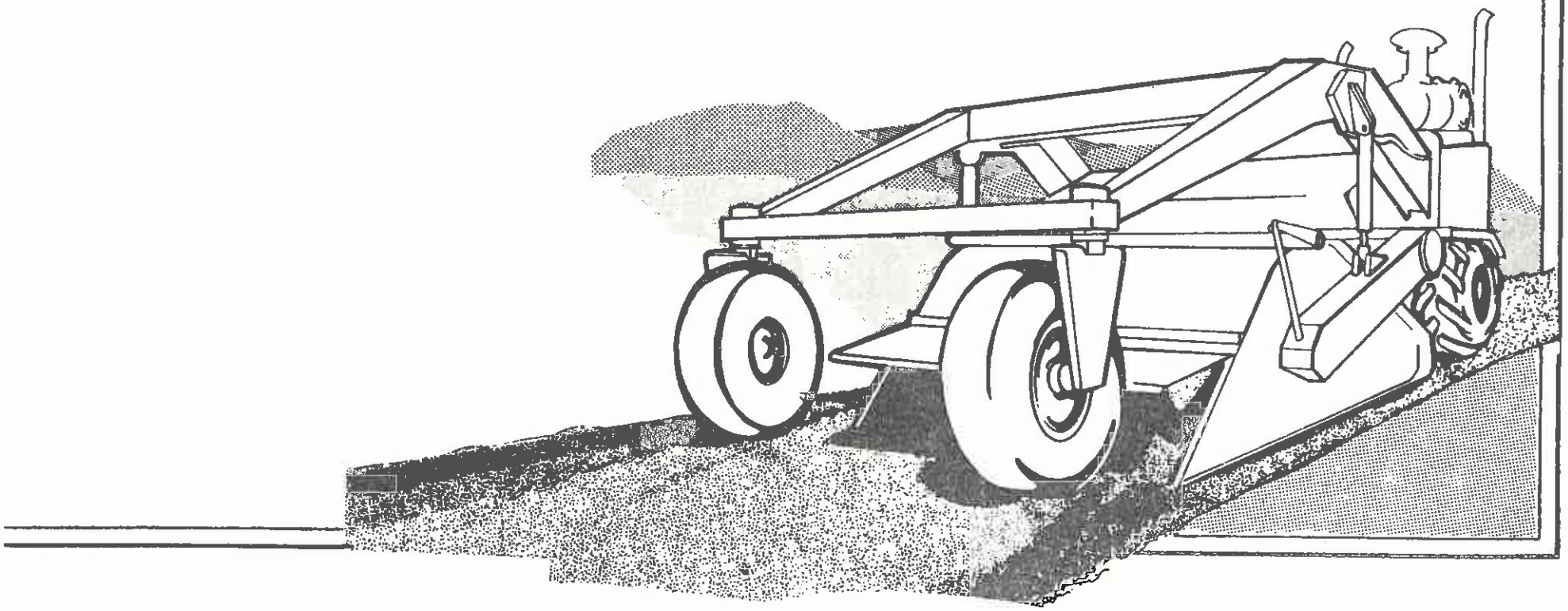
Florida Department of Transportation

SUBGRADE AND BASE INSPECTION



SUBGRADE AND BASE INSPECTION

A training course developed by the

FLORIDA DEPARTMENT OF TRANSPORTATION

This 2001 update was produced by Dr. Sastry Putcha, P. E.
State Construction Geotechnical Engineer,
in cooperation with District reviewers and State Construction Training Office staff

The Office of Construction
Florida Department of Transportation

Douglas Townes, State Construction Training Engineer
Yvonne Collins, State Construction Training Coordinator

FOREWORD

Subgrade and Base Inspection is a training course in the activities required to ensure proper field inspection and to achieve subgrades and bases that comply with the specification requirements. The major areas covered in this course include:

- construction preparation;
- materials inspection and control;
- equipment familiarization;
- application and mixing operations inspection;
- compacting and finishing operations inspection;
- final checking and testing; and
- documentation.

