cost to the Department.

Ensure that existing pavement markings are removed, such that scars or traces of removed markings will not conflict with new stripes and markings by a method approved by the Engineer.

Prior to applying pavement stripes and markings, remove any material that would adversely affect the bond of the pavement stripes and markings by a method approved by the Engineer.

Establish tack points at appropriate intervals for use in aligning stripes, and set a stringline from such points to achieve accuracy.

Apply traffic stripes or markings only to dry surfaces, and when the ambient air and surface temperature is at least 40EF [5°C] and rising. Follow the manufacturer=s recommendations for application temperature. Do not apply pavement markings when winds are sufficient to cause spray dust.

Apply traffic stripes or markings, having well defined edges, over existing pavement markings such that not more than 2 inches [50 mm] on either end and not more than 1 inch [25 mm] on either side is visible.

Apply all final traffic stripes and markings prior to opening the road to traffic.

710-4.2 Corrections for Deficiencies to Applied Traffic Stripes and Markings: Remove and reapply a 1.0 mile [1.0 kilometer] LOT centered around any deficiency, at no additional cost to the Department.

710-4.3 Rate of Paint Application: Meet the following minimum rate of application:

6 inch [150 mm] solid traffic stripe: 25 gal/mi [59 L/km].

6 inch [150 mm] skip traffic stripe: 6.2 gal/gm [15 L/gkm].

Any other width stripe: a direct proportion of the above.

710-4.4 Required Film Thickness: Apply paint to attain a minimum wet film thickness of 15 mils [380 Φm].

710-4.5 Application of Spheres: Apply glass spheres immediately and uniformly following the paint application, at a rate of not less than 6 lb/gal [0.72 kg/L] of paint.

710-4.6 Retroreflectivity: Apply white and yellow pavement markings that will attain an initial retroreflectance of not less than 300 cd/fcAft5 [300 mcd/lxAm5] and not less than 250 cd/fcAft5 [250 mcd/lxAm5], respectively. Ensure that the intermittent and final retroreflectance of white and yellow pavement markings are not less than 150 cd/fcAft5 [150 mcd/lxAm5]. This does not apply to transverse lines, bike lane symbols and longitudinal lines adjacent to or in a proposed bike lane.

710-4.7 Color: Use white striping and marking material that is pure white, free from any tint and showing no deviations from magnesium oxide color standard greater than the following:

Scale Definition	Magnesium Oxide Standard	Sample
RD	100	75% minimum
Reflectance		
a. Red-Green	0	-5 to +5
b. Yellow-Blue	0	-10 to +10

Use yellow striping and marking material which visually matches Federal Test Standard Number 595-color 33538, and meet the following criteria for chromaticity coordinates (x,y):

x	0.455	0.510	0.472	0.530
y	0.444	0.485	0.400	0.456

710-5 Tolerances in Dimensions and in Alignment.

710-5.1 Dimensions:

710-5.1.1 Longitudinal Lines: Apply painted skip segments of 10 foot [3 m], with a 30 foot [9 m] unpainted gap between segments. Apply painted segments with no more than ∀12 inches [∀300 mm] variance, so that over-tolerance and under-tolerance lengths will approximately balance. Apply longitudinal lines at least 2 inches [50 mm] from construction joints of portland cement concrete pavement.

710-5.1.2 Transverse Markings, Gore Markings, Arrows, and Messages: Apply paint in multiple passes when the marking cannot be completed in one pass, with an overall line width allowable tolerance of ∀1 inch [∀25 mm].

710-5.1.3 Contrast Lines: Use black paint to provide contrast on concrete or light asphalt pavement, when specified by the Engineer. Apply black paint in 10 foot [3 m] segments following each longitudinal skip line.

710-5.2 Alignment: Apply painted stripes, that will not deviate more than

1 inch [25 mm] from the stringline on tangents and curves one degree or less. Apply painted stripes that will not deviate more than 2 inches [50 mm] from the stringline on curves greater than one degree. Apply painted edge stripes uniformly, not less than 2 inches [50 mm] or more than 4 inches [100 mm] from the edge of pavement, without noticeable breaks or deviations in alignment or width.

710-5.3 Correction Rates: Make corrections of variations in width at a maximum rate of 10 feet [3 m] for each 0.5 inch [13 mm] of correction. Make corrections of variations in alignment at a maximum rate of 25 feet [8 m] for each 1 inch [25 mm] of correction, to returned to the stringline.

710-5.4 Alignment of Stripes: Remove and replace at no additional cost to the Department traffic stripes that deviates more than 1 inch [25 mm] in any 40 feet [12 meters] from the stringline.

710-6 Contractor's Responsibility for Notification.

Notify the Engineer prior to the placement of the materials. Furnish the Engineer with the manufacturer=s name and LOT numbers of the materials and glass spheres to be used. Ensure that the approved LOT numbers appear on the materials and glass spheres packages. Submit a certified test report to the Engineer indicating that the materials meet all requirements specified.

710-7 Protection of Newly Painted Stripes.

Do not allow traffic onto newly applied traffic stripes and markings until they are sufficiently dry to permit vehicles to cross them without damage. Remove and replace any portion of the traffic stripes and markings damaged by passing traffic or from any other cause, at no additional cost to the Department.

710-8 Method of Measurement.

The quantities to be paid for under this Section will be as follows:

(1) The length, in gross miles [kilometers], of Skip Traffic Stripes.

(2) The length, in net miles [net kilometers], of Solid Traffic Stripes.

(3) The length, in feet [meters], of Solid Traffic Stripes and Skip Traffic Stripes.

(4) The number of directional arrows and pavement messages, painted.

(5) The area, in square feet [square meters], of Reflective Paint (Island Nose).

(6) The area, in square feet [square meters], of Remove Existing Markings.

The quantities to be paid for will also include 6/10 foot [β m] skip traffic stripe sections as indicated in the plans. Measurement will be taken as the distance from the beginning of the first painted stripe to the end of the last painted stripe with proper deductions made for unpainted intervals as determined by plan dimensions or stations, subject to 9-1.3. Unpainted intervals will not be included in pay quantity.

The gross-mile [gross-kilometer] measurement of Skip Traffic Stripes will be taken as the distance from the beginning of the first painted stripe to the end of the last painted stripe, and will include the unpainted intervals. It will not include any lengths of unpainted intervals which, by design or by other intent of the Department, are greater than 30 feet [9 m]. Final measurement will be determined by plan dimensions or stations, subject to 9-1.3.1.

710-9 Basis of Payment.

Prices and payments will be full compensation for all work specified in this Section, including, all cleaning and preparing of surfaces, furnishing of all materials, application, curing and protection of all items, protection of traffic, furnishing of all tools, machines and equipment, and all incidentals necessary to complete the work. Final payment will be withheld until all deficiencies are corrected.

Payment will be made under:

Item No. 710- 6- Directional Arrow, Painted - each.
Item No. 2710- 6- Directional Arrow, Painted - each.
Item No. 710- 7- Pavement Messages, Painted - each.
Item No. 2710- 7- Pavement Messages, Painted - each.
Item No. 710- 11- Remove Existing Markings (Paint) - per square foot.
Item No. 2710- 11- Remove Existing Markings (Paint) - per square meter.
Item No. 710- 21- Skip Traffic Stripe (White/Black) - per gross mile.
Item No. 2710- 21- Skip Traffic Stripe (White/Black) - per gross kilometer.
Item No. 710- 22- Skip Traffic Stripe (Yellow) - per gross mile.
Item No. 2710- 22- Skip Traffic Stripe (Yellow) - per gross kilometer.
Item No. 710- 23- Solid Traffic Stripe (White/Black) - per net mile.
Item No. 2710- 23- Solid Traffic Stripe (White/Black) - per net kilometer.
Item No. 710- 24- Solid Traffic Stripe (Yellow) - per net mile.
Item No. 2710- 24- Solid Traffic Stripe (Yellow) - per net kilometer.
Item No. 710- 25- Solid Traffic Stripe (White/Black) - per foot.
Item No. 2710- 25- Solid Traffic Stripe (White/Black) - per meter.
Item No. 710- 26- Solid Traffic Stripe (Yellow) - per foot.
Item No. 2710- 26- Solid Traffic Stripe (Yellow) - per meter.
Item No. 710- 27- Skip Traffic Stripes (White/Black) - per foot.
Item No. 2710- 27- Skip Traffic Stripes (White/Black) - per meter.
Item No. 710- 28- Skip Traffic Stripe (Yellow) - per foot.
Item No. 2710- 28- Skip Traffic Stripe (Yellow) - per meter.
Item No. 710- 29- Reflective Paint (Island Nose) (White) - per square foot.
Item No. 2710- 29- Reflective Paint (Island Nose) (White) - per square meter.
Item No. 710- 30- Reflective Paint (Island Nose) (Yellow) - per square foot.
Item No. 2710- 30- Reflective Paint (Island Nose) (Yellow) - per square meter.
Item No. 710- 79- Alternating Skip Traffic Stripe - per gross mile.
Item No. 2710- 79- Alternating Skip Traffic Stripe - per gross kilometer.

SECTION 711

THERMOPLASTIC TRAFFIC STRIPES AND MARKINGS

711-1 Description.

Apply thermoplastic traffic stripes and markings, or refurbish existing thermoplastic traffic stripes and markings, in accordance with the Contract Documents and remove traffic stripes and markings as required. For preformed materials, see Section 713.

711-2 Materials.

711-2.1 General: Use only thermoplastic materials listed on the Qualified Products List (QPL). Use materials meeting the requirements of 971-1 and 971-17 for initial traffic striping and markings or recapping. Use materials for refurbishing existing thermoplastic traffic stripes and markings meeting the requirements of 971-1 and 971-20 (or 971-17 when specifically indicated in the Contract Documents). The Engineer will take random samples of all thermoplastic material in accordance with the Department=s Sampling, Testing and Reporting Guide schedule.

711-2.2 Glass spheres (for reflective traffic stripes and markings): Use only glass spheres meeting the requirements of 971-1 and 971-14. The Engineer will take random samples of all glass spheres in accordance with FM 3D-1155 and the Department=s Sampling, Testing and Reporting Guide schedule.

711-3 Equipment.

Use equipment to install hot applied thermoplastic material constructed to provide continuous uniform heating to temperatures exceeding 390EF [200EC], mixing and agitation of the material reservoir and the line dispensing devices to prevent accumulation and clogging. All parts of the equipment which contact the material are to be constructed for easy accessibility and exposure for cleaning and maintenance. Use equipment that will maintain the thermoplastic material at a plastic temperature, to all mixing and conveying parts, including the line dispensing device. Do not use pans, aprons or similar appliances which the dispenser overruns. Use equipment which will provide for varying traffic stripes and marking application widths and meet the following requirements:

(a) mobile and capable of traveling at a uniform, predetermined rate of speed, both uphill and downhill, in order to produce a uniform application of thermoplastic material and maneuverable to the extent that straight lines can be followed and normal curves can be made in a true arc.

(b) capable of applying glass spheres to the surface of the completed stripe by an automatic sphere dispenser attached to the striping machine such that the glass spheres are dispensed closely behind the installed line. Use a glass spheres dispenser equipped with an automatic cut-off control synchronized with the cut-off of the thermoplastic material and applies the glass spheres in a manner such that the spheres appear uniform on the entire traffic stripes and markings surface with, 50 to 60% embedment. Provide each nozzle with suitable line guides, either metallic shrouds or air blasts.

(c) equipped with a special kettle for uniformly melting and heating the thermoplastic material. The kettle must be equipped with an automatic temperature control device and material thermometer for positive temperature control and to prevent overheating or scorching of the thermoplastic material.

(d) meet the requirements of the National Fire Protection Association, state, and local authorities.

711-4 Application.

711-4.1 General: Apply thermoplastic material to the pavement either by spray, extrusion or other means approved by the Engineer. The Engineer will conduct field tests in accordance with FM 5-541. Remove and replace traffic stripes and markings not meeting the requirements of this Section at no additional cost to the Department.

Ensure that existing pavement markings are removed, such that scars or traces of removed markings will not conflict with new stripes and markings by a method approved by the Engineer.

Prior to applying pavement stripes and markings, remove any material that would adversely affect the bond of the pavement stripes and markings by a method approved by the Engineer.

Apply traffic stripes or markings only to dry surfaces, and when the ambient air and surface temperature is at least 55EF [13°C] and rising. Follow the manufacturer=s recommendations for application temperature. Do not apply pavement markings when winds are sufficient to cause spray dust.

Offset longitudinal lines at least 2 inches [50 mm] from construction joints of portland cement concrete pavement.

Prior to installation of the thermoplastic material, apply a two-part epoxy primer sealer recommended by the manufacturer, on all portland cement concrete surfaces.

Apply traffic stripes or markings, having well defined edges, over existing pavement markings such that not more than 2 inches [50 mm] on either end and not more than 1 inch [25 mm] on either side is visible.

Apply all final pavement markings prior to opening the road to traffic.

711-4.2 Corrections for Deficiencies:

711-4.2.1 Recapping Newly Applied Traffic Stripes and Markings: Recapping applies to conditions where additional thermoplastic material is applied to new traffic stripes or markings. Recap a 1.0 mile [1.0 kilometer] LOT centered around the deficiency with additional thermoplastic material or by complete removal and reapplication at no additional cost to the Department.

If the Engineer determines that recapping will result in a thickness exceeding the maximum allowed, the traffic stripes or markings may be completely removed and reapplied, or removed to a thickness that will meet the minimum and maximum thickness criteria when recapped.

711-4.2.2 Refurbishing of Existing Traffic Stripes and Markings: Refurbishing applies to conditions where additional thermoplastic material is applied to existing traffic stripes or markings. Unless the Contract Documents provide otherwise, use materials meeting the requirements of 971-20. Use materials meeting the requirements of 971-17 only where specifically indicated in the Contract Documents.

If the Engineer determines that refurbishing of traffic stripes or markings will result in a thickness exceeding the maximum allowed, the existing traffic stripes or markings may be completely removed and reapplied, or removed to a thickness that will meet the minimum and maximum thickness criteria when refurbished.

711-4.3 Thickness:

711-4.3.1 Initial Traffic Striping and Markings or Recapping per 971-17: Apply or recap traffic stripes or markings such that, after application of drop-on glass spheres (AASHTO M 247 Type I), all lane lines, center lines, transverse markings (except pavement edge lines) and traffic stripes and markings within traffic wearing areas (such as dotted turning guide lines), will have a thickness of 0.10 to 0.15 inch [2.5 to 4.0 mm] when measured above the pavement surface at the edge of the traffic stripe or marking.

Also, all pavement edge lines, gore, island, and diagonal stripe markings, bike lane symbols and messages, wherever located, will have a thickness of 0.07 to 0.10 inch [1.8 to 2.5 mm] when measured above the pavement surface at the edge of the traffic stripe or marking.

711-4.3.2 Refurbishing Existing Traffic Strips and Markings: Apply thermoplastic material at a thickness greater than or equal to the minimum thickness listed on the QPL. Ensure that the combination of existing stripe and overlay after application of drop-on glass spheres (AASHTO M 247 Type I), does not exceed the maximum thickness of 0.10 inch [2.5 mm] for edge lines and 0.150 inch [4.0 mm] for lane and center lines.

711-4.4 Glass Spheres: Apply reflective glass spheres to all white and yellow traffic stripes or markings immediately behind the striping mechanism, at the rate of 0.10 lb/ft^2 [0.5 kg/m^2] of thermoplastic surface, with 50 to 60% embedment.

Apply a mixture consisting of 50% glass spheres and 50% sharp silica sand to all thermoplastic transverse lines, bike lane symbols and longitudinal lines adjacent to or in a proposed bike lane, at a rate of 0.10 lb/ft^2 [0.5 kg/m^2] thermoplastic surface.

711-4.5 Retroreflectivity: Apply white and yellow pavement markings that will attain an initial retroreflectance of not less than 300 mcd/lxAm5 and not less than 250 mcd/lxAm5, respectively. Ensure that the intermittent and final retroreflectance of white and yellow pavement markings are not less than 150 mcd/lxAm5. This does not apply to transverse lines, bike lane symbols and longitudinal lines adjacent to or in a proposed bike lane.

711-4.6 Color: Use white thermoplastic material that is pure white, free from any tint and showing no deviations from magnesium oxide color standard greater than the following:

Scale Definition	Magnesium Oxide Standard	Sample
RD	100	75% minimum
Reflectance		
a. Red-Green	0	-5 to +5
b. Yellow-Blue	0	-10 to + 10

Use yellow thermoplastic material which visually matches Federal Test Standard Number 595-color 33538, and meet the following criteria for chromaticity coordinates (x,y):

x	0.455	0.510	0.472	0.530
y	0.444	0.485	0.400	0.456

711-4.7 Durability: Durability is the measured percent of thermoplastic material completely removed from the pavement. The thermoplastic material line loss must not exceed 5.0%.

711-5 Contractor's Responsibility for Notification.

Notify the Engineer prior to the placement of the thermoplastic materials. Furnish the Engineer with the manufacturer=s name and LOT numbers of the thermoplastic materials and glass spheres to be used. Ensure that the approved LOT numbers appear on the thermoplastic materials and glass spheres packages. Submit a certified test report to the Engineer indicating that the materials meet all requirements specified.

711-6 Protection of Newly Applied Traffic Stripes And Markings.

Do not allow traffic onto newly applied traffic stripes and markings until they are sufficiently dry to permit vehicles to cross them without damage. Remove and replace any portion of the traffic stripes and markings damaged by passing traffic or from any other cause, at no additional cost to the Department.

711-7 Method of Measurement.

The quantities to be paid for under this Section will be as follows:

(a) The net length, in feet [meters], of each of the various types of thermoplastic lines, stripes and bands, authorized and acceptably applied.

(b) The number of thermoplastic pavement messages and directional arrows, authorized and acceptably applied.

(c) The total traversed distance in gross miles [kilometers] of skip line. The actual applied line is 25% of the traverse distance for a 1:3 ratio. This equates to 1,320 feet [250 m] of marking per mile [kilometer] of single line.

(d) The area, in square feet [square meters], of Remove Existing Markings (Thermoplastic), acceptably removed.

(e) The length, in net miles [net kilometers], of Solid Traffic Stripe, authorized and acceptably applied.

(f) The length, in gross miles [gross kilometers], of Alternating Skip Traffic Stripe, authorized and acceptably applied.

711-8 Basis of Payment.

Prices and payments will be full compensation for all work specified in this Section, including, all cleaning and preparing of surfaces, furnishing of all materials, application, curing and protection of all items, protection of traffic, furnishing of all tools, machines and equipment, and all incidentals necessary to complete the work. Final payment will be withheld until all deficiencies are corrected.

Payment will be made under:

Item No. 711- 3- Pavement Messages, Thermoplastic - each.

Item No. 2711- 3- Pavement Messages, Thermoplastic - each.
Item No. 711- 4- Directional Arrows, Thermoplastic - each.
Item No. 2711- 4- Directional Arrows, Thermoplastic - each.
Item No. 711- 5- Guide Lines, Thermoplastic (Dotted) - per foot.
Item No. 2711- 5- Guide Lines, Thermoplastic (Dotted) - per meter.
Item No. 711- 7- Remove Existing Pavement Markings-(Thermoplastic) - per square foot.
Item No. 2711- 7- Remove Existing Pavement Markings-(Thermoplastic) - per square meter.
Item No. 711- 31- Skip Traffic Stripe, Thermoplastic (White)- per gross mile.
Item No. 2711- 31- Skip Traffic Stripe, Thermoplastic (White)- per gross kilometer.
Item No. 711- 32- Skip Traffic Stripe, Thermoplastic (Yellow)- per gross mile.
Item No. 2711- 32- Skip Traffic Stripe, Thermoplastic (Yellow)- per gross kilometer.
Item No. 711- 33- Skip Traffic Stripe, Thermoplastic (White) - per foot.
Item No. 2711- 33- Skip Traffic Stripe, Thermoplastic (White) - per meter.
Item No. 711- 34- Skip Traffic Stripe, Thermoplastic (Yellow) - per foot.
Item No. 2711- 34- Skip Traffic Stripe, Thermoplastic (Yellow) - per meter.
Item No. 711- 35- Solid Traffic Stripe, Thermoplastic (White) - per foot.
Item No. 2711- 35- Solid Traffic Stripe, Thermoplastic (White) - per meter.
Item No. 711- 36- Solid Traffic Stripe, Thermoplastic (Yellow) - per foot.
Item No. 2711- 36- Solid Traffic Stripe, Thermoplastic (Yellow) - per meter.
Item No. 711- 37- Solid Traffic Stripe, Thermoplastic (White) - per net mile.
Item No. 2711- 37- Solid Traffic Stripe, Thermoplastic (White) - per net kilometer.
Item No. 711- 38- Solid Traffic Stripe, Thermoplastic (Yellow) - per net mile.
Item No. 2711- 38- Solid Traffic Stripe, Thermoplastic (Yellow) - per net kilometer.

SECTION 713

PREFORMED PAVEMENT STRIPES AND MARKINGS

713-1 Description.

Apply preformed reflectorized plastic pavement symbols, legends, stripes and markings, in accordance with the Contract documents and remove traffic stripes and markings as required.

713-2 Materials.

Use only preformed pavement stripes and markings materials listed on the Qualified Products List (QPL), and meet the requirements of 971-1 and 971-18. The Engineer will take random samples of the materials in accordance with the Department=s Sampling, Testing and Reporting Guide schedule.

713-3 Equipment.

Use equipment that is mobile and maneuverable to the extent that straight lines can be followed and normal curves can be made in a true arc.

713-4 Application.

713-4.1 General: Apply pavement stripes and markings to the pavement by means approved by the Engineer. The Engineer will conduct field testing in accordance with FM 5-541. Remove and replace pavement stripes and markings not meeting the requirements of this Section at no additional cost to the Department.

Ensure that existing pavement markings are removed, such that scars or traces of removed markings will not conflict with new stripes and markings by a method approved by the Engineer.

Prior to applying pavement stripes and markings, remove any material that would adversely affect the bond of the pavement stripes and markings by a method approved by the Engineer.

Apply traffic stripes or markings only to dry surfaces, and when the ambient air and surface temperature is at least 55EF [13°C] and rising. Follow the manufacturer=s recommendations for application temperature. The Engineer will measure temperatures in accordance with FM 5-541.

Offset longitudinal lines at least 2 inches [50 mm] from construction joints of portland cement concrete pavement.

Apply a primer sealer of the type recommended by the manufacturer of the pavement stripes and markings material on all portland cement concrete surfaces, prior to installation.

Apply traffic stripes or markings, having well defined edges, over existing pavement markings such that not more than 2 inches [50 mm] on either end and not more than 1 inch [25 mm] on either side is visible.

Apply all final pavement markings prior to opening the road to traffic.

713-4.2 Corrections for Deficiencies: Remove and reapply a 1.0 mile [1.0 kilometer] LOT centered around any deficiency, as determined by the Engineer, at no additional cost to the Department.

713-4.3 Thickness: Apply traffic stripes or markings such that, after installation, the stripes or markings will have a thickness of 0.02 to 0.09 inch [0.508 to 2.286 mm] when measured above the pavement surface at the edge of the traffic stripe or marking.

713-5 Retroreflectivity.

Apply white and yellow pavement stripes and markings that will attain an initial retroreflectance of not less than 300 mcd/lxAm5 and not less than 250 mcd/lxAm5, respectively. Ensure that the intermittent and final retroreflectance of white and yellow pavement markings are not less than 150 mcd/lxAm5. This does not apply to transverse lines, bike lane symbols and longitudinal lines adjacent to or in a proposed bike lane.

713-6 Color.

Use white pavement stripes and marking material that is pure white, free from any tint and showing no deviations from magnesium oxide color standard greater than the following:

Scale Definition	Magnesium Oxide Standard	Sample
RD	100	75% minimum
Reflectance		
a. Red-Green	0	-5 to +5
b. Yellow-Blue	0	-10 to +10

Use yellow pavement stripes and marking material which visually matches Federal Test Standard Number 595-color 33538, and meet the following criteria for chromaticity coordinates (x,y):

x	0.455	0.510	0.472	0.530
y	0.444	0.485	0.400	0.456

713-7 Durability.

Durability is the measured percent of pavement marking material completely removed from the pavement. The pavement marking material line loss must not exceed 5.0% of surface area.

713-8 Contractor's Responsibility for Notification.

Notify the Engineer prior to the placement of pavement stripes and marking material. Furnish the Engineer with the manufacturer=s name and LOT numbers of the material to be used. Ensure that the approved LOT numbers appear on the material packages. Submit a certified test report to the Engineer indicating that the materials meet all requirements specified.

713-9 Protection of Newly Applied Stripes.

Do not allow traffic onto newly applied traffic stripes and markings until they are sufficiently attached to permit vehicles to cross them without damage. Remove and replace any portion of the traffic stripes and markings damaged by passing traffic or from any other cause, at no additional cost to the Department.

713-10 Basis of Payment.

When preformed pavement stripes and markings are used as an alternate to extruded or sprayed thermoplastic traffic stripes and markings, the quantities will be paid for in accordance with Section 711. Such prices and payments will be full compensation for all work specified herein. Final Payment will be withheld until all deficiencies are corrected.

SECTION 715

HIGHWAY LIGHTING SYSTEM

715-1 Description.

Install a highway lighting system in accordance with the details shown in the plans. Include in the system the light poles, bases, luminaires, ballasts, pull boxes, cable, conduit, substations, expansion joints, protective devices, transformers and control devices; all as specified or required for the complete facility.

715-2 Shop Drawings and Working Drawings.

Submit shop drawings and working drawings with descriptive specifications and engineering data for panel board, transformer, primary oil switch, fused cutouts, light poles (including brackets), luminaires, ballast, photo-electric cell, and cable or any other item requested by the Engineer as specified in Section 5.

715-3 Materials and Equipment to be Installed.

715-3.1 General: Meet the materials and equipment requirements of Section 992. Provide products of established, reputable manufacturers of electrical equipment, meeting NEC requirements, the regulations of the National Board of Fire Underwriters, and the approval of the Engineer.

715-3.2 Criterion Designation of Materials and Equipment: Where a criterion specification is designated for any material or equipment to be installed, by the name or catalog number of a specific manufacturer, understand that such designation is intended only for the purpose of establishing the style, quality, performance characteristics, etc., and is not intended to limit the acceptability of competitive products. The Engineer will consider products of other manufacturers which are approved as similar and equal as equally acceptable.

715-4 Furnishing of Electrical Service.

Start the system with a weatherhead on a riser on a service pole and extend through the required metering equipment of the power company, and through the lighting system as shown.

The power company will provide service to the areas in the vicinities indicated. Consult and cooperate with the power company in locating its distribution transformer and service pole so that the lines will be as short and direct as possible. Bear any line-extension costs up to the first 2,000 feet [600 m]. Furnish or install only those parts of the metering equipment or connections that are customary and required by the power company in the locality involved.

715-5 Excavation and Backfilling.

715-5.1 General: For excavation and backfilling, meet the requirements of

Section 125, except that when rock is encountered, carry the excavation 3 inches [75 mm] below the required level and re-fill with sand or with selected earth material, 100% of which passes the 1 inch [25 mm] sieve.

715-5.2 Trenches for Cable: Construct trenches for cable or conduit no less than 6 inches [150 mm] in width and deep enough to provide a minimum cover in accordance with the Roadway and Traffic Design Standards.

715-5.3 Placing Backfill for Cable: For installation of the cable, place an initial layer of 6 inches [150 mm] thick, loose measurement, sand or selected earth material, 100% of which passes a 1 inch [25 mm] sieve. Place and compact the remaining material in accordance with 125-8.

715-6 Concrete Bases for Light Poles.

715-6.1 Bases: Provide bases for light poles of the sizes and shapes shown in the plans.

715-6.2 Setting Anchor Bolts: Set anchor bolts according to manufacturer's templates and adjust to a plumb line, check for elevation and location, and hold rigidly in position to prevent displacement while pouring concrete.

715-6.3 Installation: Install poured-in-place bases at least one week before installing the poles, and thoroughly tamp the earth around the base to prevent settling.

Do not erect high mast lighting poles before the concrete in the support footing has cured for at least seven days. The Engineer may allow pole installations prior to seven days provided the footing concrete strength is at least 2,500 psi [17 MPa]. Determine concrete strength from tests on a minimum of two test cylinders, tested in accordance with Section 346.

715-6.4 Alternate Foundation: The Contractor may use screw type foundations meeting the following requirements in lieu of precast or cast-in-place concrete foundations detailed on Roadway and Traffic Design Standards, Index No. 17503.

715-6.4.1 Screw Type Foundations Located Above the Water Table:

(a) Design: For steel screw type foundations, meet the latest edition of the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals and the requirements herein. Provide steel equaling or exceeding the requirements of ASTM A 53, Type E, Grade B for the pipe and ASTM A 36 [ASTM A 36M] for the plates and bars. Design screw type foundations to be installed by auguring into the ground using a right hand turning movement with a working installation torque of up to 20,000 ftAlb [27 kN≅m]. Provide a minimum base plate thickness of 1δ inches [35 mm]. Provide base plates with holes to match the number and location of the light pole anchor bolts. Make the holes 1/16 inch [1.6 mm] larger in diameter than the light pole anchor bolts. Use base plates of sufficient size to provide the required bolt edge distances. Notch the base plates to indicate the orientation of the shaft cableways. Provide pipes for these screw type foundations having a minimum of 10.75 inches [273.0 mm] outside diameter and a minimum wall thickness of 0.365 inch [9.27 mm]. Provide an opening at the bottom of the pipe for drainage purposes. Hot-dip galvanize the whole foundation after fabrication in accordance to ASTM A 123 [ASTM A 123M]. Submit drawings to the Department for approval as specified in Section 5.

(b) Limits of Use: The Contractor may use screw type foundations only with roadway light poles whose maximum working load reactions at their base do not exceed the following:

moment = 30,600 ftAlb [41.5 kN≅m]
shear = 1,020 lb [4.5 kN]
torsion = 3,000 ftAlb [4.0 kN≅m]
axial = 400 lb [1.8 kN]

For soil properties for these installations, meet the following minimum requirements:

cohesionless:
friction angle = 30 degrees
unit weight = 100 lb/ft^3 [1,600 kg/m^3]
cohesive:
cohesion = 1,000 ftAlb [48 kPa]

(c) Installation: Prior to installation, submit pole reaction and soil property data to the Engineer for approval.

Install by auguring into the ground. Use only a small amount of downward pressure, sufficient to ensure engagement of the augers. The Engineer will not allow installation into pre-excavated hole. Ensure that the pole manufacturer provides bolts for connecting the pole to the foundation, and install bolts complete with nuts and lockwashers. Do not allow the top of the installed base plate to protrude more than 2 inches [50 mm] above the ground surface.

715-6.4.2 Screw type foundations when the water table is encountered: When the water table is encountered within the depth of the screw type foundations permitted in 715-6.4.1 above, the Contractor may propose a project-specific screw type foundation design. In this event, submit to the Engineer, for approval, design calculations and drawings which account for the presence of the water table. When making the calculations, take into account the variability of the soil strata above and below the water table which may result in deeper foundations, larger diameter pipe, or both.

Provide screw type foundation material in accordance with 715-6.4.1(a), and use the in-situ soil properties, determined from the on-site soil boring investigation conducted in accordance with 715-6.4.1(c), in the proposed foundation design.

715-7 Laying Cables.

Place the direct-burial cables by moving the cable reel along the trench so that the cables are placed directly in their final position in the trench, with a minimum of handling and dragging. Space the cables at least 3 inches [75 mm] apart, both vertically and horizontally, and separate them with clean sand. Place the bottom cables on a 3 inches [75 mm] bed of sand and cover the top cables with 3 inches [75 mm] of sand prior to backfilling. Leave at least 3 feet [0.9 m] of slack cable where the cable enters and leaves ducts, and after looping into light poles. Leave adequate slack in light poles and bracket cables and other conductors. Protect cables pulled into conduit or ducts against abrasion, kinking, and twisting. Locate pull boxes so that the cable is not subjected to excessive pulling stresses.

715-8 Splicing.

Make all conductor splices in the bases of the light poles, or in pull boxes designed for the purpose. Do not make underground splices unless specifically authorized by the Engineer, and then only as directed by him.

Make all necessary splices or connections with solderless connectors or compression sleeves. Do not use twist-on connectors if any of the conductors involved is larger than No. 10.

715-9 Conduit and Ducts.

715-9.1 General: Install conduit and ducts at the locations shown in the plans, or as required for a satisfactory installation. Provide conduit or ducts for all crossings under roads and streets.

715-9.2 Conduit in Structures: Use conduit of either rigid steel or PVC for embedding in structural concrete. Install an expansion joint at every structural expansion joint through which the conduit passes. Provide exposed runs of conduit with adequate expansion joints as shown in the plans or approved by the Engineer. Obtain the Engineer's approval of the design of the expansion joints.

715-9.3 Pre-wired Direct-burial Duct: Where specifically specified in the plans or directed by the Engineer, install a pre-wired, flexible polyethylene plastic pipe containing the conductors for the lighting circuits. Provide conductors and polyethylene pipe as described in the plans.

715-10 Erecting Light Poles.

715-10.1 General: Install the light poles at the locations and in accordance with the details shown in the plans. Unless otherwise specifically approved by the Engineer, fasten racket arms to the shaft prior to erection. Adjust the poles to a plumb line after erection and use metal shims or leveling nuts if necessary to obtain precise alignment. Use a thin cement grout where necessary to eliminate unevenness or irregularities in the top of the base.

715-10.2 Adjusting Anchor Bolts: Where poles are to be placed on existing foundations or bases with anchor bolts in place, furnish poles with a base which fits the anchor bolt spacing. Include the cost of any necessary extension of existing anchor bolts in the price bid for the lighting system.

715-10.3 Installation of Luminaire: Install the luminaire on the bracket in accordance with the manufacturer's instructions, and place it so that the light pattern is evenly distributed along the roadway.

715-10.4 Electrical Connections: Make primary ballast connections in accordance with manufacturer's instructions. Install sufficient cable to allow all connections to be made outside the light pole base. Connect the ground conductor to the ground stud provided.

715-10.5 Identification Plates: If required by the Contract Documents, stamp the identification plate on the pole with an identifying number or legend. Number the poles consecutively, beginning with number 1. Stamp each light pole number with : inch [19 mm] figures and stamp each circuit number with 2 inch [13 mm] figures.

715-11 Grounding.

Ground in strict accordance with the National Electrical Code (NEC), local ordinances, applicable codes, and the requirements of the local utility company. For grounding, meet the following minimum requirements:

Solidly interconnect and connect to ground the grounding terminal of each lightning arrestor, the tank of the transformer, and the neutral. Use one or more approved rods, ε inch [15.87 mm] in diameter and 10 feet [3.0 m] long, as ground rod. Provide connectors at the ground rod as shown in the plans or approved by the Engineer. Protect grounding conductors on the wooden poles by cedar or cypress wood molding, extending at least 8 feet [2.4 m] above grade.

Ground each metal light pole not on a bridge structure with an approved rod, 10 feet [3.0 m] in length and at least ε inch [15.87 mm] in diameter. Drive the rod vertically until the top of the rod is approximately 6 inches [150 mm] below the ground. Attach a No. 6 bare conductor to the rod with an approved clamp, and to the light pole through the grounding lug.

For poles on bridge structures, bring the grounding conductors out to a pull box at each end of the structure and connect them to driven ground rods, 20 feet [6 m] in length and at least ε inch [15.87 mm] in diameter.

715-12 Labeling.

Stencil labels on the cases of oil switch, transformer, panel board, and photo-electric cell with white oil paint, as designated by the Engineer. Also, mark the correct circuit designations in accordance with the wiring diagram on the terminal marking strips of each terminal block and on the card holder in the panel board.

715-13 Markers.

Construct duct, cable, and splice markers as shown in the plans, and place them over the ends of underground ducts and at each change in direction of cable or conduit run. Place markers flat on the ground with 1 inch [25 mm] projecting above finished grade.

715-14 Tests of Installation.

Upon completion of the work, test the installation to ensure that the installation is entirely free of ground faults, short circuits, and open circuits and that it is in satisfactory working condition. Furnish all labor, materials, and apparatus necessary for making the required tests. Remove and replace any defective material or workmanship discovered as a result of these tests at no expense to the Department, and make subsequent re-tests to the satisfaction of the Engineer.

Make all arrangements with the power supplier for power. Pay all costs, excluding energy charges, required for the test period.

Not less than 48 hours prior to the beginning of the test period, give the power supplier the schedule for such test.

Test the installation under normal operating conditions during the seven day test period specified in 715-15, rather than as a continuous burn test period.

If the work is not open to traffic at the end of the seven day test period, de-energize the lighting system until the work is opened.

715-15 Acceptance of Highway Lighting.

The Engineer may make partial acceptance of the highway lighting based on satisfactory performance of all highway lighting for seven consecutive days. The seven day evaluation period may commence upon written authorization by the Engineer that highway lighting is considered ready for acceptance evaluation. Contract Time will be charged during the entire highway lighting evaluation period. Correct any defects in materials or workmanship which might appear during the evaluation period at no expense to the Department. Transfer to the Department any guarantees on equipment or materials furnished by the manufacturer and ensure that the manufacturer includes with such guarantees the provision that they are subject to such transfer, and proper validation of such fact. The Department=s written acceptance of highway lighting and the transfer to the Department of all manufacturer guarantees will be conditions precedent to final acceptance of all work under the Contract in accordance with 5-11.

715-16 Method of Measurement.

The quantities to be paid for will be as follows, completed and accepted:

(a) Conduit: The length, in feet [meters], including elbows, sweeps, connecting hardware, trenching and backfill as indicated in the plans and the Roadway and Traffic Design Standards, and the cost of restoring cut pavement, sidewalks, sod, and etc., to its original condition.

(b) Luminaire and Bracket Arm: The Contract unit price will include the bracket arm, luminaire with lamp, and all necessary mounting hardware as indicated in the plans and the Roadway and Traffic Design Standards.

(c) Load Center: The Contract unit price will include the service pole, insulators, weatherheads, transformers, enclosures, panel boards, breakers, safety switches, H.O.A. switches, lighting protectors, fuses, photo electric assembly, meter base, and all external and internal conduit and conductors for the service as indicated in the plans and the Roadway and Traffic Design Standards.

(d) Light Pole Foundation: The Contract unit price will include the foundation and anchor bolts with lock nuts and washers as indicated in the plans and the Roadway and Traffic Design Standards.

(e) Luminaire: The Contract unit price will include the luminaire with lamp and necessary mounting hardware as indicated in the plans and the Roadway and Traffic Design Standards.

(f) Pull Box: The Contract unit price will include the pull box and cover as indicated in the plans and the Roadway and Traffic Design Standards.

(g) High Mast Parts: The Contract unit price will include the part specified with all mounting hardware as indicated in the Contract Documents and the Roadway and Traffic Design Standards.

(h) Frangible Base for Light Pole: The Contract unit price will include the frangible base, attachments, bolts, and washers as indicated in the plans and the Roadway and Traffic Design Standards.

(i) Photo Electric Control Assembly: The Contract unit price will include the photo electric control, transformers, conduit, and conductors as indicated in the plans and the Roadway and Traffic Design Standards.

(j) Pre-Fab Pilaster: The Contract unit price will include the pilaster and all mounting hardware as indicated in the plans.

(k) High Mast Lighting Pole Complete: The Contract unit price will include the pole, luminaires with lamps, lowering system, breakers and anchor bolts with lock nuts and washers as indicated in the plans and the Roadway and Traffic Design Standards.

(l) Conductor: The length, in feet [meters], as indicated in the plans and the Roadway and Traffic Design Standards.

(m) Lighting Pole Complete: The Contract unit price will include the pole, bracket arm, luminaire with lamp, anchor bolts with lock nuts and washers, frangible base and foundation.

(n) Pole Cable Distribution System: The Contract Unit price will include the surge protector, fuse holders with fuses, waterproof connectors and the waterproof wiring connection to the luminaries.

715-17 Basis of Payment.

Prices and payments will be full compensation for all work specified in this Section, including all materials, equipment and tests.

DIVISION III
Materials

AGGREGATES

SECTION 901

COARSE AGGREGATE

901-1 General.

901-1.1 Composition: Coarse aggregate shall consist of naturally occurring materials such as gravel, or resulting from the crushing of parent rock, to include natural rock, slags, expanded clays and shales (lightweight aggregates) and other approved inert materials with similar characteristics, having hard, strong, durable particles, conforming to the specific requirements of this Section.

Coarse aggregate for use in a hot bituminous mixture may also consist of reclaimed portland cement concrete pavement meeting the requirements of 901-5. Washing of this material will not be required if the requirements of 901-1.2 for maximum percent of material passing the No. 200 [75 μm] sieve can be met without washing.

Materials substantially retained on the No. 4 [4.75 mm] sieve, shall be classified as coarse aggregate.

Approval of mineral aggregate sources shall be in accordance with 6-3.3.

901-1.2 Deleterious Substances: All coarse aggregates shall be reasonably free of clay lumps, soft and friable particles, salt, alkali, organic matter, adherent coatings, and other substances not defined which may possess undesirable characteristics. The weight of deleterious substances shall not exceed the following percentages:

Coal and lignite (AASHTO T 113) 1.00
Soft and friable particles (AASHTO T 112) 2.00*
Clay lumps (AASHTO T 112) 2.00*
Cinders and clinkers 0.50
Free shell 1.00**
Material passing the No. 200 [75 µm] sieve (FM 1-T 011)
At Source...1.75***
At Point of Use 3.75***
Organic Matter (wet) 0.03
Chert (less than 2.40 specific gravity SSD) (AASHTO T-113)...3.00****

*The maximum percent by weight of soft and friable particles and clay lumps together shall not exceed 3.00.

**Aggregates to be used in asphaltic concrete may contain up to 5% free shell. Free shell is defined as that portion of the coarse aggregate retained on the No. 4 [4.75 mm] sieve consisting of loose, whole, or broken shell, or the external skeletal remains of other marine life, having a ratio of the maximum length of the particle to the shell wall thickness exceeding five to one. Coral, molds, or casts of other shells, and crushed clam and oyster shell indigenous to the formation will not be considered as free shell.

***The requirement for maximum percent of material passing the No. 200 [75 µm] sieve for a LOT or stockpile of any coarse aggregate component shall be as follows:

(a) For any samples obtained by the Department for acceptance purposes or assurances purposes at the source of production, the average percent of material passing the No. 200 [75 µm] sieve of two composite samples shall not exceed 1.75%. No individual test shall exceed 2.0%.

(b) For assurance samples or acceptance samples, as designated by the Department. Obtained at the point of use, the average percent of material passing the No. 200 [75 µm] sieve for two composite samples shall not exceed 3.75%. No individual test shall exceed 4.0%.

****This limitation applies only to coarse aggregates in which chert appears as an impurity. It is not applicable to aggregates which are predominantly chert.

901-1.3 Physical Properties: Coarse aggregates shall meet the following physical property requirements, except as noted herein:

Los Angeles Abrasion (FM 1-T 096)................................ maximum loss 45%
Soundness (Sodium Sulfate) (FM 1-T 104)..................... maximum loss 12%*
Flat or elongated pieces .... maximum 10%**

*For source approval - Aggregates exceeding soundness loss limitations will be rejected unless performance history shows that the material will not be detrimental for Portland Cement Concrete or other intended usages.

**A flat or elongated particle is defined as one having a ratio between the maximum and the minimum dimensions of a circumscribing prism exceeding five to one.

901-1.4 Gradation: Coarse aggregates shall conform to the gradation requirements of Table 1, when the stone size is specified. However, Table 1 is waived for those aggregates intended for usage in bituminous mixtures, provided the material is graded on sieves specified in production requirements contained in 6-3.3, and meets uniformity and bituminous design requirements.

TABLE 1
Standard Sizes of Coarse Aggregate

Amounts Finer than Each Laboratory Sieve (Square Openings), weight percent								
Size No.	Nominal Size Square Openings	4 inches [100 mm]	32 inches [90 mm]	3 inches [75 mm]	22 inches [63 mm]	2 inches [50 mm]	12 inches [37.5 mm]	1 inches [25 mm]
1	32 to 12 in. [90 to 37.5 mm]	100	90 to 100	X	25 to 60	X	0 to 15	X
2	2 to 12 inches [63 to 37.5 mm]	X	X	100	90 to 100	35 to 70	0 to 15	X
24	22 to : inches [63 to 19.0 mm]	X	X	100	90 to 100	X	25 to 60	X
3	2 to 1 inches [50 to 25 mm]	X	X	X	100	90 to 100	35 to 70	0 to 15
357	2 inches to No. 4 [50 to 4.75 mm]	X	X	X	100	95 to 100	X	35 to 70
4	12 to : inches [37.5 to 19 mm]	X	X	X	X	100	90 to 100	20 to 55
467	12 inches to No. 4 [37.5 to 4.75 mm]	X	X	X	X	100	95 to 100	X
5	1 to 2 inches [25 to 12.5]	X	X	X	X	X	100	90 to 100
56	1 to δ inches [25 12.5 mm]	X	X	X	X	X	100	90 to 100
57	1 inch to No. 4 [25 to 4.75 mm]	X	X	X	X	X	100	95 to 100
6	: to δ inches [19 to 9.5 mm]	X	X	X	X	X	X	100
67	: to δ inches [19 to 9.5 mm]	X	X	X	X	X	X	100
68	: inch to No. 8 [19 to 2.36 mm]	X	X	X	X	X	X	X
7	2 inch to No. 4 [12.5 to 4.75 mm]	X	X	X	X	X	X	X
78	2 inch to No. 8 [12.5 to 2.36 mm]	X	X	X	X	X	X	X
8	δ inch to No. 16 [9.5 to 1.18 mm]	X	X	X	X	X	X	X
89	δ inch to No. 16 [9.5 to 1.18 mm]	X	X	X	X	X	X	X
9	No. 4 to No. 16 [4.75 to 1.18 mm]	X	X	X	X	X	X	X
10	No. 4 to 0 [4.75 mm]	X	X	X	X	X	X	X

TABLE 1 (Continued)
Standard Sizes of Coarse Aggregate

Amounts Finer than Each Laboratory Sieve (Square Openings), weight percent

Size No.	Nominal Size Square Openings	: inches [19 mm]	2 inch [12.5 mm]	δ inch [9.5 mm]	No. 4 [4.75 mm]	No. 8 [2.36 mm]	No. 16 [1.18 mm]	No.50 [0.30 mm]
1	32 to 12 inches [90.0 to 37.5 mm]	0 to 5	X	X	X	X	X	X
2	22 to 12 inches [63.0 to 37.5 mm]	0 to 5	X	X	X	X	X	X
24	22 to : inches [63.0 to 19.0 mm]	0 to 10	0 to 5	X	X	X	X	X
3	2 to 1 inches [50.0 to 25 mm]	X	0 to 5	X	X	X	X	X
357	2 inches to No. 4 [50.0 to 4.75 mm]	X	10 to 30	X	0 to 5	X	X	X
4	12 to : inches [37.5 to 19 mm]	0 to 15	X	0 to 5	X	X	X	X
467	12 inches to No. 4 [37.5 to 4.75 mm]	35 to 70	X	10 to 30	0 to 5	X	X	X
5	1 to 2 inches [25.0 to 12.5 mm]	20 to 55	0 to 10	0 to 5	X	X	X	X
56	1 to δ inches [25.0 to 9.5 mm]	40 to 85	10 to 40	0 to 15	0 to 5	X	X	X
57	1 inches to No. 4 [25.0 to 4.75 mm]	X	25 to 60	X	0 to 10	0 to 5	X	X
6	: to δ inches [19.0 to 9.5 mm]	90 to 100	20 to 55	0 to 15	0 to 5	X	X	X
67	: inch to No. 4 [19.0 to 4.75 mm]	90 to 100	X	20 to 55	0 to 10	0 to 5	X	X
68	: inch to No. 8 [19.0 to 2.36 mm]	90 to 100	X	30 to 65	5 to 25	0 to 10	0 to 5	X
7	2 inch to No. 4 [12.5 to 4.75 mm]	100	90 to 100	40 to 70	0 to 15	0 to 5	X	X
78	2 inch to No. 8 [12.5 to 2.36 mm]	100	90 to 100	40 to 75	5 to 25	0 to 10	0 to 5	X
8	δ inch to No. 8 [9.5 to 4.75 mm]	X	100	85 to 100	10 to 30	0 to 10	0 to 5	X
89	δ inch to No. 16 [9.5 to 1.18 mm]	X	100	90 to 100	20 to 55	5 to 30	0 to 10	0 to 5
9	No. 4 to No. 16 [4.75 to 1.18 mm]	X	X	100	85 to 100	10 to 40	0 to 10	0 to 5
10	No. 4 to 0 [4.75 mm]	X	X	100	85 to 100	X	X	X

NOTE: The gradations in Table 1 represent the extreme limits for the various sizes indicated, which will be used in determining the suitability for use of coarse aggregate from all sources of supply. For any grade from any one source, the gradation shall be held reasonably uniform and not subject to the extreme percentages of gradation specified above.

901-2 Natural Stones.

Course aggregate may be processed from gravels, granites, limestones, dolomite, sandstones, or other naturally occurring hard, sound, durable materials meeting the requirements of this Section.

901-2.1 Gravels: Gravel shall be composed of naturally occurring quartz, free from deleterious coatings of any kind. The minimum dry-rodded weight (FM 1 T 019) shall be 95 lb/ft^3 [1,522 kg/m^3].

Crushed gravel shall consist of 85%, by weight, of the material retained on the No. 4 [4.75 mm] sieve, having three crushed faces.

901-2.2 Granites: Coarse aggregate produced from the crushing of granites shall be sound and durable. For granites to be used in bituminous mixtures and surface treatments, the Los Angeles Abrasion requirement of 901-1.3 is modified to permit a maximum loss up to 50 (FM 1-T 096). Maximum amount of mica schist permitted is 5% (AASHTO T 189).

901-2.3 Limestones, Dolomite and Sandstone: Coarse aggregates may be produced from limestone, dolomite, sandstones, and other naturally occurring hard, durable materials meeting the requirements of this Section.

Pre-Cenozoic limestones and dolomite shall not be used as crushed stone aggregates either coarse or fine for Asphaltic Concrete Friction Courses, or any other asphaltic concrete mixture or surface treatment serving as the final wearing course. This specifically includes materials from the Ketone Dolomite (Cambrian) Newala Limestone (Mississippian), and Northern Alabama and Georgia.

As an exception to the above up to 20% fine aggregate from these materials may be used in asphaltic concrete mixtures other than Friction Courses which serve as the final wearing course.

901-2.4 Cemented Coquina Rock: For Cemented Coquina Rock to be used in bituminous mixtures, the Los Angeles Abrasion requirement of 901-1.3 is modified to permit a maximum loss up to 50 (FM 1-T 096) provided that the amount of material finer than No. 200 sieve [75 µm] generated during the Los Angeles Abrasion test is less than 18%.

901-3 Manufactured Stones.

901-3.1 Slags: Coarse aggregate may be produced from molten nonmetallic by-products consisting essentially of silicates and aluminosilicates of calcium and other bases, such as air-cooled blast-furnace slag or phosphate slag, provided it is reasonably uniform in density and quality, and reasonably free from deleterious substances as specified in 901-1.2. In addition it must meet the following specific requirements:

Sulphur content .... not more than 1.5%
Dry rodded weight (FM 1-T 019) .... minimum 70 lb/ft^3 [1,120 kg/m^3]
Glassy Particles .... not more than 10%

Slag shall not be used as an aggregate for portland cement concrete.