TABLE OF CONTENTS

DIRECTIONS TO COURSE USERS

TRAINING TECHNIQUE

This course has been designed for self-instructional training:

- You can work alone.
- You can make as many mistakes as are necessary for learning -- and correct your own mistakes.
- You can finish the training at your own speed.

You will keep this book as your reference, so work neatly.

PREREQUISITES

The Department Construction Training Policy requires that you take two courses within the first year of your employment: Construction Mathematics and Contract Plan Reading. For Subgrade and Base Inspection, you will need both. In addition, you should have completed Earthwork Inspection or know the subject matter thoroughly.

HOW TO USE THIS BOOK

This is not an ordinary book. You cannot read it from page to page as you do other books. This book gives you some information and then asks a series of questions about that information. The questions are asked in such a way that you will have to think carefully and draw some conclusions for yourself. If you have difficulty answering the questions, review the sections that give you trouble before going on.

The answers to the questions are in the back of each chapter.

EXAMINATION

An Examination has been developed for Subgrade and Base Inspection.

The Examination contains questions and problems only -- and no answers. To help you prepare for the Examination, a Review Quiz is included at the end of this course. If you have no difficulty with the Review Quiz, the Examination should present no problems.

CHAPTER ONE

Basic Information About Subgrades

CONTENTS

1

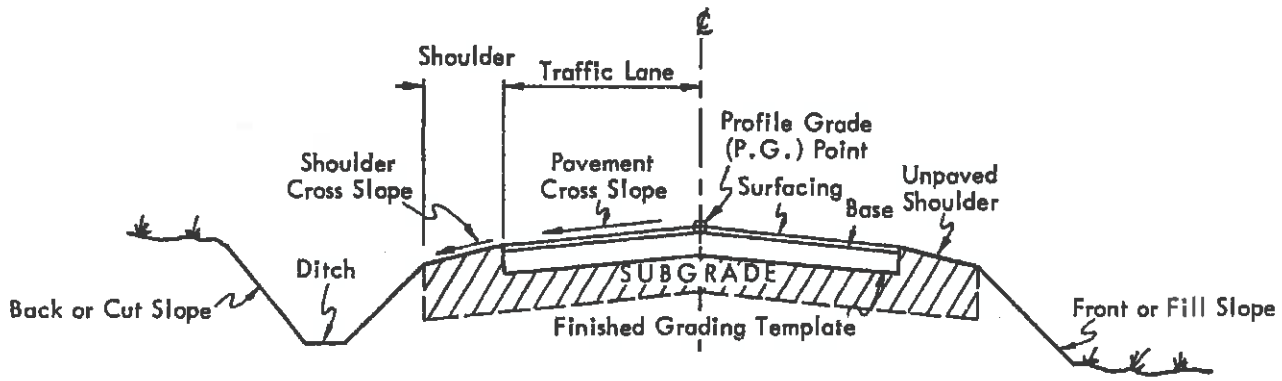
BASIC INFORMATION ABOUT SUBGRADES

In this first chapter of Subgrade and Base Inspection, we will cover information that is basic to your work as an Inspector. We will discuss the basic roadway parts and their functions and the types of subgrade operations that will be covered in this course.