For Air-Cooled Blast Furnace Slag, the Los Angeles Abrasion requirement of 901-1.3 is modified to permit a maximum loss up to 50 (FM 1-T 096) provided that the amount of material finer than No. 200 sieve [75 µm] generated during the

Los Angeles Abrasion test is less than 18%.

901-4 Lightweight Aggregates.

901-4.1 Lightweight Coarse Aggregate for Bituminous Construction: Lightweight coarse aggregate may be produced from naturally occurring materials such as pumice, scoria and tuff or from expanded clay, shale or slate fired in a rotary kiln. It shall be reasonably uniform in quality and density, and free of deleterious substances as specified in 901-1.2, except that the term cinders and clinkers shall apply to those particles clearly foreign to the extended aggregate in question.

In addition, it must meet the following specific requirements:

Material passing the No. 200 Sieve
[75 μm] .... maximum 3.00%, (FM 1-T 011)
Dry loose weight (FM 1-T 019) .... 33-55 lb/ft^3 [530-880 kg/m^3]*
Los Angeles Abrasion (FM 1-T 096) .... maximum 35%
Ferric Oxide (ASTM C 641) .... maximum 1.5 mg
(Option of Engineer)

*Source shall maintain dry-loose unit weight within ∀6% of Quality Control average. Point of use dry-loose unit weight shall be within ∀10% of Source Quality Control average.

901-4.2 Lightweight Coarse Aggregate for Structural Concrete: The requirements of 901-4.1 are modified as follows:

Aggregates shall not be produced from pumice and scoria.

Los Angeles Abrasion (FM 1-T 096, Section 12) shall be 45%, maximum.

901-5 Reclaimed Portland Cement Concrete Pavement.

The reclaimed portland cement concrete pavement shall be from a source which was produced and placed in accordance with applicable Specifications. The material shall be crushed and processed to provide a clean, hard, durable aggregate having a uniform gradation free from adherent coatings, steel reinforcements, vegetable matter, base material, joint fillers, and bituminous materials.

The Contractor's (Producer's) crushing operation shall produce an aggregate meeting the applicable gradation requirements. The physical property requirements of 901-1.3 for Soundness shall not apply and the maximum loss as determined by the Los Angeles Abrasion (FM 1-T 096) is changed to 50.

The sources of reclaimed portland cement concrete pavement will be treated as a mine and subject to the requirement of Section 6.

901-6 Exceptions, Additions and Restrictions.

Pertinent specification modifications, based on material usage, will be found in other Sections of the specifications.

SECTION 902

FINE AGGREGATE

902-1 General.

902-1.1 Composition: Fine aggregate shall consist of natural silica sand, screenings, local materials, or subject to approval, other inert materials with similar characteristics, or combination thereof, having hard, strong, durable particles, conforming to the specific requirements of this Section.

Approval of mineral aggregate sources shall be in accordance with 6-3.3.

902-1.2 Deleterious Substances: All fine aggregate shall be reasonably free of lumps of clay, soft or flaky particles, salt, alkali, organic matter, loam or other extraneous substances. The weight of deleterious substances shall not exceed the following percentages:

Shale 1.0
Coal and lignite 1.0
Cinders and clinkers 0.5
Clay Lumps 1.0

902-2 Silica Sand.

902-2.1 Composition: Silica sand shall be composed only of naturally occurring hard, strong, durable, uncoated grains of quartz, reasonably graded from coarse to fine, meeting the following requirements, in percent total weight.

Sieve Opening Size	Percent Retained	Percent Passing
No. 4 [4.75 mm]	0 to 5	95 to 100
No. 8 [2.36 mm]	0 to 15	85 to 100
No. 16 [1.18 mm]	3 to 35	65 to 97
No. 30 [600 µm]	30 to 75	25 to 70
No. 50 [300 µm]	65 to 95	5 to 35
No. 100 [150 µm]	93 to 100	0 to 7
No. 200 [75 µm]	minimum 96	maximum 4

Silica sand from any one source, having a variation in Fineness Modulus greater than 0.20 either way from the Fineness Modulus of target gradations established by the producer, may be rejected.

902-2.2 Organic Impurities: Silica sand shall be subject to the colorimetric test for organic impurities. If the color produced is darker than the standard solution, the aggregate shall be rejected unless it can be shown by appropriate tests that the impurities causing the color are not of a type that would be detrimental to Portland Cement Concrete. Such tests shall be in accordance with Florida Methods FM 1-T 21 and FM 1-T 71. When tested for the effect of organic impurities on strength of mortar, the strength ratio at seven and 28 days, calculated in accordance with Section 8 of FM 1-T 71, shall not be less than 95%.

902-3 Sands for Miscellaneous Uses.

902-3.1 Anchor Bolts and Pipe Joints: Sand for setting anchor bolts, pipe joints or other similar uses shall meet the quality requirements of 902-2 except that gradation requirements are waived.

902-3.2 Brick Masonry: Sand for brick masonry shall meet the quality requirements of 902-2 except for gradation requirements. All the materials shall pass the No. 8 [2.36 mm] sieve, and be uniformly graded from coarse to fine.

902-3.3 Sand-Cement Riprap: Sand for sand-cement riprap shall meet the quality requirements of 902-2 except for gradation requirements. The material shall meet the following gradation limits:

Sieve Size	Percent Passing
No. 4 [4.75 mm]	minimum 97%
No. 100 [150 μm]	maximum 20%
No. 200 [75 μm]	maximum 5%

902-4 Filter Material for Underdrains.

Silica sand for use as filter material for Types I through IV Underdrains shall meet the requirements of 902-2 except that the requirements of 902-1.2 and 902-2.2 shall not apply. The aggregate shall be reasonably free of organic matter and other deleterious materials. The gradation requirements of 902-2.1 shall apply except no more than 2% shall pass the No. 200 [75 μm] sieve.

Filter material for Type V Underdrain shall meet the above requirements except that there shall be no more than 1% of silt, clay and organic matter, that the aggregate shall have a Uniformity Coefficient of 1.5 or greater, and that 10% diameter shall be No. 70 to 35 sieve [212 to 500 μm]. The Uniformity Coefficient shall be determined by the ratio D60 divided by D10, where D60 and D10 refer to the particle diameter corresponding to 60 and 10% of the material which is finer by dry weight.

902-5 Screenings.

902-5.1 Composition: Screenings shall be composed of hard, durable particles, either naturally occurring, such as gravel screenings, or resulting from the crushing or processing of the parent rock, to include natural rock, slags, expanded clays or shales (lightweight aggregates), or other approved inert materials with similar characteristics.

Aggregates classified as screening shall conform to the following gradation requirements:

Sieve Size	Percent Passing
δ in. [9.5 mm]	100%
No. 4 [4.75 mm]	85 to 100%
No. 200 [75 μm]	maximum 15%

When permitted by specifications a screening component may contain up to 18% material passing the No. 200 [75 μm] sieve.

902-5.2 Specific Requirements:

902-5.2.1 Screenings from Department Approved Sources of Coarse Aggregate: Processed screenings from fully Approved Sources of Coarse Aggregate are subject to gradation and maximum percent passing the No. 200 [75 μm] sieve tests. Should Coarse Aggregate Source Approval status change, or unsatisfactory in-service history develop, additional control requirements may be implemented.

Screenings for use in hot bituminous mixture may consist of screenings from the processing of reclaimed portland cement concrete pavement to produce coarse aggregate.

902-5.2.2 Screenings from Other Sources: Screenings, from sources other than Department Approved Sources of Coarse Aggregate, must meet the following additional general requirements:

Modified Los Angeles
Abrasion ....95% statistical probability of meeting maximum loss of 23%.
Boil Test or 48 hour Soak..................................maximum loss of 2%
Specific Gravity*
Absorption*
Soundness*
Sulfur*
Phosphate*
Extraneous Substances*

*Specific specification requirements based on material usage found in appropriate Bituminous or Portland Cement Sections.

Based on specific material characteristics, processing techniques and in-service history on Department projects, specific source requirements may be assigned.

902-5.2.3 Screenings For Use in Portland Cement Concrete: Screenings produced from either the Miami Oolite, Miami Ft. Thompson, or Loxahatchee Ft. Thompson Formations may be substituted for silica sand for use in concretes, except for concrete pavements, approach slabs, bridge decks and precast superstructure segments. (However, screenings will be permitted in the concrete when the bridge deck or approach slab is to be covered with an asphaltic concrete surface course.)

These screenings must meet the gradation requirements of AASHTO M 6, Section 6.1, as well as the maximum percent passing the No. 200 [75 μm] sieve, Fineness Modulus, and Organic requirements of 902-2 Silica Sand. In addition, the saturated, surface dry specific gravity shall be at least 2.48.

902-6 Local Materials.

Local materials shall be composed of hard, strong, durable particles, either naturally occurring, such as natural sands, or resulting from the crushing or processing of parent rock, to include natural sand and rock, slags, expanded clays or shales (lightweight aggregate), or other approved inert materials with similar characteristics.

Aggregates classified as local material shall conform to the following gradation requirements:

Sieve Size	Percent Passing
δ in. [9.5 mm]	100%
No. 10 [2.00 mm]	85 to 100%
No. 200 [75 μm]	maximum 15%

In addition to meeting the requirements of 902-1.2, the material shall not contain excessive quantities of other deleterious substances, such as roots, cans, debris, etc. If clay size material is present, it shall not exceed 7%, as determined by Florida Method FM 1-T 088, and it shall be of a type which will not produce clay balls when used. The aggregate must be suitable for designated use, as determined by laboratory tests. If the deposit consists of stratified layers of varying characteristics and gradation, the producer shall employ such means as necessary to secure a uniform material.

Local materials will not be required to be produced under the requirements of 6-3.3, provided they can meet the above requirements.

902-7 Exceptions, Additions and Restrictions.

Other specification modifications, based on material usage may be found in the appropriate Sections of the specifications.

FLEXIBLE-PAVEMENT MATERIALS
(INCLUDING MATERIALS FOR STABILIZING)

SECTION 911

LIMEROCK MATERIAL FOR BASE

AND STABILIZED BASE

911-1 General.

This Section governs materials to be used on construction of limerock base and limerock stabilized base.

911-2 Furnishing of Material.

Except as might be specifically shown otherwise, all limerock material and the sources thereof shall be furnished by the Contractor. Approval of mineral aggregate sources shall be in accordance with 6-3.3. Any limerock material occurring in State-furnished borrow areas shall not be used by the Contractor in constructing the base, unless permitted by the plans or other Contract Documents.

911-3 Composition.

The minimum of carbonates of calcium and magnesium in the limerock material shall be 70%. The maximum percentage of water-sensitive clay mineral shall be 3. Determination shall be at the option of the Engineer.

911-4 Liquid Limit and Plasticity Requirements.

911-4.1 Material for Limerock Base: The liquid limit shall not exceed 35 and the material shall be non-plastic.

911-4.2 Material Used in Limerock Stabilized Base: The liquid limit shall not exceed 35 and the plastic index shall not exceed ten.

911-5 Mechanical Requirements.

911-5.1 Deleterious Material: Limerock material shall not contain cherty or other extremely hard pieces, or lumps, balls or pockets of sand or clay size material in sufficient quantity as to be detrimental to the proper bonding, finishing, or strength of the limerock base.

911-5.2 Gradation and Size Requirements:

911-5.2.1 For Limerock Base: At least 97% (by weight) of the material shall pass a 32 inch [90 mm] sieve and the material shall be graded uniformly down to dust. The fine material shall consist entirely of dust of fracture. All crushing or breaking-up which might be necessary in order to meet such size requirements shall be done before the material is placed on the road.

911-5.2.2 For Limerock Stabilized Base: For this use the limerock material shall meet the requirements of 911-5.2.1 except that 97% shall pass the 12 inch [37.5 mm] sieve.

911-6 Limerock Bearing Ratio Requirements.

Limerock material used in construction of limerock base shall have an average LBR value of not less than 100. The average LBR value of material produced at a particular source shall be determined in accordance with an approved quality control procedure.

SECTION 912

SAND-CLAY BASE MATERIAL

912-1 General Requirements.

Sand-clay material for use in the construction of Sand-Clay Base shall be a mixture of sand and clay, and shall be free of trash, foreign matter and other deleterious material. It shall not contain lumps or aggregate of such nature or in sufficient quantity to prevent the obtaining of a smooth surface, free from pits and pockets. It shall not contain particles of aggregate which will not pass a 1 inch [25 mm] sieve.

912-2 Composition and Gradation.

The material passing the No. 10 [2 mm] sieve shall meet the following requirements for composition, gradation, etc.:

	Percent of material passing No. 10 [2 mm] sieve
Clay (material smaller than 5 μm)	8 to 21
Silt (material from 5 to 50 μm)	0 to 10
Combined clay and silt	8 to 25

912-3 Bearing Value and Plasticity.

912-3.1 Bearing Value: The material shall have a Limerock Bearing Ratio Value of at least 75.

912-3.2 Plasticity: The material shall meet the following requirements for plasticity (based on tests made on the portion passing the No. 40 [425 μm] sieve):

Liquid Limit - Not greater than 25.

Plasticity Index - Not greater than 6.

SECTION 913

SHELL MATERIAL

913-1 General.

913-1.1 Composition: Shell materials to be used for shell base or shell stabilized base, shall consist of naturally occurring deposits formed essentially of broken mollusk shell, corals and the skeletal remains of other marine invertebrates. Live or steamed shell, or man-made deposits as a by-product of the shellfish industry will not be permitted.

Approval of mineral aggregate sources shall be in accordance with 6-3.3.

913-1.2 Deleterious Substances: Shell materials shall be reasonably free of lumps of clay, organic matter, and other substances not defined which may possess undesirable characteristics. The material shall not contain silica sand in sufficient quantity to prevent bonding.

913-1.3 Physical and Chemical Properties: Shell materials shall meet the following physical and chemical requirements:

Limerock Bearing Ratio (FM 5-515) - The material shall have an average LBR value of not less than 100. Material represented by any individual LBR value of less than 90 is unacceptable.

Plasticity (FM 1-T 089 and FM 1-T 090) - That portion of the material passing the No. 40 [425 μm] sieve shall be non-plastic.

Carbonates (FM 5-514) - The minimum percentage of carbonates of calcium and magnesium shall be 50.

913-2 Dredged Shell.

913-2.1 Definition: Dredged shell shall be defined as those shell materials meeting the requirements of 913-1, which are dredged from ocean, bay or lake deposits.

913-2.2 Gradation Requirements: Materials classified as Dredged Shell shall meet the following gradation requirements:

Passing 32 inch [90 mm] sieve	97% (maximum dimension not to exceed 6 inches [150 mm])
Passing No. 4 [4.75 mm] sieve	maximum 50%
Passing No. 200 [75 µm] sieve	maximum 7.5% (by weight)

913-3 Bank-Run Shell.

913-3.1 Definition: Bank-Run Shell shall be defined as those shell materials meeting the requirements of 913-1 which are presently found as "dry land" deposits.

913-3.2 Gradation Requirements: Materials classified as Bank-Run Shell shall meet the following gradation requirements:

Passing 32 inch [90 mm] sieve	97% (maximum dimension not to exceed 6 inches [150 mm])
Passing No. 4 [4.75 mm] sieve	maximum 80%
Passing No. 200 [75 µm] sieve	maximum 20% (washed)

913-4 Exceptions, Additions and Restrictions.

Other specification modifications, based on material usage, may be found in applicable Sections of the specifications.

SECTION 913A

SHELL - ROCK MATERIAL

913A-1 General.

Shell-rock materials to be used for shell-rock base shall be defined as naturally occurring heterogeneous deposits of limestone with interbedded layers or lenses of loose and cemented shell, to include cemented sands (calcitic sandstone). This material shall be mined and processed in a manner which will result in a reasonably homogenous finished product.

Approval of mineral aggregate sources shall be in accordance with 6-3.3.

913A-2 Deleterious Substances.

Shell-rock materials shall not contain lumps of clay, organic matter, cherty or other extremely hard materials, or other substances not defined, in sufficient quantity as to be detrimental to the finishing, strength, or performance of the base. The material shall not contain loose, free silica sand in sufficient quantity to prevent bonding of the base, or to result in a surface which is susceptible to distortion under construction traffic, or accumulation of loose sand on the finished surface which precludes bonding of the bituminous tack coat with the base, nor shall the material contain more than 50% loose, free shells, corals or skeletal remain of other marine invertebrates (retained on the No. 4 [4.75 mm] sieve). Materials shall contain no water sensitive clay minerals.

913A-3 Physical and Chemical Properties.

Shell-rock material shall meet the following physical and chemical properties:

Limerock Bearing Ratio (LBR) (FM 5-515) - Production of this material shall be controlled so as to meet the following requirements for LBR value:

The average of test values shall not be less than 100.
No individual test value shall be less than 90.
No two consecutive test values between 90 and 100.

Plasticity (FM 1-T 089 and FM 1-T 090) - That portion of the material passing the No. 40 [425 μm] sieve shall be non-plastic.

Carbonates (FM-5-514) - The minimum of the average percentage of carbonates of calcium and magnesium shall be 50. Material represented by any individual carbonate LOT average of less than 45% is unacceptable.

Gradation Requirements - Materials classified as shell-rock shall be graded uniformly down to dust and in addition, meet the following specific requirements:

Passing 32 inch [90 mm] sieve (maximum dimension not to exceed 6 inches [150 mm]) ....minimum 97%
Passing No. 4 [4.75 mm] sieve .... maximum 70%
Passing No. 200 [75 μm] sieve ....maximum 20% (washed)

SECTION 914

MATERIALS FOR SUBGRADE STABILIZATION

914-1 General.

The specification requirements of the various materials as contained in this Section are to govern their use only when these materials are used in the stabilizing of the subgrade.

914-2 Materials for Type C Stabilizing (Florida Soil Bearing Value)

914-2.1 General: When Type C Stabilization is to be done and it is necessary that the materials for stabilizing be brought in from outside project limits, such materials shall meet the requirements of this Article.

914-2.2 Types of Materials: The materials to be used for Type C stabilizing may be soil, ground limestone, crushed limerock, oyster shell, coquina shell, rock screenings, or any other material, including recyclable materials, which is suitable. Organic soils such as muck or materials that may deteriorate over time, cause excessive deformations, contain hazardous substances, contaminates, or do not improve the bearing capacity of the stabilized material shall not be used as a stabilizer (See Section 914-4 for qualifying tests for these conditions).

914-2.3 Admixture Materials: Lime or other approved material which will reduce the plasticity by chemical reaction, may be mixed-in with the stabilizing material or with the mixed stabilized section of the roadbed, where necessary to reduce the plasticity of the stabilized roadbed.

914-2.4 Plasticity and Maximum Size: Materials having a plasticity index of more than ten or a liquid limit greater than 40 shall not be used as a stabilizer. At least 97% of the stabilizing material shall pass a 32 inch [90 mm] sieve.

914-3 Materials for Type B Stabilizing (Limerock Bearing Ratio)

914-3.1 Commercial Materials:

914-3.1.1 General: Materials may be either limerock, shell rock, cemented coquina or shell base sources approved by the Department.

914-3.1.2 Specific Requirements for Limerock: For limerock, carbonates of calcium and magnesium shall be at least 70%. Materials having a plasticity index of more than ten or a liquid limit greater than 40 shall not be used as a stabilizer. The gradation of limerock shall be such that 97% of these materials will pass a 32 inch [90 mm] sieve.

914-3.1.3 Crushed Shell: Crushed shell for this use shall be mollusk shell (i.e., oysters, mussels, clams, cemented coquina). Steamed shell will not be permitted.

This shell shall meet the following requirements:

Material having a plasticity index of more than ten or a liquid limit greater than 40 shall not be used as a stabilizer.

At least 97% by weight of the total material shall pass a 32 inch [90 mm] sieve and at least 50% by weight of the total material shall be retained on the No. 4 [4.75 µm] sieve.

Not more than 20% by weight of the total material shall pass the No. 200 [75 µm] sieve. The determination of the percentage passing the No. 200 [75 µm] sieve shall be by washing only.

In the event that the shell meets the above requirements without crushing, crushing will not be required.

914-3.2 Local Materials: Local materials used for this stabilizing may be soils or recyclable materials such as crushed concrete, roof tiles and asphalt coated base or reclaimed pavement. However, no materials that deteriorate over time, cause excessive deformations, contain hazardous substances, contaminates, or do not improve the bearing capacity of the stabilized material may be used. (See Section 914-4 for qualifying tests for these conditions.) The Contractor shall provide information or test results to the District Materials Engineer to substantiate these properties. At least 97% by weight of the total material shall pass a 32 inch [90 mm] sieve. Material having a plasticity index greater than ten or a liquid limit greater than 40 shall not be used as a stabilizer.

No blending of materials to meet these requirements will be permitted unless authorized by the District Materials Engineer. When blending is permitted blended material shall be tested to ensure the above requirements are met before being spread on the roadway.

914-4 Testing of Materials for Use as Stabilizer.

No testing of any materials proposed to be furnished by the Contractor will be made by the Department prior to the determination of the successful bidder, and the bidder shall make his own arrangements for the preliminary determination of the suitability of the particular material he proposes to use. For evaluation of deterioration and excessive deformation, each material source shall not have an average organic content (minimum of three tests) greater than 2.5% and any individual test value more than 4.0%. The organic content shall be performed in accordance with FM1-T267 on the portion of a sample passing the No. 4 [4.75 μm] sieve. If toxic substances, elements or compounds are suspected at concentrations defined by EPA, qualifying tests shall be performed. Test methods for these substances shall be those mandated by EPA and analyzed by a certified laboratory. All test results of the proposed stabilizing material shall be submitted to the District Materials Engineer for approval at least 14 days prior to commencement of the field stabilizing operation. The District Materials Engineer may request samples of the stabilizing material and subgrade soil for verification tests.

SECTION 915

CEMENTED COQUINA SHELL MATERIAL

915-1 Composition.

Cemented Coquina Shell Materials to be used as cemented coquina base or stabilized base, shall be defined as naturally occurring deposits formed essentially of broken mollusk shell, corals and the skeletal remains of other marine invertebrates, which are presently found as "dry land" deposits and which have been cemented together by carbonates or other natural cementing agents.

Approval of mineral aggregate sources shall be in accordance with 6-3.3.

915-2 Deleterious Substances.

Cemented Coquina Shell Materials shall be reasonably free of lumps of clay, organic matter, and other substances not defined which may possess undesirable characteristics. The material shall not contain loose, free silica sand in sufficient quantity to prevent bonding.

915-3 Physical and Chemical Properties.

Cemented Coquina Shell shall meet the following physical and chemical properties.

Limerock Bearing Ratio (FM-515) - The material shall have an average LBR value of not less than 100. Material represented by any individual LBR value of less than 90 is unacceptable.

Plasticity (FM 1-T 089 and FM 1-T 090) - That portion of the material passing the No. 40 [425 μm] sieve shall be non-plastic.

Carbonates (FM 5-514) - The average percentage of carbonates of calcium and magnesium shall be 45. Material represented by any individual carbonate and magnesium LOT average of less than 40.5% is unacceptable.

915-4 Gradation requirements.

Cemented Coquina shall have the following gradation requirements:

Passing 32 inch [90 mm] sieve	97% (maximum dimension not to exceed 6 inches [150 mm])
Passing No. 4 [4.75 mm] sieve	maximum 70%
Passing No. 200 [75 µm] sieve (dry weight)	maximum 20% (by washing)

915-5 Exceptions, Additions and Restrictions.

Other specification modifications, based on material usage, may be found in applicable Sections of the specifications, or revisions thereto.

SECTION 916

BITUMINOUS MATERIALS

916-1 Asphalt Cement.

The grades of asphalt cement shall conform to the requirements given in the following Table 1:

	Table 1 ASPHALT CEMENT	
Test	Conditions	Viscosity Grade Minimum/Maximum Value
		AC-5
Viscosity -P	140EF [60EC]	500 ∀ 100 [50 ∀ 10 PaAs]
Viscosity - cSt	275EF [135EC]	minimum 175 [0.000175m^2/s]
Penetration (0.1 mm)	77EF [25EC], 100 g, 5 seconds	minimum 140
Flash Point	COC	minimum 350EF [177EC]
Solubility	in Trichlorethylene	minimum 99.0%
Tests on Residue from Thin Film Oven Test:		
Viscosity Ratio	Visc. 140EF [60EC] after TFOT Visc. 140EF [60EC] before TFOT	maximum 4
Loss on Heating		maximum 1.0%
Ductility	77EF [25EC], 50 mm/minute	minimum 1,000 mm
		AC-10

	Table 1 ASPHALT CEMENT	
Test	Conditions	Viscosity Grade Minimum/Maximum Value
Viscosity -P	140EF [60EC]	1,000 ∀ 200 [100 ∀ 20 Pa≅s]
Viscosity -cSt	275EF [135EC]	minimum 250 [0.00025 m^2/s]
Penetration (0.1 mm)	77EF [25EC], 100 g, 5 seconds	minimum 80
Flash Point	COC	minimum 425EF [218EC]
Solubility	in Trichloroethylene	minimum 99.0%
Tests on Residue from Thin Film Oven Test:		
Viscosity Ratio	Visc. 140EF [60EC] after TFOT Visc. 140EF [60EC] before TFOT	maximum 4
Loss on Heating		maximum 0.5%
Ductility	77EF [25EC], 50 mm/minute	minimum 900 mm
		AC-20
Viscosity -P	140EF [60EC]	2000 ∀ 400 [200 ∀ 40 Pa≅s]
Viscosity -cSt	275EF [135EC]	minimum 300 [0.0003m^2/s]
Penetration (0.1 mm)	77EF [25EC], 100 g, 5 seconds	minimum 60
Flash Point	COC	minimum 450EF [230EC]
Solubility	in Trichlorethylene	minimum 99.0%
Test on Residue from Thin Film Oven Test:		
Viscosity Ratio	Visc. 140EF [60EC] after TFOT Visc. 140EF [60EC] before TFOT	maximum 4
Loss on Heating		maximum 0.5%
Ductility	77EF [25EC], 50 mm/minute	minimum 800 mm
		AC-30
Viscosity -P	140EF [60EC]	3000 ∀ 600 [300 ∀ 60 Pa≅s]
Viscosity -cSt	275EF [135EC]	minimum 350 [0.000350 m^2/s]
Penetration (0.1 mm)	77EF [25EC], 100 g, 5 seconds	minimum 50
Flash Point	COC	minimum 450EF [230EC]

	Table 1 ASPHALT CEMENT	
Test	Conditions	Viscosity Grade Minimum/Maximum Value
Solubility	in Trichlorethylene	minimum 99.0%
Tests on Residue from Thin Film Oven Test:		
Viscosity Ratio	Visc. 140EF [60EC] after TFOT / Visc. 140EF [60EC] before TFOT	maximum 4
Loss on Heating		maximum 0.5%
Ductility	77EF [25EC], 50 mm/minute	minimum 500 mm

Spot Test, when and as specified. (See note below.)

Standard with Naphtha Solvent- Negative for all grades.

Naphtha-Xylene Solvent- percent Xylene-Negative for all grades

Heptane-Xylene Solvent- percent Xylene-Negative for all grades.

Note: The use of the spot test is optional. When it is specified, the Engineer shall indicate whether the standard naphtha solvent, the naphtha-xylene solvent, or the heptane-xylene solvent will be used in determining compliance with this requirement, and also, in the case of xylene solvents, the percentage of xylene to be used.

All hot bituminous mixtures (except recycled mixtures) must contain Viscosity Grade AC-30 as specified above.

For Viscosity Grade AC-30, silicone shall be added to the asphalt cement at the rate of 25 cm^3 of silicone mixed to each 5,000 gallons [19 m^3] of asphalt cement. If a dispersing fluid is used in conjunction with the silicone, the resultant mixture containing the full 25 cm^3 shall be added, in accordance with the manufacturer's recommendation. The blending of silicone mixture with the asphalt cement shall be done by the producer prior to shipment.

Viscosity Grade AC-30 used in friction course mixes shall contain 0.5% heat-stable antistrip additive by weight of asphalt from an approved source. The antistrip additive shall be introduced and mixed into the asphalt cement at the asphalt terminal during loading or by the Contractor at the asphalt plant in a manner satisfactory to the Engineer.

Material failing to meet the viscosity requirements (140EF [60EC]) shown above will be paid for at reduced rates as shown in Table 2 below:

Table 2	
AC-5: Viscosity in poises at 140EF, [in Pa≅s at 60EC]	Percentage of Original Payment
400 - 600 [40 - 60]	100%
375 - 399 or 601 - 625 [37 - 39 or 60 - 63]	90%
340 - 374 or 626 - 660 [34 - 36 or 64 - 66]	80%
Less than 340 [34] or greater than 660 [66]	*50%

AC-10: Viscosity in poises at 140EF, [in Pa≅s at 60EC]	Percentage of Original Payment
800 - 1,200 [80 - 120]	100%
750 - 799 or 1,201 - 1,250 [75 - 79 or 120 - 125]	90%
680 - 749 or 1,251 - 1,320 [68 - 74 or 126 - 132]	80%
Less than 680 [68] or greater than 1,320 [132]	*50%

AC-20: Viscosity in poises at 140EF, [in Pa≅s at 60EC]	Percentage of Original Payment
1,600 - 2,400 [160 - 240]	100%
1,500 - 1,599 and 2,401 - 2,500 [150 - 159 and 240 - 250]	90%
1,375 - 1,499 and 2,501 - 2,625 [138 - 149 and 251 - 263]	80%
Less than 1,375 [138] or greater than 2,625 [263]	*50%

AC-30: Viscosity in poises at 140EF, [in Pa≅s at 60EC]	Percentage of Bid Price square yard or ton [square meter or metric ton]
2,400 - 3,600 [240 - 360]	100%
2,250 - 2,399 or 3,601 - 3,750 [225 - 239 or 360 - 375]	97%
2,075 - 2,249 or 3,751 - 3,925 [208 - 224 or 376 - 393]	94%
Less than 2,075 [208] or greater than 3,925 [393]	*86%

* May be removed and replaced at the discretion of the Engineer.

916-1.2 Sampling and Certification: The supplier shall furnish a certification indicating compliance with the above specifications, including silicone and antistrip when required, for all asphalt cements delivered to the project.

For each shipment delivered to the asphalt terminal, the asphalt supplier shall submit a certified test report to the State Materials Office to include all properties specified for a particular grade of asphalt cement. The test results may be from a sample taken from the storage tank(s) after delivery or from a random sample taken from the barge or rail car(s).

All materials delivered to the project shall be identified by viscosity grade.

916-2 Recycling Agents.

916-2.1 Requirements: The asphalt recycling agent shall be an asphalt cement or an asphalt cement blended (as necessary) with a softening agent or flux oil, and shall meet the following requirements:

TABLE I

Absolute Viscosity,

(V60) after TFOT (Thin Film Oven Test)................................3:1 Ratio maximum
Smoke Point ....260EF [125EC] minimum
Flash Point...400EF [205EC] minimum
Solubility ....97.5% minimum

Emulsified recycling agent shall meet the following requirements:

TABLE II

Storage Stability- 24 hour .... 1.0% maximum
Sieve Test .... 0.1% maximum
Residue by Evaporation...65.0% minimum

Residue from the emulsified recycling agent shall meet the requirements in Table I.

Recycling Agents may also be standard grade asphalt cements meeting the requirements of Table 1 in 916-1.1.

Silicone shall be added to the recycling agent at a rate of 25 cm^3 for each 5,000 gallons [19 m^3] of recycling agent. For emulsified recycling agent the silicone shall be added to the residue at the stated rate prior to emulsification. If a dispersing fluid is used in conjunction with the silicone, the resultant mixture containing the full 25 cm^3 shall be added, in accordance with the manufacturer's recommendation. The blending of silicone mixture with the residue shall be done by the supplier prior to shipment.

The recycling agent, or emulsified asphalt recycling agent, shall contain 0.5% heat-stable antistrip additive by weight of asphalt from an approved source. The antistrip additive shall be introduced and mixed into the recycling agent, or emulsified recycling agent, at the terminal.

916-2.2 Sampling and Certification: The supplier shall furnish a certification indicating compliance with the above specification for all recycling agents or emulsified recycling agents delivered to the project.

For each shipment delivered to the asphalt terminal, the asphalt supplier shall submit a test report to the State Materials Office to include all properties specified for a particular recycling agent or emulsified recycling agent. The test results may be from a sample taken from the storage tank(s) after delivery or from a random sample taken from the barge or rail car(s).

916-3 Cut-Back Asphalts.

916-3.1 Requirements: Rapid-curing, cut-back asphalt shall conform with the requirements of AASHTO M 81, except that the penetration range shall be from 60-120 instead of 80-120.

For Grade RC-3000, in addition to the requirements shown in Table 1 of AASHTO M 81 the following values shall be added to the requirements for Distillation Test:

Distillate, Percentage by Volume of Total Distillate to 680EF [360EC]	Grade RC-3000 Maximum

to 320EF [160EC]	0
to 374EF [190EC]	10
to 437EF [225EC]	40

All other requirements for the distillation test (and for other properties included in the table) shall be as shown in Table 1 of AASHTO M 81.

Medium-curing, cut-back asphalt shall conform with the requirements of AASTHO M 82.

916-3.2 Sampling and Certification: For each tank of cut-back asphalt delivered to or prepared at the asphalt terminal, the asphalt supplier shall submit a sample to the State Materials Office for testing before use. A pretest number will then be assigned by the State Materials Office which shall be furnished with all cut-back asphalt delivered to the project.

916-4 Emulsions.

916-4.1 Requirements: Anionic Emulsified Asphalt shall meet the requirements of AASHTO M 140 with the exception that the cement mix test will be waived when the asphalt is used in non-mix application, such as tack coats and primes. Cationic Emulsified Asphalt shall meet the requirements of AASHTO M 208. Additional emulsions permitted by specifications shall meet the following requirements:

HIGH FLOAT EMULSIONS

Test	Conditions	Asphalt Emulsion Grade AE-60
		Minimum/Maximum
Tests on Emulsion:		
Saybolt Furol Visc	122EF [50EC]	75/400 seconds
Settlement	5 days (a)	maximum 5%
Storage Stability	24 hour (b)	maximum 1%
Sieve Test		maximum 0.10%
Demulsibility	50 mL $CaCl_2$ 0.10 N	minimum 75%
Residue by Distillation		minimum 65%
Oil Portion	500EF. Dist. [260EC. Dist.]	maximum 1% by volume
Tests on Residue:		
Penetration (0.1 mm)	77EF [25EC], 100 g, 5 seconds	minimum 40
Absolute Viscosity	140EF [60EC]	minimum 3,200 poise [320 Pa≅s]
Ductility	77EF [25EC], 50 mm/minute	minimum 400 mm
Float Test	140EF [60EC]	minimum 1,200 seconds

Solubility	in Trichlorethylene	minimum 97.5%

Test	Conditions	Asphalt Emulsion Grade AE-90 Minimum/Maximum
Tests on Emulsion:		
Saybolt Furol Visc	122EF [50EC]	75/400 seconds
Settlement	5 days (a)	maximum 5%
Storage Stability	24 hour (b)	maximum 1%
Sieve Test		maximum 0.10%
Demulsibility	50 mL $CaCl_2$ 0.10 N	minimum 75%
Residue by Distillation		minimum 65%
Oil Portion	500EF. Dist. [260EC. Dist.]	maximum 2% by volume
Tests on Residue:		
Penetration (0.1 mm)	77EF [25EC], 100 g, 5 seconds	minimum 70
Absolute Viscosity	140EF [60EC]	minimum 1,600 poise [160 Pa≅s]
Ductility	77EF [25EC], 50 mm/minute	minimum 400 mm
Float Test	140EF [60EC]	minimum 1,200 seconds
Solubility	in Trichlorethylene	minimum 97.5%

Test	Conditions	Asphalt Emulsion Grade AE-150
		Minimum/Maximum
Tests on Emulsion:		
Saybolt Furol Visc	122EF [50EC]	75/400 seconds
Settlement	5 days (a)	maximum 5%
Storage Stability	24 hour (b)	maximum 1%
Sieve Test		maximum 0.10%
Demulsibility	50 mL $CaCl_2$ 0.10 N	minimum 75%
Residue by Distillation		minimum 65%
Oil Portion	500EF. Dist. [260EC. Dist)]	maximum 3% by volume
Tests on Residue:		
Penetration (0.1 mm)	77EF [25EC], 100 g, 5 seconds	minimum 125
Absolute Viscosity	140EF [60EC]	minimum 800 poise [80 Pa≅s]
Ductility	77EF [25EC],	minimum 400 mm

	50 mm/minute	
Float Test	140EF [60EC]	minimum 1,200 seconds
Solubility	in Trichlorethylene	minimum 97.5%

Test	Conditions	Asphalt Emulsion Grade AE-200 Minimum/Maximum
Tests on Emulsion:		
Saybolt Furol Visc	122EF [50EC]	minimum 45 seconds
Settlement	5 days (a)	maximum 5%
Storage Stability	24 hour (b)	maximum 1%
Sieve Test		maximum 0.10%
Demulsibility	50 mL $CaCl_2$ 0.10 N	minimum 75%
Residue by Distillation		minimum 62%
Oil Portion	500EF. Dist. [260EC. Dist)]	maximum 8% by volume
Tests on Residue:		
Penetration (0.1 mm)	77EF [25EC], 100 g, 5 seconds	minimum 150
Absolute Viscosity	140EF [60EC]	minimum 400 poise [40 Pa≅s]
Ductility	77EF [25EC], 50 mm/minute	
Float Test	140EF [60EC]	minimum 1,200 seconds
Solubility	in Trichlorethylene	minimum 97.5%

(a) The test requirement for settlement may be waived when the emulsified asphalt is used in less than five days.
(b) The 24-hour (one day) storage stability test may be used instead of the five day settlement test.

SPECIAL MS-EMULSION		
Test	Conditions	Minimum/Maximum
Tests on Emulsion:		
Saybolt Furol Visc	77EF [25EC]	minimum 45 seconds
Storage Stability	24 hour	maximum 1%
Sieve Test	50 mL $CaCl_2$ 0.10 N	maximum 0.10%
Demulsibility		minimum 65%
Residue by Distillation		minimum 62%
Naphtha Content	500EF. Dist. [260EC. Dist)]	maximum 8% by volume
Tests on Residue:		
Penetration (0.1 mm)	77EF [25EC], 100 g, 5 seconds	minimum 50
Ductility	77EF [25EC],	minimum 400 mm

SPECIAL MS-EMULSION		
Test	Conditions	Minimum/Maximum
	50 mm/minute	
Absolute Viscosity	140EF [60EC]	minimum 800 poise [80 Pa≅s]
Solubility	in Trichloroethylene	minimum 97.5%

Maximum application temperature shall be 170EF [75EC].

EMULSIFIED ASPHALT GRADE CRS-2H

Test	Conditions	Minimum/Maximum
Tests on Emulsion:		
Saybolt Furol Visc.	122EF [50EC]	100/400 seconds
Settlement	5 days (a)	maximum 5%
Storage Stability	24 hour (b)	maximum 1%
Demulsibility	35 mL 0.8% Sodium Dioctyl Sulfosuccinate (c)	minimum 40%
Particle Charge		positive
Sieve Test		maximum 0.1%
Residue		minimum 65%
Tests on Residue:		
Penetration (0.1 mm)	77EF [25EC], 100 g, 5 seconds	80/140
Ductility	77EF [25EC], 50 mm/minute	minimum 400 mm
Solubility	in Trichloroethylene	minimum 97.5%

(a) The test requirement for settlement may be waived when the emulsified asphalt is used in less than five days.
(b) The 24-hour (one day) storage stability test may be used instead of the five day settlement test.
(c) The demulsibility test shall be made within 30 days from date of shipment.

ASPHALT EMULSION PRIME (AEP)

Test	Conditions	Minimum/Maximum
Tests on Emulsion:		
Saybolt Furol Visc.	77EF [25EC]	20/150 seconds
Settlement	5 days (a)	maximum 5%
Storage Stability	24 hour (b)	maximum 1%
Sieve Test		maximum 0.1%
Residue		minimum 55%
Naphtha Content	500EF. Dist [260EC. Dist.]	maximum 12% by volume
Tests on Residue:		
Penetration (0.1 mm)	77EF [25EC],100 g,	40/200

	5 seconds	
Ductility	77EF [25EC], 50 mm/minute	minimum 400 mm
Solubility	in Trichloroethylene	minimum 97.5%

(a) The test requirement for settlement may be waived when the emulsified asphalt is used in less than five days.

(b) The 24-hour (one day) storage stability test may be used instead of the five day settlement test.

ASPHALT EMULSION GRADE RS-1

Test	Conditions	Minimum/Maximum
Tests on Emulsion:		
Saybolt Furol Visc	77EF [25EC]	20/100 seconds
Storage Stability	24 hour	maximum 1%
Demulsibility	35 mL 0.02N $CaCl_2$ (a)	minimum 60%
Sieve Test		maximum 0.10%
Residue by Distillation		minimum 55%
Naphtha Portion	500EF. Dist [260EC. Dist.](b)	maximum 3% by volume
Tests on Residue From Distillation Test:		
Penetration (0.1 mm)	77EF [25EC],100 g, 5 seconds	minimum 60
Viscosity	140EF [60EC]	minimum 1,600 poise [160 Pa≅s]
Ductility	77EF [25EC], 50 mm/minute	minimum 400 mm
Solubility	in Trichloroethylene	minimum 97.5%

(a) The demulsibility test shall be made within 30 days from the date of shipment.

(b) When RS-1 has been modified to include naphtha, the 24-hour storage stability test will be waived.

EMULSION PRIME (RS TYPE)

Test	Conditions	Minimum/Maximum
Tests on Emulsion:		
Saybolt Furol Visc.	77EF [25EC]	minimum 75 seconds
Storage Stability	24 hour	maximum 1.0%
Sieve Test		maximum 0.1%
Naphtha Content		5/15% by volume
Residue		minimum 55%
Tests on Residue:*		
Penetration (0.1 mm)	77EF [25EC], 100 g, 5 seconds	minimum 50
Viscosity	140EF [60EC]	minimum 800 poise [80

		Pa≅s]
Solubility	in Trichloroethylene	minimum 97.5%

* Residue by distillation shall be in accordance with AASHTO T 59 except that the maximum temperature shall be 329 ∀ 10EF [165 ∀ 5EC] and the sample shall be maintained at this temperature for 20 minutes.

EPR-1 PRIME

Tests	Conditions	Minimum/Maximum
Tests on Emulsion:		
Saybolt Furol Visc.	77EF [25EC]	6/24 seconds
Sieve Test (a)		maximum 0.1%
Residue by Distillation (b)		minimum 15%
Particle Charge Test (c)		positive
Tests on Residue: (d)		
Flash Point	COC	minimum 410EF [210EC]
Viscosity	cSt-140EF [60EC]	350/600 [0.00035/0.00060 m^2/s]
Aniline Point		85E/110EF [29E/43EC]

(a) Distilled water shall be used in place of 2% sodium oleate solution.
(b) Residue by distillation shall be in accordance with AASHTO T 59 with the exception that a 50 g sample is heated to 300EF [149EC] until foaming ceases, then cooling immediately and calculating results.
(c) Caution: this material has a positive particle charge, and therefore should not be mixed with materials having a negative particle charge.
(d) Residue by distillation shall be in accordance with AASHTO T 59 except that the maximum temperature shall be 329 ∀ 10EF [165 ∀ 5EC] and the sample shall be maintained at this temperature for 20 minutes.

916-4.2 Sampling and Certification: For each tank of emulsified asphalt delivered to or prepared at the asphalt terminal, the asphalt supplier shall submit a sample to the State Materials Office for testing before use. A pretest number will then be assigned by the State Materials Office which shall be furnished with all emulsified asphalt delivered to the project.

For all emulsion prime (EPR-1) delivered directly to the project for use, the supplier shall furnish a certification indicating compliance with all the specification requirements for EPR-1 Prime. When the EPR-1 is shipped to the Contractor in concentrated form, the supplier shall furnish a certification indicating compliance with all the specification requirements for EPR-1 Prime for each batch of material when blended with the appropriate amount of water. The Contractor shall blend the concentrate EPR-1 with the appropriate amount of water indicated by the supplier prior to use as a prime coat, and for each distributor load of material delivered to the project, shall furnish a certification indicating compliance with the supplier's requirements for blending along with a copy of the supplier's certification for the concentrate. In the event that the diluted EPR-1 Prime is not used in a 12-hour period, the material shall be thoroughly mixed by circulation or other suitable means prior to it's use.

SECTION 917

MINERAL FILLER

917-1 Composition.

Mineral filler shall consist, in general, of limerock dust, portland cement, slag dust, hydrated lime, or any other inert mineral matter from sources approved by, the Engineer. The mineral filler shall be thoroughly dry and free from lumps consisting of aggregations of fine particles. Ground phosphate will not be allowed as a mineral filler.

Stone or slag screenings may also be used as filler material for asphaltic concrete mixtures, under the provisions specified in 917-3, below.

917-2 Gradation.

The mineral filler shall meet the following gradation requirements:

Total passing No. 30 [600 μm] sieve.. 100%
Total passing No. 80 [180 μm] sieve................................ 95% (minimum)
Total passing No. 200 [75 μm] sieve................................ 65% (minimum)

917-3 Provision for Use of Coarser Filler Material.

Process screenings from stone or slag, having a coarser gradation than as specified above, may also be used as filler material provided the particular product, and the source thereof, are approved by the Engineer and that the material meets the following requirements.

(a) All of the material shall pass the No. 10 [2 mm] sieve, and not more than 35% shall pass the No. 200 [75 μm] sieve.

(b) The material passing the No. 200 [75 μm] sieve shall be free from organic impurities, and not more than 4.0% of such shall consist of clay minerals. The plasticity index of the material passing the No. 200 [75 μm] sieve shall not exceed 4.

(c) For the stone or slag material from which the screenings are produced the loss, when subjected to the Los Angeles Abrasion Test, shall not exceed 45%.

SECTION 919

GROUND TIRE RUBBER

FOR USE IN ASPHALT RUBBER BINDER

919-1 Description.

This specification governs ground tire rubber for use in asphalt rubber binders for use in a variety of paving applications.

919-2 General Requirements.

The ground tire rubber shall be produced from tires by an ambient grinding method. The entire process or a final separate grinding process shall be at or above ordinary room temperature. The rubber shall be sufficiently dry so as to be free flowing and to prevent foaming when mixed with asphalt cement. The rubber shall be substantially free from contaminants including fabric, metal, mineral, and other non-rubber substances. Up to 4% (by weight of rubber) of talc or other inert dusting agent, may be added to prevent sticking and caking of the particles.

Ground tire rubber used for any of the applications described herein shall be a product included on the Qualified Products List (QPL).

919-3 Physical Requirements.

The physical properties of the ground tire rubber shall be determined in accordance with FM 5-559, and shall meet the following requirements:

Specific Gravity..1.10 ∀ 0.06
Moisture Content..Maximum 0.75%
Metal Contaminants ....Maximum 0.01%

Gradation - The gradation shall meet the limits shown in Table 919-1 for the type of rubber specified.

Table 919-1
Gradations of Ground Tire Rubber

Sieve Size % Passing	Type A	Type B	Type C
No. 10 [2.00 mm]	---	---	100
No. 20 [850 μm]	---	100	85-100
No. 40 [425 μm]	100	85-100	20-60
No. 80 [180 μm]	90-100	10-50	5-20
No. 100 [150 μm]	70-90	5-30	---
No. 200 [75 μm]	35-60	---	---

919-4 Chemical Requirements.

The chemical composition of the ground tire rubber shall be determined in accordance with ASTM D 297 and shall meet the following requirements:

Acetone Extract ....Maximum 25%
Rubber Hydrocarbon Content .... 40 to 55%
Ash Content.. Maximum 8%*
Carbon Black Content .... 20 to 40%
Natural Rubber .... 16 to 45%
* 10% for Type A rubber

919-5 Packaging and Identification Requirements.

The ground tire rubber shall be supplied in moisture resistant packaging such as either disposable bags or other appropriate bulk containers. Each container or bag of ground tire rubber shall be labeled with the manufacturer's designation for the rubber and the specific type, maximum nominal size, weight and manufacturer's batch or LOT designation.

919-6 Certification Requirements.

For initial product approval, the manufacturer of the ground rubber shall furnish the State Materials Office a certified test report from an independent testing laboratory that affirms the material meets all the requirements specified. After initial approval, the producer shall submit copies of this certified test report that are relative to ongoing Contracts. They shall also include a certification that the material conforms with all requirements of this Specification, and shall be identified by manufacturer's batch or LOT number.

MATERIALS FOR PORTLAND CEMENT CONCRETE (STRUCTURAL PAVEMENT AND MISCELLANEOUS)

SECTION 921

PORTLAND CEMENT AND BLENDED CEMENT

921-1 General.

The production and quality control of cement shall conform to the Florida Department of Transportation Standard Operating Procedures included in the Specifications Package.

The cement shall conform to the requirements of the AASHTO designations shown in (a) below with the additional restrictions as required by (b) below:

(a) Types Permitted: Except where a particular type of cement is specified on the plans or Specifications, and as specifically restricted in Section 346, cement may be Types I, II, III, IV, V (AASHTO M 85), or IP, IP(MS), IS (AASHTO M 240).

(b) Restrictions:

1. Alkali Content: Only Portland cement containing a maximum of 0.6% alkali, or less, calculated as Na_2O (% Na_2O plus 0.658 % K_2O), shall be used.

2. Heat of Hydration: Limits on the maximum heat of hydration may apply if required in Section 346.

The following definitions are applicable to the production and quality control of cement:

Sources of Supply - A source of supply shall be the cement supplier responsible for supplying the final product. Where the supplier has more than one manufacturing facility, the source of supply may be designated as the manufacturer/facility.

Approved Source - The term Approved Source shall indicate a cement supplier that has been qualified by the State Materials Office. A list of Approved Cement Sources will be maintained by the State Materials Engineer.

Current Quality Control Plan Approval - A current indication of quality control approval status, for each cement supplier, will be maintained by the State Materials Engineer in conjunction with the Approved Source List.

Purchaser - The term "purchaser" in the AASHTO Specifications shall be taken as the Department.

Approved Laboratory - An approved laboratory is a laboratory acceptable to the State Materials Engineer and which has been currently inspected by the Cement and Concrete Reference Laboratory (CCRL) and which has corrected all deficiencies noted at the time of inspection. The laboratory must also authorize CCRL to send copies of inspection reports to the State Materials Engineer.

921-2 Mixing Different Cements.

Different brands of cement, cement of the same brand from different facilities, or different types of cement shall be stored separately and shall not be mixed. Concrete containing different cements shall not be mixed during any continuous placement.

921-3 Methods of Acceptance of Portland Cement.

(a) Certification: Cement from an approved source with a current quality control plan approval may be accepted on the basis of certified mill analysis test results meeting the requirements of the applicable AASHTO and FDOT Specifications. Certification of these test results shall be provided to the District Materials Office and corresponding samples for independent assurance shall be provided upon request. Certification testing shall be performed by an approved laboratory.