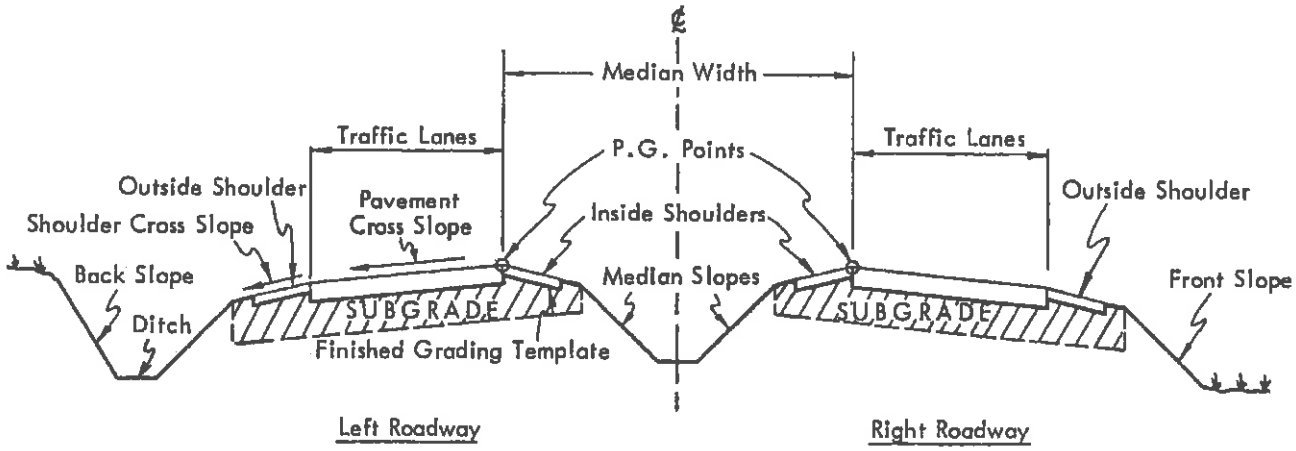
ROADWAY PARTS AND FUNCTIONS

PARTS

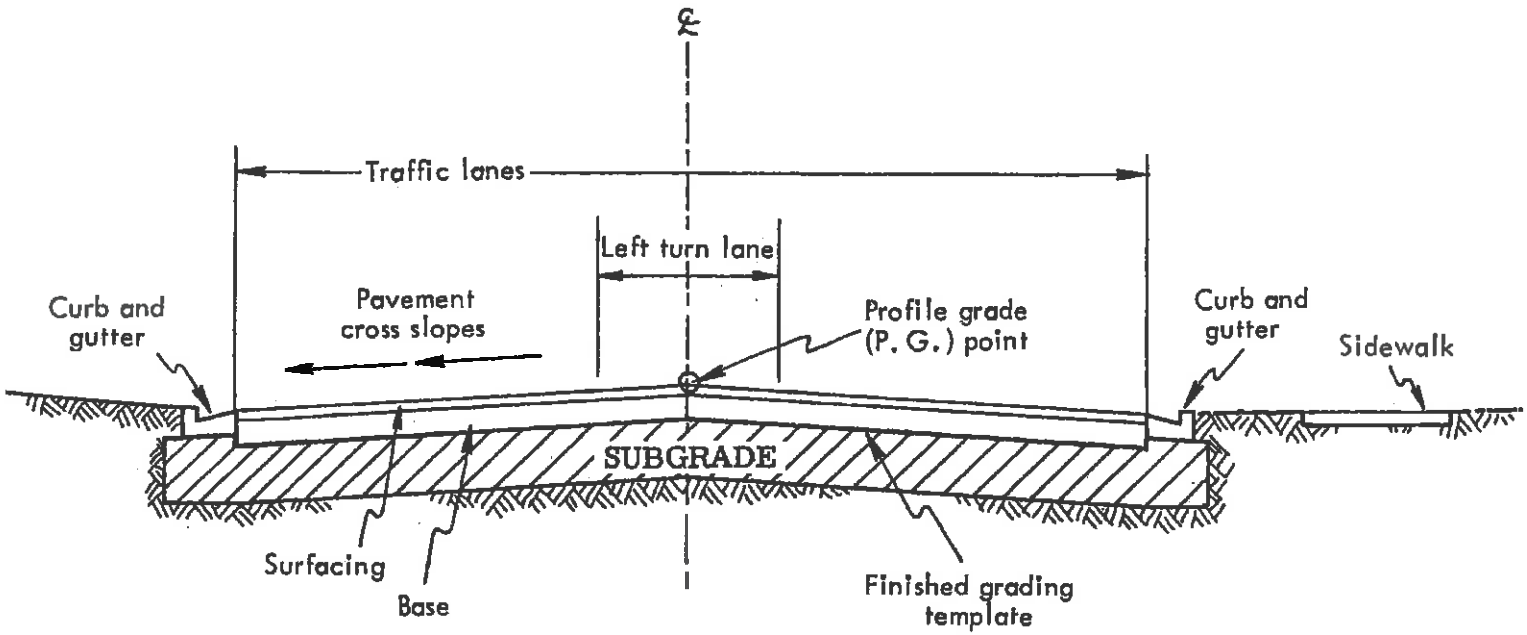
As an Inspector, you should be familiar with the major parts of roadways. Typical sections are especially helpful in identifying these different parts. Review the typical section below:



NOTE: The profile grade (PG) line may not be the highest elevation of the pavement.
Now let's review a typical divided highway section.