(b) Acceptance Tests: Cement from approved sources without an approved quality control plan shall be acceptance tested for compliance to AASHTO and this Specification prior to incorporation into work. Acceptance tests shall be performed on designated LOTs of 400 tons [360 metric tons] or less. Acceptance testing shall be performed by an approved laboratory which shall be inspected by the Cement and Concrete Reference Laboratory (CCRL) as a cement testing laboratory and which has corrected any deficiencies noted at the time of inspection. The laboratory to perform acceptance testing must authorize CCRL to send a copy of the inspection report to the State Materials Office.

921-4 Packing Handling and Storing.

Cement may be delivered in bags or in bulk. The storage building, bin or silo shall be weatherproof and shall be located convenient to the work. On small jobs, storage in the open may be permitted by the Engineer in which case raised platforms and adequate waterproof coverings shall be provided.

921-5 Rejection.

Cement failing to meet the requirements of this Specification shall be rejected.

Cement which has been damaged, is partially set, lumpy or caked shall not be used. The entire contents of the sack or bulk container which contains damaged cement shall be rejected.

Bagged cement which varies more than 5% from the designated weight, or if the average weight of 50 sacks, taken at random, is less than the designated weight, the cement shall be rejected.

921-6 Standard Operating Procedures for Quality Control of Cement.

921-6.1 General: Cement suppliers shall submit a proposed quality control plan to the State Materials Engineer for plan approval. In addition to the quality control plan, the supplier must submit test reports from an approved laboratory which certifies that the cement in current production or supply conforms to these Specifications. Upon initial quality control plan approval and receipt of cement certifications, the suppliers will be placed in an approved source status with an approved quality control plan.

921-6.2 Quality Control Plan: The supplier's quality control plan shall be sufficient to insure that more than 97% of all cement delivered for FDOT work shall meet all Specification requirements. Upon request of the Department, the supplier shall provide split samples of the cement collected for quality control testing. Split samples shall be delivered to the Office of Materials in Gainesville, Florida and shall be identified as representing a designated LOT of cement.

The quality control plan shall include the following elements:

Company name, address and location.

Facility addresses and locations.

Designation of Responsible Personnel including facility managers, quality control managers and qualified technicians.

Description of the facility and procedures for material storage, material handling, material selection and material diversion.

Description of the quality control program including LOT designation, required testing and analysis, testing frequencies and correction, and control mechanisms.

Description of the testing facilities and methods.

Transportation/shipping facilities and procedures.

Documentation and record keeping facilities and procedures.

921-6.3 Cement Ownership and Responsibility: For purposes of Quality Control Plan approval status, the cement supplier will be responsible for cement quality until the cement is accepted by the concrete producer. Where the cement has been accepted by a concrete producer and is subsequently found deficient, the concrete plant approval may be withdrawn with respect to further use of that cement and reinstated only when the deficiency is adequately resolved and such reinstatement is made by the State Materials Engineer.

921-6.4 Quality Control Plan Approval Control: Continued approval of the Cement Quality Control Plan is the responsibility of the State Materials Engineer. Discontinuance of approval may be based on testing at the point of use, testing by the manufacturer or proven poor performance of the cement in concrete.

In the specific instance of a failing cement sample taken as part of the FDOT Independent Assurance Program, the failure shall initiate a three day sampling program. After the initial cement sample failure, the FDOT will collect three additional samples, one each on three consecutive working days, from the location of the original failure. Failure of any one of the three additional samples will be considered adequate evidence to withdraw the Cement Quality Control Plan Approval.

Notification of failing test results will be distributed to both cement suppliers and concrete producers as designated in the Approved Quality Control Plans. Split samples of additional samples will be provided to the cement supplier and concrete producer upon request.

Reinstatement of the Cement Quality Control Plan Approval will occur when the cement producer satisfies the State Materials Engineer that the specific cause of the failures has been identified and corrected or that a statistical analysis on the current cement production indicates that the current cement production meets or exceeds the requirements of this Specification.

921-6.5 Sampling of Cement: Cement samples shall be jointly obtained, by the FDOT Inspector and the concrete producer representative, during delivery or from the concrete producers storage facilities. Samples shall be obtained by one of the methods in Florida Methods FM 5-503. The concrete producer may select a preferred sampling method and shall provide safe access and the necessary equipment to collect the required samples. Samples shall be a minimum of 10 pounds [4.5 kg] in size. Sample documentation shall include signatures of both the FDOT Inspector and the concrete producer representative.

SECTION 922

HYDRATED LIME

Hydrated lime shall conform with the requirements of ASTM C 206, Type N.

SECTION 923

WATER FOR CONCRETE

923-1 Chemical and Physical Requirements.

Water for use with cement shall be clean and practically free of oil, acid, alkali, chlorides, organic matter, and other deleterious substances.

Water from city water supplies which are approved by a public health department may be accepted without being tested. Water from all other sources shall be tested and approved before use and shall not contain impurities in excess of the following limits:

Acidity or alkalinity calculated in terms of calcium carbonate........ 0.05%
Total organic solids.. 0.05%
Total inorganic solids... 0.08%
Total chlorides as sodium chloride... 0.05%

A period of ten days shall be allowed for tests on water after the sample has been received in the Laboratory.

The Department may require additional compliance testing at any time, of any water source, at the discretion of the Engineer.

923-2 Mortar Tests.

Mortar, composed of the water to be used on the project and standard sand and cement, when subjected to standard soundness, time of setting, and 1:3 mortar tests, shall show no unsoundness and, when compared with a similar test of mortar consisting of distilled water and the same sand and cement, it shall show no marked change in time of setting, and its strength shall not be less than 90% of that using distilled water.

SECTION 924

ADMIXTURES FOR CONCRETE

924-1 General.

This Section covers materials for use as admixtures for concrete. The use of admixtures is restricted to those admixtures as may be allowed or required elsewhere in the specifications for specific concrete applications. Admixtures shall comply to applicable AASHTO designation specifications as modified in 924-2.3 and 924-2.4. Admixtures which have been previously qualified for Department use are listed on a Qualified Products List as described in 924-2.1. Admixtures not on the Department=s list may be qualified using the procedure described in 924-2.2.

924-2 Acceptance of Admixtures.

924-2.1 Qualified Products List: The Department maintains a list of qualified admixtures for air-entraining, water-reducing, and water-reducing and retarding which have previously been determined as meeting requirements for use on Department projects. Admixtures included on this list, will be permitted without further testing.

The inclusion of any specific product on the Qualified Products List, as specified in 6-1, indicates that the product has been given contingent approval, as evidenced by previous tests and apparent effectiveness under field conditions.

Except as specified in Sections 346 and 347, no further testing will be required for any product on the Qualified Products List unless there is indication in actual field use of inadequate or unreliable results.

924-2.2 Certification: Manufacturers of admixtures not included on the Department=s Qualified Products list shall provide certified test results from an independent laboratory acceptable to the Engineer and inspected by the Cement and Concrete Reference Laboratory (CCRL) on a regular basis, with all deficiencies corrected. Test results shall indicate compliance with test requirements as modified herein of AASHTO M 154 for air-entraining, AASHTO M 194 for water-reducing (Type A) or water-reducing and retarding (Type D), accelerating (Type C) and water-reducer and accelerating (Type E), ASTM C 494 for High Range Water Reducer (Type F or Type G), and ASTM G 109 for corrosion inhibitor.

924-2.3 For Air-Entraining: Air-entraining admixtures not on the Department's Qualified Products current list shall meet the requirements of AASHTO M 154, except for the following modifications and exceptions:

1. The coarse aggregate shall be Size No. 57 meeting the requirements of Section 901.
2. The fine aggregate shall meet the requirements of Section 902.
3. The cement shall meet the requirements of Section 921.
4. The flexural strengths, resistance to freezing and thawing, and length change are waived.

924-2.4 For Type A (Water-Reducing) and Type D (Water-Reducing and Retarding): Water-reducing and water-reducing and retarding admixtures not on the Department's Qualified Products list shall meet the requirements of AASHTO M 194 for Type A and D, respectively, except for the following modifications and exceptions:

1. The coarse aggregate shall be Size No. 57 meeting the requirements of Section 901.
2. The fine aggregate shall meet the requirements of Section 902.
3. The cement shall meet the requirements of Section 921.
4. The flexural strengths in Table I (AASHTO M 194) and compressive strength at six months and one year are waived.

924-2.5 For Type F or Type G (High Range Water Reducer): High Range Water Reducers shall meet the requirements of ASTM C 494 and all the additional requirements in 346-2.5.3.

924-2.6 For Corrosion Inhibitors: Corrosion inhibitors shall meet the requirements of ASTM G 109 and all requirements in Section 346.

924-2.6.1 Calcium Nitrite Corrosion Inhibitor: Calcium nitrite is a chemically reactive admixture used in concrete to inhibit the corrosion of embedded reinforcing steel and other metallic components. The calcium nitrite supplier shall furnish the Engineer with test certificates from an independent laboratory indicating compliance with this Specification. The test certificate shall include results of physical tests per AASHTO M 194 and corrosion inhibiting properties per ASTM G 109. Calcium nitrite shall be supplied by the same manufacturing source throughout the project. If a single primary source of calcium nitrite cannot be maintained throughout the project, new test certificates shall be submitted. The Engineer will determine specification compliance of a new supplier=s product, and evaluate the effectiveness of the new calcium nitrite product before approving the source.

(1) Only non-accelerating calcium nitrite solution (neutral set version) shall be used in concrete.

(2) The active ingredient shall be calcium nitrite [$Ca(NO_2)_2$].

(3) The calcium nitrite shall be furnished in solution containing not less than 29% calcium nitrite solids. The concentration of the calcium nitrite solution shall be verified by spectrophotometric analysis or other comparable methods. The nitrite concentration shall be measured in accordance with Standard Methods for the Examination of Water and Waste Water, 18th Edition.

(4) A volume of one gallon [3.78 L] of calcium nitrite solution shall weigh within the range of 10.40 to 11.92 lb. [4.71 to 5.40 kg].

(5) Dosage Rate: The calcium nitrite solution shall be added to the concrete mixture at a rate of 4.50 to 4.60 gal/yd^3 [22.2 to 22.9 L/m^3] of concrete.

(6) The addition of calcium nitrite to the concrete mix shall not adversely affect the properties of fresh and hardened concrete. Calcium nitrite concrete shall meet the physical requirements of AASHTO M 194 for concrete containing Type A, water- reducing admixtures except that the requirements for Compressive Strength, min. % of control, shall be 100 for all ages.

The following table lists the corrosion inhibiting test result limits for calcium nitrite concrete tested in accordance with ASTM G 109.

Inhibit Corrosion when tested in accordance with ASTM G 109	
Measured average macrocell current any time during the test Average macrocell current at test completion	less than 10 μA less than 2 μA
Average visible corrosion measured as percent corroded area of control	85% or less

924-2.7 Contingency of Continued Approval: The continued approval of admixtures allowed for use, as based on the above specification requirements, will also be subject to the contingencies specified in 924-1.

924-3 Performance Test on Air-Entraining Admixtures, For Effect on Strength of Concrete.

924-3.1 Conditions under which Test is Required: For any air-entraining admixture selected for use the Engineer may call for a performance test (either prior to or at any time during construction) for determining its effect on the strength of the concrete. In general, this check-test will be required only when there is indication that such admixture is giving erratic results or is unduly reducing the strength of the concrete. Testing shall be in accordance with 924-3.2 and 924-3.3.

924-3.2 Permissible Reduction in Strength of the Concrete: For concrete composed of the same cement and aggregates (and in the same proportions) to be used in the work, and containing the admixture under test, in an amount sufficient to produce between 3 and 5% entrained air in the plastic concrete, the compressive strength at seven days shall be at least 90% of the strength of the same concrete without the admixture.

924-3.3 Method of Test for Strength Reduction: The percentage reduction in strength shall be calculated from the average strength of at least three standard 6 inch by 12 inch [150 mm by 300 mm] cylinders of each class of concrete. Specimens shall be made and cured in the laboratory in accordance with FM 1-T 126, and shall be tested in accordance with FM 1-T 22. The percentage of entrained air shall be determined in accordance with FM 1-T 152 or FM 1-T 196.

924-4 Retesting.

For approved water-reducing and water-reducing and retarding admixtures which, due to indication of giving erratic results, are required to be retested as specified in 924-1, such retesting shall be in accordance with the following procedure. The admixture shall be checked for comparison between infrared spectrophotometry, pH value and solids content. Any marked variation from the original curve, pH value or solids content will be considered sufficient evidence that the chemistry of the original material has been changed and, therefore, the use of this material will be rejected and the material removed from the Qualified Products List.

SECTION 925

CURING MATERIALS FOR CONCRETE

925-1 Burlap.

Burlap for curing concrete shall consist either of two layers, each weighing 10 to 18 ounces/10sf^2 [0.30 to 0.55 kg/m^2], or of four layers, each weighing 6 to 7 ounces/10sf^2 [0.18 to 0.21 kg/m^2]. Burlap which has been used as a container for sugar shall not be used. Burlap that is being used for the first time shall be thoroughly washed in order to remove starches used in sizing the material. Burlap shall be furnished in strips of at least 3 feet [1.0 m] wide and shall be at least 3 feet [1.0 m] longer than the width of surface to be covered.

925-2 Membrane Curing Compound.

925-2.1 General: Membrane curing compound shall conform to requirements of AASHTO M 148 (Type 1 for clear compound and Type 2 for white-pigmented compound), and the following additional requirements:

The membrane curing compound shall be of a consistency suitable for spraying at temperatures prevalent at the time of construction operations, and which forms a continuous, uniform film. It shall be free from precipitated matter caused by conditions of storage or temperature. The compound shall be relatively nontoxic.

Curing compound delivered to the job in drums shall be in the manufacturer's original container, labeled with the manufacturer's name, plant location, grade designation of compound, LOT number, and quantity.

Curing compound delivered in bulk shall be supplied from and delivered to storage tanks designed to provide thorough agitation by means of compressed air. Thorough agitation shall be performed prior to shipment from manufacturer's plant and prior to use at job site.

925-2.2 Sampling: Samples shall be obtained as specified in AASHTO M 148. Filled containers, represented by the sample(s) shall be sealed and marked by the sampling agency for later identification and correlation. Each sample shall be at least 1 quart [1 liter]. If the compound has been pretested, only an information card need be submitted. Fourteen days shall be allowed after arrival of the sample at the laboratory for completion of the tests.

925-2.2.1 Drum Shipment: At least one sample representing each 40 drums 295 ft^3 [8.33 m^3], or fraction thereof, shall be taken for testing.

925-2.2.2 Bulk Shipment: At least three samples representing 800 ft^3 [22.7 m^3], or fraction thereof, shall be taken for testing.

925-2.2.3 Storage: Curing compound that has been tested and stored for longer than six months but less than one year shall be retested prior to use. Compound that has been stored longer than one year shall not be incorporated into the work.

925-3 Sheet Materials.

925-3.1 General: Waterproof paper, polyethylene film and white burlap-polyethylene sheet, for curing concrete shall meet the requirements of AASHTO M 171, with the additional requirements for waterproof paper and for polyethylene film as shown below.

925-3.2 Additional Requirements for Waterproof Paper: The paper as prepared for use shall be in such dimensions that each unit as laid will extend at least 18 inches [450 mm] beyond the edges of the slab. If laid longitudinally, paper not manufactured in sizes which will provide this width shall be securely sewed or cemented together; the joints being sealed in such manner that they do not open up or separate during the curing period.

At the option of the Contractor, instead of the single longitudinal strip specified above, the blanket may be furnished in three strips; one strip being the neat width of the pavement, with two side strips.

925-3.3 Additional Requirements for Polyethylene Sheeting: The sheets, as prepared for use, shall be of such dimensions that each unit as laid will extend beyond the edges of the slab by at least twice the thickness dimension of the pavement edge, and the sheets shall overlap by at least 18 inches [450 mm].

No sheet may be reused except after individual inspection and approval by the Engineer. Any sheets determined by the Engineer to be so damaged as to not afford the protection to the concrete in preventing moisture loss during the curing period will be rejected.

SECTION 926

EPOXY COMPOUNDS

926-1 Types of Compounds.

Epoxy resin compounds for application to portland cement concrete, bituminous cement concrete, metals and other type surfaces shall be two-component systems of the applicable of the following types as designated.

Type A - An epoxy resin, for bonding fresh concrete to hardened concrete.

Type B - An epoxy resin adhesive, for bonding hardened concrete to hardened concrete.

Type C - An epoxy resin adhesive, for bonding traffic markers to hardened concrete and to asphaltic concrete.

Type D - A coal-tar, modified epoxy resin for application as a skid-resistant or protective overlay for cement concrete.

Type E - A fluid epoxy for crack injection in the repair of old structures.

Type F - An epoxy for repairing spalled areas on concrete bridge structures with these subtypes:

F-1 - A non sagging gel type for vertical surfaces, and

F-2 - A pourable type for repairs where forms are to be used.

Type G - An epoxy for rebuilding expansion joints and associated wearing surfaces.

Type H - An epoxy for structural bonding where asphalt overlays are to be in contact with the hardened compound.

Type I - An epoxy for filling small holes in concrete such as lifting bolt cut-outs on beams, etc.

Type J - An epoxy for installing rebar and anchor bolts into hardened concrete.

Type K - An epoxy for underwater sealing of the bottom of the jacket of an integral pile jacket system.

Type L - An epoxy for coating the interior of sewage disposal tanks.

Type M - An epoxy for coating steel H piling for fender systems (water immersion).

Type N - An epoxy for preparing mortars and concrete for patching portland cement concrete pavement.

Type O - An epoxy coating system consisting of a penetrant and a surface coating to be used singly or in combination for the protection of concrete surfaces, both new and repaired.

Type P - An epoxy for bonding metals.

926-2 General Requirements.

All types of compounds except D, L, M, and O shall contain no volatile solvent.

All types of compounds except C, F, I, J, L, M, N and O shall be basically pure reactive material with a maximum ash content of 2%.

All types shall have simple mix ratios of one to one or two to one or shall be supplied in pre-measured containers in which all of the contents of both packages are to be mixed.

Certain terms used in this specification shall have these meanings:

low modulus - the stress-strain property for which ultimate tensile strength is attained at over 10% elongation.

high modulus - the stress-strain property for which ultimate tensile strength is attained at under 6% elongation.

non-sagging gel - grades of mixed compounds which will not perceptibly flow under their own weight on a vertical surface in the unhardened state.

pourable - grades of mixed compound sufficiently fluid that they (either neat or filled) can be cast into and will take the shape of a mold.

926-3 Specific Requirements for Types A and B Compounds.

926-3.1 Mixing and Application: Types A and B epoxy compounds (for bonding fresh concrete to hardened concrete or bonding precast concrete parts) shall be mixed, applied, and cured in accordance with the manufacturer's directions, or as might be directed otherwise by the Engineer.

Epoxy compounds shall be used only under conditions which are compatible with the material being applied in accordance with the specific directions of the manufacturer.

926-3.2 Performance Tests:

(a) For Epoxy Bonding Compounds: The performance test, upon which the acceptance of epoxy bonding compounds is based, is described below. Test specimens shall be cured at a temperature of 73 ∀ 3EF [23 ∀ 2EC]. The epoxy compounds shall be tested for composite cylinder shear (diagonal shear) as specified below.

The test specimen of concrete shall be prepared in a 3 by 6 inch [76 by 152 mm] mold. The first portion of the test specimen may be formed by sawing a full size 3 by 6 inch [76 by 152 mm] cylinder on a 45-degree slope from the vertical, giving a maximum height of 43 inches [108 mm] to a minimum height of 13 inches [32 mm], or through the use of an elliptical insert of the same dimensions. The concrete shall be cast as described in AASHTO T 23, using Class III Concrete (Florida DOT designation) with Type III Cement. The specimens shall be cured in the standard manner, and for at least four days. At the end of this period the half cylinder on which the epoxy resin is to be applied shall be prepared for bonding by removal of all loose particles and oil film and then coated with a thick coat of the epoxy compound under test. The portion of the cylinder shall then be replaced in the mold and plastic concrete of the same mix as before added to the mold to form the 3 by 6 inch [76 by 152 mm] cylinder. Reference test cylinders are prepared with each batch of concrete.

After the composite test cylinder has cured for a 3-day period in a moist cabinet, the compressive strength is determined. This strength is compared to the strength of the weaker of the two concretes from which the test cylinder was made. If the ratio of the compressive strength of the composite cylinder to the compressive strength of the weaker concrete is less than 0.90, the epoxy compound is rejected.

(b) For Epoxy Mortars: Epoxy mortar shall be prepared for testing using two parts of standard concrete sand and one part of mixed epoxy compound. Three 2 inch [50 mm] cubes shall be cast from the epoxy mortar and cured for three days prior to testing. The cubes shall be tested in direct compression. The average compressive strength of the three test specimens shall be at least 5,000 psi [35 MPa].

The molds for epoxy mortar test specimens and compressive loading shall be in accordance with AASHTO T 106.

926-4 Specific Requirements for Type C Compounds.

Epoxy adhesives for pavement markers will be approved on the basis of satisfactory performance in field tests. If, during a one year period, more than 2% of the markers in a test site are displaced due to failure of the adhesive, the adhesive will not be considered acceptable.

926-5 Specific Requirements for Type D Compounds.

These compounds shall meet the requirements of AASHTO M 200.

926-6 Specific Requirements for Type E Compounds.

Epoxies for crack injection shall meet the Specification for Type B compound with these additional requirements:

Viscosity five minutes after mixing	300 to 600 cps at 77EF by ASTM D 2393	[0.3 to 0.6 Pa≅s at 25EC by ASTM D 2393]
Wet bond strength to concrete,minimum	250 psi at seven days by Florida Method FM 5-518	[1.7 MPa at seven days by Florida Method FM 5-518]

926-7 Specific Requirements for Type F Compounds.

Epoxies for repairing spalled areas shall meet these requirements:

Subtype F-1 for repairing vertical and other surfaces shall be a trowelable low modulus, non-sagging gel epoxy compound capable of bonding to wet surfaces with these properties:

Color	Shall match gray color No. 36622 of Federal Standard No. 595a
Viscosity	Gel
Maximum sand loading	2.25 parts sand to one part mixed epoxy by volume
Elongation in tension minimum	10% by ASTM D 638, seven day cure
Wet bond to Steel and Concrete minimum	250 psi [1.7 MPa] by Florida Test Method FM 5-23

Subtype F-2 for filling larger spalls where a form is required to build back to the original surface shall be a pourable low modulus type compound capable of bonding to wet surfaces with these properties:

Color	Shall match gray color No. 36622 of Federal Standard No. 595a
Maximum sand loading	2.25 parts sand to one part mixed epoxy by volume
Elongation in tension, minimum	10% by ASTM D 638, seven day cure
Exotherm	110EF [43EC] by ASTM D 2471, 415 mL sample
Wet bond strength	250 psi [1.7 MPa] at seven days by Florida Method FM 5-518

926-8 Specific Requirements for Type G Compounds.

Epoxies for rebuilding expansion joints shall be pourable types which may be mixed with sand and with these requirements for the mix:

Compressive strength	
at 24 hours, minimum	4,500 psi [30 Mpa]
at seven days, minimum by the method of 926-3.2(b)	7,500 psi [50 Mpa]
Bond to wet concrete at seven days by Florida Method FM 5-518	250 psi [1.7 Mpa]
Maximum sand loading	2.25 parts to one part mixed epoxy by volume
Elongation in tension at seven days, ASTM D 638, minimum	2%
Color	Natural
Exotherm, maximum by test method ASTM D 2471,	

Compressive strength	
1 pint [415 mL] sample size	110EF [43EC]

926-9 Specific Requirements for Type H Compounds.

Epoxies for structural bonding where bituminous pavement overlays will come in contact with the hardened compound shall meet the requirements for Types A and B compounds above and the manufacturer shall provide test data showing that cutback and emulsified asphalts, asphalt cement, and bituminous mixes shall bond to but not soften or otherwise damage the epoxy after a curing period of four days.

926-10 Specific Requirements for Type I Compounds.

Epoxies for cosmetic patching of small areas on new concrete structures and components shall be of any non-sagging grade which has a gray color matching that of Shade 36622 of the Federal Standards and which has been demonstrated to the Engineer to bond satisfactorily to the concrete.

926-11 Specific Requirements for Type J Compounds.

Epoxies for installing rebar and anchor bolts into the hardened concrete shall meet the requirements of Section 937 and be installed in accordance with Section 416. When the Contract Documents call for the use of Type J, Class I, II, III, IV, epoxy or a Class IV Adhesive Anchor System, use materials meeting the requirements of Section 937, constructed in accordance with Section 416. Use materials meeting Section 937 to construct doweled splices for prestressed concrete piles.

926-12 Specific Requirements for Type K Compounds.

Epoxies for sealing the bottom of integral pile jackets in the repair of concrete piles shall be a type which will harden underwater with these requirements for the sand-epoxy mix:

Compressive strength at seven days, minimum by the method described in 926-3.2(b)	4,500 psi [30 Mpa]
Bond	
to wet concrete, minimum	250 psi [1.7 Mpa]
to wet pile jacket, minimum (by Florida Method FM 5-518)	150 psi [1.0 Mpa]
Maximum sand loading	2.25 parts to one part mixed epoxy by volume
Viscosity of mixed epoxy component at 77EF [25EC], five minutes by ASTM D 2393	1,000-2,000 cps [1 to 2 Pa≅s]

The epoxy sand mix shall be capable of flowing through water in the void area of the jacket so as to provide a water tight seal of the depth indicated on the plans or approved shop drawings and to maintain this seal during subsequent construction steps.

926-13 Specific Requirements for Type L Compounds.

Epoxies for coating the interior of sewage disposal system tanks shall be of an approved type. Manufacturers shall submit data and a record of previous usage showing satisfactory performance in the protection of concrete from the aggressive effect of sewage for a five year minimum to the Office of Materials and Research.

926-14 Specific Requirements for Type M Compounds.

Epoxy coatings for steel H piling used in fender systems shall comply with the requirements of Corps of Engineers Specification C-200. Products not meeting these requirements may be approved by the Office of Materials and Research on the basis of data furnished by the manufacturer documenting equal or superior performance.

Application shall be according to the manufacturers published recommendations with the additional requirements that application shall be in two coats of approximate equal thickness and the total dry film thickness measured by a magnetic gauge shall be not less than 16 mils [400 µm].

926-15 Specific Requirements for Type N Compounds.

Epoxy adhesives for making epoxy mortar or concrete for patching portland cement concrete pavement shall be any of approved products listed at the time of the work. Mix designs for mortar and concrete shall be submitted to the Engineer at the time of the preconstruction conference. Approval shall be by a field demonstration made by the Contractor using the criteria of bond to the pavement, matching color, durability, and absence of excessive surface slicking under traffic flow for acceptance.

The basic approval of new adhesives shall be made by the Office of Materials and Research using a six months road test with mortar-concrete mix designs recommended by the epoxy manufacturer.

926-16 Specific Requirements for Type O Compounds.

These compounds shall be fluid penetrants or surface coatings to be used singly or in combination for the protection of concrete surfaces.

The basic approval of these compounds is through an accelerated electrolysis test, Florida Method FM 5-518. Acceptable products shall meet the minimum resistivity requirements at the end of 10 or 50 days test as described in Florida DOT Research Report 79/207. Manufacturers wishing to qualify products shall obtain the special concrete test cylinders from the Corrosion Section, Office of Materials and Research, apply their coating according to their Specifications, and return the cured specimens for test along with technical literature which shall include the dry film thickness specified.

Materials other than epoxy may be qualified under this type.

926-17 Packaging, Labeling, and Safety.

All containers shall be identified as Component A - contains epoxy resin or Component B - contains hardener, and shall show the type, mixing directions, batch numbers, manufacturer's name, date of packaging, shelf life expiration date and quantity in pounds or gallons [kilograms or liters]. Mix ratios shall be prominently shown on labels. Potential hazards shall be stated on each package in accordance with the Federal Hazardous Products Labeling Act including this minimum warning:

Caution

Epoxies will cause dermatitis if proper precautions are not followed. Avoid contact with skin and eyes, use gloves and protective creams on hands. Goggles should be used to protect the eyes; however, in the event of eye contact, flush with water for ten minutes and secure immediate medical attention.

926-18 Storage.

Epoxy materials which have been in storage for more than 12 months will not be accepted for use.

926-19 Certification Required.

The manufacturer of the epoxy compound shall certify that the product supplied meets the requirements of the Specification for that type. Each certification shall cover only one type. Due to the wide range of application of the products within some types, the manufacturer shall additionally certify that he has examined the particular application and that his product is recommended for that stated use for that specific project.

926-20 Qualified Products Lists.

The epoxy compound used for any of the applications described in 926-1 shall be a product included in the approved list.

Samples of epoxy materials will be taken in accordance with the Department's Sampling, Testing and Reporting Guide Schedule and on a random basis at the discretion of the Engineer. If the results of tests performed on these samples indicate failure to comply with any specific requirement of this Specification or significant inconsistencies in material properties, new qualification tests including strength, bond, exothermic and elongation values, as appropriate for the particular material, and a comparison with original infrared spectrophotometry values will be required.

Any marked variation from the original test values for a material or evidence of inadequate field performance of a material will be considered to be sufficient evidence that the properties of the material have changed and the material will be removed from the approved list.

926-21 Fillers.

Fillers for mixing mortars and grouts may be as recommended by the manufacturer of the particular epoxy compound and may be supplied as packages accompanying the epoxy or premixed in accordance with approved properties.

If a manufacturer recommends only the gradation of filler, it must be a silica sand commercially available in Florida and shall be a gradation listed in Table I or a specified blend of these gradations.

The silica sands specified in Table I shall be clean, kiln dried, packaged in strong moisture proof bags, contain no more than 0.2% organic trash, and be chloride free.

Fillers shall not be used with these compounds: Types C, E, J, L, M, and O.

When the fillers specified in Table I are used, the maximum amount shall be 2.25 volumes to one volume of mixed compound.

TABLE I
GRADATION REQUIREMENTS FOR FILLERS FOR USE WITH EPOXY COMPOUNDS

	GRADE			
	A	B	C*	D**
Sieve Opening Size	Required % Passing			
No. 4 [4.75 mm]			95-100	95-100
No. 6 [3.35 mm]		90-100		
No. 8 [2.36 mm]			0-15	85-100
No. 16 [1.18 mm]				65-97
No. 20 [850 µm]	80-100	0-20		
No. 30 [600 µm]	0-40			25-70
No. 50 [300 µm]	0-10			5-35
No. 100 [150 µm]				0-7

*For use only in sections 12 inch [38 mm] or greater in thickness.
**Same as quartz sand fine aggregate for cement concrete (902-1.3.1).

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SECTION 927

IRON OXIDE PIGMENT

(For Coloring Concrete Surfaces)

The iron oxide pigment material used for coloring the concrete shall be a crystalline pigment known as black magnetic oxide of iron or ferrosoferric oxide, made by a process of chemical precipitation so as to form a pigment of uniformly small particle size. The material shall have a blue-black color and there shall be no brownish hue.

A representative sample, weighing at least 2 lb. [0.2 kg] shall be submitted for testing procedure. The mass tone shall be equal to the Department's standard sample in black intensity and blue tone when compared in the following manner.

A paste is made from 35 g of the sample and 15 g of alkali-refined linseed oil, by rubbing upon a smooth or frosted glass slab or lithographer's stone with a spatula or a muller. A mixture identical in size shall be made with the standard pigment, using the same linseed oil and making the same kind and number of rubs.

The colors of the two pastes shall be compared by viewing the underside of adjacent smears placed upon a colorless microscopic glass slide.

The tinting strength of the material shall be equal to the standard in strength and blue tone when compared in the following manner.

Use a fine ground zinc oxide paste made by grinding 2.75 parts by weight of lead-free zinc oxide with one part by weight of alkali-refined linseed oil. Mix 25 g of this zinc oxide paste with 2 g of black permanent concrete stain and compare the tints on glass as was done for color.

The specific gravity shall be not less than 4.68.

When a 10 g sample is digested for 15 minutes in a hot mixture of 75 mL concentrated hydrochloric acid and 25 mL concentrated nitric acid, only slight trace of insoluble residue shall remain after dilution of 250 mL with distilled water.

Not more than 2% shall be retained on a 325 mesh [45 µm] sieve by the water-washing method.

SECTION 929

FLY ASH, SLAG, MICROSILICA AND OTHER POZZOLANIC MATERIALS FOR PORTLAND CEMENT CONCRETE

929-1 General Requirements.

929-1.1 Fly Ash: Fly ash shall meet the requirements of ASTM C 618 for Class C or Class F. Sampling and testing shall follow the requirements of ASTM C 311.

929-1.2 Slag: Slag shall meet the requirements of ASTM C 989. Sampling and testing procedures shall follow the requirements of ASTM C 989.

929-1.3 Microsilica: Microsilica shall meet the requirements of ASTM C 1240 using the referenced test methods and frequencies.

929-2 Basis for Source Approval.

929-2.1 Fly Ash: The fly ash supplier shall submit certified test reports from an approved laboratory acceptable to the Engineer, certifying that the fly ash conforms to this Specification and was obtained from the residue of an electric generating plant using ground or powdered coal. The fly ash supplier shall utilize a quality control plan approved by the State Materials Office.

The Department reserves the right to withdraw quality control plan approval and to require fly ash shipments to be individually tested prior to incorporation into Department work. Quality control plan approvals may be reconsidered at any time the performance of a fly ash is in question including problems with concrete quality, erratic quality control data or failure of independent assurance test samples to meet all requirements.

The approved laboratory shall be inspected by the Cement and Concrete Reference Laboratory on a regular basis as a fly ash testing laboratory, and shall have corrected any deficiencies noted at the previous inspection. The laboratory must authorize the Cement and Concrete Reference Laboratory to send a copy of the inspection report to the State Materials Office.

929-2.2 Slag: The slag manufacturer shall furnish, at the time of shipment, certification of test results from samples of the material taken during production or transfer, and certifying compliance to applicable requirements of ASTM C 989. The slag manufacturers shall also state in writing the nature, amount and identity of any processing or other additions made to the slag.

929-2.3 Microsilica: The supplier of microsilica shall furnish a certification stating the results of the tests made on the microsilica taken during production or transfer, indicating that the applicable requirements have been met.

929-3 Special Requirements.

929-3.1 Fly Ash (Class C): When a Class C fly ash is used in moderately or extremely aggressive environments, tests made by the supplier shall verify improved sulfate resistance of the concrete in accordance with ASTM C 1012, and improved corrosion protective properties measured by FM 5-522, as compared to similar concrete made with Class F fly ash. No mix designs will be approved in advance of satisfactory completion of such tests.

929-3.2 Slag: Only Ground Granulated Blast-Furnace Slag Grade 100 or better (28 day Index) will be permitted.

929-3.3 Microsilica: For slurried or densified microsilica, tests shall be made on the raw microsilica from which these products were made.

929-4 Exceptions.

Neither fly ash nor slag shall be used in conjunction with Type IP or Type IS cements.

929-5 Acceptance Testing.

929-5.1 Fly Ash: Acceptance of fly ash from sources operating under an approved quality control plan shall be based on certified tests meeting the chemical (Supplementary Optional included) and physical requirements of ASTM C 618 for each LOT, not to exceed 1,985 tons [1,800 metric tons] per LOT. When the loss on ignition exceeds 5%, the Uniformity Requirements in the Supplementary Optional Physical Requirements shall be mandatory. These tests (including the physical and chemical tests) shall be made for each LOT, not to exceed 400 tons [360 metric tons] per LOT.

Certification of these tests shall be provided to the District Materials Office, and corresponding samples for independent assurance tests shall be provided upon request.

929-5.2 Slag: Acceptance of slag shall be based on certified test reports meeting the chemical and physical requirements of ASTM C 989 for each LOT, not to exceed 2,500 tons [2,300 metric tons] per LOT. Reference Cement used for determination of Slag Activity shall meet the requirements of ASTM C 989.

Certification of these tests shall be provided to the District Materials Office, and corresponding samples for independent assurance tests shall be provided upon request.

929-5.3 Microsilica: Acceptance of microsilica shall be based on certified test reports, meeting the chemical and physical requirements of ASTM C 1240. The frequency of tests shall be as stated in ASTM C 1240.

SECTION 930

PACKAGED, DRY, RAPID HARDENED AND VERY RAPID HARDENED CONCRETE OR MORTAR MATERIALS FOR CONCRETE REPAIR

930-1 Description.

This Section covers the materials for packaged, dry, cementitious concrete or mortar materials for rapid repairs to hardened portland cement concrete pavements and structures. Materials that contain organic compounds, such as bitumens, epoxy resin, and polyesters as the principal binder are not included.

Packaged, dry concrete material shall contain aggregate of which more than 5% by weight of the total mixture is retained on a δ inch [9.5 mm] sieve.

Packaged, dry mortar material may contain aggregate of which less than 5% by weight of the total mixture is retained on a δ inch [9.5 mm] sieve. These materials may not be extended by the addition of aggregate in the field.

Aqueous solutions of inorganic compounds and aqueous emulsions or dispersions of inorganic compounds may be used to replace some or all of the required mixing water. These liquids must be furnished as components of the packaged materials.

930-2 Applicable Documents.

Florida Test Methods:

FM 1-T 022 Compressive Strength of Cylindrical Concrete Specimens.

FM 1-T 106 Compressive Strength of Hydraulic Cement Mortar Using 2 inch [50 mm] Cubic Specimens.

FM 1-T 131 Type of Setting of Hydraulic Cement by Vicat Needle.

FM 1-T 154 Time of Setting of Hydraulic Cement by Gilmore Needles.

FM 1-T 160 Length Change of Cement Mortar and Concrete.

FM 1-T 126 Making and Curing Concrete Test Specimens in the Laboratory.

FM 1-T 248 Reducing Field Samples of Aggregates to Testing Size.

FM 5-516 Determining Low-Levels of Chloride Concrete and Raw Materials.

Others:

ASTM C 387 Specification for Packaged, Dry, Combined Materials for Mortar and Concrete.

ASTM C 494 Specification for Chemical Admixtures for Concrete.

ASTM E 96 Test Methods for Water Vapor Transmission of Materials in Sheet Form.

930-3 Classification.

Two types of packaged, dry cementitious materials for concrete repairs (rapid hardening and very rapid hardening) are identified in Table 1.

Table 1
Physical Requirements

Minimum Compressive Strength, psi [MPa]				
	3 hours	1 day	7 day	28 day
Rapid Hardening	500 [3.447]	2,000 [13.79]	4,000 [27.58]	*
Very Rapid Hardening	2,000 [13.79]	4,000 [27.58]	6,000 [41.37]	*

Maximum Length Change (FM 1-T 160)		
	Rapid Hardening	Very Rapid Hardening
Allowable increase, after 28 days in water, based on length at one day, %	+0.15	+0.15
Allowable decrease, after 28 days in water, based on length at one day, %	!0.15	!0.15
Allowable difference between increase in water and decrease in air determination, %	0.20	0.20

*The strength at 28 days shall not be less than the strength at seven days.

Consistency		
	Slump (Concrete) inches [mm]	Flow (Mortar) (%)
Rapid hardening, minimum consistency at 15 minutes after addition of the mixing liquid	3 [76.2]	100
Very rapid hardening, minimum consistency at five minutes after addition of the mixing liquid	3 [76.2]	80

Time of Setting, Minutes		
	Rapid Hardening	Very Rapid Hardening
Initial Set	30 to 60	10 to 29

930-4 Chemical Requirements.

The material shall not contain total chlorides or other corrosive ingredients in excess of 0.40 lb/yd^3 [0.24 kg/m^3] of the hardened concrete when used in reinforced structures. Chloride determination shall be made in accordance with FM 5-516.

930-5 Sampling.

A LOT is the quantity of packaged repair material normally placed on a pallet. Generally, this quantity will weigh from 2,000 to 4,000 lbs. [900 to 1,800 kg].

A unit sample is a single package of material randomly selected from the LOT.

930-6 Specimen Preparation.

930-6.1 Concrete: Mechanically mix the packaged, dry concrete material with water and/or mixing liquid. Determine the properties of the unhardened mixture, and mold and cure the required specimens in accordance with FM 1-T 126.

(a) The sample of packaged dry material shall be any combination of whole packages yielding not less than β ft^3 [0.02 m^3] of hardened material.

(b) Base the quantity of water, other liquid component, or both added to the sample on the quantity per bag stated in the instructions for use.

(c) Place the sample in the mixing machine and add the required amount of liquid. Start mixing immediately and continue mixing for the length of time indicated in the directions for use.

(d) When making the slump test, schedule work so the test will be completed in 5 ∀ 2 minute after the mixing liquid is added to the very rapid hardening materials or 15 ∀ 2 minute after mixing the liquid with the rapid hardening materials.

(e) Mold the required number of specimens using additional samples as may be necessary, mixing in accordance with (a) through (d). Do not use the mixtures for molding test specimens when the slump test is less than that specified in Table 1.

Where the nominal maximum particle size is not greater than 1 inch [25 mm] the use of cylindrical molds 4 inches [102 mm] in diameter by 8 inches [203 mm] in length is suggested.

930-6.2 Mortar: Mechanically mix packaged, dry mortar material with mixing liquid. Determine the properties of the unhardened mixture, and mold and cure the specimens in accordance with FM 1-T 106 or modifications as outlined herein.

(a) The sample obtained from the packaged dry material shall weigh 6.6 ∀ 0.05 lb [3.0 ∀ 0.02 kg] and shall be representatively obtained from a whole package in accordance with FM 1-T 248.

(b) Base the quantity of water, or other liquid component, or both added during mixing on the quantity per unit of weight stated in the directions for use.

(c) When making the flow test, schedule work so the test will be completed in 5 ∀ 2 minute after the start of mixing liquid with the very rapid hardened materials or 15 ∀ 2 minute after mixing the liquid with the rapid hardening materials.

(d) Mold the required number of specimens using additional samples as necessary mixing in accordance with (a) through (c). Do not use the mixtures for molding test specimens when the flow is less than that specified in Table 1.

930-6.3 Temperature: In those cases where the manufacturer has indicated in the package markings, or elsewhere, that the packaged repair material can be mixed and applied at temperatures that lie beyond the range of 70EF ∀ 15E[20 ∀ 8EC], the product must meet the requirements of Table 1. Specimens shall be mixed, molded and cured during the first three hours within ∀2EF [∀1EC] of the extreme temperature(s) stated by the manufacturer in the package markings.

930-7 Test Methods.

Manifestly Faulty Specimens - Treat manifestly faulty specimens in accordance with 15.2 in ASTM C 494.

Compressive Strength - Prepare and test three test specimens for each age of test and each level of mixing temperature. Test in accordance with FM 1-T 022 for concrete and FM 1-T 106 for mortar. The average strength of the test specimens for each age of test and each preparation temperature shall be not less than that prescribed in Table 1.

Length Change - Make and cure the test specimens in accordance with FM 1-T 160, except omit the curing period in Section 6 and Paragraph 6.3. Both 7.1.1 and 7.1.2 shall apply. The average length change of the test specimens for each preparation temperature and for each storage condition after 28 days shall meet the requirements shown in Table 1.

930-8 Rejection.

All broken packages will be rejected.

Material that fails to meet any of the requirements of this Specification will be rejected.

Rejection and reason(s) for rejection should be reported to the producer or supplier promptly and in writing.

Material in local storage in the hands of a vendor for more than six months after completion of tests shall be retested before use and rejected if it fails to conform to any of the requirements of this Specification.

930-9 Certification.

When specified in the purchase order or contract, a producer, supplier, or an independent testing laboratory shall furnish certification to the purchaser that the material has been tested in accordance with this Specification and found to meet the requirements. When specified in the purchase order or contract, a report of test results on samples taken from material shipped shall be furnished. Date of the test report furnished in accordance with the purchase order request shall not be more than 45 days prior to shipment of the order.

930-10 Qualified Products List.

The material use for application described in 930-1 shall be a product included in the Qualified Products List.

930-11 Marking.

All packages shall be marked to contain the following information:

(a) Must be marked with LOT identification number and material expiration date.

(b) Directions for use that shall include but are not limited to:

(1) The type and kind of adhesive recommended (if any) to bond fresh repair material to the concrete or mortar being repaired.

(2) The recommended amount of water, other liquid component, or

both, to be mixed with the package contents.

(3) The recommended length of mixing time or sequence of mixing and resting times in minutes.

(c) Date the material was packaged.

(d) The yield in cubic feet [cubic meters] or yield in square feet per inch [square meters per millimeter] thickness when mixed with the recommended amount of liquid.

(e) The net weight in each container. The contents of any container shall not vary by more than 2% from the weight stated in the markings. The average weight of filled containers in a LOT shall be not less than the weight stated in the markings.

930-12 Packaging.

The material from which the containers are made shall have water vapor transmission not greater than 2,048 lb/ft^2 [10 Mg/m^2] in 24 hours as determined in accordance with Procedure B of ASTM E 96.

The packaged materials shall be in containers weighing 50 to 55 pounds [23 to 25 kg].

930-13 Additional Testing.

The Department reserves the right to conduct further field testing if desired.

930-14 Mixing.

The material(s) shall be mixed in accordance with manufacturer's recommendations.

930-15 Field Representation.

Manufacturers will be required to provide field representation upon request.

ACCESSORY MATERIALS FOR
CONCRETE PAVEMENT AND CONCRETE STRUCTURES

SECTION 931

METAL ACCESSORY MATERIALS FOR CONCRETE

PAVEMENT AND CONCRETE STRUCTURES

931-1 Reinforcement Steel (for Pavement and Structures).

931-1.1 Steel Bars: Billet steel bars for concrete reinforcement shall conform to the requirements of ASTM A 615 [ASTM A 615M] except that the process of manufacture will not be restricted. For processes not included in ASTM A 615 [ASTM A 615M] the phosphorus content will be limited to 0.08%. When the use of Rail Steel is permitted by the plans such steel shall meet the requirements of AASHTO M 42 [AASHTO M 42M].

The following special requirements shall apply:

(1) Unless otherwise specified or shown on the plans all reinforcement

bars No. 10 and larger shall be deformed bars.

(2) All billet-steel bars shall be of the grade called for on the plans.

(3) Twisted bars shall not be used.

(4) Wherever in the Specifications the word "purchaser" appears it shall be taken to mean the Department.

Acceptance of reinforcing steel shall be based on test samples taken randomly by the Department and manufacturer's certified mill analysis of test results meeting the specification limits of the ASTM or AASHTO designation for the particular size, grade and any additional requirements. Randomly taken test samples and certification of test values, representing each production LOT of reinforcing steel, shall be provided to the Engineer for each Contract prior to use. Randomly taken test samples shall be cut from bundled steel that is shipped to the jobsite.

931-1.2 Metal Fabric: Welded steel wire fabric for concrete reinforcement shall meet the requirements of AASHTO M 55.

Welded deformed steel wire fabric for concrete reinforcement shall meet the requirements of AASHTO M 221.

Wherever the word "purchaser" is used it shall mean the Department.

931-2 Metal Materials for Joints in Concrete Pavement.

931-2.1 Sheet Metal Bottom Strips: The sheet metal strip for protecting the bottom and side edges of transverse expansion joints shall be composed of galvanized sheet metal of 0.0157 inch [0.40 mm] minimum thickness and shall conform to the requirements of ASTM A 653 [ASTM A 653M].

The sheets shall be furnished in accordance with the dimensions shown on the plans. They may be in one continuous piece, or spliced. When splicing is used the metal shall be lapped not less than 3 inches [75 mm] and securely fastened, by welding or otherwise, in such manner as to leave the spelter undamaged and produce a smooth sliding surface in contact with the pavement slab. The splices shall be spaced not less than 10 feet [3 m] apart and not less than 5 feet [1.50 m] from either end. The complete sheet shall not vary from a straight line by more than 1 inch [25 mm] from end to end.

931-2.2 Bars and Chairs for Longitudinal Joints: Transverse reinforcing steel across the joint shall be deformed steel bars conforming to the requirements of 931-1.1 except that the bars may be any Grade shown in ASTM A 615 [ASTM A 615M].

These bars, and the chairs to hold them in place, shall be of the type and spacing as indicated on the plans.

931-2.3 Dowel Bars: Dowel bars shall be plain steel bars conforming to the requirements of ASTM A 615 [ASTM A 615M] for any Grade of steel shown. They shall be of the length, size and spacing as shown on the plans.

931-2.4 Chairs and Metal Expansion Caps: The chairs and metal expansion caps shall be of an approved type as shown on the plans.

Dowel bars for expansion joints shall have a metal cap on one end so placed to provide ample space for movement of the slab. Continuous sleeves covering 2 of the length of the bar will not be permitted. Other fasteners may be approved. Dowel bars shall be coated with an approved material to break the bond.

931-3 Metal Dowel Bar Assemblies for Joints in Concrete Pavement.

931-3.1 Qualified Products List: The dowel bar assembly used shall a product included on the Qualified Products List.

Manufacturers or distributors seeking approval of their material in accordance with this specification shall demonstrate the performance of their products in accordance with the requirements in 931-3.2 thru 931-3.6.

931-3.2 Rigidity: The dowel bars shall be supported by an approved welded assembly possessing sufficient rigidity to hold the dowel bars in position to such accuracy that error or deviation from its required position in any bar in the entire installation after the pavement has been finished shall be no greater than 2 inch [13 mm].

The assembly shall have continuous parallel spacer bars and two continuous parallel bearing members of no less than 3 inch [6.3 mm] diameter wire. One spacer bar shall be located at or near each end of the dowel. Alternate ends of dowels shall be welded to a spacer bar in such a manner as to maintain the dowels parallel to each other and permit sliding movement in the joint.

The free ends of each dowel shall be retained securely in place by means of wire loops or metal tubes welded to the other spacer bar. An expansion cap shall be installed on one end of each bar if the dowels are being used in an expansion joint.

Suitable struts or ties shall be provided to hold the assembly in correct position during installation.

The assembly shall have an upright support welded to the spacer bar and continuous bearing member at the end of each dowel and a continuous bearing member.

If the upright support consists of a single vertical wire, the support shall be no less than 5/16 inch [8 mm] diameter wire. Otherwise, the support shall be no less than 3 inch [6.3 mm] in diameter.

931-3.3 Sand Plates: Sand plates, if required, shall be made from no less than δ inch [9.5 mm] sheet steel. Each plate shall have no less than 0.1 ft^2 [0.001 m^2] of bearing area. The plates shall be furnished in sufficient number to provide uniform support for the complete assembly. They may be furnished separate from the assembly units, or attached thereto by welding, suitable clips, or other approved means.

931-3.4 Welds: The welds of the assembly shall be made securely. A broken weld will be cause for rejection of the length of section of the assembly where it occurs.

931-3.5 Assembly Placement: When the dowel bar assembly is in place, it shall act as a rigid unit with each component part securely held in position relative to the other member of the assembly.

The entire assembly shall be held securely in place during placing, consolidating, and finishing the concrete by means of metal pins. Pins used on granular subbase or cold mixed bituminous stabilized subbase shall penetrate at least 12 inches [300 mm] below the dowel bar assembly. The pins shall be of no less than 3 inch [6.3 mm] diameter wire and shall be provided with a hook or arm welded to the pin in such a manner that it shall secure the assembly in place.

Nail securing systems may be used as an anchoring device on hot bituminous stabilized subbase. The nail shall be no less χ inch [3 mm] in diameter, no less than 2 inches [50 mm] in length and the nail head or attached washer shall be not less than 2 inch [13 mm] outside diameter. The nail shall be driven through both ends of a metal strap after it has been placed around one of the lower transverse bars on the dowel bar assembly.

At least eight pins or nails shall be used for each 12 foot [3.6 m] section (a lane width) of assembly. Sand plates, if required, shall be drilled to receive the pins.

The Contractor shall provide the equipment and personnel necessary to verify dowel bar location after the concrete is placed and has received the initial screeding.

931-3.6 Materials: The wire for the welded assembly shall be in accordance with all applicable requirements of ASTM A 82.

One coat of zinc chromate paint shall be used as specified in 971-5. Application shall be in accordance with 561.

SECTION 932

NONMETALLIC ACCESSORY MATERIALS FOR

CONCRETE PAVEMENT AND CONCRETE STRUCTURES

932-1 Joint Materials.

932-1.1 Preformed Joint Filler for Pavement and Structures: Preformed joint filler shall meet the requirements of AASHTO M 153 or AASHTO M 213, or cellulose fiber types meeting all the requirements of AASHTO M 213 except the asphalt content is acceptable provided they contain minimums of 0.2% copper pentachlorophenate as a preservative and 1.0% waterproofing wax. For AASHTO M 153, unless a particular type is specified, either Type I, Type II or Type III may be used.

Preformed joint fillers shall have a thickness equal to the width of the joint required, and shall be furnished in lengths equal to the widths of the slabs in which they are to be installed, except that strips which are of a length not less than the distance between longitudinal joints, or between longitudinal joint and edge, may be used if laced or clipped together in a manner approved by the Engineer. The depth and shape of the joint filler shall conform to the dimensions shown in the plans. For doweled joints, proper provision shall be made for the installation of the dowels.

932-1.2 Joint Sealer for Pavement and Structures:

932-1.2.1 General: This Specification covers joint sealer intended for use in sealing joints in asphalt and concrete pavements. These materials may also be used to seal joints in concrete bridges and other structures.

932-1.2.2 Material: The material shall meet the requirements of either ASTM D 1190 (Concrete Joint Sealer, Hot-Poured Elastic Type), ASTM D 1850 (Concrete Joint Sealer, Cold-Application) or ASTM D 3405 (Joint Sealants, Hot-Poured, for Concrete and Asphalt Pavements).

932-1.2.3 Sampling and Certification: The manufacturer shall furnish to the State Materials Engineer, six certified copies of his test reports for each LOT of material furnished to each project. These reports shall indicate the results of test required by this Specification. They shall include a certification that the materials conform with this Specification, and shall be identified by project number and manufacturer's batch number.

Each certification shall cover only one type of material. Due to the wide range of application of the products within some types, the manufacturer shall additionally certify that his product is recommended for that stated use for that specific project.

Samples shall be furnished for testing in such size and number as directed by the Engineer.

932-1.2.4 Qualified Products List: The joint sealant used shall be included on the Qualified Products List.

Manufacturers or distributors seeking approval of their material in accordance with this Specification shall demonstrate the performance of their products in accordance with Florida Test Methods FM 5-532 or FM 5-533.

932-1.2.5 Shipment: The material shall be delivered in containers plainly marked with the manufacturer's name or trademark product name, LOT number and date of expiration.

932-1.2.6 Bond Breaker Rod: The bond breaker rod shall be a closed cell, expanded polyethylene foam rod of the size and dimensions shown on the plans. It shall be compatible with the joint sealant and no bond or reaction shall occur between the rod and the sealant.

All bond breaker rods installed shall be covered by a sealant at the end of each work day.

Bond breaker tape approved by the sealant manufacturer may be used in lieu of bond breaker rod when sealing random cracks.

932-1.3 Low Modulus Silicone Sealant:

932-1.3.1 General: Low Modules Silicone sealant shall be furnished in a one part silicone formulation meeting the requirements specified herein. Acetic acid cure sealants are not acceptable. A primer as specified in 932-1.4 for bonding sealant to concrete shall be used if required by the manufacturer. When a manufacturer's product is tested and approved by the Department using a primer, primer will be required for project installation.

Low modulus silicone sealants may be either a non-self-leveling or a self-leveling type, unless specified otherwise in the plans or Specifications.

Silicones shall be identified in the following manner:

Type A - A low modulus, non-sag (non-self-leveling) silicone formulation, used in sealing horizontal and vertical joints in cement concrete pavements and bridges (i.e., concrete-concrete joints). Tooling is required.

Type B - A very low modulus, self-leveling silicone formulation, used in sealing horizontal joints (including joints on moderate slopes) in cement concrete pavements and bridges (i.e., concrete-concrete joints). Tooling is not normally required.

Type C - An ultra-low modulus, self-leveling silicone formulation, used in sealing horizontal joints (including joints on moderate slopes)in cement concrete pavements and bridges (i.e., concrete-concrete joints). It can also be used to seal the joints between cement concrete pavements and asphaltic concrete shoulders (including asphalt-asphalt joints). Tooling is not normally required.

932-1.3.2 Physical Requirements:

SILICONE SEALANT TYPE	Type A	Type B	Type C
Flow (maximum)	0.3 inches [7.6 mm]		
Extrusion rate	1.25-4.2 g/s	1.7-11.0 g/s	4.58-9.2 g/s
Tack-free time at 77 ∀ 3EF [25 ∀ 1.5EC] and 45 to 55% Relative Humidity	20-75 minutes	120 minutes, maximum	60 minutes, maximum
Specific gravity	1.1 to 1.515	1.10 to 1.40	1.26 to 1.34
Durometer hardness, Shore A (Cured seven days at 77 ∀ 3EF [25 ∀ 1.5EC] and 50 ∀ 5% Relative Humidity)	10-25		
Durometer hardness, Shore 00 (Cured 21 days at 77 ∀ 3EF [25 ∀ 1.5EC] and 50 ∀ 5% Relative Humidity)		40-80	20-80
Tensile stress (maximum) at 150% elongation	45 psi [300 kPa],	40 psi [275 kPa],	15 psi [100 kPa],
Elongation (Cured seven days at 77 ∀ 3EF [25 ∀ 1.5EC] and 50 ∀ 5% Relative Humidity)	800% minimum		
Elongation (Cured 21 days at 77 ∀ 3EF [25 ∀ 1.5EC] and 50 ∀ 5% Relative Humidity)		800% minimum	1400% minimum
Ozone and Ultraviolet Resistance	No chalking, cracking or bond loss after 5,000 hours, minimum.		
Bond to concrete mortar briquets (primed if required) (Cured seven days at 77 ∀ 3EF [25 ∀ 1.5EC] and 50 ∀ 5% Relative Humidity)	50 psi [350 kPa] minimum		
Bond to concrete briquets (Cured 21 days at 77 ∀ 3EF [25 ∀ 1.5EC] and 50 ∀ 5% Relative Humidity)		40 psi [275 kPa], minimum	35 psi [240 kPa], minimum (includes bond to asphalt)
Movement Capability	No adhesive or cohesive failure and adhesion, 10 cycles at -50 to +100%		

932-1.3.3 Methods of Test:

Flow	MIL S 8802
Extrusion Rate	MIL S 8802
Tack Free Time	MIL S 8802
Specific Gravity	ASTM D 792, Method A
Durometer Hardness	ASTM D 2240
Tensile Stress	ASTM D 412 (Die C)
Elongation	ASTM D 412 (Die C)
Ozone and Ultraviolet	ASTM C 793

Bond to mortar briquets:

Portland Cement Mortar: Briquets shall be molded and cured 28 days minimum in accordance with AASHTO T 132. Cured briquets shall be dried at 230 ∀ 5EF [110 ∀ 2.5EC], sawed in half and bonded together with a thin section of sealant. After cure of sealant, briquets will be tested in accordance with AASHTO T 132.

Asphaltic Concrete: Briquets shall be molded using types S-III bituminous concrete mixture as specified in Section 331, using the briquets molds of AASHTO T 132. Compacted briquets shall be sawed in half and bonded together with a thin section of sealant. After cure of sealant, briquets will be tested in accordance with AASHTO T 132.

Movement capability and adhesion	ASTM C 719

932-1.3.4 Field Cure: 6 inch [150 mm] samples of the sealant shall be taken by the Engineer from the joint at the end of a two week curing period and tested for durometer hardness (by Florida Method FM 3 D2240), except that the requirements of a 1 inch [25 mm] sample width shall not apply. A minimum hardness of 7.0 is required as evidence of adequate cure.

932-1.3.5 Tolerance: A tolerance in cross-sectional height at midpoint of -1/16 to +3/16 inch [-1.6 to +4.8 mm] will be allowed to the nominal values shown for each joint width on the plan sheet. The Engineer shall check one joint for each 1,000 feet [300 m] of roadway by cutting out specimens. If the cross section of the cut specimen is out of the allowable range, additional specimens shall be taken as follows. One joint every 100 feet [30 m] of pavement not to exceed 500 feet [150 m]. If the average of the specimens is out of tolerance, the Contractor shall remove and replace the entire 500 feet [150 m] section at his expense. Installation tolerance shall be verified at 1,000 feet [300 m] intervals.

932-1.3.6 Sampling and Certification: Samples shall be furnished for testing in such size and number as directed by the Engineer.

The manufacturer shall furnish, directly to the State Materials Engineer, six certified copies of his test reports for each LOT of material furnished to each project. These reports shall indicate the results of test required by this Specification. They shall include a certification that the materials conform with this Specification, and shall be identified by project number and manufacturer's batch number.

As an exception to the ozone and ultraviolet resistance test and bond to mortar test on each LOT, the manufacturer may provide certified test results showing that the basic sealant formulation has passed the 5,000-hour accelerated weathering test and certify that the LOTs or batches are identical to the formulation tested and provide, with each LOT or batch supplied, a certified test results which is typical of the material shipped and not more than six months old.

932-1.3.7 Qualified Products List: The silicone sealant used for the application described shall be included on the Qualified Products List.

Manufacturers or distributors seeking approval of Low Modulus Silicone Sealants shall demonstrate the performance of their products in accordance with FM 5-533.

932-1.3.8 Shipment: Sealant material shall be delivered in containers plainly marked with the manufacturer's name or trademark, product name, LOT number, and date of expiration.

932-1.4 Primer: When required by the manufacturer's product, a primer shall be used with the Low Modulus Silicone Sealant.

The manufacturer shall perform his quality control tests on each LOT of sealant primer material furnished to each project and furnish a certified report that each LOT of primer material furnished to a project meets his Company's Specifications for that product and the primer is suitable for its intended use.

Sealant primer material shall be delivered in containers plainly marked with the manufacturer's name or trademark and product name, LOT number and date of expiration.

932-1.5 Backer Rod and Tape Bond Breakers: Joint dimensions, bond breaker suitability (by type and project) and other applicable bond breaker uses shall be in agreement with the requirements of Roadway and Traffic Design Standards, Index No. 305. Any modifications or exceptions to these requirements shall be shown in the plans.

For new construction projects or general use where the joints to be sealed have uniform width, a closed cell, expanded polyethylene foam backer rod bond breaker shall be required. For rehabilitation projects and similar joint seals where the joints to be sealed have irregular width, an open cell, expanded polyethylene foam backer rod bond breaker with an impervious skin shall be required.

The backer rod shall be compatible with the joint sealant. No bond or reaction shall occur between the rod and the sealant.

Tape bond breaker approved by the sealant manufacturer may be used in lieu of backer rod bond breaker when sealing joints and/or random cracks, as required.

All installed bond breakers shall be covered by sealant at the end of each work day.

932-2 Pads for Structures.

932-2.1 Resilient Pads: Resilient pads shall be of laminated, preformed, fabric and rubber construction, composed of multiple layers of 8 ounce [0.227 kg] cotton duck impregnated and bound with high-quality natural rubber, or of equivalent and equally suitable materials compressed into resilient pads of uniform thickness. The number of plies shall be such as to produce the specified thickness, after compression and vulcanizing. The finished pads shall withstand compression loads, perpendicular to the plane of the laminations, of not less than 10,000 lb/in^2 [69 MPa] without detrimental reduction in thickness or extrusion.

932-2.2 Neoprene Pads:

932-2.2.1 General: Neoprene pads, (elastomeric bearings) may be either of two types: (1) plain pads, composed of neoprene compound, or (2) composite pads, composed of layers of neoprene compound between which steel plates are bonded. In addition to the internal steel plates, the composite pads may have external steel load plates bonded to the upper or lower elastomeric layer or both.

Unless otherwise shown in the plans, plain pads shall be used only in thicknesses up to : inch [19 mm]; and pads thicker than : inch [19 mm] shall be composite.

The pads shall be furnished with the dimensions indicated in the plans and shall be composed of the specified elastomer type, grade, and shear modulus (or hardness) and adequate for the specified design load. The pads shall be tested at the appropriate level and shall satisfy any special requirements in the plans.

The elastomer portion of the elastomeric compound shall be 100% polychloroprene (neoprene). The elastomeric compound shall meet the requirements of ASTM D 2000 for the specific requirements shown in the following table:

Serial Designations for Basic Requirements			Suffix Designations
Durometer 50	Durometer 60	Durometer 70	All Durometer
2BC525	3BC625	3BC725	A14, B14, C12, E034, F17, K21, Z (OZONE)
Note: The complete designation of test requirements consists of the basic designation plus the suffix designation.			

ASTM D1149:	Durometer 50	Durometer 60	Durometer 70
100 pphm OZONE in air by volume, 20% strain, 100E ∀2EF [38 ∀ 1EC], 100 hours, Mounting Procedure D518, Procedure A	No Cracks	No Cracks	No Cracks

Adhesion (composite pads only), ASTM D429:

	Durometer 50	Durometer 60	Durometer 70
Bond made during vulcanization	40 lb/in [7.0 N/mm]	40 lb/in [7.0 N/mm]	40 lb/in [7.0 N/mm]

Unless otherwise specified in the plans, the elastomer shall be 50 Durometer and adequate for 1,000 lb/in^2 [7 MPa] Design Compression Stress.

The pads shall be cast under pressure and heat and shall be individually molded to the size and shape called for in the plans. Pads shall be furnished in one piece, and the elastomer portions shall not be laminated in any manner.

Flash tolerance, finish, rubber-to-metal bonding, and appearance shall meet the requirements of the latest edition of the Rubber Handbook as published by the Rubber Manufacturers Association, Inc., RMA F3 and T.063 for molded bearings and RMA F2 for extruded bearings.

Plain pads may be molded or extruded and vulcanized in large sheets and cut to size. Cutting shall not heat the materials and shall produce a smooth finish to ANSI 250.

The pads shall be prepared and packaged by the manufacturer and shall be shipped in unbroken identifiable packages. Each package shall list the number of pads, the type of pads, and the purchase order number. The required mill test reports shall accompany the packaged pads. No package of pads shall weigh more than 1,800 lbs [820 kg].

932-2.2.2 Dimensional Tolerances: Plain pads and composite pads shall be built to the design dimensions and these Specifications with the following tolerances:

1. Overall Vertical Dimensions:	
Design Thickness 13 inch [31.8 mm] or less: Design Thickness over 13 inch [31.8 mm]:	-0, +χ inch [-0, +3.2 mm] -0, +3 inch [-0, +6.4 mm]
2. Overall Horizontal Dimensions	
36 inches [900 mm] and less:	-0, +3 inch [-0, +6.4 mm]
Over 36 inches [900 mm]:	-0, +2 inch [-0, +12.7 mm]
3. Thickness of Individual Layers of Elastomer (Composite Pads Only) at any point within the bearing:	∀20% of design value but no more than ∀χ inch [∀3.2 mm]
4. Variations from a Plane Parallel to the Theoretical Surface (as determined by measurements at the edge of the bearings)	
Top:	slope relative to the bottom of no more than 0.005 radians
Sides:	3 inch [6.4 mm]
5. Position of Exposed Connection Members:	χ inch [3.2 mm]
6. Edge Cover of Embedded Laminates or Connection Members:	-0, +χ inch [-0, +3.2 mm]
7. Size of Holes, Slots or Inserts:	+χ inch [+3.2 mm]
8. Position of Holes, Slots or Inserts:	+χ inch [+3.2 mm]

932-2.2.3 Specific Requirements for Composite Pads: The composite (neoprene and steel) pads shall be cast as a unit in a mold and bonded and vulcanized under heat and pressure. The molds shall have standard shop practice mold finish. The internal steel laminates shall be gritblasted and cleaned of all surface coating rust and mill scale before bonding, shall be free of sharp edges and burrs, and shall have a minimum edge cover of 3 inch [6.4 mm]. External load plates, if used, shall be protected from rusting by the manufacturer and preferably shall be hot-bonded to the bearing during vulcanization.

Composite pads shall consist of alternate laminations of neoprene and hot-rolled steel sheets molded together as a unit. Unless otherwise shown in the plans, the pads shall meet the following requirements: The outer metal laminations shall be 3/16 inch [4.8 mm], and the inner laminations shall be 14-gauge [2.0 mm]. The outer laminations of neoprene shall be 3 inch [6.4 mm]; and the inner laminations shall be of equal thickness, the actual thickness depending upon the number of laminations. Unless otherwise shown in the plans, all components of the composite pad shall be molded together into an integral unit; and all edges of the steel laminations shall be covered by a minimum of 3 inch [6.4 mm] of elastomer. Exposed laminations, apparent as a result of manufacturing techniques, shall be sealed flush on the finished bearing pad with a bonded vulcanized patch consisting of material equivalent to that used in the manufacture of the pad. The pad surface shall be free of cuts, blemishes, and molding defects in excess of : inch [19 mm] in length and χ inch [3.2 mm] in depth and shall be free of foreign matter. The top and bottom bearing surfaces shall each have an integral sealing rib approximately χ inch [3.2 mm] in depth (in addition to the specified total thickness) and 3/16 inch [4.8 mm] in width around their peripheries, which shall be free of cuts, tears, an separations. Variations from specified dimensions for individual laminations shall not exceed those specified in 932-2.2.2. Steel reinforcement in composite pads shall conform to AASHTO M 251.

932-2.2.4 Testing for Physical Properties: The pads shall meet the requirements for physical properties as specified in 932-2.2.5 when tested in accordance with ASTM Designations shown. Test specimens shall be prepared in accordance with ASTM D 3183. The pads will be acceptable on the basis of meeting the requirements for Durometer 50, 60 or 70, whichever is called for in the plans.

932-2.2.5 Original Physical Properties:

Durometer	50	60	70
Hardness (ASTM D 2240)	50 ∀5 points	60 ∀5 points	70 ∀5 points
Tensile Strength* (ASTM D 412), minimum	2,250 psi [15.5 MPa]	2,250 psi [15.5 MPa]	2,250 psi [15.5 MPa]
Elongation at Break*, minimum	400%	350%	300%

*Test results of these properties of test samples prepared from finished pads shall not be more than 10% below the specified value.

932-2.2.6 Change in Original Physical Properties: The material, oven-aged 70 hours at 212EF [100EC] and tested in accordance with ASTM D 573, shall show the following:

Hardness .... 0 to +15 points, change
Tensile Strength ....-15% change, maximum
Elongation at Break ....-40% change, maximum

932-2.2.7 Extreme Temperature Characteristics:

Compression Set (ASTM D 395 Method B, 22 hours
at 212EF [100EC]).. 35% maximum

932-2.2.8 Oil Swell:

Volume change (ASTM D 471, using ASTM Oil

No. 3, 70 hours at 212EF [100EC]) .... 120% maximum

932-2.2.9 Ozone Cracking Resistance:

Time within which no cracks develop (ASTM D 1149) 100 pphm of ozone in air by volume at 20% strain and a temperature

of 100∀2EF [38 ∀ 1EC] .... 100 hours, minimum

932-2.2.10 Bond Between Neoprene and Steel (Composite Pads only):

ASTM D 429, Method B ....40 lb/in [7.0 N/mm]

932-2.2.11 Bearing Tests and Acceptance Criteria: The acceptance criteria shall have two levels. Level I acceptance criteria shall be applied to all pads. Level II acceptance criteria shall be applied to more critical or unusual pads as required in the plans.

Level II test shall also be used to resolve differences over the acceptance of pads to which only Level I tests shall have been applied.

Level I criteria require that the pad be manufactured according to this Specification and any additional requirements specified in the plans. The manufacturer shall proof load each composite pad with a compressive load 1.5 times the maximum design load. If bulging patterns imply laminate placement which does not satisfy design criteria and manufacturing tolerances or if bulging suggests poor laminate bond, the pad shall be rejected. The pad shall be acceptable if the number of surface cracks do not exceed 5; however, if there are more than three separate surface cracks which are greater than 0.08 inch [2 mm] wide and 0.08 inch [2 mm] deep or any one surface crack which is greater than 1.0 inch [25 mm] long and 0.08 inch [2 mm] deep, the pad shall be rejected. Cracks shall be measured under test loading conditions.

Unless otherwise specified in the plans, the maximum design load in pounds [newtons] shall be 1,000 [7.0] times the pad area in square inches [square millimeters].

Level I criteria requires that the elastomer satisfies the minimum properties of 932-2.2.1 except as otherwise specified in the plans. Tensile strength, elongation at break, Durometer hardness, bond strength, and ozone resistance shall be tested for each production LOT of pads. A LOT shall consist of a single type of bearing, of the same design and material, submitted for inspection at the same time, as defined in ASTM D 4014. A new set of all tests shall be required whenever there is a change in the type or source of raw materials, elastomer formulation or production procedures.

Level II criteria require that all Level I conditions are satisfied, except that individual conditions may be waived by the Engineer if Level II certification is used as an arbitration of disputes. Any failure at Level II shall constitute rejection of the entire LOT. As a minimum, shear modulus and compressive stiffness shall be determined in accordance with ASTM D 4014. The shear modulus may be determined by testing a piece of the finished pad as specified in ASTM D 4014 (if possible), or a comparable non-destructive test may be performed on the complete pad. A compressive stiffness test shall be performed on the complete pad. The shear modulus shall fall within 15% of the value specified in the plans or within the following limits if no value for shear stiffness is specified:

Durometer Hardness	50	60	70
Shear Modulus at 73EF [23EC]	85-110 psi [0.59 to 0.76 MPa]	120-155 psi [0.83 to 1.07 MPa]	160-260 psi [1.10 to 1.79 MPa]
creep deflection at 25 years instantaneous deflection	25%	35%	45%

The compressive stiffness shall vary by no more than 10% from the median value of all pads, nor more than 20% from the design value, if specified. However, a compressive stiffness and a shear stiffness shall not both be specified for the same pad.

For the properties of the rubber compound to be measured by test in Level I, one extra pad shall be produced per LOT, selected at random for the necessary destructive sampling. The rubber samples shall be cut from interior laminates of the pad. In the sampling, internal surfaces exposed by vertically sawing through the middle of the pads, shall be measured for Durometer hardness as a check on completeness of vulcanization. All readings for hardness shall fall within the range for the Durometer value specified.

For Level II non-destructive testing, two pads per LOT shall be provided. For LOTs exceeding 50 pads, at least one additional pad shall be tested for every 50 pads or part thereof.

When plain or laminated neoprene pads are detailed in the plans and fabricated in accordance with the plans and Specification, submittal of shop drawings will not be required. The Contractor shall submit shop drawings to the Engineer for approval prior to fabrication of neoprene pads that are not fabricated as detailed in the plans or have external steel load plates or other materials bonded to the upper or lower elastomeric layers.

The Contractor shall also provide the Department with written notification 30 days prior to the start of pad production. This notification shall include the project number, quantity and size of pads being produced, manufacturer's name, location, and the name of the representative who will coordinate production, inspection, sampling and testing with the Department.

After completion of pad production, the Contractor shall allow the Department 14 days after notification for selecting the pads to be tested. The time required for testing shall be determined by the testing lab selected by the Contractor. All tests shall be conducted by an independent laboratory approved by the Department and under the direction of the Engineer. The Department reserves the right to perform additional Level I or check tests on no more than one pad per LOT, if deemed necessary. As a convenience and by agreement, the independent laboratory may use the manufacturer's test facilities providing that testing machines are shown to comply with AASHTO T 67.

The Contractor shall provide all pads, including pads that are needed for fulfilling testing requirements. All costs of testing and any extra pads needed for testing shall be borne by the Contractor and included in the bid price for the bearing pads.

If a pad fails the requirements of the compressive proof load, the pad shall be rejected (other tests failures affect LOT acceptance). If a pad for a given LOT fails to meet other test requirements specified herein, all pads in that LOT shall be rejected. In this event, the Contractor may provide two additional pads from the rejected LOT for a repeat test at Level II. All costs associated with additional (repeat) tests shall be borne by the Contractor. Both pads must pass Level II Test for acceptance of the LOT.

932-2.2.12 Mill Analysis Reports: For both plain pads and composite pads, six certified copies of the manufacturer's complete mill analysis, including actual results of all tests specified in this Subarticle, and properly identified by project number, shall be furnished to the Engineer by the Contractor. The mill analysis reports shall be for material representative of that furnished.

The manufacturer shall certify that each pad satisfies the design specification. Each composite pad shall be permanently marked. The marking shall consist of the order number, LOT number, pad identification number, and elastomer type and hardness number. Where possible, unless otherwise specified in the plans, the marking shall be on a face which is visible after erection of the structure.

SECTION 933

ACCESSORY MATERIALS FOR PRESTRESSED CONCRETE

933-1 Cables for Pretensioning.

The cables for prestressing concrete members shall be high-tensile-strength, 7-wire strand conforming to the requirements of AASHTO M 203 with the addition of 9/16 inch [14.29 mm] strand meeting the following requirements:

TABLE 1
BREAKING STRENGTH REQUIREMENTS

Nominal Diameter of Strand, inch [mm]	Breaking Strength of Strand, lbf [kN]	Nominal Steel Area of Strand, in^2 [mm^2]	Nominal Weight of Strands, lb/1000 ft [kg/1000 m]
Grade 270 [Grade 1860]			
9/16 [14.29]	51,700 [230]	0.191 [123.23]	650 [967]

TABLE 2
YIELD STRENGTH REQUIREMENTS

Nominal Diameter of Strand, inch [mm]	Initial Load, lbf [kN]	Minimum Load at 1% Extension, lbf [kN]
Grade 270 [Grade 1860]		
9/16 [14.29]	5,170 [23.0]	43,940 [195.5]

TABLE 3 DIAMETER RELATION BETWEEN CENTER AND OUTER WIRES	
Nominal Diameter of Strand, inch [mm]	Minimum Difference Between Center Wire Diameter and Diameter of any Outer Wire, in. [mm]
Grade 270 [Grade 1860]	
9/16 [14.29]	0.003 [0.0762]

As an exception to the above, at the Contractor's option, stabilized strands may be used in lieu of stress relieved strands. Calculations shall be submitted, showing the substitution meets the following requirements:

1. The strands meet all the requirements of ASTM A 416, Grade 270 [ASTM A 416M, Grade 1860].

2. The net compressive stress in the concrete after all losses is at least as large as that provided by the stress relieved strands.

3. The ultimate strength of the structure with the new strands meets the requirements of the applicable AASHTO Specifications.

The stabilized strand (low-relaxation strand) shall have identification marks applied at the manufacturing plant. The identification marks shall be color coded and applied at intervals not exceeding 100 feet [30 m].

933-2 Bars for Posttensioning.

The bars shall be of high-tensile-strength steel, and shall be equipped with wedge-tool end anchorages which will develop the minimum specified ultimate bar stress on the nominal bar area. The physical properties of the bar steel and the stress-strain curve, determined by static tensile tests, shall conform to the following:

Ultimate stress, minimum .... 145,000 psi [1000 MPa]
Stress at 0.7% elongation, minimum .... 130,000 psi [896 MPa]
Stress at 0.3% elongation, minimum .... 75,000 psi [517 MPa]
Elongation in 20 diameters, minimum 4%
Modulus of elasticity, minimum .... 25,000,000 [172 GPa]
Diameter tolerance .... +0.02375 or -0.010 inch [+0.603 or -0.254 mm]

933-3 Parallel Wire Assemblies for Posttensioning.

The wire assemblies shall consist of parallel wires of the number and size shown in the plans. Wires shall conform to the requirements of ASTM A 421 [ASTM A 421M], with Type BA (Button Anchorage) used for cold end deformations and Type WA used for the wedge-type anchorage without cold end deformations. At the option of the Contractor, stabilized strands may be used in lieu of stress relieved strands provided calculations are submitted, showing the substitution meets the requirements specified in 933-1 for stabilized strands.

933-4 Anchorages for Posttensioned Tendons.

933-4.1 For Bars: Wedge-type anchorages shall be used for bars. The wedge device shall develop the minimum ultimate stress specified for the nominal bar area.

Wedge anchorages shall bear against anchorage plates fabricated of hot-rolled steel having physical characteristics not less than as specified for No. 1040 of the American Iron and Steel Institute (AISI) Specifications.

933-4.2 For Parallel Wire Assemblies: Anchorage for parallel wire assemblies may be provided by cold-end deformation of the wires (Button Anchorage) bearing against suitable anchorage plates, or by wedge-type anchorages of the sandwich-plate or conical type. The anchorage device shall be capable of developing at least 90% of the specified ultimate strength of the total number of wires anchored.

Conical type anchorages shall be embedded within the ends of the concrete members unless otherwise specified. Anchorages shall generally bear against embedded grids of reinforcing steel of approved type.

933-4.3 Alternates for Both Types: Alternate type anchorages will be considered if proposed by the Contractor. Any alternate anchorage will be required to develop the full specified ultimate strength for bars or at least 90% of the specified ultimate strength for parallel wire assemblies.

As a specific exception, threaded anchorages not on upset or over-size reinforcing ends will not be considered.

933-5 Required Tests for Reinforcing.

933-5.1 General: Tests shall be made to determine the physical characteristics of prestressing reinforcement. For tests specified to be made by the manufacturer, certified copies of all test results shall be submitted to the Department and the Department shall be privileged to have all tests witnessed by its Inspectors.

933-5.2 Cables, Wires and Wire Anchorages: Acceptance of cables, wires and wire anchorages shall be based on manufacturer's certified mill analysis of test results meeting the Specification limits of ASTM or AASHTO as specifically designated.

Certifications of cable for prestressing shall contain for each heat number or production LOT, all test results required by AASHTO M 203 and the modulus of elasticity expressed in MPa or the stress-strain curve with units identified.

Random samples may be selected and tested by the Department for verification purposes.

933-5.3 Bars:

933-5.3.1 Proof Test: During manufacture each bar shall be proof-tested to a minimum stress of 130,000 psi [896 MPa].

933-5.3.2 Static Test: From each mill heat received, one static test shall be made by the manufacturer on an assembled bar and anchorage, to determine the physical properties of the steel and the assembly. Such physical properties shall conform to the minimum physical properties specified in 933-2.

SECTION 934

NON-SHRINK GROUT

934-1 Scope.

This Section covers only prepackaged non-shrink cementitious grout for structural use.

934-2 Applicable Documents.

FM 1-T 126: Method of making specimens.

FM 1-T 106: Method of testing compressive strengths.

FM 1-T 197: Method for testing time of set.

FM 5-516: Method for determining low-levels of chloride in concrete and raw materials.

ASTM C 939: Method for flow of Grout for preplaced aggregate concrete (flow cone method).

ASTM C 1090: Method for measuring changes in height of cylindrical specimens from hydraulic cement grout.

934-3 Type Permitted.

Only non-metallic formulations of grouts are allowed. Gas producing, metal oxidizing and expansive aggregate grouts are not allowed.

934-4 Requirements.

When tested as provided in 934-2, at the fluidity or consistency designated for the specified application, the grout shall meet the following requirements:

Expansion, at 3, 14, 28 days	Not greater than 0.4%
Expansion, at 3 or 14 days	Not greater than expansion at 28 days.
Shrinkage, at 28 days	None
Compressive strength,	
seven days	2,500 psi [17 MPa] minimum
28 days	5,000 psi [35 MPa] minimum
Time of set, final	8 hours maximum
Chloride Content	0.40lb/yd^3 [0.25 kg/m^3] maximum

934-5 Acceptance.

Except as provided for herein, non-shrink grout shall be one of the products included on the Qualified Products List. Materials that are included on the Qualified Products List, as provided in 934-8, require no additional testing. For materials proposed for use that are not on the Qualified Products List, submit a unit sample to the Engineer for testing at the State Materials Laboratory. Unit samples submitted for testing shall be a single package of no less than 1 ft^3 [0.03 m^3]. Materials remaining in storage for more than six months must be retested before use.

934-6 Rejection.

Materials shall be rejected at the point of use if the materials are caked, lumpy, or show any signs of deterioration. Materials shall be rejected if the grout does not achieve the design fluidity or consistency when mixed according to the manufacturer=s recommendations.

All broken or open packages shall be rejected.

934-7 Packaging.

Cementitious materials for grouts must be packaged in suitable moisture resistant containers and clearly labeled. Where applicable, manufacturers recommendations, limitations and cautions shall be clearly visible on each label.

934-8 Qualified Products List.

Manufacturers seeking evaluation of non-shrink grout shall meet the requirements of 6-1 and this Specification. Materials which fail to meet the requirements of 934-4, when tested for manufacturer=s evaluation or jobsite approval, will not be included on the Qualified Products List.

SECTION 935

PACKAGED, DRY, THERMOSETTING POLYMER CONCRETE MATERIAL FOR CONCRETE REPAIR

935-1 Description.

This Section covers packaged, dry, thermosetting, polymer concrete material for rapid repairs to hardened portland cement concrete pavement and structures. Only low odor materials such as styrene diluted polyester resin will be considered.

These materials may be used as alternates to the epoxy material in applications covered by Sections 354, 401, 406 and 409.

935-2 Materials.

The materials to be considered as alternates shall meet the following Physical Requirements:

Type 1 Polymer Concrete: Moderate compressive strength for repairing fair to low quality concrete where moderate compressive strength is desired.

Type 2 Polymer Concrete: Low modulus with lower compressive strength and more flexibility for repairing low quality and or moving concrete (across working cracks).

Property	Type 1 Polymer Concrete	Type 2 Polymer Concrete
Compressive Strengths		
2 hours	1,500 psi [10.3 Mpa]	800 psi [5.5 Mpa]
24 hours	3,500 psi [24 Mpa]	1,500 psi [10.3 Mpa]
7 days	4,500 psi[31 Mpa]	2,000 psi [13.8 Mpa]
28 days	4,500 psi [31 Mpa]	2,000 psi [13.8 Mpa]
Working Time	12 to 20 minutes	12 to 20 minutes
	7 day compressive strength test values:	

Property	Type 1 Polymer Concrete	Type 2 Polymer Concrete
PCC Bond Strength-ASTM C 882	3,500 psi [24 Mpa] minimum	2,000 psi [13.8 MPa] minimum
Compressive Strength-ASTM C 579	4,500 psi [31 MPa] minimum	2,000 psi [13.8 MPa] minimum
Flexural Strength-ASTM C 580	1,800 psi [12.4 MPa] minimum	800 psi [5.5 MPa] minimum
Shrinkage-ASTM C 531	0.03% maximum	0.03% maximum
Expansion-ASTM C 531	0.000012 in/in/EF [2.16H 10^{-5} mm/(mm≅EC)] maximum	0.000012 in/in/EF [2.16H 10^{-5} mm/(mm≅EC)] maximum
Tensile Strength-ASTM C 307	900 psi [6.2 Mpa] minimum	400 psi [2.7 MPa] minimum

The catalyst, resin and aggregate blend shall be provided by the manufacturer and approved by the Department.

If the area is being used for maintenance of traffic, the repair shall be capable of receiving traffic within two hours or as noted in the plans.

Constructability: The Contractor shall furnish to the Engineer for approval shop drawing as may be required to complete repairs in compliance with the design shown in the plans and the manufacturers recommended repair system.

935-3 Sampling.

A LOT is the packaged repair material normally placed on a pallet. A unit sample is a single container or package of material randomly selected from the LOT.

935-4 Rejection.

All broken containers will be rejected. Material that fails to meet any of the requirements of this specification will be rejected. Rejection and reasons for rejection will be reported to the producer or supplier in writing. Material in local storage in the hands of a vendor for more than six months after testing will be retested before use. Retested material will be rejected if it fails to conform to any of the requirements of this Specification.

935-5 Certification.

The Contractor shall furnish to the Engineer a certified test report, as specified in 6-1, for the materials furnished and described in this specification indicating the material meets all requirements specified. When the material is supplied for a specific application, the producer shall additionally certify that he has examined the particular application and recommends the product for that application. This examination shall include a consideration of any section sensitivity or sag tendency of the product.

935-6 Marking.

All containers shall be marked with the following information:

(a) Lot identification number and material expiration date

(b) Directions for use shall include but are not limited to the following:

(1) The type and kind of adhesive recommended (if any) to bond fresh repair material to the concrete or mortar being repaired.

(2) The recommended amount of resin, other liquid component, or both, to be mixed with the package contents.

(3) The recommended length of mixing time or sequence of mixing and resting times in minutes.

(c) Date the material was packaged.

(d) The yield in cubic feet [cubic meters] or yield in ft^2/in [m^2/mm] thickness when mixed with the recommended amount of liquid.

(e) The net weight in each container. (The contents of any container shall not vary by more than 2% from the weight stated in markings. The average weight of filled containers in a LOT shall be not less than the weight stated in the markings.)

935-7 Qualified Products List.

Polymer concrete materials shall be on the Qualified Products List (QPL).

935-8 Additional Testing.

The Department reserves the right to conduct further field testing at the discretion of the Engineer.

935-9 Mixing and Installation.

The material(s) shall be mixed and installed in accordance with manufacturer's recommendations. Manufacturers will be required to provide field representation upon request.

SECTION 936

WIRE ROPE FOR FENDER PILE CLUSTER

Unless otherwise shown on the plans, galvanized aircraft quality wire rope with ultraviolet ray resistant polypropylene impregnation shall be used. The polypropylene plastic shall form a wall of protection by using spacer wires in the outer gallery of each strand and shall be effectively bonded to the outer plastic jacket. The rope diameter shall be 2 inch [12.7 mm] and the outside diameter of the covering ε inch [15.9 mm]. The rope construction shall be 6 by 19 independent wire rope core with nominal strength of 22,800 pounds [100 kN]. All ends shall be protected with heat shrinkable end caps, compatible with the rope's polypropylene. The caps shall provide an effective water-tight seal and shall be installed in accordance with the manufacturer's instructions. The rope shall conform to Federal Specifications W83420 for aircraft quality and the protective coating shall conform to ASTM A 475 (Type 1 coating).

SECTION 937

ADHESIVE BONDING MATERIAL SYSTEMS

FOR STRUCTURAL APPLICATIONS

937-1 General Requirements.

Adhesive bonding material systems for structural applications shall consist of 2-part chemical components, pre-packaged to automatically proportion and mix the materials for use. Manual proportioning of the components will not be permitted. The material systems shall be specifically intended for use in structural applications for bonding anchors and dowels to hardened concrete. Applications are limited to anchors and dowels installed in positions ranging from vertically downward to horizontal.

937-2 Qualified Products List.

Manufacturers of adhesive bonding material systems may apply for inclusion of individual products on the Qualified Products List. The application shall be made in accordance with 6-1 and shall include certified test reports from an independent testing laboratory which shows the material system meets all the requirements specified herein.

937-3 Minimum Performance Requirements (FM 5-568).

When tested in accordance with FM 5-568, the adhesive bonding material system shall meet the following requirements:

Uniform Bond Stress	
Confined Tension	2,290 psi [15.8 MPa]
Damp-Hole Installation	1,680 psi [11.6 MPa]
Elevated Temperature	2,290 psi [15.8 MPa]
Horizontal Orientation	2,060 psi [14.2 MPa]
Short Term Cure	1,710 psi [11.8 MPa]
Specified Bond Strength	1,080 psi [7.5 MPa]

Maximum Coefficient Of Variation for Uniform Bond Stress 20%

Long Term Load (Creep):

(1) The rate of displacement shall decrease during the 42 day application of load.

(2) At 42 days the total displacement due to creep (with load still applied) shall be less than 0.03 inch [0.75 mm] and during the last 14 days of the 42 day load duration, the total displacement due to creep shall be less than 0.003 inch [0.075 mm].

(3) After removal of the 42 day load, the uniform bond Stress from a subsequent Confined Tension Test shall not be less than 1,826 psi [12.6 MPa].

937-4 Product Identification (Fingerprint) Properties (FM 5-569).

References for comparison including Infrared Absorption, Density or Average Weight, Gel Time or Setting Time, and Bond Strength shall be determined in accordance with FM 5-569.

937-5 Packaging and Marking.

The adhesive bonding material system shall be delivered to the project site in original unopened containers with the manufacturer=s label identifying the product. Each package shall be clearly marked with the following information:

Manufacturer=s name and address
Product Name
Date of Manufacture
Expiration Date
Lot Identification Number
Storage and Handling Requirements

Each package shall include the manufacturer=s instructions for anchor and dowel installation. The instructions shall include the following information:

Diameters of drilled holes for applicable anchor and dowel sizes.

Cleaning procedure for drilled holes, including a description of permitted and prohibited equipment and techniques.

Allowable temperature ranges for storage, installation and curing.

Identification of acceptable mixing/dispensing nozzles.

Fabrication requirements for anchors and dowels.

Description of tools permitted or required for installation.

Method of identifying properly proportioned and mixed adhesive materials.

Time and temperature schedule for initial set and full-strength cure.

Special requirements for special installation conditions such as damp holes, or horizontal orientation of the anchor or dowel.

DRAINAGE MATERIALS

SECTION 941

CONCRETE PIPE

(For Culvert and Underdrains)

941-1 Concrete Culvert Pipe (Round).

941-1.1 General Specifications: Round concrete culvert pipe shall meet the requirements of ASTM C 76 [ASTM C 76M], except as modified herein, and shall conform to the specific requirements of this Section.

941-1.2 Specific Requirements:

Concrete Pipe shall meet the design requirements of the class of pipe called for in the plans. Pipe design shall be based upon requirements set forth in ASTM C 76 [ASTM C 76M] or Special Designs which meet the requirements of ASTM C 655 [ASTM C 655M]. For pipe designated as Class S, the pipe design will meet the requirements for ASTM C 655 [ASTM C 655M] and the 0.01 inch [0.3 mm] crack and ultimate D-loads given on the Roadway and Traffic Design Standards, Index Number 205.

The process of manufacture and the details of the pipe design, including strength of the concrete, will comply with the Standard Operating Procedure for the Inspection of Precast Drainage Products.

At the Contractor=s option, non-reinforced pipe up to and including 36 inches [900 mm] in diameter, may be used in place of reinforced concrete pipe designated Class S, Class I, Class II, Class III, and Class IV. Non-reinforced pipe shall meet the requirements of ASTM C 985 and the ultimated D-loads given on the Roadway and Traffic Design Standards, Index Number 205. Such pipe shall be properly marked.

941-1.3 Modifications to ASTM C 76 [ASTM C 76M]: The following shall supersede the provisions of ASTM C 76 [ASTM C 76M]:

(a) The materials used in concrete must be certified from the source and shall conform to the following:

(1) Portland Cement..Section 921
(2) Fine Aggregate...Section 902
(3) Coarse Aggregate..Section 901
(4) Water...Section 923
(5) Admixtures...ASTM C 494
(6) Fly Ash..Section 929
(7) Blended Hydraulic Cements.............................AASHTO M 240

The gradation requirements for concrete aggregates as set forth in Sections 901 and 902 shall not apply.

(b) All Joint Reinforcement shall be according to the Department's Roadway and Traffic Design Standards.

(c) When membrane curing compounds are used, they shall meet the requirements of 925-2. The compounds shall be applied according to 400-16. The curing compound shall be applied immediately after the pipe has been removed from the form.

(d) Each manufacturer of the pipe shall provide a suitable apparatus for testing his product in accordance with FM 3-C 497. Upon the request of the Engineer and under his supervision, the manufacturer shall perform tests outlined in FM 3-C 497 as the Engineer may deem necessary in order to establish the quality of the product as required by these specifications. No payment or allowance will be made to the manufacturer for such equipment, for expenses in testing, or for the pipe broken.

(e) Variation of laying lengths of two opposite sides of pipe shall not be more than 1.04% of the diameter, with a maximum of 2 inch [13 mm] in any length of pipe, except where beveled-end pipe for laying on curves is specified.

(f) All marking on precast pipe shall include the type of wall.

(g) All repairs shall be in accordance with 941-1.5.3.

941-1.4 Specific Causes for Rejection of Pipe: Specific causes for rejection of concrete pipe, in addition to any failure to meet the general requirements specified above, are as follows:

(a) Failure to meet the requirements listed in ASTM C 76 [ASTM C 76M] for permissible variations in dimensions with the exceptions outlined in 941-1.3 above.

(b) Occurrence of defects listed in ASTM C 76 [ASTM C 76M].

941-1.5 Special Requirements for Pipe Joints when Round Rubber Gaskets are to be Used:

941-1.5.1 General: When round rubber gaskets are to be installed in the pipe joint, the gasket shall be the sole element relied on to maintain a tight joint. These Specifications shall be used in conjunction with the Roadway and Traffic Design Standards outlining other requirements for this type of construction.

941-1.5.2 Design of Joint: The joint shall be of the bell-and-spigot type or the double spigot and sleeve type, meeting the requirements called for on the Roadway and Traffic Design Standards, which includes such details. The joint shall be so proportioned that the spigot, or spigots, shall readily enter the bell or sleeve of the pipe.

The joint ring forms for forming the joint surface shall be of heavy steel, cast iron, or aluminum, and shall be accurately machined to the dimensions of the joint. They shall be a true circular form within a tolerance of 1/32 inch [1 mm]. Dimensional checks of joint ring form shall indicate for each size pipe a length of spigot, or tongue, not more than χ inch [3 mm] shorter than the bell, or groove, depth. The pipe shall be so manufactured that joint surfaces are concentric with the inside of the pipe within a tolerance of 3/32 inch [2.5 mm]. The shape and dimensions of the joint shall be such as to provide compliance with the following requirements:

(a) The joint shall be so dimensioned that when the gasket to be used is placed on the spigot it will not be stretched more than 20% of its original length.

(b) The space provided for the gasket shall be a groove in the spigot end of the pipe and such space, when the joint is made, shall not be more than 110% of the volume of the gasket.

(c) The joint shall be designed so that when the outer surface of the spigot and the inner surface of the bell come into contact at some point on the periphery, the diametric deformation in the gasket at the point of contact shall not be greater than 50% of the normal gasket diameter, and the diametric deformation in the gasket at a point opposite the contact point shall not be less than 20% of the normal gasket diameter.

(d) When the pipes are joined, there shall be parallel surfaces on both the bell and the spigot, extending from the edge of the gasket toward the bell face for a distance of not less than : inch [19 mm]. These parallel surfaces shall in no case be farther apart than χ inch [3 mm] when the spigot is centered in the bell. The tapers on these surfaces shall not exceed three degrees.

(e) The inside surface of the bell at the end of the bell shall be flared to facilitate joining the pipe sections without damaging or displacing the gasket.

941-1.5.3 Tolerances in Imperfections, and Permissible Repairs: The entire surfaces of near-contact of the jointed pipes shall be free from air holes, chipped or spalled concrete, laitance, and other such defects.

Pipes showing minor manufacturing imperfections or handling injuries to the bell or spigot may be acceptable if such defects can be, and are, acceptably repaired as prescribed below.

Individual air holes (trapped air), or spalled areas with a length of up to one-half the pipe radius, or 12 inches [300 mm] whichever is less, may be repaired by careful use of a hand-placed, stiff, pre-shrunk, 1-to-1 mortar of cement and fine sand, and with no additional preparation other than a thorough washing with water of the defect. Curing shall be done either by moisture curing under wet burlap or by application of an approved membrane curing compound. Such repaired pipe which is sound, properly finished and cured, and which otherwise conforms to specification requirements will be acceptable.

Exposed reinforcing and minor spalling in the spigot groove may be accepted if repaired in the following manner: The spalled areas will be chipped back to solid concrete. Exposed reinforcing will be cleaned of all laitance and scale. The entire area is to be coated with an approved epoxy at a thickness of 5 to 10 mils [125 to 250 μm]. The coating shall be smooth and conform to the shape of the groove. The epoxy shall be a Type F-1 as specified in Section 926.

941-1.6 Special Requirements for Pipe Joints when Profile Rubber Gaskets are used: When profile rubber gaskets are to be installed in the pipe joints, the gaskets shall be considered to be the sole element relied on to maintain a tight joint. The joint design shall meet the requirements set forth in Article 7 of ASTM C 443.

941-2 Elliptical Concrete Pipe.

Elliptical concrete pipe shall conform with the requirements of ASTM C 507 [ASTM C 507M], except that the exceptions and modifications to ASTM C 76

[ASTM C 76M], as specified in 941-1.3 for round concrete pipe, shall apply also to elliptical pipe, where applicable. Standard elliptical pipe shall meet the requirements of Table I for Class HE-III and special elliptical pipe shall meet the requirements of Table I for Class HE-IV.

When profile rubber gaskets are to be installed in the pipe joints, the gaskets shall be considered to be the sole element relied on to maintain a tight joint. However, a filter fabric jacket shall also be used as specified in 430-7.3. The joint design shall meet the requirements set forth in Article 7 of ASTM C 443 [ASTM C 443M].

941-3 Concrete Underdrain Pipe.

Concrete pipe for underdrains shall be perforated, and shall meet the requirements of ASTM C 444 [ASTM C 444M], with the following modifications:

(a) Strength of Finished Pipe: Underdrain pipe will not be required to be reinforced, and will not be tested for strength of the finished pipe. Approval of the strength of the finished pipe will be based on visual inspection and check.

(b) Perforations: The perforations shall be molded into the pipe at the time of fabrication, and any undue chips, fractures, etc., incurred thereby, either in the interior of the pipe or on the periphery, which are sufficient to significantly impair the strength or efficiency, will be cause for rejection of the pipe.

The perforations shall be circular, and of the diameter called for below, with a tolerance of ∀1/16 inch [∀2 mm]. In all pipe included in any single order, or for any single installation operation, such diameter shall be reasonably uniform.

SCHEDULE OF PERFORATIONS FOR CONCRETE UNDERDRAIN PIPE				
Internal Diameter of Pipe	Diameter of Perforations *(Design)	No. of Rows	**Approximate Rows between Rows	**Spacing within Rows
6 inches [150 mm]	δ inch [10 mm]	4	4 inches [100 mm]	5-6 inches [125-150 mm]
6 inches [150 mm]	3 inch [6 mm]	4	4 inches [100 mm]	4-5 inches [100-125 mm]
8 inches [200 mm]	δ inch [10 mm]	4	5 inches [125 mm]	5-6 inches [125-150 mm]
8 inches [200 mm]	3 inch [6 mm]	4	5 inches [125 mm]	4-5 inches [100-125 mm]

*1/16 inch [2 mm] fabrication tolerance, over and under.

**Perforations to be staggered in alternate rows. The spacing between rows shall be uniform.

SECTION 942

PIPE GASKETS

942-1 Round Rubber Gaskets for Pipe Joints.

Except where O-ring type gaskets are specified for special cases and for special type pipe, round rubber gaskets for use in concrete pipe joints shall meet the requirements of Article 6.9 of ASTM C 361 [ASTM C 361M], with the additional requirements that the gasket used shall be of such cross sectional area and perimeter as to properly fit the space provided in the pipe joint in which it is to be used.

Prior to use, the gasket shall be stored in as cool a place as practicable.

942-2 Cold Adhesive Preformed Plastic Gaskets (For Sealing Elliptical Concrete Pipe Joints).

942-2.1 General: Cold adhesive preformed plastic gaskets shall be of a material, shape and size so as to effect a permanent water tight seal in joints of elliptical concrete pipe. A minimum of two pieces of gasket material shall be used in each joint.