Nearly the same terms apply to single roadways and divided highways. The only differences are these: (1) on divided highways, a distinction is made between inside and outside shoulders, but there is no such distinction between shoulders on single roadways, and (2) divided highways have medians, but single roadways, of course, do not. Finally, here's a typical urban or municipal section.

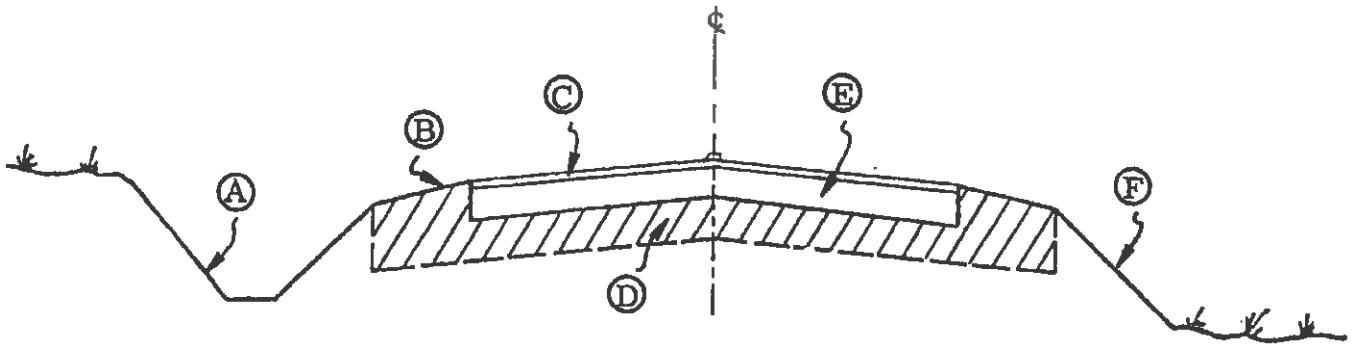


Again, the same terms apply to municipal sections as to single and divided roadways. The main difference with municipal sections is the presence of curb and gutter and the absence of shoulders. However, some roads may have curb and gutter construction on one side and shoulder on the other side.

Now, quiz yourself on what we just discussed by taking the quiz on the next page.

QUIZ

Identify the roadway parts labeled and the typical section below.



A. _____

B. _____

D. _____

E. _____

F. _____

FUNCTIONS

The definitions and functions of the different parts of roadways are described below:

- ROADWAY: The portion of a highway within the limits of construction.

- ROADBED: The portion of the roadway occupied by the subgrade and the unpaved shoulders. roadbed provides support for the base course and pavement

- SHOULDER: The portion of the roadbed outside the edges of the traveled way (or back of curb) and extending to the top of front slopes. The shoulders may be either paved or unpaved. They provide lateral support for the pavement.

- SUBGRADE: The portion of the roadbed immediately below the base course or pavement which usually must be constructed to a design bearing value or be otherwise specially treated.

- BASE COURSE: The course which is constructed on the subgrade to provide support for the pavement.

- PAVEMENT: The surface or traveled way which supports the traffic load and distributes it to the roadbed, and which provides a smooth, skid-resistant wearing surface.

QUIZ

Do single roadways have medians? _____.

On divided highways, a distinction is made between _____ and _____ shoulders.

Curb and gutter is generally found in _____ sections.

Do all types of roadway sections have profile grade points? _____.

What is the term for the portion of a highway within the construction limits? _____.

The portion of the roadbed outside the edges of the traveled way and extending to the top of front slopes is the _____.

What portion of the roadway is occupied by the subgrade and unpaved shoulders? _____.