The gasket material shall be protected by a 2-piece removable wrapper. To facilitate application, the 2-piece wrapper shall be so designed that one-half may be removed longitudinally without disturbing the other half.

The size of the gasket shall be in accordance with the manufacturer's recommendation for the particular joint in which it is to be used. However, the minimum size for each of the gaskets used in a joint shall be in accordance with the following:

NON SI UNITS

Pipe Size (Inches)	Nominal Gasket Size (Inches)	Minimum Cross-Section (In^2)
Up to 19 by 30	12	1.75
19 by 30 to 53 by 83	1:	2.5
Over 53 by 83	2	3.25

SI UNITS

Pipe Size (mm)	Nominal Gasket Size (mm)	Minimum Cross-Section (mm^2)
Up to 490 by 770	38	1,130
490 by 770 to 1,340 by 2,110	45	1,615
Over 1,340 by 2,110	50	2,095

The above minimum size requirements are based on a joint designed with a maximum taper of ten degrees and an in-place annular space of approximately

3 inch [6 mm].

942-2.2 Composition: The gasket sealing the joints shall be produced from blends of refined hydrocarbon resins and plasticizing compounds reinforced with inert mineral filler. The material shall contain no solvents and shall not produce irritating fumes or obnoxious odors. The gasket shall not depend on oxidizing, evaporation or chemical action for its adhesive or cohesive strength.

The chemical composition of the gasket material shall meet the following requirements:

	Minimum	Maximum
Bitumen (petroleum plastic content) (% by weight)	50	70
Ash-Inert Mineral Matter (% by weight)	30	50
Volatile Matter (@ 325E F [163EC)] (% by weight)		2.0

The gasket joint sealing compound when immersed for 30 days at ambient room temperature separately in 5% solution of caustic potash, a mixture of 5% hydrochloric acid, a 5% solution of sulfuric acid, and a saturated hydrogen sulfide solution shall show no visible deterioration.

The physical properties of the gasket joint sealing compound as shipped shall meet the following requirements:

	Minimum	Maximum
Specific Gravity @ 77EF [25EC]	1.2	1.35
Ductility @ 77EF [25EC]	50 mm	
Softening Point @ 77EF [25EC]	320EF [160EC]	
Penetration (0.1 mm) 77EF [25EC] @ (150 gms [150 g]) five seconds	50	120

942-2.3 Certification: The manufacturer of the gasket material shall furnish the Engineer certified test results covering each shipment of material to each project.

942-3 Resilient Connectors for Sealing Precast Structures to Pipe Joints.

942-3.1 General: Resilient connectors shall meet the requirements of ASTM C 923 [ASTM C 923M] with the modification that a hydrostatic pressure test up to 6.0 psi [40 kPa] without leakage will suffice. The connectors shall also be compatible with the precast structure and pipe.

942-3.2 Certification Requirements: The Contractor shall provide three certified copies of test reports and certification from the manufacturer that the material furnished meets all requirements of ASTM C 923 [ASTM C 923M] with the modification that a hydrostatic pressure test up to 6.0 psi [40 kPa] without leakage will suffice. Certifications shall be sent directly to the State Materials

Engineer at Gainesville.

942-3.3 Qualified Products List (QPL): The resilient connector used shall be a product included on the Qualified Products List.

942-4 Profile Rubber Gaskets for Concrete Pipe Joints.

(a) Round Pipe: The gaskets shall meet the requirements specified in Article 6.9 of ASTM C 361.

(b) Elliptical Pipe: The gaskets shall meet the requirements specified in Article 6.1.1 of ASTM C 443.

Additionally, the gaskets used shall be of such cross sectional area and perimeter as to properly fit the space provided in the pipe joint in which it is to be used.

The gaskets shall be stored in as cool a place as practicable prior to use.

SECTION 943

CORRUGATED STEEL PIPE AND PIPE ARCH

(Including Underdrain)

943-1 General Requirements.

Corrugated steel pipe, including round culvert pipe, pipe arch and underdrain and coupling bands for each type shall conform to AASHTO M 36 [AASHTO M 36M].

In addition, except for underdrain corrugated steel pipe including pipe arch shall be fabricated with helical corrugations with a minimum of two annular corrugations formed on each end of each pipe to accommodate a coupling band. Annular fabrication is not permitted unless specifically called for in the plans or specifications.

943-2 Round Culvert Pipe.

For round culvert pipe used as sidedrain, unless shown otherwise in the plans the minimum thickness of the metal (including galvanizing - AASHTO M 218, or aluminum coating - AASHTO M 274), shall be as specified below.

NON SI UNITS

TABLE I
THICKNESS OF METAL FOR SIDEDRAIN PIPE

Nominal Diameter (Inches)	Metal Sheet Gauge No.	Mean Thickness Metal (Inches)
6	18	0.0516
8	16	0.0635
10	16	0.0635
12	16	0.0635

NON SI UNITS

TABLE I

THICKNESS OF METAL FOR SIDEDRAIN PIPE

Nominal Diameter (Inches)	Metal Sheet Gauge No.	Mean Thickness Metal (Inches)
15	16	0.0635
18	16	0.0635
21	16	0.0635
24	16	0.0635
30	14	0.0785
36	14	0.0785
42	12	0.1084
48	12	0.1084
54	12	0.1084
60	10	0.1382
66	10	0.1382
72	10	0.1382
78	8	0.1681
84	8	0.1681
90	8	0.1681
96 and over	8	0.1681

SI UNITS

TABLE I

THICKNESS OF METAL FOR SIDEDRAIN PIPE

Nominal Diameter (mm)	Mean Thickness Metal (mm)
150	1.32
200	1.63
250	1.63
300	1.63
375	1.63
450	1.63
525	1.63
600	1.63
750	2.01

SI UNITS

TABLE I

THICKNESS OF METAL FOR SIDEDRAIN PIPE

Nominal Diameter (mm)	Mean Thickness Metal (mm)
900	2.01
1,050	2.77
1,200	2.77
1,350	2.77
1,500	3.51
1,650	3.51
1,800	3.51
1,950	4.27
2,100	4.27
2,250	4.27
2,400 and over	4.27

NON SI UNITS

TABLE II

PERMISSIBLE VARIATION IN THICKNESS OF METAL FOR PIPE AND CONNECTING BANDS

Metal Sheet Gauge No	Mean Thickness of Metal (Inches)	Permissible Variation (Inches)
18	0.0516	0.007
16	0.0635	0.007
14	0.0785	0.008
12	0.1084	0.009
10	0.1382	0.009
8	0.1681	0.009

SI UNITS

TABLE II

PERMISSIBLE VARIATION IN THICKNESS OF METAL FOR PIPE AND CONNECTING BANDS

Mean Thickness of Metal (mm)	Permissible Variation (mm)
1.32	0.18

1.63	0.18
2.01	0.20
2.77	0.23
3.51	0.23
4.27	0.23

943-3 Pipe Arch.

For corrugated metal pipe arch, in addition to the requirements shown in AASHTO M 36 [AASHTO M 36M], thickness of the metal shall be as shown for the equivalent size round pipe in Tables I and II, above, and the fabrication of the pipe arch sections shall be such as to insure a substantially flat invert.

943-4 Alternate Connecting Bands.

In addition to the connecting bands as specified in AASHTO M 36 [AASHTO M 36M], alternate types of connecting bands are specified in 430-8.1.3, for use with the types of installations as shown.

943-5 Bituminous Coating and Paved Invert.

When bituminous coating is specified, the pipe, or pipe arch, shall be coated in accordance with the requirements of AASHTO M 190, for Type A (Fully Bituminous Coated).

When bituminous coated and paved invert are specified the pipe or pipe arch shall be coated and paved in accordance with AASHTO M 190, for Type C (Fully Bituminous Coated and Paved). The temperature of the asphalt at the time of coating and the duration of the pipe submerged time shall be optimized such that excess coating does not adhere to the pipe. Excess coating is deemed to exist when generalized plugging is present on 50% or more of the pipe circumference.

943-6 Paved Interior.

When bituminous coated and paved interior are called for, the coating and paving shall meet the requirements specified above for bituminous and paved invert (Type C), with the following additions and exceptions:

(a) The smooth pavement formed by the asphalt cement shall extend over the entire interior of the pipe.

(b) The exterior coating and the interior paving shall be applied.

(c) No markings will be required on the outside of the pipe to designate the center line of the top of the pipe.

(d) Lifting lugs shall be attached to the pipe, and shall be suitably placed to facilitate moving the pipe without damage to the exterior or interior bituminous material.

943-7 Basis of Acceptance of Bituminous Coating and Paving.

The acceptance of the bituminous coating, paved invert, and paved interior will be based on the manufacturer's certified mill tests.

943-8 Underdrain Pipe.

Corrugated metal pipe for underdrain shall conform to the requirements of AASHTO M 36 [AASHTO M 36M] except that Class IV pipe, as specified in Article 18.1.1.4 therein, shall not be used.

SECTION 944

STRUCTURAL PLATE STEEL PIPE AND PIPE ARCH

944-1 Description.

This Section covers the materials for corrugated galvanized steel structural plate pipe and pipe arch, including the necessary bolts and nuts for connecting plates and for assembling the pipe or pipe arch at the point of destination when so specified. The sizes of the pipe or pipe arch shall be as shown in the plans.

944-2 Materials.

Structural plate pipe and pipe arch shall be of galvanized steel, complying with the requirements of AASHTO M 167 [AASHTO M 167M], with the additional requirement that the minimum thickness of the plates shall be as shown in the plans.

944-3 Tolerance in Span and Height.

A tolerance of ∀4%, will be allowed in the specified span and height of pipe arches. A tolerance of -2 to +4 inches [-50 to +100 mm] will be allowed in the specified diameter of round pipe.

944-4 Bituminous Coating.

When bituminous coating is specified, all plates shall be fully coated on both sides with asphalt cement. The bituminous coating shall conform to the requirements of AASHTO M 190, for Type A.

944-5 Mill Analysis and Guarantee.

Six certified copies of Mill Analysis and Guarantee shall be furnished to the Engineer, and acceptance of the pipe will be based on such reports.

944-6 Assembly Diagrams.

Diagrams for assembling shall be furnished unless the pipe or pipe arch is furnished completely assembled.

944-7 Fabrication.

The fabrication of the pipe and pipe arch shall comply with the applicable requirements of Section 23, Division II, of AASHTO's Standard Specifications for Highway Bridges. Unless otherwise specified, the pipe and pipe arch shall be of full section for the entire length.

944-8 Assembly.

When purchase contracts stipulate that the pipe be assembled, the dealer shall furnish the pipe and pipe arch completely assembled at the point of destination, or at the site, as specified, and in lengths as specified.

944-9 Direct Purchases by the Department.

When the Department purchases the pipe or pipe arch direct from the dealer, the quantity to be paid for shall be the number of feet [meters] of pipe and of pipe arch, as ordered, provided that sufficient materials meeting the requirements of these specifications shall be furnished to construct the pipe and pipe arch of the length and sizes shown.

The quantity shall be the net length as ordered, with no allowance for length in excess thereof.

The price per foot [meter] for direct purchases shall be full compensation for furnishing the complete materials for the pipe or pipe arch, including all bolts and nuts required for connecting the plates. When assembling of the pipe or pipe arch is specified, such price shall also include all labor, equipment, tools and incidentals required for completely assembling the pipe or pipe arch.

SECTION 945

ALUMINUM PIPE, INCLUDING UNDERDRAIN, PIPE ARCH AND STRUCTURAL PLATE PIPE AND PIPE ARCH

945-1 Corrugated Aluminum-Alloy Culverts and Underdrains.

Aluminum-alloy culvert pipe and underdrains shall meet the requirements of AASHTO M 196 [AASHTO M 196M] and with the additional provisions contained herein. Except for underdrain, corrugated aluminum pipe including pipe arch shall be fabricated with helical corrugations with a minimum of two annular corrugations formed into each end of each pipe to accommodate a coupling band. Annular fabrication is not permitted unless specifically called for in the plans or specifications.

For Sidedrains, unless shown otherwise in the plans the minimum thickness of the metal shall be as specified below.

NON SI UNITS

TABLE I
THICKNESS OF METAL FOR SIDEDRAIN PIPE

Nominal Diameter or Equivalent (inches)	Sheet Gauge No.	Mean Thickness of Metal (inches)
6	18	0.048
8	16	0.060

NON SI UNITS

TABLE I

THICKNESS OF METAL FOR SIDEDRAIN PIPE

Nominal Diameter or Equivalent (inches)	Sheet Gauge No.	Mean Thickness of Metal (inches)
10	16	0.060
12	16	0.060
15	16	0.060
18	16	0.060
21	16	0.060
24	16	0.060
30	14	0.075
36	14	0.075
42	12	0.105
48	12	0.105
54	12	0.105
60	10	0.135
66	10	0.135
72 and over	8	0.164

SI UNITS

TABLE I

THICKNESS OF METAL FOR SIDEDRAIN PIPE

Nominal Diameter or Equivalent (mm)	Mean Thickness of Metal (mm)
150	1.22
200	1.52
250	1.52
300	1.52
375	1.52
450	1.52
525	1.52
600	1.52
750	1.91
900	1.91
1,050	2.67

SI UNITS

TABLE I

THICKNESS OF METAL FOR SIDEDRAIN PIPE

Nominal Diameter or Equivalent (mm)	Mean Thickness of Metal (mm)
1,200	2.67
1,350	2.67
1,500	3.43
1,650	3.43
1,800 and over	4.17

Where bituminous coated aluminum pipe is specified the bituminous coating shall meet the requirements as specified for corrugated steel pipe in 943-5. Bituminous coated and paved aluminum pipe shall meet the additional requirements specified in 943-6 and 943-7, as applicable.

Class IV pipe shall not be used.

945-2 Aluminum Alloy Structural Plate Pipe, Pipe Arch and Arches.

945-2.1 General Requirements: Aluminum alloy structural plate pipe, pipe arch, and arches shall conform to AASHTO M 219 [AASHTO M 219M], with the exceptions and additions specified herein. The nominal thickness of the plate shall be as shown in the plans.

945-2.2 Bolts and Nuts: In lieu of shaped bolts and nuts, standard type bolts and nuts, with special shaped washers, may be used. For aluminum bolts and nuts the material shall conform to the chemical requirements shown in Table I of ASTM B 211 [ASTM B 211M], for Alloy 6061. Nuts shall be lubricated at the factory, with a suitable wax compound. The bolts may be sampled and tested before erection or may be accepted on the basis of the manufacturer's certification.

For steel bolts and nuts, the material shall meet the requirements of either ASTM A 307 or ASTM A 325 [ASTM A 325M], as appropriate, and shall be hot double-dipped galvanized.

Aluminized steel bolts, or other equally suitable devices for connecting the plates, may be used if approved by the Engineer.

945-2.3 Certification of Tests: For all aluminum materials, test certifications as specified in 965-2, shall be furnished.

945-2.4 Direct Purchases by the Department: The provisions of 944-9, for the conditions of direct purchase of structural plate steel pipe and pipe arches, shall also apply to Departmental purchases of aluminum alloy structural plate pipe, pipe arches and arches.

SECTION 946

CAST IRON PIPE

946-1 Cast Iron Culvert Pipe.

Cast iron culvert pipe of diameter 12 inches [300 mm] and over shall conform with the requirements of AASHTO M 64, (including the requirements for the coating as specified in Article 7.1 of AASHTO M 64). Cast iron culvert pipe smaller than 12 inches [300 mm] in diameter shall meet ANSI Standard A21.51 and the joints shall meet ANSI Standard A21.11.

Unless a particular type or class of pipe is designated in the plans the Contractor may furnish any class included in the above specifications. Only one class or type shall be furnished for any one Contract. The pipe shall be smooth bore pipe.

946-2 Cast Iron Soil Pipe.

Cast iron soil pipe, for roof drains or for other purposes where such pipe is designated, shall meet the requirements of either of the following:

(1) ASTM A 74, for service-type pipe.

(2) The building code of the municipality or other governmental authority having jurisdiction within the area of the installation.

SECTION 947

CLAY PIPE

947-1 Clay Pipe Other than for Underdrain.

Clay pipe for use other than as underdrain shall meet the requirements of AASHTO M 65.

947-2 Clay Pipe for Underdrains.

Clay pipe for underdrains shall be perforated and shall be of first quality, hub and spigot style, vitrified clay. It shall be sound, and without warps, cracks or other imperfections. The pipe shall be thoroughly and perfectly burned and shall be fully and smooth salt-glazed. The pipe shall be sufficiently tough that it may be cut with a chisel and hammer to a reasonably uniform cleavage.

This pipe shall be furnished in uniform lengths for any order of pipe or for any particular installation operation, with a minimum length of 2 feet [600 mm].

The perforations shall meet the requirements for dimensions, size, location, etc. as specified in AASHTO M 65.

SECTION 948

MISCELLANEOUS TYPES OF PIPE

948-1 Polyvinyl-Chloride Pipe, or Acrylonitrite-Butadiene-Styrene Plastics Pipe.

948-1.1 For Bridge Drains: Polyvinyl-chloride pipe, for use in bridge drains which will be exposed shall conform to the requirements of ASTM D 1785, for Type II, Grade 1, Schedule 40 PVC pipe. For the portion of bridge drains encased in concrete, the pipe may be as specified in 948-1.4.

948-1.2 Pressure Pipe: Pressure pipe for direct burial under pavement shall conform to the requirements of ASTM D 1785, for Type I, Grade I, Schedule 40, for sizes up to and including 22 inches [60 mm], and Schedule 80 for sizes up to 4 inches [100 mm]. Pressure pipe 4 inches [100 mm] in diameter and larger shall conform to the requirements of AWWA C900-75, DR18, and ASTM D 1785, Type I, Grade I or other types as may be specifically called for in the plans or special provisions.

948-1.3 Pipe Marking: All polyvinyl-chloride pipe shall be marked as required by Article 8 of ASTM D 1785, and acceptance of the pipe may be based on this data.

948-1.4 Nonpressure Pipe: Polyvinyl-chloride pipe and Acrylonitrite-butadiene-styrene pipe, intended for direct-burial or concrete encasement, shall meet the following requirements:

(a) PVC Pipe: ASTM D 3034, SDR-35, or ASTM F 949, profile wall without perforations.

(b) ABS Pipe: ASTM D 2680.

The manufacturer of the PVC or ABS pipe shall furnish to the Engineer six copies of mill analysis covering chemical and physical test results.

948-1.5 Underdrain: Polyvinyl-chloride pipe for use as underdrain shall conform to the requirements of ASTM F 758 or ASTM F 949. Also, PVC underdrain manufactured from PVC pipe meeting ASTM D 3034, perforated in accordance with the perforation requirements given in AASHTO M 36 or AASHTO M 196 will be permitted.

948-1.6 Edgedrain: Polyvinyl-chloride pipe for use as edgedrain shall conform to the requirements of ASTM F 758, ASTM F 949 or ASTM D 3034 pipe shall be perforated in accordance with the perforation requirements given in AASHTO M 36 or AASHTO M 196. Additional perforations will be required as indicated in the Roadway and Traffic Design Standards, Index No. 286 for pipes designated under ASTM F 758 and ASTM D 3034. Polyvinyl chloride pipe intended for direct burial in asphalt shall meet the following requirements:

(a) ASTM D 3034, SDR-35, or ASTM F 949

(b) NEMA TC-2 (pipe material and compounds) and NEMA TC-3 (pipe fittings) for PVC (90E C electrical conduit pipe) NEMA ECP-40 and NEMA ECP-80. Underwriter Laboratory Specifications referenced under NEMA specifications for electrical conductivity are not required.

(c) Pipe shall withstand asphalt placement temperatures specified without permanent deformation.

(d) Perforations shall be in accordance with AASHTO M 36M or AASHTO M 196M.

948-1.7 Polyvinyl Chloride (PVC) Pipe (12 to 48 Inches [300 to 1,200 mm]): Polyvinyl Chloride (PVC) Pipe for side drain, cross drain, storm drain and other specified applications shall conform to AASHTO M 278 having a minimum cell classification of 12454C or 12364C as specified in ASTM D 1784 for smooth wall PVC pipe, or AASHTO M 304 having a minimum cell classification of 12454C or 12364C for PVC ribbed pipe. For side drain and cross drain applications, mitered end sections as indicated in the Roadway and Traffic Design Standards, Indexes 272 and 273 requires fabrication from another approved culvert material.

948-2 Corrugated Polyethylene Tubing and Pipe.

948-2.1 General: For underdrain, Corrugated Polyethylene Tubing and fittings shall meet the requirements of AASHTO M 252. For edgedrain, Corrugated Polyethylene Tubing and fittings shall meet the requirements of AASHTO M 252, except as modified in 948-2.2. For storm drain side drain, french drain and cross drain. Corrugated Polyethylene Pipe shall meet the requirements of AASHTO M 294 and the additional provisions specified in 948-2.3.

The tubing or pipe shall not be left exposed to sunlight for periods exceeding the manufacturer's recommendation.

948-2.2 Edgedrain (4 to 10 inches [100 to 250 mm]): The requirements for Edgedrain as specified in AASHTO M 252 are modified as follows:

(a) Coiling of tubing 6 inches [150 mm] in diameter or greater is not permitted. Tubing shall have a minimum pipe stiffness of 46 psi [275 kPa] at 5% deflection.

948-2.3 Corrugated Polyethylene Pipe (12 to 40 inches [300 to 1,200 mm]): Corrugated Polyethylene Pipe for side drain, cross drain, storm drain and other specified applications shall conform to AASHTO M 294 with the following exception: corrugations may only be annular. Pipe shall also conform to the minimum cell classification 335420C as specified in ASTM D 3350. For side drain and cross drain applications, mitered end sections as indicated in the Roadway and Traffic Design Standards, Indexes 272 and 273 requires fabrication from another approved culvert material.

948-3 Filter Fabric Sock for Use with Underdrain.

For Type I Underdrain specified in the Roadway and Traffic Design Standard Index 286, filter sock shall be an approved strong rough porous, polyester or other approved knitted fabric which completely covers and is secured to the perforated plastic tubing underdrain in such a way as to prevent infiltration of trench backfill material.

The knitted fabric sock shall be a continuous one piece material that fits over the tubing like a sleeve. It shall be knitted of continuous 150 denier yarn and shall be free from any chemical treatment or coating that might significantly reduce porosity and permeability.

The knitted fabric sock shall comply with the following physical properties:

Weight, applied (oz./sq. yd.)	3.5 min	ASTM D 3887
Grab tensile strength (lbs.)	50 min.*	ASTM D 5034
Equivalent opening size (EOS No.)	25 min.**	Corps of Engineers CW-02215-77
Burst strength (psi)	100 min.**	ASTM D 3887

*Tested wet.
**Manufacturer's certification to meet test requirement.

The knitted fabric sock shall be applied to the tubing in the shop so as to maintain a uniform applied weight. The tubing with knitted fabric sock shall be delivered to the job site in such manner as to facilitate handling and incorporation into the work without damage. The knitted fabric sock shall be stored in UV-resistant bags until just prior to installation. Torn or punctured knitted fabric sock shall not be used.

SECTION 949

BRICK AND CONCRETE MASONRY UNITS FOR

MANHOLES, INLETS AND OTHER STRUCTURES

949-1 Clay Brick and Shale Brick.

This brick shall meet the requirements of AASHTO M 114, for Grade MW.

949-2 Concrete Brick.

Concrete brick shall meet the requirements of ASTM C 55 for Grade S-II.

949-3 Concrete Masonry Units.

Concrete masonry units for use in manholes, inlets and similar structures shall meet the requirements of ASTM C 139.

When the masonry units are produced by a manufacturer exercising quality control procedures acceptable to the Department, such units may be accepted on the basis of six test certificates furnished to the Department. Such certificates shall be signed by an authorized agent of the manufacturer, and identified by project number.

TIMBER PRODUCTS AND MATERIALS

SECTION 951

INSPECTION OF TIMBER PRODUCTS

951-1 Control of Quality.

All timber products manufactured for incorporation into the work shall be produced by a producer/treater approved by the Department for such production. If approval is withdrawn by the Department during production for a construction project, it is the Contractor's responsibility to (a) obtain another approved producer/treater to produce the timber products, or (b) await reestablishment of approval of the disapproved producer/treater. Cost or delays associated with producer/treater approval or disapproval shall be borne by the Contractor.

The producer/treater of timber products shall exercise quality control through an approved Quality Control Plan conforming with the Procedure for the Inspection of Timber Products. Products produced under this Quality Control Plan will not relieve the Contractor of his responsibility for unsuitable materials or workmanship, which might become apparent at the job site, nor of the necessity of his replacing any material which might be determined upon subsequent inspection to be unsuitable.

951-2 Preparations Prior to Requesting Inspection.

Prior to the requested time of inspection for approval of a producer/treater, the authorities of the treating plant shall become knowledgeable with the most current requirements of the Department's Specifications as appropriate to his production/treatment. The producer/treater shall make his facility totally accessible to appropriate Department's inspection personnel. Such access for inspection shall include, but not be limited to, all physical artifacts and processes, materials records and copies of certified shipping documents (such as a treatment certification, a treating report, and an assay report). All calls for inspections shall be made at least two weeks in advance.

Upon approval of a producer/treater facility, the Department will inspect the facility periodically for continued approval.

951-3 Certification.

Each order/shipment to the job site must be accompanied with a notarized certification indicating compliance to the appropriate specifications. The certification shall include: the project/order number, charge numbers, and assay retention results. The producer/treater shall maintain all pertinent documents for a period of three years. Each timber product must also have a preapproved producer/treater identification mark on every item delivered to the job site.

SECTION 952

STRUCTURAL TIMBER

952-1 General Specifications for All Structural Timber.

This Section specifies the requirements for pine timber to be used as structural members in the Department's work, including untreated timber as well as timber to be treated. All such timber shall be manufactured and graded in accordance with the current edition of the Standard Grading Rules for Southern Pine Timber, of the Southern Pine Inspection Bureau The requirements of No. 1 dense shall apply to this timber.

952-2 Timber for Other Specific Uses.

952-2.1 Specification Grade: For timber to be used for columns, sills, wheelguards, bulkhead, sheeting, bracing, fender wales, or any other purpose for which the grade is not specified otherwise, the specification grade shall be as follows:

Nominal Thickness	Nominal Width	Grade
1 to 1.5 inches [25 to 38 mm]	2 inches [51 mm] and wider	No. 1 Boards
2 to 4 inches [51 to 102 mm]	2 inches [51 mm] and wider	No. 1 Dimension
5 inches [127 mm] and larger	5 inches [127 mm] and larger	No. 2 Timbers

952-2.2 Permissible Knot Sizes for Fender Wales: For timber used as fender wales, the maximum permissible size of knot (at any point on any face) shall be as follows:

For nominal width of face of 10-3: inches [254-95 mm]
For nominal width of face of 12-42 inches [305-114 mm]

952-3 Untreated Pine Timber - Specific Requirement for Heartwood.

In addition to meeting all of the requirements of 952-1 and 952-2, pine timber which is to be used as untreated timber will be required to show at least 85% of heartwood on any girth.

SECTION 953

TIMBER PILING

(Including Timber Sheet Piling)

953-1 General.

Piles shall be of timber which will stand the driving for which they are intended. They shall be sound and solid. Piling cut from southern pine shall contain at least 30% of summer wood.

Cypress piles used for purposes other than as foundation piling shall have, at the butt, a diameter of red or black heart of at least 12 inches [300 mm].

Douglas fir used for timber piling shall be Pacific Coast Douglas Fir.

Piles shall be cut above the ground swell, shall have a form taper, and shall not vary more than ∀6 inches [∀150 mm] from the specified length.

Specific requirements for timber sheet piles are contained in 953-6, herein.

953-2 Diameter of Butt and Tip.

For round piles the minimum butt diameter shall be 12 inches [300 mm], measured at a section 3 feet [1 m] from the end.

For piles up to 50 feet [15 m] in length the minimum tip diameter shall be 8 inches [200 mm]. For lengths in excess of 50 feet [15 m], a graduated reduction in tip diameter at the rate of 1 inch [25 mm] for each 10 feet [3 m] of length in excess of 50 feet [15 m] will be permitted. This reduction will correspond to 7 inch [175 mm] tips for 60 foot [18 m] piles and 6 inch [150 mm] tips for 70 foot [21 m] pile; at which length these allowable reductions shall cease. As an exception to the above, when so shown in the plans, 7 inch [175 mm] diameter tips on timber piles less than 60 feet [18 m] in length will be accepted. No piles shall have tips less than 6 inches [150 mm] in diameter. The maximum diameter at the cut-offs shall be 20 inches [500 mm].

953-3 Straightness Requirements.

A straight line drawn from the center of the butt to the center of the tip shall not, at any point, fall further away from the center of the pile than a distance equal to 1% of the length of the pile.

The surface of the pile shall not contain kinks greater than 1 inch [25 mm] in 5 feet [1.5 m], as measured by a straightedge.

953-4 Peeling and Trimming.

The pile shall be peeled soon after cutting. In the operation of removing the bark from the pile, not more than three annual rings of the solid wood shall be removed. All knots shall be trimmed close to the body of the pile.

953-5 Permissible Knots and Other Defects.

The diameter of sound knots shall not exceed one-third of the diameter of the pile at the point where the knot occurs.

In these specifications a sound knot shall be defined as a knot which is solid across its face, is as hard as the surrounding wood and shows no indication of decay. It may vary in color from red to black and may contain a pith hole not more than 3 inch [6 mm] in diameter.

An unsound knot may or may not be as hard as the surrounding wood, but contains decay, and will be allowed only in accordance with the restrictions in ASTM D 25.

Any defect, or combination of defects, which would be more injurious than the maximum allowable knot will not be acceptable.

Turpentine cuts will be allowed on all timber piles provided that no single cut shall exceed one-half of the circumference of the pile, and that the length of the cut shall not be more than 15% of the length of the pile. Piles to be used as outside piles in timber bents shall not have more than one turpentine cut.

953-6 Timber Sheet Piles.

Unless a particular species of timber is called for in the plans, timber sheet piles may consist of any species which will satisfactorily stand driving. They shall be sawn with square corners and shall be free from worm holes, loose knots, wind shakes, decayed or unsound portions, and other defects which might impair the strength or tightness.

The piles shall be of the dimensions shown in the plans and shall be treated in accordance with Section 955.

SECTION 954

TIMBER FENCE POSTS AND BRACES

954-1 Types of Timber, and Treating Requirements.

Timber fence posts and braces shall be of southern yellow pine and shall be treated in accordance with Section 955.

Prior to the treatment, all knots on the posts shall be trimmed close to the body of the post.

954-2 Requirements for Cutting.

Round or square posts will be permitted but all posts on a single project shall be the same. The posts shall be cut from sound and solid trees and shall contain no unsound knots. The butt shall be cut at a sufficient distance above the ground swell of the tree that there will be no abrupt change in cross-section of the post.

The butts shall be sawn square. The post tops shall be sawn neatly and at right angles to the vertical axis of the post.

954-3 Knots, etc.

Sound knots will be permitted provided the diameter of the knot does not exceed α of the diameter of the piece at the point where it occurs.

Peck (in cypress posts) shall be limited as provided for knots; the area of permissible peck not exceeding the area occupied by permissible knots, and a combination of peck and knots not exceeding the aggregate of knots allowed.

The posts shall be free from decayed wood, rot, and red heart, and of ring shake or season checks which penetrate at any point more than 3 the diameter of the piece, or are greater than 3 inch [6 mm] wide.

954-4 Peeling.

All posts shall be peeled for their full length, and all inner and outer bark removed, except that isolated strips of inner bark which do not exceed 2 inch [13 mm] in width or 3 inches [75 mm] in length will be permitted.

954-5 Straightness.

The straightness of the post shall be such that for any 8 foot [2.5 m] post (or for any 8 feet [2.5 m] of length, for longer posts) a straight line from the center of the tip to the center of the butt (or from center of the cross sections at the extremes of the 8 foot [2.5 m] lengths) shall not fall outside the center of the mid-section of the 8 foot [2.5 m] length by more than 2 inches [50 mm].

954-6 Dimensions.

954-6.1 Minimum Lengths Allowable:

Line posts - 8 feet [2.5 m].

Corner and pull posts - 8 feet, 6 inches [2.6 m].

Braces - As required by plans.

(A tolerance of -1 inch + 2 inches [25 or +50 mm] will be allowed in the lengths shown for the posts.)

954-6.2 Minimum Allowable Cross Section:

Round line posts - 4 inch [100 mm] diameter.

Round braces, corner and pull posts - 5 inch [125 mm] diameter.

Square line posts - 4 by 4 inches [89 by 89 mm].

Square braces, corner and pull posts - 5 by 5 inches [114 by 114 mm].

The minimum diameters specified for round posts are applicable before preservative treatment. When the treated post is inspected at the job site a tolerance of δ inch [10 mm] under such diameters will be allowed, to compensate for shrinkage resulting from treatment and storage.

SECTION 955

TREATING TIMBER AND PILING

(INCLUDING TREATING MATERIALS)

955-1 General.

The work specified in this Section is the treating of structural timber, timber piling and timber posts. The method of treatment for all such timber materials shall be in accordance with ASTM D 1760, with the exceptions and additions as specified herein.

955-2 Preservative.

The treating of round timber piles (SYP) shall be with chromated copper arsenate (CCA). Ammoniacal copper arsenate (ACA) may be substituted to treat Pacific Coast Douglas Fir if Southern Yellow Pine can not be purchased. All timber posts, braces, structural timber, sheet piles, and all other timber items shall be treated with CCA.

955-3 Process.

For round timber piling, structural timber, sheet piling, posts, braces, and all other timber items, the treatment shall be by the full cell process.

955-4 Requirements for Preservative Materials.

955-4.1 Salt Preservative: The salt preservative shall be chromated copper arsenate of the following compositions:

	Minimum (%)	Maximum (%)
Hexavalent Chromium, as CrO_3	33.0	50.5

	Minimum (%)	Maximum (%)
Copper, as CuO	17.0	22.0
Arsenic, as As_2O_5	30.0	48.0

The active ingredients in the solution shall be in proportions within the range required for the salt itself.

The pH of the treating solution shall be between 1.6 and 3.2.

Tests to determine conformance with the foregoing requirements shall be made in accordance with the standard methods of the American Wood Preservers' Association, Standard A2. Random samples of the preservative will be tested by the Department's Office of Materials and Research.

When Douglas Fir is used, ammoniacal copper arsenate shall be used as the salt preservative in lieu of chromated copper arsenate. Ammoniacal copper arsenate shall meet the requirements of ASTM D 1325. Tests to determine conformance shall be in accordance with AWPA Standard A-2.

955-5 Requirements for Retainment.

955-5.1 Piling: A minimum of 2.50 lb/ft^3 [40.1 kg/m^3] of CCA oxides shall be retained in zone 1, outer 0.50 inch [12.7 mm] and 1.5 lb/ft^3 [24.0 kg/m^3] in zone 2, outer 0.50 to 2 inches [12.7 to 51 mm].

If ACA is used, a minimum of 2.50 lb/ft^3 [40.1 kg/m^3] shall be retained in the 0.0 to 1 inch [0 to 25 mm] zone.

955-5.2 Structural Timber and Sheet Piles: When installation is not in a salt (or brackish) water environment, the minimum retention shall be 0.60 lb/ft^3 [9.6 kg/m^3] of CCA oxides, as determined by cores from the outer 0.60 inch [15.2 mm]. When installation is in a salt (or brackish) water environment, a minimum of 2.50 lb/ft^3 [40.1 kg/m^3] of CCA oxides shall be retained in the outer 0.60 inch [15.2 mm].

All guardrail material (timber posts, blocks, wedges, etc.) shall retain a minimum of 0.40 lb/ft^3 [6.4 kg/m^3] of CCA oxides in the outer 1 inch [25 mm] zone.

955-5.3 Posts: Timber fence posts shall retain a minimum of 0.40 lb/ft^3 [6.4 kg/m^3] of CCA oxides in the outer 1 inch [25 mm] zone.

955-5.4 Determination of Retention: Retention shall be determined by assay performed and certified by the treating company.

955-6 Penetration Requirements.

955-6.1 For Structural Timber and Sheet Piles: For the treatment of structural timber and of sheet piles, Article 5.1 in ASTM D 1760 (headed "Results of Treatment Retention of Preservative") is deleted and replaced by the following: "The preservative shall permeate the sapwood to a depth of 3.5 inches [90 mm], or to 90% of the sapwood thickness; whichever is the greater, with the additional provision that if less than 20% of the number of pieces bored fail to pass such depth requirement, and none of the pieces bored shows less than 85% sapwood penetration, the charge will be considered acceptable.

Where 20% or more of the number of pieces bored fail to meet such requirements for sapwood penetration, or when any of the pieces bored show a sapwood penetration less than 85%, the entire charge will be rejected or shall be retreated."

955-6.2 For Round Piles and Fence Posts: Any round pile or post, which does not show complete sapwood penetration will be rejected or shall be retreated to meet such penetration requirement.

955-6.3 Retreatment: The necessity for retreatment of structural timber, piling and posts shall be avoided as far as practicable and if it becomes apparent that due measures are not being taken to prevent such necessity, the acceptance of retreated materials may be withdrawn.

When retreatment is necessary the maximum limits for temperature of steam or preservative, and for preservative pressure, which apply to the original treatment shall not be exceeded during the retreatment.

955-6.4 Determination of Penetration: Sapwood penetration shall be determined by taking at least one increment boring core from each pile and cap, and other pieces of similar dimensions and, for other sizes of material, at least one boring from the charge for each 1,000 FBM [2 m^3] in the charge. All bored holes shall be immediately plugged, with tight fitting treated plugs.

955-7 Handling Salt Treated Piling.

In handling of piles which have been treated with chromated copper arsenate or ammoniacal copper arsenate, cable slings shall be used. Mechanical grabbers or pointed tools shall not be permitted. Rough or careless handing shall be avoided at all times.

955-8 Identification of Treating Plants for Round Piling.

The treating plant shall brand, or place a distinctive permanent mark, on each round pile, approximately 6 feet [2 m] from the butt end, such that the plant responsible for the treatment can be readily determined at any time during the service life of the piling.

METAL MATERIALS AND FABRICATION DETAILS FOR METAL ITEMS

SECTION 961

PRODUCER'S TEST REPORTS, AND CERTIFICATION

OF COMPLIANCE WITH SPECIFICATIONS

(Structural Metals)

For certain structural metals, the detail specifications require test reports covering chemical and physical tests to be furnished by the Contractor, if so requested. In other cases where it is specified that the metal parts comply with definite chemical or physical specifications, the Contractor shall furnish, if requested (directly to the State Materials Engineer, at Gainesville), six certified copies of test reports covering chemical and physical test results. Each copy must show the full and complete designation of the project for which the materials are intended for use, and specific identification of each item.

SECTION 962

STEEL AND OTHER FERROUS METALS AND METAL ITEMS

962-1 Mill Tests and Analysis Reports.

For structural steel items, including rivets, bolts, etc., the Contractor shall supply the Engineer, if requested, with a certified copy of detailed mill inspection and chemical reports made by a reliable engineering firm capable of making such inspection and report in accordance with these specifications and best practice. Unless otherwise so indicated in the plans, mill inspection will be waived, in which case the Contractor shall furnish the State Materials Engineer, at Gainesville, six certified copies of mill tests and analysis reports of such structural shapes as bear the manufacturer's name and melt number and when such identification does not exist the Engineer may require samples for test purposes to be cut from such material and tests made and reported by a reputable laboratory; all expenses being borne by the Contractor. Each copy of the reports shall show the designation of the project on which the materials are intended to be used. The Contractor will not be required to furnish shop inspection reports. As an exception to the above, at the discretion of the Engineer, mill tests and analysis reports for small orders from fabricators and warehouses may be waived.

When requested by the Inspector, the Contractor shall supply satisfactory scales and shall perform, in the presence of the Inspector, all work involved in handling and weighing any material to be incorporated in the finished structure. If the weight of any member or piece of material is more than 2% less than the computed weight, such shall be cause for rejection.

Certified mill analysis reports furnished the Department by manufacturers of foreign structural steel and steel H piling may be subject to verification by the Department. The cost of such verification whether performed by the Department or a commercial laboratory will be borne by the Contractor.

962-2 Miscellaneous Steel (ASTM Designations).

The Steel items listed below shall conform to the ASTM Designations, as shown.

Structural Carbon Steel
(except where specified otherwise in the plans)ASTM A 36 [ASTM A 36M]
Carbon Steel (for welded construction)........ASTM A 36 [ASTM A 36M]
Low-Alloy Steel ....(as shown in the plans)
Machine Bolts, Nuts and Tap Bolts......................................ASTM A 307
High-Strength Bolts, Nuts and
Hardened Washers ....ASTM A 325 [ASTM A 325M]
Low-Alloy Steel Sheet for Fillers..ASTM A 607, Grade 50 [345], Class 1

In addition to the requirements above, steel items shall conform to the ASTM specifications for the grades of steel designated below as modified.

(1) Grade A36 [250] specification ASTM A 36 [ASTM A 36M].

(a) The second sentence of paragraph 1.2 of ASTM A 36 [ASTM A 36M] is deleted and the following sentence is inserted: "These shall apply only when shown on the plans except that Supplementary Requirement S3 is mandatory for main load carrying components subject to tensile stress."

(b) Paragraph S3 is added to ASTM A 36 [ASTM A 36M] as follows: "The material supplied shall meet the longitudinal Charpy V-notch tests specified in Table A. Sampling and testing procedures shall be in accordance with ASTM A 673 [ASTM A 673M]. The (H) frequency of heat testing shall be used."

TABLE A

Thickness-inches [millimeters]	Group 1-See Footnote
up to 4 inches [100 mm]	15 ft. lb. @ 70EF [20 J @ 21EC]

Footnote:

Group 1: Minimum service temperature 0EF [-18EC] and above.

(2) Grade A 440 specification A 440.

(a) Add new paragraph 1.2 as follows: "Supplemental requirements are provided where improved notch toughness is important. These supplemental requirements S1 are mandatory for main load carrying member components subject to tensile stress."

(b) Add new paragraph S1 as follows: "The material supplied shall meet the longitudinal Charpy V-notch tests specified in Table A. Sampling and testing procedures shall be in accordance with ASTM A 673 [ASTM A 673M]. The (H) frequency of heat testing shall be used."

TABLE A

Thickness-inches [millimeters]	Group 1-See Footnote
up to 4 inches [100 mm]	15 ft. lb. @ 70EF [20 J @ 21EC]
Footnote: Group 1: Minimum service temperature 0EF [-18EC] and above.	

(3) Grade A 441 specification ASTM A 441.

(a) Add new paragraph 1.2 as follows: "Supplemental requirements are provided where improved notch toughness is important. These supplemental requirements S1 are mandatory for main load carrying member components subject to tensile stress."

(b) Add new paragraph S1 as follows: "The material supplied shall meet the longitudinal Charpy V-notch tests specified in Table A. Sampling and testing procedures shall be in accordance with ASTM A 673 [ASTM A 673M]. The (H) frequency of heat testing shall be used."

TABLE A

TABLE A	
Thickness-inches [millimeters]	Group 1-See Footnote
up to 4 inches [100 mm]	15 ft. lb. @ 70EF [20 J @ 21EC
Footnote: Group 1: Minimum service temperature 0EF [-18EC] and above.	

(4) Grade A 242 [242M] specification ASTM A 242 [ASTM A 242M].

(a) Add new paragraph 1.2 as follows: "Supplemental requirements are provided where improved notch toughness is important. These supplemental requirements S1 are mandatory for main load carrying member components subject to tensile stress."

(b) Add new paragraph S1 as follows: "The material supplied shall meet the longitudinal Charpy V-notch tests specified in Table A. Sampling and testing procedures shall be in accordance with ASTM A 673 [ASTM A 673M]. The (H) frequency of heat testing shall be used."

TABLE A	
Thickness-inches [millimeters]	Group 1-See Footnote
up to 4 inches [100 mm]	15 ft. lb. @ 70EF [20 J @ 21EC]
Footnote: Group 1: Minimum service temperature 0EF [-18EC] and above.	

(5) Grade A 588 [588M] specification ASTM A 588 [ASTM A 588M].

(a) Add new paragraph 1.2 as follows: "Supplemental requirements are provided where improved notch toughness is important. The supplemental requirements S1 are mandatory for main load carrying member components subject to tensile stress."

(b) Add new paragraph S1 as follows: "The material supplied shall meet the longitudinal Charpy V-notch tests specified in Table A. Sampling and testing procedures shall be in accordance with ASTM A 673 [ASTM A 673M]. The (H) frequency of heat testing shall be used."

TABLE A*	
Thickness-inches [millimeters]	Group 1-See Footnote
up to 4 inches [100 mm] mechanically fastened	15 ft. lb. @ 70EF [20 J @ 21EC]
up to 2 inches [50 mm] welded	15 ft. lb. @ 70EF [20 J @ 21EC]
over 2 to 4 inches [50 to 100 mm] welded	20 ft. lb. @ 70EF [27 J @ 21EC]
Footnote: Group 1: Minimum service temperature 0EF [-18EC] and above.	
*If the yield point of the material exceeds 65 ksi [450 MPa], the temperature for the CVN value for acceptability shall be reduced by 15EF [8EC] for each increment of 10 above 65 ksi [70 above 450 MPa]	

(6) Grade A 572 [572M] specification ASTM A 572 [ASTM A 572M].

(a) Delete existing paragraph 1.2. Add new paragraph 1.2 as follows: "Supplemental requirements S2.1 are provided where improved notch toughness is important. These supplemental requirements are mandatory for main load carrying member components subject to tensile stress."

(b) Add new paragraph S2.1 as follows: "The materials supplied shall meet the longitudinal Charpy V-notch tests specified in Table A. Sampling and testing procedures shall be in accordance with ASTM A 673 [ASTM A 673M]. The (H) frequency of heat testing shall be used."

TABLE A*

Thickness-inches [millimeters]	Group 1-See Footnote
up to 4 inches [100 mm] mechanically fastened	15 ft. lb. @ 70EF [20 J @ 21EC]
up to 6 inches [50 mm] welded	15 ft. lb. @ 70EF [20 J @ 21EC]

Footnote: Group 1: Minimum service temperature 0EF [-18EC] and above.

*If the yield point of the material exceeds 65 ksi [450 MPa], the temperature for the CVN value for acceptability shall be reduced by 15EF [8EC] for each increment of 10 above 65 ksi [70 above 450 MPa]

(7) Grade A 514 [514M] specification ASTM A 514 [ASTM A 514M].

(a) Add new paragraph 1.3 as follows: "Supplemental requirement S3 is mandatory for main load for carrying member components subject to tensile stress."

(b) Add new paragraph S3 as follows: "The material supplied shall meet the longitudinal Charpy V-notch tests specified in Table A. Sampling and testing procedures shall be in accordance with ASTM A 673 [ASTM A 673M]. The (P) frequency testing shall be used."

TABLE A

Thickness - inches [millimeters]	Group 1-See Footnote
up to 4 inches [100 mm] mechanically fastened	25 ft. lb. @ 30EF [35 J @ -1EC]
up to 22 inches [65 mm] welded	25 ft. lb. @ 30EF [35 J @ -1EC]
over 22 to 4 inches [65 to 100 mm] welded	35 ft. lb. @ 30EF [45 J @ -1EC]

Footnote: Group 1: Minimum service temperature 0EF [-18EC] and above.

962-3 Steel Castings.

Steel castings shall conform to the requirements of ASTM A 27 [ASTM A 27M]. Unless otherwise shown in the plans all castings shall be Grade 65 to 35 [450 to 240].

962-4 Steel Forgings.

Steel forgings from which pins, rollers, trunnions, shafts, gears, or other forged parts are to be fabricated shall conform to ASTM A 668 [ASTM A 668M]. Unless otherwise specified, Class C shall be used.

962-5 Cold-Rolled Steel.

Cold-rolled steel for shafting shall conform to the requirements of ASTM A 108, for the grade specified or shown on approved shop plans.

962-6 Annealing.

Steel parts requiring their full strength, and which have been partially heated, shall be subsequently annealed. Slight bends in pieces of secondary importance may be made without heating the metal. Crimped web stiffeners need not be annealed.

The annealing shall be done by heating uniformly to the proper temperature, followed by slow and uniform cooling in the furnace. The temperature of the pieces shall be under full control at all stages.

A record of the annealing charges shall be furnished the Engineer showing the pieces included in each charge and the treatment they received.

962-7 Galvanizing Structural Steel and Accessories.

962-7.1 Fasteners: Bolts, nuts, washers and other fastener items shall be galvanized in accordance with the requirements of ASTM A 153 [ASTM A 153M]. When zinc coating is required by the plans or specifications for high strength bolts, nuts and washers, the supplier has the option of furnishing either hot-dip galvanized (Class C of ASTM A 153 [ASTM A 153M]) or mechanically deposited zinc coated (Class 50 of ASTM B 695) products unless the specific process is called for in the plans or specifications. The bolt, nut and washer used in the fastener assembly shall be coated by the same process, i.e., hot-dip or mechanically deposited. After erection, the bolts, nuts, and washers shall be cleaned of all oil and deleterious material and then painted according to the written recommendations of the manufacturer of the structural steel zinc primer paint.

962-7.2 Shapes, Plates, Bars and Strips: Zinc coatings applied by dipping in a molten bath of zinc onto structural steel articles or products fabricated from structural steel shapes, plates, bars, and strips χ inch [3 mm] thick and heavier, shall conform to the requirements of ASTM A 123 [ASTM A 123M], ASTM A 143 and ASTM A 384, except as follows:

(a) When dipping in a molten bath of zinc produces detrimental effects such as distortion, warpage and embrittlement to the steel which has been designated in the plans to be used, the Contractor shall select an alternate grade of steel suitable for fabrication and galvanizing without detrimental effect.

(b) When the Contractor selects an alternate grade of steel to that designated in the plans he shall submit his selection together with appropriate redesign computations to the Engineer for approval.

(c) Redesign computations to accommodate the substitution of an alternate grade steel shall demonstrate that the finished product is equal to or better, in all respects, than the original design.

Mechanical galvanizing shall be permitted when the materials specified in the plans or specifications are of the type which can be mechanically galvanized with no detrimental effects on the material. When mechanical galvanizing is utilized, the process shall be in accordance with ASTM B 695 unless otherwise required by the plans and specifications. Chromate treatment shall not be used unless specifically required in the Contract Documents.

962-8 Gray-Iron Castings (Including Frames and Grates).

Iron castings shall conform to ASTM A 48 [ASTM A 48M] and, for machinery parts, shall be of the No. 30 Classes. For manholes which are to be constructed within the area of vehicular traffic the frames and gratings shall be machine-ground, so that irregularity of contact will be reduced to a minimum and the grates will be rattleproof.

962-9 Steel Materials for Specific Items.

962-9.1 Pipe Railings: Steel or gas pipe used as railing shall conform to the requirements of ASTM A 53, for Standard Weight Pipe.

962-9.2 Steel Sheet Piling: Steel sheet piles shall conform to the requirements of ASTM A 328 [ASTM A 328M], including the requirement for copper content.

962-9.3 Steel Sign Supports and Accessories:

962-9.3.1 Steel Materials: The steel members for the sign supports shall meet the particular specifications called for in the plans.

962-9.3.2 Galvanizing of Steel Members: The steel members for sign supports shall be galvanized in accordance with the requirements of 962-7.

962-9.3.3 Bolts, Nuts and Washers: Steel bolts, nuts and lockwashers shall meet the requirements of ASTM A 307 unless otherwise specified. Bolts, nuts and lockwashers shall be galvanized in accordance with ASTM A 153 [ASTM A 153M].

962-10 Steel for Concrete Reinforcement, Fencing and Guardrail.

The requirements for the steel for these items are contained in the following Sections.

Reinforcing Steel for Concrete Pavement
and for Structural Concrete ....Section 931
Guardrail Materials..Section 967

SECTION 964

NON-FERROUS METAL MATERIALS AND ITEMS

(OTHER THAN ALUMINUM)

964-1 Bronze Castings and Rolled Bronze.

Bronze castings shall conform to the requirements of ASTM B 22. The various alloys shall be as required by that specification for the particular use or as designated on the plans.

Bronze bearing and expansion plates shall conform to ASTM B 100, Alloy No. 510. Where self-lubricating expansion plates are specified, the requirements of 964-2 shall also apply.

964-2 Self-Lubricating Bearing Plates.

Except as might be specified otherwise in the plans, self-lubricating bearing plates shall conform to the following requirements:

The bronze alloy shall be either rolled plate conforming to ASTM B 100, Alloy No. 510, or castings conforming to ASTM B 22, Alloy 911.

The plates shall be provided with recesses (not grooves) which shall be filled with a lubricating compound.

The lubricant shall be of the solid type and shall consist of graphite-metallic substances having lubricating properties, and a lubricating binder. Lubricating materials shall be of a type capable of withstanding atmospheric elements and which will not promote chemical or electrolytic reactions. The lubricant shall be integrally molded and pressed into the recesses by hydraulic pressure of at least 6,000 psi [40 MPa], to form a dense, nonplastic lubricant.

The recesses shall be arranged in a geometric pattern such that successive rows shall overlap in the direction of motion. The entire bearing area of all surfaces which have provision for motion shall be lubricated by means of these lubricant-filled recesses. The total area of recesses shall comprise not less than 25% nor more than 35% of the total bearing area of the plate.

Bearing plates shall be furnished of the size shown in the plans. Bearing surfaces shall be machine-finished and the surface roughness shall not exceed 125 micro-inches [3 µm], when measured in accordance with ANSI (ASA) standards. The lay of the tool marks shall be in the direction of motion. All machined surfaces shall be flat within 0.005 inch per inch [mm per mm] of length and width.

For mating curved surfaces, concave surfaces shall have a positive tolerance not exceeding 0.01 inch [0.25 mm] and convex surfaces a negative tolerance not exceeding 0.01 inch [0.25 mm].

The coefficient of friction between self-lubricating plates and steel surfaces machined to ANSI No. 125 finish shall not exceed 0.10, under unit loading of 1,200 psi [8.3 MPa].

Prior to erection, the self-lubricating plates and the steel surfaces on which they bear shall receive a coating of graphite lubricant, in stick or paste form.

964-3 Babbitt Metal.

Babbitt metal for bearings shall conform to the requirements of ASTM B 23. Unless otherwise shown in the plans, Alloy Grade No. 3 shall be used.

964-4 Copper Water Stops.

Unless a different requirement is shown in the plans copper water stops shall meet the requirements of ASTM B 370.

964-5 Mill Analysis Tests.

Tests on bronze castings, rolled bronze, self-lubricating bearing plates and babbitt metal will be waived provided the manufacturer furnishes the Department's State Materials Engineer, six certified copies of the mill analysis, containing all tests required by the specifications, and properly identified by project number.

SECTION 965

GENERAL PROVISIONS FOR ALUMINUM ITEMS

(Including Welding)

965-1 Surface Appearance and Protection.

The exterior surfaces of aluminum castings, pipes, tubes, formed sheets, and structural shapes shall, when placed in the work, have a clean, uniform silvery appearance, free of dark streaks and discoloration.

Aluminum members (including specifically aluminum light poles and signs poles) which are of such size or shape that the surfaces might be marred during transit and prior to their being installed, shall be appropriately and adequately protected against such damage, by wrapping with paper or by other effective means.

965-2 Tests of Aluminum Materials (Mill-Analysis Reports).

For all aluminum materials proposed for use, six certified copies of mill analysis will be required, with certification by the producer that the parts are of the alloys specified and meet the specifications called for. Such reports shall be forwarded to the Department's State Materials Engineer, at Gainesville.

965-3 Welding Aluminum Sign Structures.

The proportioning of weld details and the operation of welding, for aluminum sign structure, shall be in accordance with Section 5 of the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals; ANSI and AWS D1.2 "Structural Welding Code - Aluminum", including the requirements for qualifications of procedures and welders, as specified therein.

(a) Alloys: The aluminum alloys to welded under these specifications may be any of the following alloys:

Wrought Nonheat-treatable Alloys:
Alloy 3003
Alloy Alclad 3004
Alloy 5052
Alloy 5083
Alloy 5086
Alloy 5456
Wrought Heat-treatable Alloys:
Alloy 6061
Alloy 6063
Cast Heat-treated Alloy
Alloy SG-70A (ASTM Designation)

(b) Filler Metals: The filler metals to be used with particular base metals shall be as shown in the table below except that other filler metals may be used if approved by the Engineer.

Base Metal	Filler Metal
3003 to 3003	ER1100
Alclad 3004 to Alclad 3004	ER4043
5052 to 5052	ER5356*
5083 to 5083	ER5183
5086 to 5086	ER5356*
5456 to 5456	ER5556
6061 to 6061	ER5356*
6063 to 6063	ER5356*
SG-70A to 6061	ER4043
SG-70A to 6063	ER4043

*ER5183, ER5356, and ER5556 may be used interchangeably for these base metals.

965-4 Welding Aluminum Structures Other Than Sign Structures.

The welding of aluminum structures, other than sign structures, such as aluminum bridge and railing structures and their aluminum components, shall be in accordance with ANSI and AWS D1.2 "Structures Welding Code - Aluminum", including the requirements for qualifications of procedures and welders, as specified therein.

SECTION 967

RAIL ELEMENTS FOR GUARDRAIL

967-1 Steel Guardrail.

Steel guardrail materials shall meet the requirements of AASHTO M 180, (except as specified below), and for either Class shown. Type 2 zinc coating will be required.

As an exception to the requirements of AASHTO M 180, the galvanizing of the rail elements shall meet the requirements of ASTM A 123 [ASTM A 123M].

All supports, fastenings and other accessories, including bolts, nuts, washers, etc., (and including the steel trailing end-anchorage rods required to be used with aluminum guardrail) shall be galvanized as specified in ASTM A 153 [ASTM A 153M].

Acceptance of steel guardrail materials shall be based on manufacturer's certified mill analysis of test results meeting the specification limits of the ASTM or AASHTO designation as stated above. Certification of these test values, representing each shipment of guardrail materials, shall be provided to the Engineer for each project.

967-2 Aluminum Guardrail.

Except as might be specified otherwise in the plans, aluminum rail and hardware shall meet the requirements specified in this Article.

The aluminum rail element shall consist of a 0.125 inch [3.2 mm] aluminum sheet, Alloy Alclad 2024-T3, formed into a deep-beam type rail in accordance with the details shown on the Roadway and Traffic Design Standards.

The rail element shall meet the following requirements:

(1) Minimum ultimate tensile strength - 62,000 psi [430 MPa].

(2) Minimum longitudinal strength through splice joint - 80,000 lbs [350 kN].

(3) Minimum thickness of plate - 0.125 inch [3.2 mm].

(4) A 2 inch [50 mm] test specimen shall elongate not less than 15%.

Bolts shall be aluminum alloy 2024-T4, shall have an anodic coating of at least 0.0002 inch [5 μm] in thickness and shall be chromate sealed.

Nuts shall be aluminum alloy 6061-T6.

Washers shall be aluminum alloy Alclad 2024-T4.

(The steel trailing end-anchorage rods, required to be used with aluminum guardrail, are specified in 967-1.)

Mill analysis reports shall be submitted as specified in Section 961 and the Contractor shall not place final orders for the delivery of the materials until he has received written notice of approval of the materials, based on the mill analysis.

REFLECTIVE PAVEMENT MARKERS

SECTION 970

MATERIALS FOR RAISED RETRO-REFLECTIVE PAVEMENT MARKERS AND BITUMINOUS ADHESIVE

970-1 Raised Retro-Reflective Pavement Markers.

970-1.1 Composition: The marker shall consist of materials conforming to ASTM D 4280.

970-1.2 Physical Requirements: The physical size of the RPM shall conform to the requirements of ASTM D 4280. Laboratory and field samples for RPMs and bituminous adhesives shall meet the requirements of ASTM D 4280 and include the following requirements:

The minimum area of each reflective face shall be 2.5 in^2 [1,600 mm^2]. The minimum base size shall be 12 in^2 [7,750 mm^2].

970-1.2.1 Designation of Marker Type, Color and Classification: The marker description shall be in order of type, color and reflective surface condition in accordance with the following charts.

RPM Type

A	2 way reflective	1 color
B	1 way reflective	1 color
D	1 way reflective	2 colors (one way reflective with nonreflecting white surface on opposite side
E	2 way reflective	2 colors

Reflective Face Color *

Color	White	Yellow	Red	Blue	Green
Code	W	Y	R	B	G

* The color of the marker shall meet the requirements of ATSM D 4280.

RPM Class

Class	Description	Expected Normal Service	ASTM Surface Designation
A	Temporary marker	Up to six months	none
B	Permanent marker	Long life	H, hard abrasion resistant lens
D	Work zone marker	Per project requirement	none
E	Temporary work zone	Up to five days	none

970-1.3 Performance Requirements: The RPM shall meet the performance requirements as specified in ASTM D 4280 Section 6.2 for coefficient of luminous intensity, flexural strength, compressive strength, resistance to cracking and thermal cycling. Test method FM 5-566 shall be applied to evaluate marker performance.

970-1.3.1 Class A markers: Meet the coefficient of luminous intensity requirements of ASTM D 4280, which the abrasion treatment is not required. Class B markers (abrasion resistant) shall meet the coefficient of luminous intensity requirements of ASTM D 4280 after abrasion and shall be designated by the manufacturer in accordance with ASTM D 4280.

970-1.3.2 In-service Minimum Reflective Intensity: The reflective pavement marker shall retain a minimum coefficient of luminous intensity for 18 months of not less than 30% of the values shown in Table 1 of ASTM D 4280. Replacement of pavement markers should be planned after the coefficient of luminous intensity drops below 0.02 cd/lx.

970-1.4 Application Properties: Application properties shall meet the requirements of Section 706.

970-1.5 Packaging and Labeling: Shipment shall be made in containers which are acceptable to common carriers and packaged in such a manner as to ensure delivery is in perfect condition. Each package shall be clearly marked as to the name of the manufacturer, type, color, quantity enclosed and date of manufacture. Show the designation of the marker in accordance with ASTM D 4280.

970-1.6 Certification: For initial product approval, the marker manufacturer and bituminous adhesive manufacturer shall furnish to the State Materials Office a certified test report from an approved independent test laboratory that affirms the materials meet all requirements specified. After initial product approval, the manufacturer shall submit copies of this test report and verification in accordance with this specification, Section 706 and FM 5-566 to the State Materials Office for ongoing contracts. If the results of tests performed on these products indicate failure to comply with any specific requirement of the product or indicate significant inconsistencies in material properties, new qualification tests may be required for the particular material. Any marked variation from the original test values for a material will be considered sufficient evidence the composition and/or properties of the materials have changed.

970-2 Bituminous Adhesive For Pavement Markers.

970-2.1 General: Bituminous adhesive as recommended by the marker manufacturer shall be used for bonding the markers to the pavement. The adhesive used shall be a product included on the Qualified Products List.

970-2.2 Specific Requirements for Bituminous Adhesives: The bituminous adhesive shall meet the properties of adhesives per ASTM D 4280 Section A1, including filler-free and filler alone properties.

970-2.3 Performance Requirements: The performance of the adhesive shall be determined in accordance with the test methods listed in ASTM D 4280.

970-3 Qualified Products List (QPL).

Manufacturers seeking approval for a Raised Retro-Reflective Pavement marker or bituminous adhesive shall submit an application, Material Safety Data Sheet (MSDS) and certification in accordance with 6-1. Final acceptance will be based on tests and verification in accordance with this Specification.

PAINTS

SECTION 971

COATINGS AND TRAFFIC MARKING MATERIALS

971-1 General Requirements.

971-1.1 Packaging and Labeling: All coatings and traffic marking materials shall be shipped in strong containers plainly marked with the weight in pounds per gallon [kilograms per liter], the volume of coatings and traffic marking materials content in gallons [liters], the color, user information, date of manufacture, LOT, batch and DOT code number. Each batch manufactured shall have a unique number. A true statement of the percentage composition of the pigment, the proportion of pigment to vehicle, and the name and address of the manufacturer, also shall be shown. The label shall warn the user of any special handling or precautions of the material, as recommended by the manufacturer. Any package not so marked will not be accepted for use under these specifications.

971-1.2 Storage: Any coatings and traffic marking materials which, although inspected and approved at the point of manufacture, hardens or livers in the containers so that it cannot be readily broken up with a paddle to a smooth, uniform painting consistency, will be rejected. All materials shall have a container storage life of one year from date of manufacture. Any coatings and traffic marking materials not acceptable for proper application will be rejected, even though it conforms to these Specifications in all other respects.

971-1.3 Mixing: All paints except aluminum shall be delivered to the project completely mixed, and ready to be used without additional oil or thinner. Gasoline shall not be used for thinner under any circumstances.

For aluminum paint, the aluminum paste and the varnish shall be packed separately.

971-1.4 Qualified Products List: All coatings and traffic marking materials shall be listed on the Qualified Products List.

Products may only be used for applications recommended by the manufacturer.

A notation of the number of coats and the thickness of each coat at which the product passes testing may be placed on the QPL. When listed, this will be the minimum criteria for application of the coating.

Manufacturers seeking evaluation of a product shall submit an application, Material Safety Data Sheet (MSDS), and certification. Final acceptance will be based on tests and verification in accordance with this specification.

971-1.5 Certification: For initial product approval, the producer of the coatings and traffic marking materials shall furnish to the State Materials Engineer a certified test report from an approved independent test laboratory that affirms the product meets all the requirements specified. The producer shall also specify if a product is limited to specific applications.

Each certification shall cover only one material type or product.

After initial product approval, the producer shall submit copies of this certified test report that are relative to ongoing Contracts. The producer shall submit copies of this test report to the Contractor and the State Materials Engineer.

If test results indicate significant inconsistencies in material properties, new qualification tests and/or comparison with original infrared spectroscopic values may be required.

971-1.6 Samples: Field samples will be obtained in accordance with the Department's Sampling, Testing and Reporting Guide Schedule.

971-1.7 Retroreflectivity: Materials for traffic stripes or markings shall meet the Reflectivity requirements specified in the application requirements for that material (Section 709, Section 710, Section 711, or Section 713).

971-1.8 Additional Requirements: Coatings and traffic stripe materials shall be characterized as non-hazardous as defined by Resource Conservation and Recovery Act (RCRA) Subarticle C rules, Table 1 of 40 CFR 261.24 AToxicity Characteristic≅. Traffic stripe materials shall contain no more than 3.0 ppm lead by weight in a cured state when tested by EPA methods 3050 and 6010.

Coatings shall contain less that 450 g/L Volatile Organic Compounds (VOC). Traffic strip materials shall contain less than 150 g/L VOC.

The presence of these compounds shall be tested for compliance by x-ray diffraction, ICP, or other methods capable of this level of detection. The material shall not exude fumes which are toxic or detrimental to persons or property.

971-2 Paint Schedule.

Applicable Specification(s)	Code	Color	Application
Steel			
971-5	Z-C	brown	Steel prime coat
971-6	B-8	lead gray	Third coat for steel
971-6	B-9	silver gray	Finish coat for steel - alternate
971-7	B-A	aluminum	Finish coat for steel
Wood			
971-9.1	W-1	white	Wood painting
971-9.2	W-7	black	Wood painting
Metal			
971-9.3	M-P	brown	Prime coat for galvanized metal
971-10	B-7	black	Finish coat for metal
971-15			Galvanizing Compound (Organic Zinc-rich coating) for Field Metalizing and Touch-up Repair
971-16			Self-Curing Inorganic Zinc Coating
Masonry			
971-11	CW-1	white	Masonry painting

971-3 Methods of Sampling and Testing.

971-3.1 General: Before the paint is used a sample shall be submitted for test. If approved, the sample will be used in determining the merits of the paint. All paints used shall equal the sample in color and quality. Code numbers shall be used in ordering and designating paints.

A pint [0.5 L] sample shall be taken from each LOT and batch delivered and shall be tested and approved before any paint is applied. Paint manufactured and sealed under State supervision may be used without further testing. Standard color chips of all paints are kept at the Materials Office, Gainesville, and may be obtained by manufacturers or other parties interested. All samples will be compared to these standards for color and any market deviation will be sufficient ground for rejection.

The Department may, at its discretion, place an Inspector at the place of manufacture of the paint. The paint manufacturer shall render all assistance and furnish all facilities for inspecting and testing the paint manufactured. This inspection is to facilitate testing and approval, but is not final, and the material must maintain its quality and working consistency at the time of use.

All materials and paints shall conform to these Specifications when analyzed by standard methods. Unless otherwise designated, a tolerance of 2% on weight in pounds per gallon [kilograms per liter], and an absolute tolerance of ∀2% on the percent pigment and the percent vehicle, may be allowed on small batches or LOTs of 50 gal [190 L] or less.

All paints and varnishes shall be filtered or clarified to the satisfaction of the Inspector before the filling of containers. All varnishes, after cooking, shall be allowed to cool and age at least seven days before being used.

971-3.2 Volumetric Weights: The weight in pounds per gallon [kilograms per liter] of varnishes, clear liquids, paints and enamels shall be determined in accordance with the applicable test methods of Federal Standard No. 141 (Test Methods) at 77EF [25EC], and the containers shall be filled by weight.

971-3.3 Bulking Factor for Aluminum Paste: Bulking factor for aluminum paste shall be taken as 0.086.

971-3.4 Test Standards: The following materials will be tested according to, and required to meet, the specified standards shown below:

Raw Tung Oil	FS TT-T-775
Raw Linseed Oil	ASTM D 234
Boiled Linseed Oil	ASTM D 260
Turpentine, gum spirits or steam distilled	ASTM D 13
Mineral Spirits	ASTM D 235
Thinner, Naphtha, low-boiling	FS TT-N 95 (Type I)
Lead Naphthenate	FS TT-D 643
Manganese Naphthenate	FS TT-D 643
Cobalt Naphthenate	FS TT-D 643
Liquid Drier	FS TT-D 651
Titanium Dioxide	ASTM D 476
Red Lead (95% grade)	ASTM D 83
Basic Carbonate White Lead	ASTM D 81
Leaded Zinc Oxide*	ASTM D 80
Basic Sulfate White Lead	ASTM D 82
Red and Brown Iron Oxide	ASTM D 3722
Magnesium Silicate	ASTM D 605
(Except Fe_2O_3 shall be less than 0.4% and R_2O_3 shall be less than 3.0%.)	
Carbon Black	ASTM D 561
Lampblack	ASTM D 209

Medium Chrome Yellow, and Orange	ASTM D 211
Zinc Chromate	ASTM D 478
Zinc Oxide, American Process	ASTM D 79
Mica, Water Ground, 325 [45 µm] sieve	ASTM D 607
Red Iron Oxide, 82 to 85%	FS TT-P 408
Zirconium Complex, Drier Catalyst, 6% Titanium Dioxide, Anatase	FS TT-P 442 (Type I)
Calcium Carbonate	ASTM D 1199 (Type GC)
Diatomaceous Silica	ASTM D 604 (Type A)
Xylene	ASTM D 846
Refined Solvent Naphtha	ASTM D 838

Note: FS = Federal Specification.
*The manufacturer, at his option, may blend normal or basic lead sulfate with zinc oxide to provide, in the finished paint, the leaded zinc oxide required in ASTM D 80.

971-4 Inert Pigments.

Only barytes, barium sulphate (artificial), silica or magnesium silicate will be considered as suitable fillers. Inerts shall in no case contain organic coloring matter, soap or emulsifying agents. Tinting pigments shall be ground in oil before mixing with paint.

971-5 Prime Coat for Painting Steel, Code Z-C.

971-5.1 Composition:

Pigment	% by Weight	
	Minimum	Maximum
Zinc Chromate	7	9
Red Lead	15	X
Red Iron Oxide*, 82 to 85% TT-P 408	X	60
Mica, 325 [45 µm] sieve	15	17
Zinc Oxide	3	4
Vehicle		
Raw Linseed Oil	54	X
Processed Tung-Linseed**	18	20
Mineral Spirits	X	25
Cobalt Naphthenate***, 6%	Total drier not more than 1.8%	
Lead Naphthenate***, 24%		

Zirconium Complex***, 6%		
Anti-Skinning Agent	X	0.05
Pigment	54	56
Vehicle	44	46

*For 2-coat differentiation, a small quantity of lampblack shall be added to replace an equal volume of red iron oxide. The manufacturer, at his option, may blend iron oxide and magnesium silicate to provide in the finished paint the iron oxide content required in this Article.

**Processed Tung-Linseed Oils: 40 parts, by weight, of Tung Oil and 60 parts, by weight, of Raw Linseed Oil are kettle-processed at 480EF [250EC] to a viscosity of Z-2 to Z-4 (Gardner). The processed oil shall not have a color greater than 11, nor an acid number greater than 3.0.

***The Drier combination may be varied at the discretion of the supplier provided that the total driers as the metal do not exceed 0.30%, by weight, on the vehicle non-volatile basis.

971-5.2 Physical Properties:

	Minimum	Maximum
Drying time, 100EF [38EC]	X	18 hours
Weight	13.0 lb/gal [1.56 kg/L]	X
Consistency, Krebs Units	75	88
Fineness of Grind, ASTM D1210	2 (HS)* [75 µm]	3 (HS)* [65 µm]

*HS is Hegman Scale.

971-6 Third and Fourth Coats for Painting Steel, Codes B-8 and B-9.

971-6.1 Tung Oil-Phenolic Varnish, 40 gallon [150 L] Oil Length: The materials used in the manufacture of this varnish shall conform to the following:

Phenolic Resin: The resin used shall be a pure phenolic resin of the nonreactive type, and shall have the following properties:

Nonvolatile	100%
Color (USDA Resin Stand.)	M to I
Melting Range (Capillary Tube Method)	260 to 295EF [127 to 146EC]
Specific Gravity	1.04 to 1.10

Oil: The total oil content of this varnish shall conform to the following:

Tung Oil, Pure, Raw	minimum 60%
Raw Linseed Oil (Co-processed with Tung Oil)	20%
Bodied Linseed Oil, "Q" Viscosity, (Chill-back)	20%
	100%

971-6.2 Varnish Reduction:

Oil Length	40 gal [150 L]
Thinner	Mineral Spirits
Nonvolatile	49 to 51%
Color	maximum 12
Viscosity (Gardner)	D to E
The reduced resin, prior to use, must be clear and free from "strings" and other foreign matter.	

971-6.3 Composition:

	% by Weight	
Pigment	Minimum	Maximum
35% Leaded Zinc Oxide	28	X
Titanium Dioxide, Rutile	12	14
Basic Carbonate White Lead	26	28
Mica, 325 [45 µm] sieve	12	13
Magnesium Silicate	X	18
Lampblack*	X	X
Vehicle		
Tung Oil Phenolic Varnish 50% Nonvolatile	68	70
Raw Linseed Oil	29	X
Mineral Spirits**	X	2
Cobalt Naphthenate, 6%	Total Drier 1.1% by weight	
Lead Naphthenate, 24%		
Anti-Skinning Agent	0.07	X
Total Pigment	56	57
Total Vehicle	43	44

*Lampblack: Sufficient lampblack is added to conform with the Standard Department of Transportation color chips for this paint, at the expense of magnesium silicate in the formulation. Code B-8 is designated as lead gray and Code B-9 is designated as silver gray.

**Mineral Spirits: The small amount of mineral spirits indicated is in addition to that contained in the 50% nonvolatile varnish and is considered as being sufficient for small consistency adjustments.

971-6.4 Physical Properties:

	Minimum	Maximum
Weight	13.5 lb/gal [1.62 kg/L]	X
Drying time, tack free, 100EF [38EC]	X	8 hours
Drying time, through dry, 100EF [38EC]	X	18 hours
Fineness of Grind, ASTM D 1210	2(HS)* [75 µm]	3(HS)* [65 µm]
Consistency, Krebs Units	78	88

*HS is Hegman Scale.

971-7 Fourth Coat for Steel, Code B-A.

971-7.1 Pigment: The pigment shall consist of aluminum paste conforming to Federal Specification TT-P 320, Type II, Class B.

971-7.2 Varnish Vehicle: The varnish vehicle shall conform to Federal Specification TT-V 81, Type II, Classes A and B.

971-7.3 Proportions: 2 lb [0.24 kg] of aluminum paste shall be mixed with 1 gal [1 liter] of the above varnish.

971-7.4 Packaging: This paint shall be packaged in a 2-compartment container, with varnish in one compartment and paste in the other, sufficient to make 5 gal [20 L] of the mixed paint.

971-7.5 Drying Time: The mixed aluminum paint shall set to touch in not less than two hours nor more than six hours, 100EF [38EC] on metal, and shall dry hard and tough in not more than 24 hours.

971-7.6 Mixing: The aluminum paint shall be freshly mixed and only enough for one day's use shall be mixed at one time. Any paint remaining after this period may be mixed with freshly prepared paint if it does not exceed 10% of the total newly mixed paint.

971-8 Shop and Field Paint for Grating.

971-8.1 General: The coating used to paint gratings and frames shall be a product on the Qualified Products List.

971-8.2 Composition: The composition of the paint shall be left to the discretion of the manufacturer with the exception of the following requirements:

a. Lead or chromium pigments shall not be used in the manufacture of the paint.

b. The volatile organic content (V.O.C.) of the paint shall not exceed 150 g/L.

971-8.3 Corrosion Tests: Products submitted for inclusion on the Qualified Products List shall comply with the requirements listed below. Clean cold rolled steel panels 3 by 8 inches by 0.032 inch thick [75 by 200 mm by 0.81 mm thick] with the number of dip coats and thickness of each coat applied according to the manufacturer's recommendations. A notation of the number of coats and the thickness of each coat at which the product passed testing will be placed on the Qualified Products List. This will be the minimum criteria for application of the coating as part of a FDOT project.

	Exposure Time	ASTM D 610 Minimum Rust Grade
a. 100% Relative Humidity (75 to 90EF [(24 to 32EC], ASTM D 2247)	600 hours	8
b. Inland Test Rack	12 months	8
Material Safety Data Sheets shall accompany all products submitted for testing.		

971-8.4 Samples and Certification of Tests: Paint samples will be obtained in accordance with the Department's sampling, testing and reporting guide schedule. For each batch of paint used, the Contractor shall furnish to the State Materials Engineer three certified copies of test reports that show the following paint analysis data:

a. Weight per gallon at 77EF [liter at 25EC] (ASTM D 1475).
b. Volatile organic content (V.O.C. ASTM D 3960).
c. Consistency in Krebs Units at 77EF [25EC] (ASTM D 562).
d. Weight percent pigment (ASTM D 3723).
e. Weight percent total solids (ASTM D 2369).
f. Drytime to handle and topcoat.
g. Shelf life.

971-9 Codes W-1, W-7, and M-P.

971-9.1 Code W-1:

971-9.1.1 General: Paint for all white painting of wood shall conform to the Specifications shown below.

971-9.1.2 Pigment Composition:

	% by Weight	
	Minimum	Maximum
Rutile Titanium Dioxide	23	X
Anatase Titanium Dioxide	8	X
Zinc Oxide	27	X
Calcium Carbonate	X	23
Magnesium Silicate	X	19

971-9.1.3 Vehicle Composition:

	% by Weight	
	Minimum	Maximum
Linseed Oil*	3	4

Isophthalic Alkyd Resin**	53	56
Mineral Spirits	X	40
Mercuric Mildewcide (10% Mercury content)	1.3	1.4
24% Lead Naphthenate	1.15	
6% Cobalt Naphthenate	0.175	
6% Manganese Naphthenate	0.233	
Anti-skinning Agent	0.2	X

*Linseed Oil:
Viscosity (Gardner)Z- 2 to Z-3
Acid Number, maximum..... 10

**Isophthalic Alkyd Resin:
Fatty Acids, minimum...... 76%
Isophthalic Acid, minimum16%
Viscosity at 70% Solids, Gardner-Holt N to O
Acid Value, on solids..... 3 to 5
Color, Hellige, maximum...... 9

971-9.1.4 Physical Properties:

	Minimum	Maximum
Pigment, by weight	53%	66%
Vehicle, by weight	45%	47%
Weight	12.3 lb/gal [1.47 kg/L]	12.7 lb/gal [1.52 kg/L]
Consistency, Krebs Units	78	82
Drying Time at 100EF [38EC]	X	6 hours

971-9.2 Code W-7: Paint for all black painting on wood shall conform to the following specifications:

Pigment.. 28 to 32% by weight
Vehicle .... 68 to 72% by weight
Volatile Matter (% of vehicle), not over .... 20% by weight
Weight ....Not less than 9.0 lb/gal [1.08 kg/L]
Drying time, 100EF [38EC], on metal ....Under 18 hours
Vehicle, over 80% raw linseed oil.
Thinner to be turpentine.
Pigment Composition:
Carbon, not less than .... 20% by weight
Red Lead, not less than.. 5% by weight
Inert (Oxide of Iron, Class III, Type B, and Fillers),
not less than .... 6% by weight

971-9.3 Code M-P: When specified, galvanized metal surfaces, after being washed with vinegar solution (one part vinegar to six parts water) and allowed to dry, shall be given one coat of metal primer conforming to the following specifications:

Pigment.. 45% by weight
Vehicle .... 55% by weight
(Vehicle shall be linseed oil and varnish type)
Volatile Matter (% of vehicle)................................... 10 to 25% by weight
Weight .... 11.5 lb/gal [1.38 kg/L]
Drying time, free from tack, 100EF [38EC], on metal...... under six hours.
Pigment Composition:
Iron Oxide, Class I .... 23% by weight
Medium Chrome Yellow, Type III.................................. 25% by weight
Inert and Tinting Pigment... 52% by weight

(This primer is not intended to be a heavy bodied paint. The color is not important).

971-10 Finish Coat for Metal, Code B-7.

This paint shall be a graphite paint. The pigment in both semi-paste and ready-mixed paint shall consist of a finely ground graphite carbon and insoluble siliceous matter. The graphite carbon may be derived from either natural or artificial graphite, and the insoluble siliceous matter may be either the natural-occurring insoluble impurities of the graphite or added insoluble siliceous matter. The pigment shall show the following analysis:

Graphite Carbon, not less than .... 50% by weight
Insoluble Siliceous Matter, not less than........................... 30% by weight
Sum of Graphite Carbon and Insoluble Siliceous Matter,
not less than .... 85% by weight
Calcium and Magnesium Carbonates and Sulphates,
not more than .... 5% by weight

The pigment shall be ground so that 100% will pass the No. 200 [75 µm] sieve.

Graphite Pigment (as above specified).................................6 lb [2.72 kg]
Linseed Oil Vehicle..1 gal [3.8 L]
Total volume of paint produced, approximately ....1.24 gal [4.7 L]
Weight of mixed paint (after thinner and dryer added),
minimum.. 9.5 lb/gal [1.14 kg/L]
Drying time, 77EF [38EC], on metal ....Under 18 hours

Raw linseed oil, or a mixture of raw and boiled oils containing not more than 25% of boiled oils, shall be used as a vehicle, except for work exposed to water action, in which case boiled linseed oil shall be used.

971-11 White-Cement Water Paint, Code CW-1.

971-11.1 Composition: This paint is an 80% white portland cement paint for general use on porous surfaces of masonry, concrete, stucco, common brick, masonry block and rough plaster (except gypsum plaster). It shall have no siliceous aggregate added. This Specification applies to hydraulic base paints, designed for use on the surfaces designated above as a decorative, protective and water-repellent coating. The white-cement water paint powder shall consist of white portland cement and titanium dioxide and may or may not contain hydrated lime. Water repellents (calcium or aluminum stearate) and hygroscopic salts (calcium or sodium chloride) shall be present. The paint shall contain no organic binder. It shall show on analysis:

	% by Weight	
	Minimum	Maximum
Portland Cement	X	80
Hydrated Lime*	10	X
Carbonated (Calculated as Carbon Dioxide)	3	X
Titanium Dioxide	5	3
Water Repellents (Calcium or Aluminum Stearate)	1	0.5
Hygroscopic Salts (Calcium or Sodium Chloride)	5	X

The total free (unhydrated) calcium oxide and magnesium oxide in the hydrated lime shall not exceed 8%, by weight, of the hydrated lime.

971-11.2 Physical Requirements: The material shall be in powder form, free from any lumps that are not easily friable and shall mix with water in proportion of 100 cm^3 (100 mL) of powder to 100 mL of water to form, after five minutes stirring, a paint showing no unwetted pigment particles. This paint, when applied to damp porous concrete with a fiber brush, and allowed to stand 18 hours in an atmosphere free of chemical fumes at a temperature of 70 to 75EF [21 to 24EC] and relative humidity of 50 to 55%, shall dry to a hard, opaque, flat finish of uniform color that will not powder, chip or rub off.

971-11.3 Methods of Sampling: The methods of sampling, inspection and tests shall be in accordance with Federal Specification TT-P-21.

971-11.4 Shipping Containers: Unless otherwise specified, commercial shipping containers shall be moisture proof and marked with the name of the material, the size, mixing directions, specification number, and the quantity contained therein, as defined by the contract or order number under which the shipment is made, and the number of the contract or order.

971-12 Two Reactive Component Materials For Traffic Stripes And Markings.

971-12.1 General: Two reactive component materials intended for use under this Specification shall include, but not be limited to, epoxies, polyesters and urethanes. Upon curing, these materials shall produce an adherent, reflective pavement marking capable of resisting deformation by traffic. The manufacturer shall have the option of formulating the material according to his own specifications. However, the criteria outlined in this Specification, Section 709 and FM 5-541 shall apply regardless of the type of formulation used. In a cured condition, all of the products designated in this Specification shall be classified as non-hazardous waste as defined by 40 CFR 261.24 when tested in accordance with EPA Method 1311, Toxicity Characteristics Leaching Procedures (TCLP). The material shall not exude fumes which are toxic or detrimental to persons or property. The material shall be free from all skins, dirt and foreign objects.

971-12.2 Composition:

Component	Test Method	Criteria
TiO_2, Type II Rutile (white paint only)	ASTM D 476	minimum 10% by weight
Lead	EPA 1311 (TCLP)	maximum 0.15 ppm
Volatile Organic Content, (VOC)	ASTM D 3960	maximum 150 g/L

971-12.3 Pigment: The yellow pigment used shall not contain lead or any other Resource Recovery and Conservation Act (RCRA) materials.

971-12.4 Glass Spheres: Glass spheres shall have an index of refraction of 1.5 or greater. The glass spheres shall meet the requirements of AASHTO M 247, Type I.

971-12.5 Sharp Silica Sand: Sharp silica sand used for bike lane symbols and longitudinal lines shall meet the following gradation requirements:

Sieve Size	% Passing
20 mils [850 μm]	100
50 mils [300 μm]	0 to 10

971-12.6 Physical Requirements: The material shall meet the following criteria:

Property	Test Method	Minimum	Maximum
Dry Opacity*	Fed Std 141a Method 4121	0.96	X
Bleed Ratio	Fed Spec TT-P-85D	0.95	X
Flexibility	Fed Spec TT-P-115D	Pass	X
Abrasion Resistance	971-12.6.3	Pass	X

*When applied at manufacturer's recommended dry film thickness.

971-12.6.1 Set To Bear Traffic Time: When applied at the temperatures and thickness specified by Section 710, the material shall set to bear traffic in not more than two minutes.

971-12.6.2 Color:

Property	White	Yellow	Black
RD* (Fed Std 141a)	minimum 87%	minimum 43%	X
Color, Visual Match (Fed Std 595a)	Color No. 37875	Color No. 33538	Color No. 37038

*After four hour ambient dry and 24 hour oven dry at 150EF [66EC].

The color of the yellow thermoplastic material shall meet the following criteria:

Initial reflectance ....43% minimum

Initial chromaticity of the cured yellow traffic paint shall fall within the area bordered by the following coordinates:

x	0.455	0.510	0.472	0.530
y	0.444	0.485	0.400	0.456

The retained color of the yellow chromaticity coordinates, shall fall within the following limits:

Chromaticity Coordinates (x,y)**

x	0.435	0.51	0.449	0.53
y	0.429	0.485	0.377	0.456

**Chromaticity shall fall in an area bordered by these coordinates of a beaded yellow line (for the life of the Reflectivity performance when measured in accordance with Florida Test Method FM 5-541) when measured with a BYK Gardner Catalog No. 9200 Handy-Color Colorimeter or approved equal by the State Materials Office in accordance with Florida Test Method FM 5-541.

971-12.6.3 Abrasion Resistance: Test four samples per LOT using a Taber Abrader. The paint shall be applied to specimen plates using a drawdown blade having a clearance of 26 mils [660 Φm]. Air dry each sample for 30 minutes and bake at 220EF [105EC] for 18 hours. Clean with a soft brush and weigh each sample. Abrade samples for 1,000 cycles with 1.1 lb [500 g] weights and CS-10 wheels. Clean the samples with a soft brush and weigh again. The average weight loss for the four plates shall not exceed 0.178 oz [50 mg] per plate.

971-12.7 Application Properties: Application properties shall meet the requirements of Section 709.

971-12.8 Packaging and Labeling: The two reactive component material shall be placed in 55 gal [210 liter] open-end steel drums with a re-usable multi-seal sponge gasket. No more than 50 gal [190 liters] of material shall be placed in any drum to allow for expansion during transport and storage. Other containers will be used for applicable products. Each container shall designate the color, generic type (e.g. epoxy), user information, manufacturer's name and address, batch number and date of manufacture. Each batch manufactured shall have a unique number. The label shall warn the user of hazards associated with handling or using the material.

971-12.9 Storage Life: Any material stored for less than one year not meeting these requirements shall be replaced at no cost to the Department.

971-13 Fast Dry Solvent Traffic Paint.

971-13.1 General: Fast dry traffic paints intended for use under this Specification shall include products that are single packaged and ready mixed. Upon curing, these materials shall produce an adherent, reflective pavement marking capable of resisting deformation by traffic. The manufacturer shall have the option of formulating the material according to his own specifications. However, the requirements delineated in this Specification, Section 710, and FM 5-541 shall apply regardless of the type of formulation used. The material shall be free from all skins, dirt and foreign objects.

971-13.2 Composition:

Component	Test Method	Criteria
Total Solids, by weight	ASTM D 2369	minimum 75%
Pigments, by weight	ASTM D 3723	minimum 57%
Vehicle Solids, % on Vehicle*		minimum 40%
TiO_2, Type II Rutile (white paint only)	ASTM D 476	minimum 1.5 lb/gal [0.18 kg/L]
Volatile Organic Content, (VOC)	ASTM D 3960	maximum 150 g/L

971-13.3 Sharp Silica Sand: Sharp silica sand used for bike lane symbols and longitudinal lines shall meet the following gradation requirements:

Sieve Size	% Passing
20 mils [850 μm]	100
50 mils [300 μm]	0 to 10

971-13.4 Physical Requirements: The material shall meet the following criteria:

Property	Test Method	Minimum	Maximum
Density	ASTM D 1475	13.5 ∀ 0.37 lb/gal [1.62 ∀ 0.17 kg/L]	N/A
Consistency at 170EF [77EC]	ASTM D 562	80 KU	100 KU
Fineness of Grind	ASTM D 1210	2 (HS) [75 Φm]	3(HS) [65 Φm]
Dry Opacity at	Fed Std 141a	0.96	X

Property	Test Method	Minimum	Maximum
5 mils [127 Φm] WFT	Method 4121		
Bleed Ratio	Fed Spec TT-P-85D	0.95	X
Flexibility	Fed Spec TT-P-115D	Pass	X
Abrasion Resistance	961-10.6.3	Pass	X

971-13.4.1 Set To Bear Traffic Time: When applied at the temperatures and thickness specified by Section 710, the material shall set to bear traffic in not more than two minutes.

971-13.4.2 Color:

Property	White	Yellow	Black
RD* (Fed Std 141a)	minimum 87%	minimum 43%	X
Color, Visual Match (Fed Std 595a)	Color No. 37875	Color No. 33538	Color No. 37038

*After four hour ambient dry and 24 hour oven dry at 150EF [66EC].

The color of the yellow thermoplastic material shall meet the following criteria:

Initial reflectance ....43% minimum

Initial chromaticity of the cured yellow traffic paint shall fall within the area bordered by the following coordinates:

x	0.455	0.510	0.472	0.530
y	0.444	0.485	0.400	0.456

The retained color of the yellow chromaticity coordinates, shall fall with the following limits:

Chromaticity Coordinates (x,y)**:

x	0.435	0.51	0.449	0.53
y	0.429	0.485	0.377	0.456

**Chromaticity shall fall in an area bordered by these coordinates of a beaded yellow line (for the life of the Reflectivity performance when measured in accordance with Florida Test Method FM 5-541) when measured with a BYK Gardner Catalog No. 9200 Handy-Color Colorimeter or approved equal by the State Materials Office in accordance with Florida Test Method FM 5-541.

971-13.4.3 Abrasion Resistance: Test four samples per LOT using a Taber

Abrader. The paint shall be applied to specimen plates using a drawdown blade having a clearance of 26 mils [660 Φm]. Air dry each sample for 30 minutes and bake at 220EF [105EC] for 18 hours. Clean with a soft brush and weigh each sample. Abrade samples for 1,000 cycles with 1.1 lb [500 g] weights and CS-10 wheels. Clean the samples with a soft brush and weigh again. The average weight loss for the four plates shall not exceed 0.178 oz [50 mg] per plate.

971-13.5 Application Properties: Application properties shall meet the requirements of Section 710.

971-13.6 Packaging and Labeling: The traffic paint shall be placed in 55 gal [210 liter] open-end steel drums with a re-usable multi-seal sponge gasket. No more than 50 gal [190 liters] of material shall be placed in any drum to allow for expansion during transport and storage.

971-14 Glass Spheres (for Reflective Pavement Marking Striping Systems).

971-14.1 General Requirements: Glass spheres shall be of a composition designed to be highly resistant to traffic wear and to the effects of weathering for the production of a reflective surface, creating night visibility of the pavement markings without altering day visibility of the marking. The general requirements of 971-1 applies to glass spheres.

The glass spheres shall conform to the requirements of AASHTO M 247, Type I with moisture resistant coating or a formulation specified by the traffic striping material manufacture and be one of the gradation, index of refraction and formulations included on the Qualified Products List (QPL).

971-14.2 Specific Properties: The glass spheres shall have an adhesion coating that will promote adhesion and proper embedment in the binder for optimum retroreflective performance. The general requirements of AASHTO M 247 Part 2 and the folowing physical requirements apply:

Property	Test Method	Specification
Gradation	ASTM D 1214	AASHTO M 247, Type 1
Roundness	ASTM D 1155	Min: 70% true spheres by weight per sive size
Refractive Index	Becke Line Method (25+/-5 C)	1.5 minimum

971-14.3 Surface Application Spheres:

971-14.3.1 Rate of Application: The glass spheres shall be applied at the rate of 6 lb [0.7 kg] of glass spheres per gallon [liter] of pigmented binder.

971-14.3.2 Sampling: A random 50 lb [23 kg] sample of glass spheres shall be obtained for each 50,000 lb [4,600 kg] shipped. Upon arrival, the quantity of material will be reduced in a sample splitter to a size of approximately 1 qt [1 liter] by the Engineer, or one 50 lb [23 kg] unopened bag.

971-14.3.3 Containers: The spheres shall be furnished in new 50 lb [23 kg] moisture-proof bags. All containers shall meet ICC requirements for strength and type and be marked in accordance with AASHTO 247 Part 5.

971-15 Galvanizing Compound (Organic Zinc-Rich Coating) for Field Metalizing and Touch up Repair.

971-15.1 Composition and Proportions: Galvanizing compound for the metalizing of welded areas and for repairing of damaged galvanized areas shall consist of at least 80% pigment and not more than 20% vehicle, and shall meet the following composition requirements for each.

Composition of Pigment:

Zinc dust (ASTM D 520, Type II) .... minimum 99.0%

Composition of Vehicle:

Non-Volatile vehicle .... minimum 22.0%

Volatile vehicle .... maximum 78.0%

The volatile portion of the vehicle shall be completely compatible with the other ingredients of the finished product and shall yield a product conforming to all physical and chemical properties required for the end product.

971-15.2 Physical Properties:

(a) The weight of the finished product shall be at least 22 lb/gal [2.6 kg/L].

(b) The consistency of the compound, when measured at 77EF [25EC], shall be 90 to 130 Krebs Units (as measured by the Stormer Viscometer).

(c) There shall be no appreciable gassing or pressure build-up in the container when material is stored at room temperature for a three month period.

(d) The pigment component of the ready-mixed compound shall not settle when the package remains unopened for a period of one year, to the extent that it cannot be readily dispersed by hand mixing. The liquid vehicle shall not liver, curdle, or show excessive bodying.

971-15.3 Application, Drying, etc.:

971-15.3.1 Application: The material shall be capable of being applied in the manner specified, without undue difficulty, in horizontal, vertical or overhead positions, such as would be required in the repairing of galvanized areas or in the galvanizing of welds.

971-15.3.2 Drying time: The compound shall set to touch in 30 minutes and shall be dry to re-coat in 12 hours. It shall be thoroughly hard within 48 hours after application.

971-15.3.3 Dry Film Thickness (DFT): Apply to achieve DFT annotated on the Qualified Products List.

971-15.3.4 Adhesiveness: Test panels coated according to the field application specifications shall be exposed to the weather for a period of at least three months, in a position of 45 degrees to vertical, facing south. At the end of this period, the test panels shall show no visible signs of peeling or of flaking.

971-15.4 Packaging and Storing: For containers of less than 1 gal [4 L] in content, commercial paint packaging will be acceptable. For 1 gal [4 L] packages, steel pails with metal thickness of 26 gauge [455 μm] shall be used. Not more than 1 gal [4 L] of compound covered by these Specifications shall be packed in a single container.

The compound shall be stored in a location where the temperature does not drop below 45EF [7EC].

971-15.5 Test Requirements: Certified copies of manufacturer's tests, certifying that the material meets the above specifications, may be accepted in lieu of tests by the Department.

971-16 Self-Curing Inorganic Zinc Coating.

971-16.1 Materials- Certification of Tests: The producer of the paints described in this Article shall furnish to the Department three copies of a certified report outlining the paint composition characteristics specified in 971-16.2.2 and the results of the physical tests specified in 971-16.2.3.1 and 971-16.2.3.2. Final acceptance, however, will be based on test results of samples obtained after delivery of the paint to the job site. The test results must conform to the values and tolerances obtained for the products when they were initially qualified. The quality control field sample tests performed shall include the following:

(1) Infrared identification curves for zinc coating vehicle component, the intermediate coat vehicle component and the finish coat vehicle component.

(2) Weight, in pounds per gallon [kilograms per L] at 77EF [25EC], for the mixed zinc primer coat, the intermediate coat and the finish coat.

(3) Consistency, in Krebs Units at 77EF [25EC], for the mixed zinc primer coat, the intermediate coat, and the finish coat.

(4) Weight percent volatile liquid of the mixed zinc primer coat, the intermediate coat and the finish coat.

(5) Weight percent of metallic zinc in the cured zinc primer coat dry film.

(6) Weight percent of metallic zinc in the zinc pigment component.

(7) Pot life of the mixed zinc primer.

971-16.2 Testing:

971-16.2.1 General: Manufacturers or distributors seeking approval of self-curing inorganic zinc coating systems for inclusion on the qualified products list shall comply with the requirements specified below.

Approval will be granted for qualifying products upon submission of the required samples and information and after tests have verified that those products submitted for a particular coating system are satisfactory.

971-16.2.2 Information to Accompany Samples: Products submitted for approval shall be accompanied by a notarized letter giving the following information:

(1) Copies of the infrared curves (2.5 to 15 μm) for the zinc coating vehicle component, the intermediate coat vehicle and the finish coat vehicle.

(2) Weight, in pounds per gallon [kilograms per liter] at 77EF [25EC], for the mixed zinc primer coat, the intermediate coat and the finish coat.

(3) Consistency, in Krebs Units at 77EF [25EC], for the mixed zinc primer coat, the intermediate coat, and the finish coat.

(4) The theoretical number of square feet [square meters] that can be covered per gallon [4 L] to a dry film thickness of 1 mil [25 μm] for the mixed zinc primer coat, intermediate coat, and the finish coat.

(5) Total volume solids (Volatile Measurement Method) of the mixed zinc primer coat, the intermediate coat and the finish coat.

(6) Generic classification of the mixed zinc primer coat, the intermediate coat and the finish coat.

(7) Weight percent solids of the generic classified components for the zinc primer, intermediate and the finish coat vehicles.

(8) Weight percent volatile liquid of the mixed zinc primer coat, the intermediate coat and the finish coat.

(9) Weight percent of metallic zinc in the cured zinc primer coat dry film.

(10) Pot life of the mixed zinc primer.

(11) Weight percent of metallic zinc in the zinc pigment component.

(12) Application and thinning instructions.

971-16.2.3 Tests:

971-16.2.3.1 Resistance Tests: Test panels for the test described below shall be prepared by applying the inorganic zinc primer to near white metal blasted steel coupons (SSPC-SP10-63, 1 to 1.5 mil [25 to 38 µm] profile) and allowing to dry for 24 hours at 77EF [25EC] and 50% RH. The dry film thickness of the coating shall be not less than 3 mils [75 µm] nor more than 5 mils [125 µm].

(1) When tested for abrasion resistance in accordance with Federal Standard 141-a, Method 6192, using CS-17 wheels and a 1,000 g load per wheel, the cured coating shall show a maximum loss of 0.2 g per thousand cycles.

(2) The cured coating shall show no loss of adhesion or hardness and shall display no flaking or cracking when held at 600EF [315EC] for three hours.

(3) The cured film shall show no flaking, blistering, cracking or loss of adhesion after being wrapped in two 0.25 inch [6 mm] thick layers of cotton wadding and saturated with tap water for 8 hours.

(4) The cured coating, diagonally scribed to expose bare steel, when tested for salt spray resistance in accordance Federal Standard 141-a Method 6061, shall show no corrosion after 1,000 hours of test. The corrosive medium shall be a 5% sodium chloride solution.

(5) The cured coating, diagonally scribed to expose bar steel and exposed to flowing tap water at 73EF [23EC], shall show no scribe corrosion, blistering, loss of adhesion or cracking after 1,000 hours test. Test panels shall be completely immersed in a suitable container of at least 5 gal [20 L] capacity with fresh water inlet and outlet which will accomplish water change at a rate not less than 15 gal/h [57 L/h].

(6) The cured coating, diagonally scribed and completely immersed for four weeks at 73EF [23EC] in a 3% solution of aerated synthetic sea water ("Sea Salt," Lake Products Co., St. Louis, Missouri), shall show no scribe corrosion, blistering, cracking, or loss of adhesion. Aeration shall be accomplished by bubbling compressed air into the solution at a rate sufficient to accomplish moderate agitation of the liquid. At least 5 gal [20 L] of solution shall be used in performing this test.