What is the function of the pavement? _____.

SUBGRADE OPERATIONS

Subgrade operations can be divided into two types: stabilization treatment. Both types strengthen the subgrade so that it will provide a durable support for the base and/or pavement. We will briefly introduce stabilization and cement treatment here, and we will discuss them in detail in later chapters.

CEMENT TREATMENT

Cement-treated subgrades are constructed by combing portland cement with the soil. The combination must be uniformly mixed, moistened, compacted finished and cured.

STABILIZATION

Subgrade stabilization increase the structural strength of the embankment to the required load-bearing capacity specified in the plans. The stabilization may be achieved by adding and mixing commercial materials - or other high-bearing materials selected from borrow pits or roadway excavations - into the embankment. Also, the subgrade may be constructed full depth with select high-bearing borrow material that only requires mixing in place.

Some Florida soils must be blended with select high-bearing materials in order to meet the bearing values required for the areas to be stabilized. In areas where the natural soils meet the bearing value requirements, the only work necessary before final testing is the thorough mixing of the material in place to provide a homogenous mixture.

There are two different methods of stabilization, designated as Types B and C. While Type B Stabilization is the most common -- and will be emphasized in this chapter -- we will also discuss Type C briefly.

Type B and C differ in the method of determining compliance with the bearing value requirements -- the Limerock Bearing Ratio Method or the Florida Soil Bearing Test.

Type B. As we mentioned, Type B Stabilization is the most commonly used of the methods.

By this method, the Contractor has the option of using either commercial or local materials as stabilizing additives.

No separate payment for stabilizing materials is made to the Contractor (other than as may be paid for as borrow).

Bearing value determinations are made by the Limerock Bearing Ratio (L.B.R.) Method.

Type C. The Type C method of stabilization is the same as the Type B method in the first two factors, namely:

- The type of material -- commercial or local -- is at the Contractor's option.
- No separate payment is made for stabilizing materials (other than as may be paid for as borrow).

However, the method of determining compliance with the bearing value requirements is the Florida Soil Bearing Test.

L.B.R. Method. Since Type B Stabilization will be emphasized in this course, we will be mainly concerned with the L.B.R. method of determining compliance with bearing value requirements. Although you will not be responsible for determining limerock bearing ratios, you will be working closely with L.B.R. values. We will discuss the L.B.R. method in more detail in Chapter Four.

Stabilization Subbase. When called for the plans, a stabilized subbase is constructed by further strengthening the upper portion of the stabilized subgrade. A loose depth of commercial stabilizing material is added and mixed in with the subgrade after the mixing operations for the entire subgrade have taken place. The minimum loose depth of commercial stabilizing material is three inches.

Before the subbase is stabilized, the bearing value requirements for the subgrade material must be met. The subgrade also must be shaped and compacted. The subbase operations themselves are similar to those for subgrade stabilizing, and will be covered in Chapter Four.

No additional tests for bearing value are made after the mixing of materials for the stabilized subbase.

QUIZ

Subgrade operations can be divided into two basic types. List them.

1. _____.

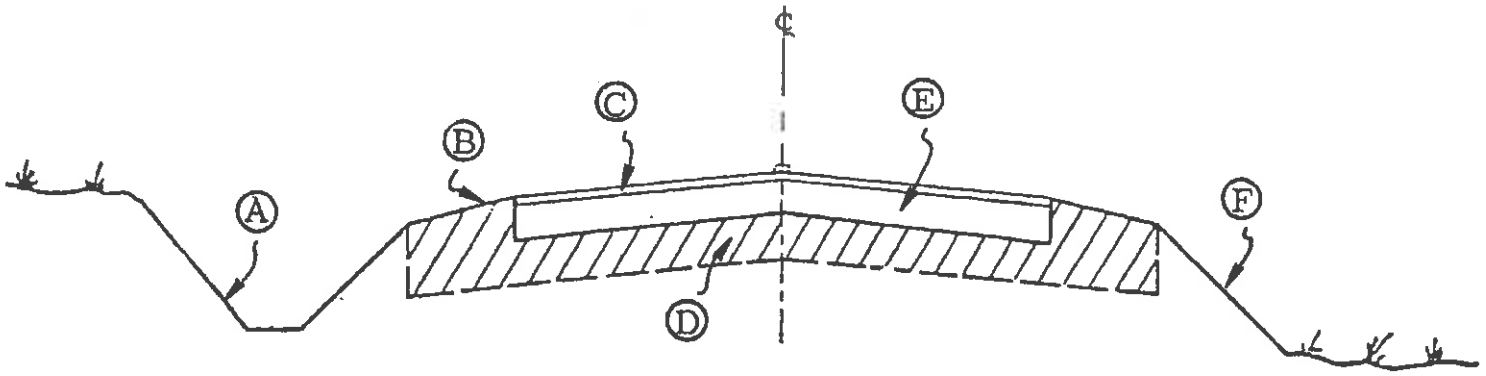
2. _____.