971-16.2.3.2 Adhesion Tests: Test panels consisting of the zinc primer coat plus the tie coat, the zinc coat plus the finish coat; and the zinc primer coat plus the tie and finish coats shall be subjected to the adhesion tests described below. The zinc primer coat shall be applied as specified in 971-16.2.3.3. The tie coat application on the zinc primer-tie coat panel and the zinc primer-tie coat finish coat panel shall have a dry film thickness of 1 to 2 mils [25 to 50 µm]. The finish coat application on the zinc primer-finish coat panel and the zinc primer-tie coat-finish coat panel shall have a dry film thickness of 3 to 5 mils [75 to 125 μm]. Drying of the tie coat and the finish coat application shall be done at a temperature of 77EF [25EC] and relative humidity of 50 to 85%. All of the prepared panels shall be allowed to dry a minimum of 72 hours before proceeding with the adhesion test.

(1) No chipping, flaking or peeling of the tie coat or finished coat shall occur when cross hatches 0.06 inch [1.5 mm] apart are cut in all of the test panels.

(2) When all of the test panels cross hatched in the manner described above are tested with the point of a knife blade, no lifting of the tie coat or finish coat shall occur.

(3) Adhesion of the tie coat to the primer shall not be decreased upon application of the finish coat, and adhesion tested by knife-point shall be equivalent to that observed with the tie coat alone over the primer.

971-16.2.3.3 Field Qualification: Manufacturers or distributors seeking approval of the self-curing inorganic zinc coating system shall demonstrate the application characteristics of their products by painting approximately 500 ft^2 [50 m^2] of steel girders under a bridge selected by the Department which shall be located in a coastal salt water environment zone. The recommended zinc primer shall be applied over the entire area to be painted. A one-third section of the primed area shall be painted with tie coat and finish coat (Three Coat System). Another one-third section of the primed area shall be painted with finish coat only (Two Coat System). The field demonstration shall include the following:

(1) Steel surfaces shall be blast cleaned using 30 by 65 mesh [230 by 600 μm] silica sand to a "Near White" condition as defined in SSPC-SP10-63. The "Near White" blast condition shall be determined by use of NACE No. 2 Visual Standard TM-01-70 or equal approved by the Department. After blast cleaning, the anchor pattern shall be from 1 to 2 mils [25 to 50 μm] deep in a dense and uniform pattern of depression and ridges as determined by use of the Keane-Tator Surface Profile Comparator or equal approved by the Department.

(2) The zinc primer coat shall be applied as recommended by the manufacturer in a single application employing multiple spray "passes" to achieve a dry film thickness of 3 to 5 mils [75 to 125 μm] above the anchor pattern. The dry film thickness shall be determined by use of an Inspector Magnetic Dry Film Thickness Gauge or equal approved by the Department. Prior to use, the magnetic dry film thickness gauge shall be calibrated with NBS No. SRM 1362 certified coating thickness calibration standards. The applied coating shall be considered deficient in thickness if the measured values are found to be less than 3 mils [75 μm] plus 30% of the anchor pattern depth obtained during the abrasive cleaning operation. Products which cannot be applied to build a dense and uniform coating shall be considered unacceptable by the Department. Products which exhibit "mudcracking" after curing shall also be considered unacceptable by the Department. The zinc primer coat shall be allowed to dry a minimum of 24 hours before application of the tie coat or finish coat.

(3) The intermediate tie coat shall be applied in a single application employing multiple spray passes to achieve a dry film thickness of 1 to 2 mils [25 to 50 μm]. The color of the tie coat shall contrast with both the color of the primer coat and the color of the finish coat.

(4) The finish coat shall be applied as recommended by the manufacturer in a single application employing multiple spray "Passes" to achieve a minimum dry film thickness of 3 mils [75 µm]. The color of the finish coat shall contrast with both the color of the primer coat and the color of the intermediate coat. Finish coat products which exhibit "bubbling" or a non-uniform appearance after drying shall be considered unacceptable by the Department.

(5) The Department shall obtain a 1 qt [1 L] field sample of each product included in the application for subsequent laboratory examination by the Department's Central Laboratory.

(6) Each of the applied coating systems shall remain exposed to weathering for a period of three years at which time there shall be no evidence of blistering, cracking, peeling or loss of adhesion between coats and there shall occur not more than 1% of area rusting in each of the test sections painted.

971-17 Thermoplastic Materials for Traffic Stripes.

971-17.1 General: Upon cooling to normal pavement temperature, these materials shall produce an adherent, reflective pavement marking capable of resisting deformation by traffic. The manufacturer shall have the option of formulating the material according to his own specifications. However, the requirements delineated in this Specification, Section 711, and FM 5-541 shall apply regardless of the type of formulation used. The pigment, glass spheres, and filler shall be well dispersed in the resin. The material shall be free from all skins, dirt and foreign objects.

971-17.2 Composition:

Component	Test Method	White	Yellow
Binder		18.0% minimum	18.0% minimum
TiO_2, Type II Ructile	ASTM D 476	10.0% minimum	X
Glass Spheres	FM 1-T 250	40.0% minimum	40.0% minimum
Yellow Pigment		X	% minimum per manufacturer
Calcium Carbonate and Inert Filler (-200 mesh [-75 µm] sieve)		32.0% maximum	39.5% maximum

Percentages are by weight.

971-17.3 Glass Spheres: Glass spheres shall meet the requirements of 971-14.

971-17.4 Sharp Silica Sand: Sharp silica sand used for transverse lines, bike lane symbols and longitudinal lines shall meet the following gradation requirements:

Sieve Size	% Passing

20 [850 µm]	100
50 [300 µm]	0 to 10

971-17.5 Physical Requirements: Laboratory samples shall be prepared in accordance with ASTM D 4960 and shall meet the following criteria:

Property	Test Method	Minimum	Maximum
Water Absorption	ASTM D 570	X	0.5%
Softening Point	ASTM D 36	195EF [90EC]	X
Low Temperature Stress Resistance	AASHTO T 250	Pass	X
Specific Gravity	Water displacement	1.9	2.3
Indentation Resistance	ASTM D 2240* Shore Durometer, A2	40	75
Impact Resistance	ASTM D 256, Method A	1.0 NA m	X
Flash Point	ASTM D 92	475EF [245EC]	X

*The durometer and panel shall be at 110EF [45EC] with a 4.4 lb [2.0 kg] load applied. Instrument measurement shall be taken after 15 seconds.

971-17.5.1 Set To Bear Traffic Time: When applied at the temperatures and thickness specified by Section 711, the thermoplastic shall set to bear traffic in not more than two minutes.

971-17.5.2 Color: The white thermoplastic material shall be pure white and free from any tint. Using a Hunter tristimulus colorimeter or approved equivalent in accordance with ASTM D 4960, the material shall not show deviations from magnesium oxide color standard greater than the following:

Scale Definition	Magnesium Oxide Standard	Sample
RD	100.0%	75.0% minimum
Reflectance		
a. Red-Green	0	-5 to +5
b. Yellow-Blue	0	-10 to +10

The color of the yellow thermoplastic material shall meet the following criteria:

Initial reflectance .... 43% minimum

Initial chromaticity shall fall within the area bordered by the following coordinates:

x	0.455	0.510	0.472	0.530

x y	0.455 0.444	0.510 0.485	0.472 0.400	0.530 0.456

The retained color of the yellow chromaticity coordinates, shall fall within the following limits:

Chromaticity Coordinates (x,y)**:

x	0.435	0.51	0.449	0.53
y	0.429	0.485	0.377	0.456
**Chromaticity shall fall in an area bordered by these coordinates of a beaded yellow line (for the life of the reflectivity performance when measured in accordance with Florida Test Method FM 5-541) when measured with a BYK Gardner Catalog No. 9200 Handy-Color Colorimeter or approved equal by the State Materials Office in accordance with Florida Test Method FM 5-541.				

971-17.6 Application Properties: Application properties shall meet the requirements of Section 711.

971-17.7 Packing and Labeling: The thermoplastic material shall be packaged in suitable biodegradable or thermodegradable containers which will not adhere to the product during shipment and storage. The container of thermoplastic material shall weigh approximately 50 lb [23 kg]. The label shall warn the user that the material shall be heated in the range as recommended by the manufacturer.

971-18 Preformed Materials for Pavement Stripes and Markings.

971-18.1 General: The preformed materials for pavement stripes and markings shall consist of white or yellow weather-resistant reflective film as specified herein. The pigment, glass spheres, and filler shall be well dispersed in the resin. However, the requirements delineated in this specification, Section 709, and FM 5-541 shall apply. The material shall be free from all skins, dirt and foreign objects.

971-18.2 Composition: The preformed pavement stripes and markings shall consist of high-quality plastic materials, pigments, and glass spheres uniformly distributed throughout their cross-sectional area, with a reflective layer of spheres embedded in the top surface.

971-18.3 Skid Resistance: The surface of the stripes and markings shall provide a minimum skid resistance value of 35 BPN (British Pendulum Number) when tested according to ASTM E 303.

971-18.4 Color: The white preformed materials shall be pure white and free from any tint. Using a Hunter tristimulus colorimeter or approved equivalent in accordance with ASTM D 4960, the material shall not show deviations from magnesium oxide color standard greater than the following:

Scale Definition	Magnesium Oxide Standard	Sample
RD Reflectance	100.0%	75.0% minimum

Scale Definition	Magnesium Oxide Standard	Sample
a. Red-Green	0	-5 to +5
b. Yellow-Blue	0	-10 to +10

The color of the yellow preformed material shall meet the following criteria:

Initial reflectance .... 43% minimum

Initial chromaticity shall fall within the area bordered by the following coordinates:

x	0.455	0.510	0.472	0.530
y	0.444	0.485	0.400	0.456

The retained color of the yellow chromaticity coordinates, shall fall within the following limits:

Chromaticity Coordinates (x,y)**:

x	0.435	0.51	0.449	0.53
y	0.429	0.485	0.377	0.456

**Chromaticity shall fall in an area bordered by these coordinates of a beaded yellow line (for the life of the reflectivity performance when measured in accordance with Florida Test Method FM 5-541) when measured with a BYK Gardner Catalog No. 9200 Handy-Color Colorimeter or approved equal by the State Materials Office in accordance with Florida Test Method FM 5-541.

971-18.5 Thickness: The preformed materials shall range in thickness from 20 to 90 mils [0.508 to 2.286 mm]. The Qualified Products List will list the specified thickness of each approved product.

971-18.6 Durability and Wear Resistance: When properly applied, the preformed material shall provide neat, durable stripes and markings. The preformed materials shall provide a cushioned resilient substrate that reduces sphere crushing and loss. The film shall be weather resistant and, through normal wear, shall show no significant tearing, rollback or other signs of poor adhesion.

971-18.7 Conformability and Resealing: The stripes and markings shall be capable of conforming to pavement contours, breaks and faults under traffic at pavement temperatures recommended by the manufacturer. The film shall be capable of use for patching worn areas of the same types of film in accordance with the manufacturer's recommendations.

971-18.8 Tensile Strength: The stripes and markings shall have a minimum tensile strength of 40 psi [275 kPa] when tested according to ASTM D 638. A rectangular test specimen 6 by 1 by 0.05 [150 by 25 by 1.5 mm] minimum thickness shall be tested at a temperature range of 40 to 80EF [21 to 27EC] using a jaw speed of 0.25 inch/min [6 mm/min].

971-18.9 Elongation: The stripes and markings shall have a minimum elongation of 25% when tested in accordance with ASTM D 638.

971-18.10 Plastic Pull test: The stripes and markings shall support a dead weight of 4 lb [1.8 kg] for not less than five minutes at a temperature range of 70 to

80EF [21 to 27EC]. Rectangular test specimen size shall be 6 by 1 by 0.05 inch [150 by 25 by 1.5 mm] minimum thickness.

971-18.11 Pigmentation: The pigment shall be selected and blended to provide a material which is white or yellow conforming to standard highway colors through the expected life of the stripes and markings.

971-18.12 Glass Spheres: The glass spheres shall meet the requirements of 971-14.

The stripes and markings shall have glass retention qualities such that, when at room temperature a 2 by 6 inches [50 by 150 mm] specimen is bent over a 0.5 inch [13 mm] diameter mandrel axis, a microscopic examination of the area on the mandrel shall show no more than 10% of the spheres with entrapment by the material of less than 40%.

The bead adhesion shall be such that spheres are not easily removed when the film surface is scratched firmly with a thumbnail.

971-19 Fast Dry Traffic Paint - Water Borne.

971-19.1 General: Fast dry traffic paints intended for use under this Specification shall include water reducible products that are single packaged and ready mixed. Upon curing, these materials shall produce an adherent, reflective pavement marking capable of resisting deformation by traffic. The material shall have the capability of being cleaned and flushed from the striping machines using regular tap water and any required rust inhibitors. The manufacturer shall have the option of formulating the material according to his own specifications. However, the requirements delineated in this Specification, Section 710, and FM 5-541 shall apply regardless of the type of formulation used. The material shall be free from all skins, dirt and foreign objects.

971-19.2 Composition:

Component	Test Method	Criteria
Total Solids, by weight	ASTM D 2369	minimum 75%
Pigments, by weight	ASTM D 3723	minimum 57%
Vehicle Solids % on Vehicle*		minimum 40%
TiO_2, Type II Rutile (white paint only)	ASTM D 476	minimum 1.5 lb/gal [0.18 kg/L]
Volatile Organic Content, (VOC)	ASTM 3960**	maximum 150 g/L

* % total solids B % pigment
100 B % pigment
** excluding water

971-19.3 Glass Spheres: The glass spheres shall meet the requirements of 971-14.

971-19.4 Sharp Silica Sand: Sharp silica sand used for bike lane symbols and longitudinal lines shall meet the following gradation requirements:

Sieve Size	% Passing
20 [850 µm]	100
50 [300 µm]	0 to 10

971-19.5 Physical Requirements: The material shall meet the following criteria:

Property	Test Method	Minimum	Maximum
Density	ASTM D 1475	13.5 ∀ 1.4 lb/gal [1.62 ∀ 0.17 kg/L]	X
Consistency at 77EF [25EC]	ASTM D 562	80 KU	100 KU
Fineness of Grind	ASTM D 1210	2(HS) [75 Φm]	3(HS) [63 Φm]
Dry Opacity at 5 mils [127 Φm] WFT	Fed Std 141a Method 4121	0.96	X
Bleed Ratio	Fed Spec TT-P-85D	0.95	X
Flexibility	Fed Spec TT-P-115D	Pass	X
Abrasion Resistance	961-10.6.3	Pass	X

971-19.5.1 Set To Bear Traffic Time: When applied at the temperatures and thickness specified by Section 710, the material shall set to bear traffic in not more than two minutes.

971-19.5.2 Color:

Property	White	Yellow	Black
RD* (Fed Std 141a)	minimum 87%	minimum 43%	X
Color, Visual Match (Fed Std 595a)	Color No. 37875	Color No. 33538	Color No. 37038

*After four hour ambient dry and 24 hour oven dry at 150EF [66EC].

The color of the yellow traffic paint shall meet the following criteria:
Initial reflectance .... 43% minimum
Initial chromaticity of the cured yellow traffic paint shall fall within the area bordered by the following coordinates:

x	0.455	0.510	0.472	0.530
y	0.444	0.485	0.400	0.456

The retained color of the yellow chromaticity coordinates, shall fall within the following limits:

Chromaticity Coordinates (x,y)**:

x	0.435	0.51	0.449	0.53
y	0.429	0.485	0.377	0.456

**Chromaticity shall fall in an area bordered by these coordinates of a beaded yellow line (for the life of the reflectivity performance when measured in accordance with Florida Test Method FM5-541) when measured with a BYK Gardner Catalog No. 9200 Handy-Color Colorimeter or approved equal by the State Materials Office in accordance with Florida Test Method FM 5-541.

971-19.5.3 Abrasion Resistance: Test four samples per LOT using a Taber Abrader. The paint shall be applied to specimen plates using a drawdown blade having a clearance of 26 mils [660 µm]. Air dry each sample for 30 minutes and bake at 220EF [105EC] for 18 hours. Clean with a soft brush and weigh each sample. Abrade samples for 1,000 cycles with 500 g weights and CS-10 wheels. Clean the samples with a soft brush and weigh again. The average weight loss for the four plates shall not exceed 50 mg per plate.

971-19.6 Packaging and Labeling: The traffic paint shall be placed in 55 gal [210 L] open-end steel drums with a re-usable multi-seal sponge gasket. No more than 50 gal [190 L] of material shall be placed in any drum to allow for expansion during transport and storage.

971-20 Thermoplastic Material - Hot Spray.

971-20.1 General: This work shall consist of furnishing and applying thermoplastic material when the project requires refurbishing existing thermoplastic stripes. The requirements delineated in this Specification, Section 711, and FM 5-541 shall apply.

971-20.2 Composition:

Component	White	Yellow
Binder	25.0% minimum	25.0% minimum
TiO_2 (ASTM D 476 Type II Ructile)	10.0% minimum	X
Glass Spheres	35.0% minimum	35.0% minimum
Yellow Pigment	X	% minimum per manufacturer
Calcium Carbonate and Inert Filler (No. 200 [75 µm] sieve)	30.0% maximum	40.0% maximum

971-20.3 Binders: The manufacturer shall have the option of formulating the material according to his own specifications. However, the physical and chemical properties contained in this Specification shall apply regardless of the type of formulation used. The pigment, beads and filler shall be well dispersed in the resin.

The material shall be free from all skins, dirt and foreign objects.

971-20.4 Physical Requirements: Sample specimens shall be prepared in accordance with ASTM D 4960, 8. Procedure shall meet the following requirements:

(a) Color: The white thermoplastic material shall be pure white and free from any tint. Using a colorimeter, such as a Gardner Color Difference Meter, the material shall not show deviations from magnesium oxide color standard greater than the following:

Scale Definition	Magnesium Oxide Standard	Sample
RD Reflectance	100	75% minimum
a. Red-Green	0	-5 to +5
b. Yellow-Blue	0	-10 to +10

The initial color of the yellow thermoplastic material shall fall within the following limits:

Reflectance...43% minimum

Chromaticity Coordinates (x,y)*:

x	0.455	0.51	0.472	0.53
y	0.444	0.485	0.4	0.456

*Chromaticity shall fall in an area bordered by these coordinates for an initial beaded yellow line when measured with a BYK Gardner Catalog No. 9200 Handy-Color Colorimeter or approved equal by the State Materials Office.

The retained color of the yellow thermoplastic line chromaticity coordinates, shall fall within the following limits:

Chromaticity Coordinates (x,y)**

x	0.435	0.51	0.449	0.53
y	0.429	0.485	0.377	0.456

**Chromaticity shall fall in an area bordered by these coordinates of beaded yellow line (for the life of the reflectivity performance when measured in accordance with Florida Test Method FM 5-541) when measured with a BYK Gardner Catalog No. 9200 Handy-Color Colorimeter or approved equal by the State Materials Office in accordance with Florida Test Method FM 5-541.

(b) Water Absorption: When tested in accordance with ASTM D 570, the thermoplastic material shall contain no more than 0.5% by weight of retained water.

(c) Softening Point: When tested in accordance with ASTM D 36, the material shall have a softening point of not less than 190EF [90EC].

(d) Low temperature Stress Resistance: A test sample shall not crack or fail to adhere to a concrete substrate when tested in accordance with AASHTO T 250.

(e) Safety: The thermoplastic binder shall not emit fumes which are toxic or otherwise injurious to persons when heated at the manufacturer's recommended application temperature.

(f) Specific Gravity: The specific gravity of the material, measured by water displacement, shall be 1.87 maximum.

(g) Set To Bear Traffic Time: When applied at the temperatures and thickness specified by Section 711, the thermoplastic shall set to bear traffic in not more than two minutes.

(h) Indentation Resistance: The hardness shall be measured by a Shore Durometer, Type A2, as described in ASTM D 2240. The durometer and the panel shall be at 110EF [45EC] with a 4 lb [2 kg] load applied, the reading shall be between 30 and 5 units after 15 seconds.

(i) Impact Resistance: When tested in accordance with Method A, ASTM D 256, the average impact resistance of four separate samples shall not be less than 10 inch pound [1 N≅m].

(j) Flash Point: The thermoplastic material shall have a flash point not less than 475EF [245EC] when tested in accordance with ASTM D 92.

971-20.5 Glass Spheres: Glass spheres shall meet the requirements of 971-14.

971-20.6 Application Properties: The thermoplastic material shall readily apply and adhere to the existing traffic stripe at temperatures as recommended by the manufacturer from equipment approved by the Engineer to produce a line which shall be continuous and uniform in shape having clear and sharp dimensions at a minimum thickness as identified in the plans. No signs of moisture shall be visible on the pavement surface as determined in accordance with the binder manufacturer's recommendations.

The material, when formed into traffic stripes, must be readily renewable by placing an overlay of new material directly over an old line of the same material. Such new material shall bond itself to the old line in a manner such that no splitting or separation occurs.

Overlay stripe thickness=s shall be measured as specified in Section 711 for refurbishing of thermoplastic stripes.

971-20.7 Packing and Marking: The thermoplastic material shall be packed in suitable biodegradable or thermodegradable containers which will not adhere to the product during shipment and storage. The container of thermoplastic material shall weigh approximately 50 lb [23 kg]. The label shall warn the user that the material shall be heated in the range as recommended by the manufacturer.

971-21 Thermoplastic Materials for Raised Rib Shoulder Warning Devices.

971-21.1 General: Upon cooling to normal pavement temperature, these materials shall produce an adherent, reflective pavement marking capable of resisting deformation by traffic. The manufacturer shall have the option of formulating the material according to his own specifications. However, the requirements delineated in this Specification, Section 701, and FM 5-541 shall apply regardless of the type of formulation used. The pigment, glass spheres, and filler shall be well dispersed in the resin. The material shall be free from all skins, dirt and foreign objects.

971-21.2 Composition:

Component	Test Method	White	Yellow
Binder		18.0% minimum	18.0% minimum
TiO_2, Type II Ructile	ASTM D 476	10.0% minimum	X
Glass Spheres	FM 1-T 250	40.0% minimum	40.0% minimum
Yellow Pigment		X	% minimum per manufacturer
Calcium Carbonate and Inert Filler (-200 mesh [-75 µm] sieve)		32.0% maximum	39.5% maximum

Percentages are by weight.

971-21.3 Glass Spheres: Glass spheres shall meet the requirements of 971-14.

971-21.4 Physical Requirements: Laboratory samples shall be prepared in accordance with ASTM D 4960 and shall meet the following criteria:

Property	Test Method	Minimum	Maximum
Water Absorption	ASTM D 570	X	0.5%
Softening Point	ASTM E 28	212EF [100EC]	X
Low Temperature Stress Resistance	AASHTO T 250	Pass	X
Specific Gravity	Water displacement	1.9	2.3
Indentation Resistance	ASTM D 2240* Shore Durometer, A2	65	X
Impact Resistance	ASTM D 256, Method A	10 inch pound [1.0 NA m]	X
Flash Point	ASTM D 92	475EF [245EC]	X
*The durometer and panel shall be at least 77EF [25EC], but not exceeding 86EF [30°C] and a 4.4 lb [2 kg] load applied. After 15 seconds, the reading shall not be less than 65 units.			

971-21.4.1 Set To Bear Traffic Time: When applied at the temperatures and thickness specified by Section 711, the thermoplastic shall set to bear traffic in not more than 15 minutes.

971-21.4.2 Color: The white thermoplastic material shall be pure white and free from any tint. Using a Hunter tristimulus colorimeter or approved equivalent in accordance with ASTM D 4960, the material shall not show deviations from magnesium oxide color standard greater than the following:

Scale Definition	Magnesium Oxide Standard	Sample
RD Reflectance	100.0%	75.0% minimum
a. Red-Green	0	-5 to +5
b. Yellow-Blue	0	-10 to +10

The color of the yellow thermoplastic material shall meet the following criteria:

Initial reflectance ....43% minimum

Initial chromaticity shall fall within the area bordered by the following coordinates:

x	0.455	0.510	0.472	0.530
y	0.444	0.485	0.400	0.456

The retained color of the yellow chromaticity coordinates, shall fall within the following limits:

Chromaticity Coordinates (x,y)**:

x	0.435	0.51	0.449	0.53
y	0.429	0.485	0.377	0.456

**Chromaticity shall fall in an area bordered by these coordinates of a beaded yellow line (for the life of the Reflectivity performance when measured in accordance with Florida Test Method FM 5-541) when measured with a BYK Gardner Catalog No. 9200 Handy-Color Colorimeter or approved equal by the State Materials Office in accordance with Florida Test Method FM 5-541.

971-21.5 Application Properties: Application properties shall meet the requirements of Section 701.

971-21.6 Packing and Labeling: The thermoplastic material shall be packaged in suitable biodegradable or thermodegradable containers which will not adhere to the product during shipment and storage. The container of thermoplastic material shall weigh approximately 50 lb [23 kg]. The label shall warn the user that the material shall be heated in the range as recommended by the manufacturer.

RECYCLED MATERIALS

SECTION 972

RECYCLED PLASTIC PRODUCTS

972-1 Description.

Recycled plastic products used shall be included on the Qualified Products List. For initial approval and annually thereafter, the producer shall furnish to the State Materials Engineer a certified test report from an approved independent test laboratory that shows the material meets all specifications herein. In addition, a one year exposure test in Florida will be required.

972-2 Definitions.

972-2.1 Recycled Plastic: Those plastics composed of post-consumer material or recovered industrial material only, or both, that may or may not have been subjected to additional processing steps designed to afford products such as regrind or reprocessed or reconstituted plastics.

972-2.2 Post-Consumer Materials: Those products generated by a business or consumer that have served their intended end use and that have since been separated or diverted from solid waste for the purpose of collection, recycling, and redisposition.

972-2.3 Recovered Material: Materials and by-products that have been recovered or diverted from solid waste, but not including those materials and by-products generated from, and commonly used within, an original manufacturing process.

972-3 Materials.

The materials used for recycled plastic products shall consist of a minimum of 70% by weight of recycled plastic and shall be uniform in composition throughout the product. The products shall exhibit good workmanship and shall be free of burns, discoloration, contamination, and other objectionable marks or defects which affect appearance or serviceability. Only chemicals, including fillers and colorants, designed to inhibit photo degradation, biological/biochemical decomposition, insect infestation, or burning will be permitted to enhance durability. The use of sufficient additives to inhibit photo degradation over the lifetime of the product are required.

972-3.1 Fence Posts: The posts shall be brown, approximating tree bark, to blend with the surroundings. They shall have no cracking, chipping, flaking, peeling or splintering in the final product. The product shall contain no more than 20% voids, by weight, over its length.

972-3.2 Delineator Posts: The product shall contain no more than 51% voids, by weight, over its length.

972-3.3 Plastic Chairs and Bolsters: Plastic may either be reinforced or non-reinforced, but shall meet the following requirements for a working temperature range of 20 to 150EF [-7 to 65EC]:

Property	Requirement	Test Method
Maximum Water Absorption	0.1%	ASTM D 570 (Section 7.1, using entire component)

972-4 Physical Requirements.

972-4.1 Line Post Physical Requirements:

972-4.1.1 Minimum dimensions for line posts:

Length: 8 feet [2.5 m].

Cross-section (Round post): 4 inch [100 mm] diameter;

Cross section (Square post): 4 by 4 inch [100 by 100 mm] minimum.

972-4.1.2 Straightness: The straightness of the post shall comply with 954-5 for timber fence posts.

972-4.1.3 Flexural Strength: The post shall meet the requirements of the latest edition of the Southern Pine Inspection Bureau's Standard Grading Rules for Southern Pine Lumber for No. 2SR Stress Rated Grade Timber.

972-4.1.4 Surface Finish: The post shall exhibit a homogeneous and smooth surface finish and be relatively free of indents or other surface imperfections.

972-4.2 Delineator Post Physical Requirements:

972-4.2.1 Marking: The top of the post on the side away from traffic shall be date stamped showing the month and year of fabrication. The numerals shall be at least 2 inch [13 mm] in height and shall be either die stamped or legibly stamped with permanent ink.

972-4.2.2 Dimensions: The post shall have a minimum width of 3 inches [75 mm] facing traffic and of such length to generally provide a height of 48 inches [1.2 m] above the pavement surface.

972-4.2.3 Color: The post shall be opaque white. The yellowness index shall not exceed 12 when tested in accordance with ASTM D 1925 or ASTM E 313. The daylight 45 degree, 0 degree luminous directional reflectance shall be a minimum of 70 when tested in accordance with ASTM E 1347.

972-4.2.4 Heat Resistance: The post shall be conditioned a minimum of two hours in an oven at 140 ∀ 30EF [60 ∀ 15EC]. The conditioned post shall be capable of straightening itself within 30 seconds when bent 180 degrees at the midpoint for each of four bends. The test on each post shall be completed within two minutes of removal from oven.

972-4.2.5 Cold Resistance: The post shall be conditioned a minimum of two hours at -5 ∀ 3EF [-20 ∀ 2EC] in an environmentally controlled test chamber. Testing shall be performed in the environmental chamber.

972-4.2.6 Impact Resistance:

(1) The post shall not be adversely affected when a device approximately at the center of the post, bends the free half of the post to a 90 degree angle with the remaining section being held stationary. The post shall return to its original shape within 60 seconds for each of four separate bends.

(2) A steel ball weighing 2 pounds [0.9 kg] shall be dropped a distance of 5 feet [1.5 m] through a virtually frictionless vertical guide to impact the surface of the post. The surface of the post being struck by the steel ball shall be in a horizontal position with the post supported and held in position at both ends. The post shall be subjected to five impact tests concentrated near the middle of the post. Fracturing, cracking or splitting of the post shall constitute failure.

972-4.2.7 Impact Performance: The post, installed according to manufacturer's recommendations, shall be capable of returning to a vertical position ∀5 degrees and remain serviceable after receiving ten vehicle impacts at 55 mph [90 km/h] at a 20 degree angle. The ambient temperature must be no less than 40EF [5EC].

972-4.2.8 Resistance to Herbicides: The posts shall be sprayed or receive a coating of the herbicide(s) currently being used by the Department, and this coating shall remain on the posts for a minimum of 48 hours and then thoroughly rinsed. The posts shall show no significant change in color, flexibility, nor integrity when subjected to this herbicide exposure.

972-5 Predicted Service Life.

In-service line posts shall provide a minimum acceptable performance life of 35 years. Conditions to be considered in establishing the minimum acceptable performance life shall include, but are not limited to, the following:

a. Insect infestations, especially by fire ants and termites causing a weight reduction resulting in a loss in strength exceeding 10% of its original strength.

b. Rotting or erosion due to soil micro-organisms.

c. Any cracks, breaks or stress cracks.

d. Water uptake exceeding 10% by weight of its original weight over its predicted lifetime.

e. Non-flammability-retarded susceptibility to burning via appropriate additives.

f. Straightness as noted in 972-4.2.

The test methods to comply with the above shall be in accordance with FM 5-557.

972-6 Sampling.

One additional product per 1,000, or a minimum of one per order shall be included in the order for Department testing.

972-7 Certification.

The manufacturer shall certify that such products have been tested in accordance with this specification and found to meet the requirements. A certification shall be provided for each LOT of a shipment. The manufacturer shall also certify the following:

a. The source of the recycled plastic waste, including the state (FL, GA, etc.) from which the recycled plastic was obtained, and type of waste (consumer or industrial).

b. The total percent of recycled plastic in the final product.

Any marked property variations from the original test values for a material or evidence of inadequate field performance of a material will be considered as sufficient proof to remove the material from the Department's Qualified Products Lists.

EROSION CONTROL MATERIALS

SECTION 981

GRASSING AND SODDING MATERIALS

981-1 Seed.

981-1.1 General: The types of seed and their mixture will be specified in the Contract Documents. The separate types of seed used shall be thoroughly dry-mixed immediately before sowing.

All seed shall meet the requirements of Florida Department of Agriculture and Consumer Services and all applicable State laws, and shall be approved by the Engineer before being sown. The seed shall have been harvested from the previous year's crop. All seed bags shall have a label attached stating the date of harvest, LOT number, percent purity, percent germination, noxious weed certification and date of test.

All quantities of seed specified shall be for pure live seed. It is the responsibility of the Contractor to calculate and apply the actual pure live seed poundage based on the label attached to each bag of seed. Shipping tickets shall indicate both pure live seed weight and bulk weight for each species. When a low percentage of grass seed or wildflower seed germination causes the quality of the seed to fall below the minimum pure live seed percentage (the product of pure seed and germination) as specified below, the Contractor may elect, subject to the approval of the Engineer, to increase the rate of application sufficiently to obtain the minimum germination rate specified. No payment will be made for the added seed.

981-1.2 Grass Seed: Each of the species or varieties of seed shall be furnished and delivered in separate labeled bags. During handling and storing, the seed shall be cared for in such a manner that it will be protected from damage by heat, moisture, rodents and other causes.

All permanent and temporary grass seed shall have been tested within a period of six months of the date of planting.

All permanent and temporary grass seed shall have a minimum percent of purity and germination as follows:

All Bahia grass Seed shall have a minimum pure seed content of 95% with a minimum germination of 80%.

Bermuda grass Seed shall be of common variety with a minimum pure seed content of 95% with a minimum germination of 85%.

Annual Type Ryegrass Seed shall have a minimum pure seed content of 95% with a minimum germination of 90%.

981-2 Sod.

981-2.1 Types: Unless a particular type of sod is called for, sod may be of either centipede, bahia grass, or bermuda grass at the Contractor's option. It shall be well matted with roots. Where sodding will adjoin, or be in sufficiently close proximity to, private lawns, other types of sod may be used if desired by the affected property owners and approved by the Engineer.

981-2.2 Dimensions: The sod shall be taken up in commercial-size rectangles, or rolls, preferably 12 by 24 inch [300 by 600 mm] or larger, except where 6 inch [150 mm] strip sodding is called for, or as rolled sod at least 12 inches [300 mm] in width and length consistent with the equipment and methods used to handle the rolls and place the sod. Sod shall be a minimum of 13 inch [32 mm] thick including a : inch [18 mm] thick layer of roots and topsoil. Reducing the width of rolled sod is not permitted after the sod has been taken up from the initial growing location. Any netting contained within the sod shall be certified by the manufacturer to be bio-degradable within a period of three months from installation.

981-2.3 Condition: The sod shall be sufficiently thick to secure a dense stand of live grass. The sod shall be live, fresh and uninjured, at the time of planting. It shall have a soil mat of sufficient thickness adhering firmly to the roots to withstand all necessary handling. It shall be free of noxious weeds and seeds. It shall be planted as soon as possible after being dug and shall be shaded and kept moist from the time it is dug until it is planted. The source of the sod may be inspected and approved by the Engineer prior to being cut for use in the work. After approval, the area from which the sod is to be harvested shall be closely mowed and raked as necessary to remove excessive top growth and debris.

Approved devices, such as sod cutters, shall be used for cutting the sod and due care shall be exercised to retain the native root soil intact.

No sod which has been cut for more than 72 hours may be used unless specifically authorized. A letter of certification from the grassing Contractor as to when the sod was cut, and what type shall be provided to the Engineer upon delivery of the sod to the job site.

981-3 Mulch.

The mulch material shall be dry straw or hay, consisting of oat, rye, or wheat straw, or of pangola, peanut, coastal bermuda or bahia grass, hay or compost; and shall be free from noxious weeds and plants. Any plant officially listed as being noxious or undesirable by any Federal Agency, any agency of the State of Florida or any local jurisdiction in which the project is being constructed shall not be used. Furnish to the Engineer, prior to incorporation onto the project, a certification from the Florida Department of Agriculture and Consumer Services, Division of Plant Industry, stating that the Mulch materials are free of noxious weeds. Any such noxious plant or plant part found to be delivered as mulch will be removed by the Contractor at his expense and in accordance with the law. Only undeteriorated mulch which can readily be cut into the soil shall be used. The Aair-dry≅ weight (as defined by the Technical Association of the Pulp and Paper Industry, for wood cellulose) shall be marked on each package by the producer.

981-4 Source Requirements for Sod and Mulch.

The Contractor shall comply with all current restrictions in regard to movement of sod and mulch material, into or within areas which are outside of quarantine boundaries for the white fringed beetle, witchweed, and West Indian sugar cane borer weevil, as issued by the Division of Plant Industry, Florida Department of Agriculture and the Animal and Plant Health Inspection Services, U.S. Department of Agriculture.

SECTION 982

COMMERCIAL FERTILIZER

982-1 Commercial Fertilizers.

Commercial fertilizers shall comply with the State fertilizer laws.

The numerical designations for fertilizer indicate the minimum percentages (respectively) of (1) total nitrogen, (2) available phosphoric acid, and (3) water-soluble potash, contained in the fertilizer.

The chemical designation of the fertilizer shall be 16-4-8. At least 50% of the phosphoric acid shall be from normal super phosphate or an equivalent source which will provide a minimum of two units of sulfur. The amount of sulfur shall be indicated on the quantitative analysis card attached to each bag or other container.

SECTION 983

WATER FOR GRASSING

The water used in the grassing operations may be obtained from any approved source. The water shall be free of any substance which might be harmful to plant growth. Effluent water shall meet all Federal, State and local requirements.

SECTION 985

GEOTEXTILE FABRICS

985-1 Fabric.

985-1.1 General: Geotextiles shall be woven or nonwoven fabrics which allow the passage of water. Impermeable liners and biodegradable fabrics are not included in this specification. Fabrics used in pavement rehabilitation and waterproofing are included in Sections 356 and 518.

985-1.2 Application: The applications of geotextile fabrics are divided into the following three main classes:

1. Drainage- under all rubble riprap, including cyclopean stone and under gabions; wrapped around drains, pipe joints, and edge-drains; filter behind walls, etc.
2. Erosion Control- silt fence and staked silt barrier
3. Stabilization- separator between embankment and soft subsoil, reinforcement and pipe bedding.

985-2 Physical Requirements.

Except when restricted in the plans or specifications, the geotextile fabric shall be a woven or non woven fabric consisting of long-chain polymeric filaments or yarns such as polypropylene, polyethylene, polyester, polyamides or polyvinylidene choloride formed into a stable network such that the filaments or yarns retain their relative position to each other. The base plastic shall contain stabilizers and/or inhibitors to make the filaments resistant to deterioration due to ultra-violet light (except for subsurface and stabilization classification), heat exposure and potential chemically damaging environment. The fabric shall be free of any treatment which may significantly alter its physical properties. The edges of the fabric shall be selvaged or otherwise finished to prevent the outer yarn from pulling away from the fabric. The fabric shall conform to the physical requirements on Roadway and Traffic Design Standards, Index No. 199 according to its application.

In addition to the physical requirements, the fabric shall be wrapped in a protective covering which is sufficient to protect it from sunlight, dirt, and other debris during shipment and storage.

985-3 Overlaps and Seams.

Overlaps shall be as specified in the plans, specifications, or Roadway and Traffic Design Standards for each particular application. In order to reduce overlaps, the geotextile fabric may be sewn together. Seams of the fabric shall be sewn with thread meeting the chemical requirements and minimum seam strength requirements given for the fabric and application as shown on Roadway and Traffic Design Standards, Index No. 199.

985-4 Certification.

The Contractor shall furnish two certified copies of a test report from the manufacturer certifying that the geotextile to be incorporated into the completed project meets the requirements of this Specification. The certified test reports shall be attested to be a person having legal authority to bind the manufacturing company. The Contractor shall also furnish two (4 by 8 inch) [(100 by 200 mm)] samples of the geotextile for product identification. In addition, the manufacturer shall maintain test records as required by this Specification. These records shall be made available to the Department upon request.

SECTION 986

CALCIUM CHLORIDE FOR DUST CONTROL

986-1 Calcium Chloride.

Calcium chloride shall meet the requirements of AASHTO M 144.

From each shipment of calcium chloride a 1 quart [1.0 L] sample shall be submitted for testing purposes to the Department's State Materials Engineer. The sample shall be in a tightly sealed container.

In obtaining the sample from the bag, the following procedure must be used: A cut, 4 or 5 inches [100 or 125 mm] in length, is made in the side of the bag. The outer layer of the material is set aside and the sample taken from at least 6 inches [150 mm] from the outside of the bag. The containers must be sealed immediately.

986-2 Water for Dampening.

The water for dampening the surface ahead of the application of the calcium chloride shall be reasonably clean, and shall be free from suspended matter.

SECTION 987

FINISH SOIL LAYER MATERIALS

987-1 Description.

All material shall be suitable for plant growth. The organic matter content of the finish soil layer after mixing shall be a minimum of 10% and a maximum of 50% as determined in accordance with AASHTO T 267 and shall be created using any of the following materials.

987-2 Materials.

Finish soil layer materials may be obtained from either, or a combination of, the following sources:

(1) Excavation within the limits of construction on the project. Such material may be stockpiled or windrowed on the project in areas approved by the Engineer.

(2) Designated borrow pits for the project.

(3) From other sources of organic soil materials provided by the Contractor.

987-2.1 Organic Soil: This may consist of muck, mucky peat and peat and shall have an organic matter content of 18% or more with 60% or more clay, or 12% or more organic matter with 0% clay.

987-2.2 Topsoil: The uppermost part of soil from 0 to 10 inches [0 to 250 mm], frequently designated as the Aplow layer≅ or the layer moved during cultivation, presumably fertile and suitable for plant growth.

987-2.3 Compost: Meet the requirements of Florida Department of Environmental Protection Rule 62.709.550 Type Y (yard waste), Type YM (yard waste and manure), Type A (municipal solid waste compost) or Rule 62.640.850 Type AA (composted biosolids) and have unrestricted distribution.

987-2.3.1 Compost for use as a Soil Amendment: If the electrical conductivity (EC) value of the compost exceeds 4.0dS (mmhos/cm) based on the saturated paste extract method, the compost shall be leached with water prior application.

987-2.3.2 Compost for use as a Mulch: The compost shall contain no foreign matter, such as glass, plastic or metal shards. The compost shall be slightly coarse to coarse in nature (over half of the solids shall be from particles 2 inch [12 mm] in size and no greater than 6 inches [150 mm]). Preference shall be given to compost or mulch made from uncontaminated woody waste materials.

TRAFFIC CONTROL MATERIALS

SECTION 992

HIGHWAY LIGHTING MATERIALS

992-1 Basic Design Criteria.

992-1.1 General: Unless otherwise specified in the plans or the specifications, the light poles and bracket arms shall be in accordance with the requirements of the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals, and with the specific requirements contained in this Section.

992-1.2 Wall Thickness of Steel Poles: The minimum wall thickness for galvanized steel poles shall be 0.1196 inch (11 gauge) [3 mm].

992-1.3 Design Calculations: The Contractor shall submit for approval, design calculations of the light poles (including bracket arms) and anchor bolts.

992-1.4 Light Pole Assembly: The light pole assembly shall conform to the applicable requirements of IES, EEI, and NEMA (Illuminating Engineering Society, Edison Electric Institute, and National Electrical Manufacturers Association).

992-2 Light Poles.

992-2.1 Galvanized Steel: Unless otherwise shown, galvanized steel light poles shall be 1 piece, continuous-tapered, round or octagonal poles and shall be manufactured from one length of steel sheet, formed in continuous tapered tube, with one continuous arc-welded vertical seam. They shall be galvanized in accordance with ASTM A 123 [ASTM A 123M].

992-2.2 Aluminum: Aluminum light poles shall be 1 piece, continuous-tapered, round or octagonal shaft, of high-strength, corrosion-resistant aluminum, and of approved alloy meeting the requirements for the design as specified in 992-1.

992-2.3 Length: The poles shall be of such length as to provide the approximate luminaire mounting height shown in the plans or directed by the Engineer.

992-2.4 Bases: Anchor base poles shall have a wiring hand hole with a weatherproof metal cover near the base, with a grounding lug located inside the pole near the hand hole. Transformer base poles shall have a grounding lug in the transformer base. A heavy cast base shall be attached to the lower end of each shaft by a continuous arc weld, inside and outside of the shaft, or by a combination of arc welding and a press fit, subject to the approval of the Engineer. The base shall be arranged for anchoring to a transformer base or a concrete foundation with four anchor bolts 1 inch [25 mm] (minimum size), unless otherwise shown in the plans.

992-2.5 General: The lighting pole assembly shall conform to the applicable requirements of IES, EEI and NEMA. The base shall be provided with the necessary anchorage, hardware, and bolt covers. An ornamental cap shall be provided to fit over the top of the pole to exclude moisture. All poles not located behind guardrail or bridge rail, or that are not wall mounted, shall be frangible, except as shown in the plans.

992-3 Bracket Arms.

Steel or aluminum bracket arms shall be of truss-type construction, consisting of upper and lower members with vertical struts, and shall have the luminaire end formed to accommodate a 2 inch [50 mm] pipe slipfitter. The bracket arms shall meet the design requirements of 992-1. Bracket arms shall be attached to either steel or aluminum poles, with machine bolts and pole adapters, unless approved otherwise.

Steel bracket arms shall be used with steel standards, and aluminum bracket arms shall be used with aluminum standards.

Steel brackets shall be galvanized in accordance with ASTM A 123 [ASTM A 123M].

992-4 Luminaires, Ballasts, etc.

Luminaires shall consist of a precision-cast aluminum housing and reflector holder, a refractor-holder latch on the street side, and a hinge with a safety catch on the house side of the luminaire; also a slipfitter suitable for attaching to a 2 inch [50 mm] mounting bracket, gasketing between the reflector and the refractor and the socket entry, an adjustable bracket capable of producing the specified IES type light distributions, and a heat-resistant, high-transmission glass prisomatic refractor. Luminaires may be mercury vapor, metal halide, or high pressure sodium vapor, as indicated in the plans.

Unless otherwise indicated in the plans, the luminaires shall have internal ballasts of the regulated output (constant wattage) type, suitable for operating on the circuits shown in the plans. The ballasts shall be pre-wired to the lamp socket and terminal board, requiring only connection of the power-supply leads to the ballast primary terminals. The efficiency of the ballast shall be at least 84% and the power factor shall be at least 95%. The ballast shall provide for regulation within ∀2% variation in lamp watts and a primary voltage variation of ∀10%.

The luminaires shall meet the requirements shown in the plans.

992-5 Conductors.

The conductors shall be color-coded and, unless otherwise shown in the plans, the conductors shall be as called for below.

Service conductors shall be stranded copper, single-conductor cable, Type RHW or THW and shall not be smaller than No. 6 AWG.

Direct-burial cable shall meet the same classification requirements as the service conductors except it shall be approved for direct burial.

Pole and bracket cable shall be a stranded cable, Type RHW or THW, and shall not be smaller than No. 10 AWG.

Roadway lighting cable shall meet the same classification requirements as the service conductors.

Underdeck structure lighting conductors shall be Type RHW or THW and shall not be smaller than No. 12 AWG.

Bonding ground conductor shall be bare (or have a green jacket) and shall be No. 6 AWG or larger.

992-6 Conduit.

992-6.1 General: Conduit shall, in general, be rigid steel. Polyvinyl-chloride conduit may be used in lieu of rigid steel when the conduit is embedded in concrete, and elsewhere if called for or if specifically approved by the Engineer.

992-6.2 Rigid Steel: Rigid steel conduit shall be hot-dip galvanized and each 10 foot [3 m] length shall carry the Underwriter's seal of approval.

992-6.3 Polyvinyl-Chloride: Polyvinyl-chloride conduit shall be high-impact, Schedule 40, and each 10 foot [3 m] length shall carry the Underwriter's seal of approval.

992-6.4 Electrical Grounds: The electrical ground rods shall be made of corrosion-resistant clad steel or other material as may be permitted by the plans or approved by the Engineer.

992-7 Ducts.

992-7.1 Type I Duct: Type I duct is a light wall duct. It shall be made by a recognized manufacturer, specifically for use in concrete-encased electrical duct work. The duct material may be asphalt-impregnated fibers or a plastic material such as styrene. The joints shall be watertight and the bore smooth. The concrete encasement shall be of Class I Concrete, at least 3 inches [75 mm] in thickness.

992-7.2 Type II Duct: Type II duct is a heavy wall duct, which shall be made by a recognized manufacturer, specifically for use as a direct-burial duct. The materials and workmanship shall be as noted for Type I duct but the walls shall be thicker to withstand the greater pressure and impact.

992-8 Fittings, Pull-boxes, and Bends.

Fittings, pull-boxes, bends and miscellaneous hardware shall be in accordance with the National Electrical Code and shall be compatible with the adjacent conduit and materials.

992-9 Wooden Service Poles.

992-9.1 General: Wooden service poles shall meet the requirements of ANSI (ASA) and shall be at least 35 feet [10.7 m] in length. The pole shall be Class 5 unless otherwise specified on the plans or in the specifications.

992-9.2 Treatment: Poles shall be treated in accordance with ASTM D 1760, Pressure Treatment of Timber Products, with the exceptions and additions as specified herein. Pressure treatment shall be with creosote oil, pentacholorophenol solution, or salt preservative meeting the requirements of 955-4 with the restriction that poles treated with pentachlorophenol solution shall not be used in a salt water nor brackish water environment.

992-9.3 Retention of Preservative:

992-9.3.1 Creosote Oil: Retention shall be at least 9 lb/ft^3 [144 kg/m^3] of wood.

992-9.3.2 Pentachlorophenol Solution: Minimum retention shall be 0.45 pound [7.2 kg] of dry pentachlorophenol chemicals per cubic foot [cubic meter] of wood.

992-9.3.3 Salt Preservative (Chromated Copper Asenate): Minimum retention shall be 0.60 pound [9.6 kg] of CCA oxide per cubic foot [cubic meter] of wood.

992-9.3.4 Measuring Retention: With all preservatives, retention shall be by assay of sample from the 0.50 to 2.00 inch [13 to 50 mm] zone, performed and certified to by the treating company.

992-9.4 Penetration of Preservative:

992-9.4.1 Determination: Penetration shall be determined as specified in 955-6.4.

992-9.4.2 Sapwood Penetration: Sapwood penetration shall be as specified in 955-6.2.

992-9.5 Retreatment: Retreatment, when necessary, shall be as specified in 955-6.3.

992-9.6 Mounting Height: Mounting height of all equipment and lines shall meet the requirements of the latest edition of the National Safety Code, the local ordinances, and the specifications of the connecting utility.

992-10 Protection of Light Poles.

Each metal pole shall be appropriately and adequately protected by "tire wrapping" with heavy paper, or by some other effective means, so that no chipping, gouging, or other significant surface damage will be incurred during transit or installation. The poles, when installed, shall be clean and uniformly free from dark streaks and discoloration.

992-11 Concrete Foundations for Light Poles.

The concrete foundations for the light poles shall be of Class I concrete unless otherwise shown in the plans. They may be either precast or cast-in-place. The foundation design shall be as recommended by the pole manufacturer and as approved by the Engineer.

992-12 Pole Cable Distribution System.

992-12.1 Conductor Splices: Unless otherwise authorized by the Engineer, splices shall be made with split bolt connectors. The connector shall be sealed in silicone gel that easily peels away leaving a clean connection. The gel will be contained in a closure that when snapped around the split bolt will provide a waterproof connection without the use of tools or taping. This closure will be UV resistant, impact resistant and abrasion resistant.

992-12.2 General (Roadway Lighting): These requirements are applicable for all systems rated up to and including 600 V.

A modular color coded cable system consisting of rubber cords with integrally molded watertight submergible connectors, inline fuses, submergible surge arrestor and breakaway connectors shall be installed. The cables shall extend from a underground junction box near the base of the pole to the luminaires at the top of the pole. A cable system shall be required at each pole.

The cable system shall consist of the following described components:

Distribution Block: The red molded body shall contain a three wire female outlet integrally molded to a 24 inch [600 mm] length of 12/3 SOWA cable with an end molded to the body and the other end shall be spliced in the field to the distribution cable that feeds through the underground junction box near the base of the pole. The block shall be watertight and submergible when the integrally fused plug on the power cable is engaged and fully seated. Dimensions shall be approximately 2 by 3 by 3 inches [50 by 75 by 75 mm]. The size is important because of limited space.

Surge Arrestor Cable: Provide a 12 inch [300 mm] length of 10/2 SOWA cable with a red male plug to match the red female connector cable extending from the fused plug on the power cable. The other end of the surge arrestor cable shall be integrally molded to a MOV submergible surge arrestor. The red male plug shall make a submergible connection when mated to the red female connector on the power cable.

Power Cable: This cable feeds the Luminaire Cable and the Surge Arrestor Cable from the load side of its integrally fused red male plug end. The red fused plug shall contain FNQ 10 amp 600 volt fuses (13/32 by 12 inch) [(10 by 40 mm)] or equal. A solid copper slug shall be installed on neutral side for line to neutral service. Both lines shall be fused for line to line service. The section that feeds the Luminaire Cable shall be a 10 foot [3 m] section of 14/3 SOWA cable with an orange female connector molded to the end extending up into the base of the pole. This female connector shall pass easily through a standard size 35 PVC elbow and make a submergible connection when mated with the orange male plug on the Luminaire Cable. The section that feeds the Surge Arrestor Cable shall be 12 inches [300 mm] in length of 10/2 SOWA cable with a red female connector on the end. The red female connector shall make a submergible connection when mated to the red male plug on the Surge Arrestor Cable.

Luminaire Cable: This cable is a variable length of 14/3 SOWA cable with an orange male molded plug molded to match the orange female end of the Power Cable. The connector shall require 25 pounds [100 N] of force to mate or disengage from the female end. When engaged, the connection shall be watertight and submergible. The cable strain relief shall extend approximately 2 inches [50 mm] from the connector. The length of the cable shall be the length of the pole and support arm plus 5 feet [1.5 m].

The Distribution Block and each connector shall be made of thermosetting synthetic polymer which is non-flame supporting and which remains flexible over a temperature range of !40 to 190EF [!40 to 85EC]. Hardness of the molded rubber shall be 65 durometer.

992-12.2.1 Testing and Performance Criteria: The system shall pass the following performance criteria in accordance with NEC 110-2:

Dielectric Test - No breakdown shall occur with a test potential of 1,960 volts applied between the primary conductors (tied together) and the protective ground for a period of one minute.

Leakage Current Test - Leakage current shall be measured on the mated connectors between the primary conductors and the protective ground conductor. When tested at the rated operating voltage, the leakage current shall not exceed 0.5 mA. The mated connectors shall then be wrapped in aluminum foil and the leakage current measured between the primary conductors and the foil wrap. When tested at the rated operating voltage, the leakage current shall not exceed 0.5 mA.

Flame Retardant Test - Flammability tests shall be conducted on the cable, the molded body of the connectors, and the molded protective caps. These materials shall be subjected to five flame applications on for l5 seconds and off for l5 seconds. The materials shall self-extinguish within one minute upon removal of the flame and not burn through.

Internal Temperature Test - The internal temperature rise of the contact area of the mated connectors shall not exceed a temperature rise of 54EF [12EC] referenced to 73EF [23EC] ambient temperature when operated at the maximum current rating.

External Temperature Test - The external temperature rise of the mated connectors and cable shall not be greater than 54EF [12EC] referenced to 73EF [23EC] ambient temperature when operated at the maximum current rating.

Fault Test - The mated connectors shall be fault tested by applying a test current of .l000 amperes, 60 HZ, for a minimum of 3 cycles (50 ms). The mated connectors shall then satisfactorily pass the dielectric test.

Drop Test - The connectors shall not break, crack or suffer other damage when subjected to eight consecutive drop tests from 3 feet [1 m] above the concrete floor with the connectors having been rotated 45 degrees between each drop.

Crushing Test - No breakage or deformation shall result when the mated and unmated connectors are subjected to a crushing force of 500 pounds [2.2 kN] for one minute. Following the crush test, the dielectric test shall be satisfactorily passed.

Impact Resistance Test - No breakage or deformation shall result when the connectors are subjected to an impact caused by dropping a cylindrical 10 pound [4.5 kg] weight having a flat face 2 inches [50 mm] in diameter from a height of 18 inches [450 mm].

Flex Test - No detachment or loosening shall result when each connector is subjected to a 5,000 cycle flex test at the cable/bond area back and forth in a plane through an angle of l80 degrees. Following the flex test the dielectric test shall be satisfactorily passed.

No Load Endurance Test - No excessive wear shall result when the male and female connectors and protective cap and female connector were subjected to 2,000 cycles of complete insertion and withdrawal.

Rain Test - The mated and capped connectors shall be subjected to a continuous water spray (simulating worst case outdoor rain down pour) for at least one hour at a rate of at least 18 inches [450 mm] per hour at an operating pressure of 5 psi [34 kPa]. The dielectric and leakage current tests shall be satisfactorily passed. The connectors shall be unmated and caps removed. Inspection shall indicate that water had been successfully prevented from reaching the contact areas of the connectors.

Watertight (Immersion) Tests - The mated and capped connectors shall be immersed in water for one hour in which the highest point of the test samples is at least 3 feet [1 m] below the water level. Immediately following the immersion, a satisfactory dielectric and leakage current tests shall be performed. The connectors shall be unmated and caps removed. Inspection shall indicate that water had been successfully prevented from reaching the contact areas of the connectors.

Exposure to Deteriorating Liquids - The cable and connectors shall be dried at 212EF [100EC] for one hour. The samples shall then be immersed in ASTM Reference Oil No. l and ASTM Reference Fuel C liquids for one hour. The samples shall show no evidence of bubbling, cracking or corrosion. Within one hour after being removed from the fluids, the test samples shall satisfactorily pass the flammability test.

992-12.3 General (Highmast Lighting): These requirements are applicable for all systems rated up to and including 600 V.

A modular cable system consisting of rubber covered cables with watertight connectors, and surge arrestor shall be installed. The cables shall extend from an underground junction box near the base of the pole to the luminaires at the top of the pole. A cable system shall be required at each highmast pole.

Power Cable: This cable shall be a 15 foot [4.6 m] section of 10/3 SOWA cable that is wired to the line side of the Circuit Breaker in the pole and the other end shall be spliced to the distribution cable that feeds through the underground junction box near the base of the pole.

Circuit Breaker Cable: This cable is a 8 foot [2.4 m] length of 10/3 SOWA cable with no connector at the end that is fed from the load side of the circuit breaker and a female connector on the other end. This female connector shall mate with the male plug on the pole cable, the male flanged receptacle on the ring junction box, and also the male plug on the lowering hoist.

Pole Cable: The length of this cable is the mounting height of the pole plus 6 feet [1.8 m]. The cable shall be 10/3 SOWA with a male plug on one end that mates with the connector on the circuit breaker cable. The other end fits under the lugs in junction box mounted on the fixture ring at the top of the pole.

Junction Box Cable: This cable is a 3 foot [1 m] length of 10/3 SOWA cable with a female connector on one end that fits the male flanged receptacle on the ring mounted junction box. The other end shall fit under the same lugs as the pole cable.

Junction Box Male Flanged Receptacle: This male flanged receptacle shall mate with the junction box cable. The back of the flanged receptacle shall be wired to the fixture bus in the junction box.

The plugs, connectors and receptacles in the highmast system shall meet the requirements of NEMA 6 or IP 67.

Surge Arrestor: The surge arrestor shall be installed in the circuit breaker panel.

SECTION 993

HIGHWAY DELINEATORS

(Including Posts and Attachments)

993-1 Type A Delineators.

993-1.1 Reflectors: The reflectors for these alternate delineators shall be of acrylic plastic and shall be a minimum of 3 inches [75 mm] in diameter. They shall be mounted in a heavy-duty housing with a back plate.

The reflector shall consist of a clear and transparent plastic lens, which shall be colorless or amber as specified, and a plastic back of the same material, fused to the lens under heat and pressure around the entire perimeter, in such manner as to form a homogeneous unit, permanently sealed against dust, water, and water vapor.

The lens shall consist of a smooth front surface, free from projections or indentations (other than for identification or orientation) and a rear surface bearing a prismatic configuration such that it will effect total internal reflection of light.

The acrylic plastic shall be of a type meeting the requirements of Federal Specification L-P-380, Type I, Class 3, and, in order that the Department can readily check the suitability of the raw material used, the manufacturer shall stipulate the raw material and the particular molding compound to be furnished.

The reflector element shall meet the test requirements specified below.

993-1.2 Durability Tests For Type A Reflectors:

(a) Seal Test: The following test will be used to determine if a reflector is adequately sealed against dust and water.

Submerge 50 samples in water bath at room temperature. Subject the submerged samples to a vacuum of 5 inches gauge [17 kPa gauge] for five minutes. Restore atmospheric pressure and leave samples submerged for five minutes, then remove and examine the samples for water intake. Failure of more than two of the 50 samples tested shall be cause for tentative rejection of the LOT.

In the event of such tentative failure of more than two of the 50 samples tested, a re-sample of the 100 reflector shall be checked-tested. If not more than four of these 100 samples fail then the LOT will be considered as acceptable.

(b) Corrosion Test: The reflector assembly shall withstand the combined corrosion test set forth in ASTM B 117.

993-1.3 Optical Requirements:

993-1.3.1 Definitions: The term, "Entrance Angle," designates the angle at the reflector between the direction of light incident on it and the direction of the reflector axis.

The term, "Observation Angle," designates the angle at the reflector between the observer's line of sight and the direction of light incident on the reflector.

The term, "Specific Intensity," designates the candle-power [candelas] returned by a reflector at the specific observation angle, for each foot-candle [lux] of illuminance at the reflector.

993-1.3.2 Specific Intensity: The specific intensity of every reflex reflector intended for use in the delineators shall be at least equal to the minimum values shown below. Failure to meet the required specific intensity shall constitute failure of the reflector being tested. Failure of more than two reflectors out of 50 subjected to test shall constitute failure of the entire LOT.

Observation Angle	Entrance Angle	Specific Intensity candle-power/foot-candle [(cd/lx)]	
		Crystal	Yellow
0.1 degree	0 degree	40 [3.7]	24 [2.2]
0.1 degree	20 degree	16 [1.5]	10 [0.93]

993-1.3.3 Optical Testing Procedure: The reflex reflector to be tested shall be spun so as to have an average orientation effect, and shall be placed at a distance of 100 feet [30 m] from a single light source having an effective diameter of 2 inches [50 mm]. The light source shall be operated at approximately normal efficiency. The return light from the reflector shall be measured by means of a photo-electric photometer having a minimum sensitivity of 1 by 10^{-7}foot-candles [1.1 by 10^{-6} lx] per mm scale division. The photometer shall have a receiving aperture of 2 inch [13 mm] diameter, shielded to prevent the entry of stray light. The distance from light source center to aperture center shall be 2.1 inches [53 mm] for the 0.1 degree observation angle.

If a test distance other than the stipulated 100 feet [30 m] is used, the source and the aperture dimensions, and the distance between source and aperture shall be modified directly as the test distance.

993-1.4 Delineator Element: The delineator element shall consist of a reflector element mounted in a housing fabricated of aluminum alloy No. 3003-H 14 (or other alloy approved as equal for the purpose), or of heavy thickness, cold-rolled, hot-dip, galvanized steel, and having a thickness of 0.064 inch [1.6 mm].

After all fabrication has been completed, the aluminum housing shall be treated with Alodine 1200, Iridite 14-2, Bonderite 721, or equal product, in accordance with the recommendations of the manufacturer of the particular treatment used.

993-1.5 Assembly: The attachment of the delineator to the housing and of the housing to the post shall be by such method that no mounting hole is required in the delineator; also, that the delineator can be easily removed from the post with proper tools but that such removal is not possible without the use of such tools.

The mounting holes shall be sized to receive 3 inch [6 mm] carriage bolts, or other 3 inch [6 mm] bolts, and shall be spaced to fit holes on the posts spaced at 1 inch [25 mm] centers.

993-2 Type C Delineators.

993-2.1 Reflective Sheeting: The reflective sheeting for these alternate delineators shall conform with the requirements of 994-2, sheeting Types III-A, III-B, III-C and III-D. The delineators shall be 4 by 4 inch [100 by 100 mm] or 4 by 8 inch [100 by 200 mm] with the reflective sheeting permanently adhered to 0.040 inch [1.0 mm] sheet aluminum of 6061-T6 (ASTM B 209) [(ASTM B 209M)] prepared in accordance with recommendations of the sheeting manufacturer.

993-2.2 Assembly: The attachment of the delineator directly to the post shall be by two holes on the face of the delineator.

The mounting holes shall be 3 inch [6 mm] square holes to receive 3 inch [6 mm] carriage bolts, or other 3 inch [6 mm] bolts and shall be spaced to fit holes on the post spaced at 1 inch [25 mm] centers.

993-3 Delineator Posts and Accessories.

The delineator posts shall be of steel or aluminum as shown in the plans and of the alloys called for. They shall have the necessary holes for attachment of the delineator housing.

The assembly shall be furnished with the necessary bolts, nuts and washers for attaching to the posts.

993-4 Insulating Materials.

Neoprene, for the separating of aluminum parts and steel parts, shall contain at least 60%, by volume, of pure neoprene. Other approved material may be used, subject to the requirement that the material shall meet the approval of the Engineer as to pliability and ability to withstand wear caused by stretching or distortion.

If other material or method is proposed for use as insulation, it shall be indicated along with any details necessary.

Additional materials specifications are shown in the plans.

993-5 Reflector Units for Guardrail.

993-5.1 General: Reflector units for use on guardrail installations shall consist of a hermetically sealed acrylic plastic prismatic reflex reflector.

993-5.2 Reflector Element: The reflectors shall be of acrylic plastic meeting the requirements of Federal Specification L-P-380, Type I, Class 3. The manufacturer shall stipulate the raw material used in the compound in order that the Department may readily check the suitability of the raw material.

The reflector shall consist of a clear transparent, or translucent amber plastic face, herein referred to as the lens, with a heat sealable plastic coated metallic foil back fused to the lens under heat and pressure around the entire perimeters of the lens to form a unit permanently sealed against dust, water and water vapor.

The reflector lens shall consist of a smooth front surface, free from projections or indentations and the necessary identification markings, and a rear surface having a prismatic configuration such that it will affect total internal reflection of light.

When the reflectors are tested as specified in 993-1.3 for Type A Delineators, the specific intensity of the colorless reflectors shall not be less than 119 at 0 degree entrance angle and not less than 47 at 20 degree entrance angle, and the specific intensity of the amber reflectors shall be not less than 71 at 0 degree entrance angle and not less than 28 at 20 degree entrance angle.

993-5.3 Installation: Markers shall be installed at locations identified in the plans and in accordance with the Roadway and Traffic Design Standards, Index No. 400.

993-5.4 Qualified Products List: Markers used to delineate guardrail shall be a product included on the Qualified Products List.

SECTION 994

REFLECTIVE SHEETING

994-1 Description.

994-1.1 General: This Section specifies the requirements for reflective sheeting materials consisting of elements embedded or suspended within a transparent, weatherproof outer surface and designed to enhance nighttime visibility of signs. Transparent and opaque process inks for production application to reflective sheeting materials by a direct or reverse silk-screening process are also covered herein.

994-1.2 Classification: Reflective sheeting materials covered herein shall be one of the following seven classifications:

Type II: an engineering grade reflective sheeting which consists of enclosed spherical lens elements embedded within a transparent plastic having a smooth flat outer surface.

Type II-A: a high performance engineering grade reflective sheeting which consists of enclosed spherical lens elements embedded within a transparent plastic having a smooth flat outer surface.

Type III-A: a high performance grade reflective sheeting which consists of encapsulated spherical lens elements embedded within a transparent plastic having a smooth flat outer surface.

Type III-B: a high performance grade reflective sheeting which consists of cube-cornered (prismatic) retro-reflective elements incorporated beneath a transparent plastic having a smooth flat outer surface.

Type III-C: a high performance grade reflective sheeting which consists of cube-cornered (prismatic) retro-reflective elements incorporated beneath a transparent plastic having a smooth flat outer surface.

Type III-D: a high performance grade reflective sheeting which contains prismatic lenses which are formed in a transparent, synthetic resin, sealed, and backed with a pressure-sensitive adhesive and liner.

Type IV: a high performance reflective, vinyl sheeting for temporary and work zone applications.

994-2 Materials.

994-2.1 Testing: The reflective sheeting shall be tested in accordance with this Section and the Florida Test Methods for Reflective Sheeting, available from the Department's Materials Office, using process evaluation test samples and shall meet the minimum requirements as stated herein. Evaluation test samples shall be processed for each color of any production run. The number of samples constituting one test set of samples shall be determined by the Department's Materials Office.

994-2.2 Reflective Intensity: The reflective sheeting shall have minimum initial specific intensity per unit area (SIA) values as shown in Table 1. The SIA shall be measured and determined in accordance with Florida Test Method FM 2-001.

Table 1
Minimum SIA Values for Reflective Sheeting

Observation Angle (degree)	Entrance Angle (degree)	Minimum SIA (cd/(Foot-candle≅ft^2)) [(cd/(lx≅m^2))]							
		White	Red	Orange	Brown	Yellow	Green	Blue	Fluorescent Orange at 90 degree
Type II									
0.2	-4	70.0	14.5	25.0	2.0	50.0	9.0	4.0	X
0.2	+30	30	6.0	7.0	1.0	22.0	3.5	1.7	X
0.5	-4	30.0	7.5	13.5	1.0	25.0	4.5	2.0	X
0.5	+30	15.0	3.0	4.0	0.5	13.0	2.2	0.8	X
Type II-A									

0.2	-4	140.0	30.0	60.0	5.0	100.0	30.0	10.0	X
0.2	+30	60.0	12.0	22.0	2.0	36.0	10.0	4.0	X
0.5	-4	50.0	10.0	20.0	2.0	33.0	9.0	3.0	X
0.5	+30	28.0	6.0	12.0	1.0	20.0	6.0	2.0	X
Type III-A									
0.2	-4	250.0	45.0	100.0	X	170.0	45.0	20.0	X
0.2	+30	150.0	25.0	60.0	X	100.0	25.0	11.0	X
0.5	-4	95.0	15.0	30.0	X	62.0	15.0	7.5	X
0.5	+30	65.0	10.0	25.0	X	45.0	10.0	5.0	X
Type III-B									
0.2	-4	250.0	45.0	100.0	X	170.0	45.0	20.0	X
0.2	+30	95.0	13.3	26.0	X	64.0	11.4	7.6	X
0.5	-4	200.0	28.0	56.0	X	136.0	24.0	18.0	X
0.5	+30	65.0	25.0	25.0	X	45.0	10.0	5.0	X
Type III-C									
0.2	-4	250.0	35.0	100.0	7.0	170.0	35.0	20.0	X
0.2	+30	80.0	9.0	34.0	2.0	54.0	9.0	5.0	X
0.5	-4	135.0	17.0	64.0	4.0	100.0	17.0	10.0	X
0.5	+30	55.0	6.5	22.0	1.4	37.0	6.5	3.5	X
Type III-D									
0.2	-4	800		450	X	X	X	X	200
0.2	+30	400		250	X	X	X	X	100
0.5	-4	200		120	X	X	X	X	80
0.5	+30	100		70	X	X	X	X	50
Type IV									
0.2	-4	250.0	35.0	70.0	X	170.0	30.0	20.0	X
0.2	+30	95.0	13.3	26.0	X	64.0	11.4	7.6	X
0.5	-4	200.0	28.0	56.0	X	136.0	24.0	18.0	X
0.5	+30	60.0	17.0	17.0	X	40.0	7.2	7.2	X

994-2.3 Rainfall Performance: The minimum SIA values of the reflective sheeting under simulated rainfall conditions shall not be less than 90% of the respective dry values as shown in Table 1. Wet performance measurements shall be made on unweathered, uncoated sheeting in accordance with Florida Test Method FM 2-001.

994-2.4 Color: The reflective sheeting shall have the same daytime and nighttime color when viewed by reflected light. The diffused daytime color of the reflective sheeting, through instrumental color testing, shall conform to the requirements of ASTM D 4956 and shall be determined in accordance with Florida Test Method FM 3-E097. Geometric characteristics must be confined to:

Illumination: incident within 10 degrees of, and centered about, a direction of 45 degrees from the perpendicular to the test surface.

Observation: within 15 degrees of, and centered about, a perpendicular to the test surface.

Conditions of illumination and observation must not be interchanged. The standards calibrating the test apparatus shall be the Munsell Papers, as indicated in ASTM D 4956. The papers must have been recently calibrated on a spectrophotometer. The test instrument shall be one of the following or an approved equivalent:

1. GARDNER Multipurpose Reflectometer or Model XL 20 Color Difference Meter.
2. GARDNER Model AC-2a Color Difference Meter or Model XL 30 Color Difference Meter.
3. MEECO Model V Colormaster.
4. HUNTERLAB D 25 Color Difference Meter.

The following CIE Chromaticity Coordinate Limits for Type III-D Reflective Sheeting are required:

Color	1		2		3		4		Reflectance Limit Y (%)	
	x	y	x	y	x	y	x	y	min	max
White	.305	.305	.355	.355	.335	.375	.285	.325	40	-
Orange*	.583	.416	.523	.397	.560	.360	.631	.369	14	30

* Also for Fluorescent Orange

994-2.5 Specular Gloss: The reflective sheeting shall have an 85-degree specular gloss of not less than 40 for Type II material and not less than 50 for Type II-A, Type III and Type IV materials, when tested in accordance with Florida Test Method FM 3-D523.

994-2.6 Colorfastness: The color of a specimen shall be weathered and shall be in conformance with the following requirements for reflective sheeting:

Accelerated Outdoor Test: Processed and applied in accordance with recommended procedures, the reflective material shall be weather-resistant, resistant to dirt and fungus accumulation and, following cleaning, shall show no appreciable discoloration, cracking, crazing, fading, blistering, or dimensional change and not less than 80% of the specified wet and dry minimum brightness values when exposed to accelerated weathering for two years, south facing, unprotected at 45 degrees, in South Florida.

Orange sheeting shall meet the above requirements for only one year of exposure, except for barricade (pre-striped) and Type IV sheeting which shall meet the above requirements after six months.

994-2.7 Adhesive Backing:

994-2.7.1 General: The adhesive backing of the reflective sheeting shall be either a pressure sensitive adhesive (Class 1) or a positionable heat activated adhesive (Class 2) that shall be applied to the approved sign surface in a manner compatible with the instructions of the sheeting manufacturer without the necessity of additional adhesive coats on either the reflective sheeting or the application surface.

994-2.7.2 Pressure Sensitive Adhesives: Pressure sensitive adhesives shall be of an aggressive tack type requiring no heat, solvent or other preapplication preparation to the reflective sheeting for adhesion to clean aluminum, fiberglass or other approved surfaces. The reflective sheeting, after application, shall tightly adhere to the application surface and show no discoloration, cracking, crazing, blistering or dimensional change.

994-2.7.3 Heat Activated Adhesives: Heat activated adhesives shall be positioned under normal working conditions and temperatures up to 100EF [40EC] without damage to the material or application surface. The adhesive shall be activated by applying heat in excess of 175EF [80EC] to the material as in the heat-vacuum process, without additional preapplication preparation to the reflective sheeting for adhesion to clean aluminum or fiberglass surfaces. The reflective sheeting after application shall be tightly adhered to the application surface and show no discoloration, cracking, crazing, blistering or dimensional change.

994-2.7.4 Protective Liner: The protective liner over the adhesive backing shall be removable from the adhesive backing by peeling without soaking in water or other solvents and without breaking, tearing or removing any adhesive from the adhesive backing. The protective liner shall be easily removed after accelerated storage for four hours at a minimum of 150EF [66EC] under a pressure of 2.5 psi [17 kPa].

994-2.8 Film: The exterior film of the reflective sheeting shall be a transparent, flexible, smooth-surfaced, moisture-resisting material and shall have sufficient strength and flexibility to be easily handled, cut to shape, processed and applied without appreciable stretching, tearing or other damage.

994-2.9 Shrinkage Resistance: Following liner removal, the reflective sheeting shall not shrink more than 1/32 inch [0.80 mm] in ten minutes nor more than χ inch [2.8 mm] in 24 hours (in any dimension) per 9 inch [225 mm] square at 75EF [24EC] and 50% relative humidity.

994-2.10 Flexibility: The sheeting, when applied to cleaned and etched 0.020 by 2 by 8 inch [0.5 by 50 by 200 mm] aluminum according to the sheeting manufacturer's recommendations, conditioned 24 hours and tested at 72EF [22EC] and 50% relative humidity, shall be sufficiently flexible to show no cracking when bent around a : inch [19 mm] mandrel. This will apply only for Type II and Type II-A sheeting.

994-2.11 Tensile Strength: The reflective sheeting shall have sufficient tensile strength so that the sheeting can be handled, processed and applied in accordance with the sheeting manufacturer's recommended procedures without damage to the sheeting.

994-2.12 Workability: The reflective sheeting shall permit preapplication handling, positioning, cutting by hand or die machine, color processing and oven drying.

994-2.13 Solvent Resistance: The processed reflective sheeting shall be solvent resistant so as to permit cleaning with naphtha and mineral spirits.

994-2.14 Color Processibility: The reflective sheeting shall permit color processing with compatible transparent and opaque process inks recommended or furnished by the sheeting manufacturer at temperatures ranging from 60 to 100EF [16 to 38EC] and a relative humidity from 20 to 80%. The sheeting processed in accordance with the sheeting manufacturer's recommendation shall show no loss or cracking of the process inks with normal handling, shop processing, cutting and application.

994-2.15 Heat Resistance: The reflective sheeting shall be heat resistant in order to permit forced oven drying of the transparent or opaque process inks recommended or furnished by the sheeting manufacturer. The Contractor shall submit complete and detailed oven drying instructions for the color processing of transparent and opaque process inks that the manufacturer recommends or furnishes. Such instructions shall be compatible with, and be within the maximum capabilities of, the Department's equipment and normal production procedures. Under no circumstances shall the forced oven drying time exceed nine minutes. The reflective sheeting processed and applied in accordance with the sheeting manufacturer's recommended procedures shall, after normal handling, produce a dry, smooth surface with no staining, discoloration, cracking, crazing, blistering or dimensional change unsuitable to the finished product's intended use. Under no circumstances shall the forced oven drying time exceed two hours for Type III-D Reflective Sheeting.

994-3 Direct and Reverse Silk-Screen Processing.

994-3.1 General: The transparent and opaque process inks furnished for direct and reverse silk-screen processing shall be of a type and quality recommended by the reflective sheeting manufacturer. Silk-screen processing in accordance with the techniques and procedures recommended by the sheeting manufacturer shall produce a uniform legend of continuous stroke width of either transparent or opaque ink, with sharply defined edges and without blemishes on the sign background that will affect the intended sign use. Transparent inks applied by reverse silk-screening over reflective sheeting shall be clear coated if recommended by the manufacturer.

994-3.2 Reverse Silk-Screen Processing:

994-3.2.1 Reflective Intensity: Finished signs produced by the reverse silk-screening process using transparent ink over white reflective sheeting processed in accordance with the techniques and procedures recommended by the sheeting manufacturer shall have minimum SIA values as shown in Table 2. The SIA shall be measured and determined in accordance with Florida Test Method FM 2-001.

Table 2
Minimum SIA Values for Finished Signs
(Reverse Silk-Screening Process)

Table 2
Minimum SIA Values for Finished Signs
(Reverse Silk-Screening Process)

Observation Angle (degree)	Entrance Angle (degree)	Minimum SIA (cd/(Foot-candle≅ft^2)) [(cd/(lx≅m^2))]			
		Red	Orange	Green	Blue
Type II					
0.2	-4	8.2	15.0	X	X
0.2	+30	3.5	6.0	X	X
0.5	-4	3.5	7.0	X	X
0.5	+30	2.5	3.0	X	X
Type II-A					
0.2	-4	28.0	31.0	20.0	8.5
0.2	+30	8.0	9.0	6.5	1.0
0.5	-4	7.0	12.0	6.0	2.0
0.5	+30	2.8	3.0	3.0	0.5
Types III-A, III-B, III-C, IV					
0.2	-4	25.0	70.0	X	X
0.2	+30	6.0	23.0	X	X
0.5	-4	11.0	24.0	X	X
0.5	+30	5.0	13.0	X	X
Type III-D					
0.2	-4	160	X	X	X
0.2	+30	80	X	X	X
0.5	-4	40	X	X	X
0.5	+30	20	X	X	X

994-3.2.2 Rainfall Performance: The minimum SIA values of finished signs produced by the reverse silk-screening process using transparent ink over white reflective sheeting, under simulated rainfall conditions, shall not be less than 80% of the respective dry values as shown in Table 2. Wet performance measurements shall be made on unweathered, uncoated signs in accordance with Florida Test Method FM 2-001.

994-3.3 Color: The diffused daytime color of the finished transparent process inks shall conform to the requirements as specified in 994-2.4. Both the finished transparent and opaque process inks shall have colorfastness in accordance with

994-2.6, the same daytime and nighttime color when viewed by reflected light, weather resistance, and a satisfactory performance life equal to or greater than that of the reflective sheeting to which the process colors are applied.

994-4 Quality Assurance.

The Contractor is responsible for the performance of all inspections required by this Section. The Department reserves the right to perform any of these inspections at any time to insure that the materials and processing conform to the requirements of this Section.

994-5 Predicted Performance Life.

994-5.1 General: The material on in-service signs shall be considered as providing the minimum acceptable predicted performance life if the sheeting or process inks have not deteriorated due to natural causes. An unacceptable predicted performance life shall be cause for immediate material rejection and replacement. Sign conditions which shall be considered detrimental to the sign's performance life, and thus unacceptable, shall include, but need not be limited to, the display of:

(a) bubbles or wrinkles on the sign face greater than 3 inches [75 mm] in length (excluding minor defects around dents or mounting holes), or any cracks, breaks or stress cracks.

(b) bubbles or wrinkles within the legend or message area (legend or message area shall be defined as the entire area within the limits of the legend or message template).

(c) a total shrinkage of more than χ inch [3 mm] in the reflective sheeting material in any dimension.

(d) delamination of the reflective sheeting between the outer surface, optical reflecting system or the adhesive backing.

(e) a lack of durable adhesive bond between the reflective sheeting and the sign blank.

(f) a loss of the transparent or opaque ink, processed and applied over the reflective sheeting, due to cracking, crazing, blistering, fading, flaking or chipping.

994-5.2 In-Service Minimum Reflective Intensity: The reflective sheeting and transparent inks processed and applied over white reflective sheeting shall have the minimum SIA values as shown in Table 3, using an observation angle of 0.2 degrees and an entrance angle of -4 degrees. Measurements shall be made on uncoated reflective sheeting. The satisfactory predicted performance life for black process inks shall equal the number of predicted performance life years of the reflective sheeting to which it is applied.

Table 3
End Of Service Values

Color Reflective Sheeting/Transparent Ink	Minimum SIA	Minimum Predicted	
	Reflective Sheeting	Transparent Ink	Performance Life

	(cd/(Foot-candle≅ft^2))	(cd/(Foot-candle≅ft^2))	
	[(cd/(lx≅m^2))]	[(cd/(lx≅m^2))]	(years)
Type II			
White	40.0	X	7
Yellow	20.0	16.0	7
Green	3.0	2.5	7
Blue	2.0	1.5	7
Brown	0.5	0.4	5
Type II-A			
White	50.0	X	10
Yellow	28.0	X	10
Red	14.5	16.0	10
Orange	18.0	18.0	3
Green	11.0	11.5	10
Blue	5.0	5.0	8
Types III-A, III-B, III-C, IV			
White	200.0	X	10
Yellow	136.0	110.0	10
Red	28.0	17.5	10
Orange	80.0	45.0	3
Green	28.0	14.0	10
Blue	16.0	12.5	10
TYPE III-D			
White	640.0	X	7
Orange	360.0	X	3
Fluorescent Orange	160.0	X	3
Red	X	128	7

994-6 Technical Assistance.

In case of material failure, the Contractor shall obtain on-site technical assistance from the manufacturer at no cost to the Department. The corrective action shall be completed to the satisfaction of the Department.

994-7 Material Rejection and Replacement.

The Department reserves the right to approve, reject, or request replacement of any or all material failing to satisfactorily meet all requirements of this Section.

Any or all rejected material which has been documented by written notification from the Department shall be removed within ten calendar days and replaced in full quantity within 30 days at no expense to the Department.

994-8 Contractor's Liability.

The Contractor shall be liable for the replacement of all reflective sheeting or all sheeting processed with transparent or opaque process inks over reflective sheeting furnished by the Contractor which fails to meet the requirements of this Section. The Contractor shall also be liable to the Department for a pro rata portion (based on the minimum predicted performance life shown in 994-5.2 and the actual life) of those additional costs to the Department (as determined by the Department) as may be incurred in manufacturing signs, sign processing, sign refurbishment, and field force removal and replacement of signs directly associated with the material failure.

After final acceptance of the Contract, the Contractor's liability for the minimum predicted performance life shall be assumed by the Reflective Sheeting Manufacturer and such responsibility for liability shall be contained in the manufacturer's certification.

994-9 Certification.

The Contractor shall be required to furnish to the Department's State Materials Engineer six certified copies of a test report from the reflective sheeting manufacturer that the reflective sheeting meets the requirements of this Section. Each certification shall cover only one type of reflective sheeting. Due to the wide range of applications of the products within some types, the certification shall additionally state that this product is recommended for use on this specific project.

994-10 Qualified Products List.

The reflective sheeting material used for any of the applications described in 700-2.5 shall be a product included on the Qualified Products List. Any marked variation from the original test values for a material below the established limits or evidence of inadequate field performance of a material will be considered to be sufficient evidence that the properties of the material have changed, and the material will be removed from the Qualified Products List.

Manufacturers seeking approval of reflective sheeting shall submit to the Department's Materials Office two 2 by 2 foot [600 by 600 mm] samples of each color and adhesive type, test data showing compliance with the requirements of this Section and a certifying statement of compliance.

Manufacturers seeking approval of process color products shall submit to the Department's Materials Office prescreened samples on the sheeting on which it is to be used. These samples are to be mounted on four 6 by 6 inch [150 by 150 mm] aluminum panels of a minimum thickness of 0.04 inches [1.0 mm]. The manufacturer shall include with his submittal test data showing compliance with the requirements of this Section and a certifying statement of compliance.

Product changes will require new samples and repeat tests.

SECTION 995

DEMOUNTABLE SIGN FACE MATERIALS

995-1 Acrylic Plastic Reflectors.

995-1.1 Description: Demountable sign letters, digits, arrows, borders and alphabet accessories shall be reflectorized and shall consist of acrylic plastic reflectors supported by embossed aluminum frames. They shall conform to the Standard alphabet for Highway Signs, of the Federal Highway Administration.

995-1.2 Design and Fabrication: The letter design shall be the Federal Standard Alphabet Series E, modified as necessary to accommodate the required reflectors.

All items except border strips shall be fabricated from 0.040 inch [1.0 mm] sheet aluminum. Border strips shall be of 0.032 inch [0.81 mm] sheet aluminum.

Mounting holes shall be provided within the frames, in accordance with the manufacturer's directions, to permit the use of screws, rivets or other acceptable fasteners.

The size and spacing of the reflector holes shall be such as will provide maximum night legibility and visibility of the finished cutout figure.

995-1.3 Finishing: After the metal fabrication has been completed, the finishing process shall be as follows:

Preparation: Aluminum frames shall be de-greased, etched and neutralized, and treated with Alodine 1200, Iridite 14-2, Bonderite 721, or equal product, and in strict accordance with the recommendations of the manufacturer of the chemical used.

Enameling: After the treating, frames shall be finished in the color specified, with baking enamel, in strict accordance with the recommendations of the manufacturers of the enamel.

995-1.4 General Requirements: The reflectors shall be of acrylic plastic meeting the requirements of Federal Specification L-P-380, Type I, Class 3. In order that the Department can readily check the suitability of the raw material used in the reflectors, the manufacturer shall stipulate such raw material and the identification of the particular molding compound.

The reflectors shall consist of a clear and transparent plastic face (herein referred to as the lens) and an opaque plastic back of identical material, fused to the lens under heat and pressure around the entire perimeter to form a homogeneous unit, permanently sealed against dust, water and water vapor. The reflectors shall be either yellow or colorless.

The lens shall consist of a smooth front surface, free from projections or indentations other than for identification, and a rear surface bearing a prismatic configuration such that it will effect total internal reflection of light.

995-1.5 Optical Requirements:

(a) Defined Terms: The following terms, as used herein, shall have the meanings shown therefor.

Entrance Angle: The angle at reflector between direction of light incident on it and direction of reflector axis.

Observation Angle: The angle at reflector between observer's line of sight and direction of light incident on reflector.

Specific Brightness: Candlepower returned at the chosen observation angle by a reflector, per square yard [square meter] of reflecting surface, for each foot-candle [lux] of illuminance at the reflector.

(b) Specific Brightness: The specific brightness of each reflex reflector intended for use in cutout letters, symbols and accessories shall be equal to or exceed the minimum values shown in the table below, with measurements made with reflectors spinning. Failure to meet the specific brightness minimum shall constitute failure of the reflector being tested. Failure of more than two reflectors out of 50 subjected to test shall constitute failure of the LOT.

Observation Angle (Degrees)	Entrance Angle (Degrees)	Specific Brightness (Candlepower/Square Inch/Foot-Candle) [(cd/(lx≅m^2))]
0.1	0	14.0 [2016]
0.1	20	5.6 [806]

For yellow reflectors the specific brightness minimum shall be 60% of the value shown above for crystal.

(c) Optical Testing Procedure: The reflex reflector to be tested shall be located at a distance of 100 feet [30 m] from a single uniformly bright light source having an effective diameter of 2 inches [50 mm]. The light source shall be operated at approximately normal efficiency. The return light from the reflector shall be measured by means of a photoelectric photometer having a minimum sensitivity of 1 x 10^{-7} foot-candles [1.1 H 10^{-6} lx] per scale division.

The photometer shall have a receiver aperture of 0.5 inch [13 mm] diameter, shielded to eliminate stray light. The distance from light source center to aperture center shall be 2.1 inches [53 mm] for the 0.1 degree observation angle. During testing the reflectors shall be spun so as to average orientation effect.

If a test distance other than 100 feet [30 m] is used, the source and aperture dimensions and the distance between source and aperture, shall be modified in the same proportion as the test distance.

995-1.6 Durability:

(a) Seal Test: The following test shall be used to determine if a reflector is adequately sealed against dust and water.

Submerge 50 samples in water bath at room temperature. Subject the submerged samples to a vacuum of 5 inches [17 kPa] gauge for five minutes. Restore atmospheric pressure and leave samples submerged for five minutes, then examine the samples for water intake. Failure of more than two of the 50 samples tested shall be cause for tentative rejection of the LOT. A re-sample of 100 reflectors shall be checked tested. If not more than four of these 100 samples fail, then the LOT will be considered acceptable.

(b) Heat-Resistance Test: Three reflectors shall be tested for four hours in a circulating air oven at 175 ∀ 5EF [79 ∀ 3EC]. The test specimens shall be placed in a horizontal position on a grid or perforated shelf permitting free air circulation. At the conclusion of the test the samples shall be removed from the oven and permitted to cool in air to room temperature. The samples, after exposure to heat, shall show no significant change in shape and general appearance when compared with unexposed control standards. No failures will be permitted.

(c) Corrosion Test: The assembled cutout letter, symbol or accessory shall withstand the combined corrosion test set forth in ASTM B 117.

995-2 Reflective Sheeting.

995-2.1 General: When so specified, the demountable sign letters, digits, arrows, borders and alphabet accessories shall be reflectorized with reflective sheeting in accordance with Section 994 or 993-2, supported by flat aluminum backing. They shall conform to the Standard Alphabet for Highway Signs of the Federal Highway Administration.

995-2.2 Design and Fabrication: The letter design shall be the Federal Standard Alphabet, Series E, modified for legibility.

All items except border strips shall be fabricated from 0.032 inch [0.81 mm] sheet aluminum, 6061-T6 alloy, with mounting holes to permit use of screws, rivets or other acceptable fasteners.

The reflective sheeting shall be adhered to the aluminum in accordance with recommendations of the sheeting manufacturer.

All letters, digits, arrows, borders, and alphabet accessories made of encapsulated lens sheeting that have a stroke width of : inch [19 mm] or less shall be supplied with sealed edges according to the instructions of the sheeting manufacturer.

995-3 Certificate of Tests.

The Contractor will be required to furnish to the Department's State Materials Engineer, six certified copies of a statement from the producer, certifying that the materials described in this Section 995 meet all the requirements of this Section and that they have passed all the stipulated tests.

SECTION 996

PORCELAIN ENAMEL LAMINATED

ALUMINUM PANEL SIGNS

996-1 Description.

This Section specifies the requirements for highway signs fabricated of porcelain enamel laminated aluminum panels, and includes the requirements for the porcelain enameling of the sign panels as well as the overall fabrication of the completed signs (consisting of single or multiple panels).

996-2 Porcelain Enameled Panels.

996-2.1 Basic Components: The porcelain-enamel laminated aluminum sign panels shall be fabricated of sheet aluminum, laminated to a honeycomb core and sealed completely around the perimeter with an extruded aluminum frame, to form a panel of the width, length and depth required, to the face of which porcelain enamel is fused; all in accordance with the requirements specified herein and the details shown in the plans.

996-2.2 Face Sheet: The face sheet of the panel shall be fabricated in one piece, from a 0.063 inch [1.6 mm] thick sheet of aluminum alloy 6061-H11, with an alloy 1100 cladding.

996-2.3 Back Sheet: The back sheet of the panel shall be fabricated in one piece, from a 0.040 inch [1.0 mm] thick sheet of aluminum alloy 3003-H14, conforming to ASTM B 209. The surface shall be treated with an amorphous chromate conversion coating, conforming to the requirements of MIL Specification C-5541.

996-2.4 Core Material: The core material shall be fungus-resistant phenolic impregnated paper honeycomb, of a thickness of 1 inch [25 mm]. The cell size shall be 2 inch [13 mm]. The weight of the paper shall be 80-pound [36.3 kg] and the impregnation shall be at least 18%, by weight.

996-2.5 Laminating Adhesive: The laminating adhesive shall be of the thermo-setting type and such as will produce a permanent oil and water-resistant bond. The manufacturer shall furnish certified copies of test reports showing that the laminating adhesive meets the above requirements and showing the results of tests thereon, made in accordance with ASTM E 72 and ASTM E 273.

996-2.6 Aluminum Perimeter Frame: Each panel section shall be provided with an extruded-aluminum perimeter frame, of channel section, the material of which shall be of Alloy 6063-T6. The top and bottom frame members shall have an integral retainer track for affixing mounting bolts to provide for blind fastening of sign panel to post support. (When vertical panels are used on signs having a horizontal finished dimension exceeding 24 feet [7.3 m], the vertical frame members shall have this integral retainer track for mounting bolts.)

An additional slot shall be milled in the top and bottom frame members, for later field insertion of post clip bolts.

The perimeter frame shall be assembled by means of self-trapping, hex head, stainless steel screws. A sealant shall be used at the corner to prevent moisture penetration.

Weep holes, χ inch [3 mm] in diameter, shall be drilled in the perimeter frame, at the bottom of each panel, located approximately 3 inches [75 mm] in from either end and in the center of the panel.

996-2.7 Rivets: Rivets used to fasten panel parts shall be χ inch [3 mm] self-plugging, aluminum break-stem type rivets. Rivets appearing directly on the sign background shall be of the same general color as the background.

One rivet shall be used at each corner on the face of the panel, to fasten the sheet to the perimeter panel.

The rivets used to fasten the copy to the panel shall also have a shoulder, approximately 0.150 inch [4 mm] long, to prevent crushing the copy when fastened. The holes shall not be drilled in the sign face until the Engineer has approved the layout of the legend and border on the sign face. The holes shall be of the manufacturer's recommended diameter and shall be drilled with high-speed drills, at the locations corresponding to the mounting holes in the legend and border.

996-3 Preparation of Panels.

996-3.1 Engineer's Access to Plant: The Engineer shall have ready access to all parts of the mill and shop during the manufacture, enameling process and fabrication of the signs, to assure that the controls provided by the manufacturer are adequate to assure proper workmanship throughout manufacture and fabrication.

996-3.2 Bonding of Panels: Prior to the laminating, the face panels shall be cleaned, in tanks of sufficient size to accommodate the complete panel.

Bonding of panels shall be done in a heated flat platten press, of sufficient size to handle the entire panel at one time and with the capacity for applying a pressure of 10 psi [70 kPa] over the entire platten area.

996-3.3 Specific Requirements of the Fabricated Panels:

996-3.3.1 Strength of Honeycomb Laminate Construction: The tensile strength of the honeycomb laminate construction (composed of the materials specified in 996-2.3) shall be at least 50 psi [345 kPa], when tested in accordance with ASTM C 297 and ASTM C 481.

996-3.3.2 Surface Tolerance of Finished Panel: Each porcelain enamel panel shall be true in flatness within 3 inch [6.5 mm] tolerance on any 8 foot [2.5 m] length. Across the face of the panel the deviation shall not exceed 0.004 in/in [0.1 mm/25 mm] width of panel face.

996-3.4 Manufacturer's Identification: The manufacturer of the porcelain enamel panels shall apply on the back of each panel the date of the manufacture and an imprint identifying the porcelain enamel surface as being his manufacture.

996-3.5 Basis of Acceptance of Panels: Acceptance of individual panels will be based on certified test results, or other certification, furnished by the manufacturer or fabricator to the Department's State Materials Engineer, indicating that all materials used in the laminated panels and all specified fabrication details meet the requirements specified.

996-4 Process of Enameling.

996-4.1 Porcelain Enamel: The porcelain enamel shall conform to the requirements of the Specification of the Porcelain Enamel Institute, No. PEI:ALS-105 (titled "Tentative Specifications for Porcelain Enamel on Aluminum as Used for Signs and Architectural Application.")

996-4.2 Preparation of Aluminum Panels: Before the porcelain enameling process is started the aluminum sheets shall be subjected to a suitable pretreatment preparation, as described in the Porcelain Enamel Institute Bulletin AL-2A, 4th Edition (Section 11), or by other approved preparation.

996-4.3 Container and Temperature: The porcelain enameling shall be performed in a "Continous" Furnace, at a temperature not exceeding the critical temperature of the metal and only such as is necessary for the forming of an adherent vitreous state.

996-4.4 Finish Requirements:

996-4.4.1 Thickness of Enamel: The thickness of the porcelain enamel shall be not less than 0.002 inch [0.05 mm].

996-4.4.2 Strength of Panels After Enameling: The panels, after enameling, shall have a minimum yield strength of 12,000 psi [83 MPa]. (If it is apparent, however, that the enameling process materially alters the temper of the aluminum panels, such that the minimum yield point of the material is below this 12,000 psi [83 MPa] minimum, then the panels may be artificially aged or processed such as to raise the yield point to this required minimum. The process used, however, shall not be such as may be detrimental to any other requirements of the specifications.)

996-4.4.3 Finish Color and Gloss: The finish color of the porcelain enamel shall be uniform within the following tri-stimulus coefficients (developed in accordance with National Bureau of Standard Procedures C 429).

Value	Green	Blue	Yellow
x	0.25 ∀ 0.02	0.17 ∀ 0.02	0.50 ∀ 0.02
y	0.39 ∀ 0.03	0.17 ∀ 0.03	0.46 ∀ 0.03
y	0.06 - 0.10	0.05 - 0.08	0.42 - 0.49

An additional tolerance of ∀0.01 is allowed for each value for differences between laboratories. The photometer shall be calibrated by standards near that of the color measured such as the NBS Standard tiles or the FHWA Color Tolerance Charts.

(Prior to manufacture and fabrication of the signs, 12 by 12 inch [300 by 300 mm] panel samples of the proposed finished color shall be submitted to the Engineer for approval.)

For the green and the blue colors, the finished porcelain enamel shall have a gloss reading of 50 to 70 units, at an angle of 45 degrees, when measured as described in ASTM C 346. For the yellow, such gloss reading shall be 70 to 90.

996-4.4.4 Adherence: The finished porcelain enamel shall meet the requirements specified in PEI Bulletin No. ASI: 105, with the following additional provisions:

The test shall be performed on samples of 3 by 12 inch [75 by 300 mm] size, processed with production run. Test samples shall be run every 1,000 ft^2 [90 m^2] of production cycle, or total of order; whichever occurs first.

(No production pieces having undergone spall testing shall be used in the contract work.)

996-4.4.5 Acid Resistance: When tested by the "Boiling 6% - Citric Acid Test," as described in ASTM C 283, (Standard Method of Test for Resistance of Porcelain enamel to Boiling Acid) the weight loss of the porcelain enamel shall be less than 20 mg/psi [0.031 mg/mm^2].

996-4.4.6 Finished Workmanship: The porcelain enamel on all surfaces which will be exposed to weathering shall be free of blemishes which might subsequently impair the serviceability, or will detract from the general appearance and the color-matching of the sign as may be perceptible from a distance of up to 25 feet [7.5 m].

996-5 Fabrication of Overall Sign.

996-5.1 Mounting of Panels onto Overall Sign: Where the horizontal width of a multi-panel sign does not exceed 24 feet [7.3 m] the panels shall be mounted horizontally. For widths exceeding 24 feet [7.3 m], the panels may be mounted either horizontally or vertically.

Panel dimensions shall be such that a minimum number of panels will be required for the overall sign (based on the concept of horizontal panels, in conjunction with the lines on copy, such that all copy will appear on each individual panel, with a minimum extent of copy crossover).

996-5.2 Jointing Multiple Panels: The face and edges of the panels, along the juncture between panels, shall be milled to a tolerance of ∀1/32 inch [∀0.8 mm] from a straight plane, such that when the two adjoining panels are assembled no gap over 1/16 inch [1.5 mm] between the panels will be discernible.

In order to obtain edge uniformity, panels may be milled up to 3 inch [6 mm], on each side.

996-5.3 Seam Closure: On multi-panel signs, aluminum seam-closure extrusions (as shown on the plans) shall be provided by the manufacturer. The seam-closure extrusions shall be set-in 3 inches [75 mm] from the edge of the panels, to provide clearance for rivets and frame.

996-5.4 Tolerances in Perimeter of Finished Sign: On the perimeter of the finished sign, a χ inch [3 mm] tolerance from flush, between the sheets and the frame, will be allowed and all edges shall be straight within χ inch [3 mm] from a straight plane.

All sharp edges which might present a hazard in handling shall be smoothed.

996-5.5 Sectional Fabrication: Signs which are too large to be shipped as a single unit may be sectionalized as approved by the Engineer. These signs shall be completely shop-assembled and, if a field joining of panels is permitted, legend and border units which overlap the joining shall be removed and replaced in the field.

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