How are the two different methods of stabilization designated? _____.

Which of the following factors are different between the two stabilization methods?

____ A. The method of determining compliance with the bearing value requirements.
____ B. The use of commercial or local materials.
____ C. The depth to which the subgrade is stabilized.
____ D. The basis of payment for the work.

The following description is for which type of stabilization? The Contractor may use either commercial or local materials. He will not be paid separately for the stabilizing materials he uses. The bearing value determinations are made by the F.M. method. Type _____ Stabilization



Write the letters of the roadway parts that make up the roadbed in the typical section above:

_____.

What three types of roadway typical sections did we review in this chapter?

_____, _____, and _____.

Are all shoulders paved? _____.

TO MAKE THE BEST USE OF THIS COURSE

Take the time to study. Don't expect to learn well by just reading -- you must study.

Studying is not the same as memorizing all the material. Don't try to memorize everything said. Instead, study well enough to understand everything and remember the main points and the special terms.

Be guided by how well you do on the QUIZZES in this text. If you cannot answer all the QUIZ questions easily, restudy the text until you can. If repeated study does not help, get help from someone.

ANSWERS TO QUESTIONS

Page 1-5

- A. back or cut slope
  B. unpaved shoulder
  C. surfacing or pavement
  D. subgrade
  E. base B and D (shoulders and subgrade)
  F. front or fill slope

Page 1-7

- no
- inside
- municipal (urban)
- yes
- roadway
- unpaved shoulder
- roadbed
- to support the traffic load and distribute it to the roadbed, and provide a smooth skid-resistant wearing surface

Page 1-10

- stabilization; cement treatment
- Types B and C
- A
- B

Page 1-11

- B,D
- Single roadway; divided highway; urban outside (municipal) section

CHAPTER TWO

Pre-Construction Preparations for

Subgrade Operations

CONTENTS

PRECONSTRUCTION PREPARATIONS FOR SUBGRADE OPERATIONS

Before subgrade operations (and base course construction) can take place, certain preparations must be made. The preparations involve both construction and inspection activities, including the following:

- staking;
- inspecting the existing surface;
- obtaining the necessary inspection equipment and materials;
- studying the contract documents; and
- meeting with the Contractor.

We will discuss each of these activities. First, let's talk about staking.

STAKING

The Contractor's survey party will set stakes for controlling line and grade. The stakes help maintain close control in checking the width and depth of the subgrade. Grade stake are set to control grade, and hubs are set to control line.

These stakes are set a maximum of 50 feet (15m) intervals on tangent sections and at a predetermined offset. On curves, the stakes will be set a maximum of 25 foot (7m) intervals. The offset distance is determined in advance by a discussion between the Foreman and the Party Chief. The offset is necessary because mixing will be done out to the shoulder line and would disturb any stakes not offset. Typically, the offset is 3 feet (1m) from the edge of the mixing operations.

GRADE STAKES

As we mentioned, grade stakes which may be referred to as "blue tops" are set to control the grade in subgrade work. You will also use them in determining whether or not the subgrade has been stabilized or treated to the proper depth. This check involves using a string line and jacks in conjunction with the stakes. We will discuss the procedure for checking depth later in the course.

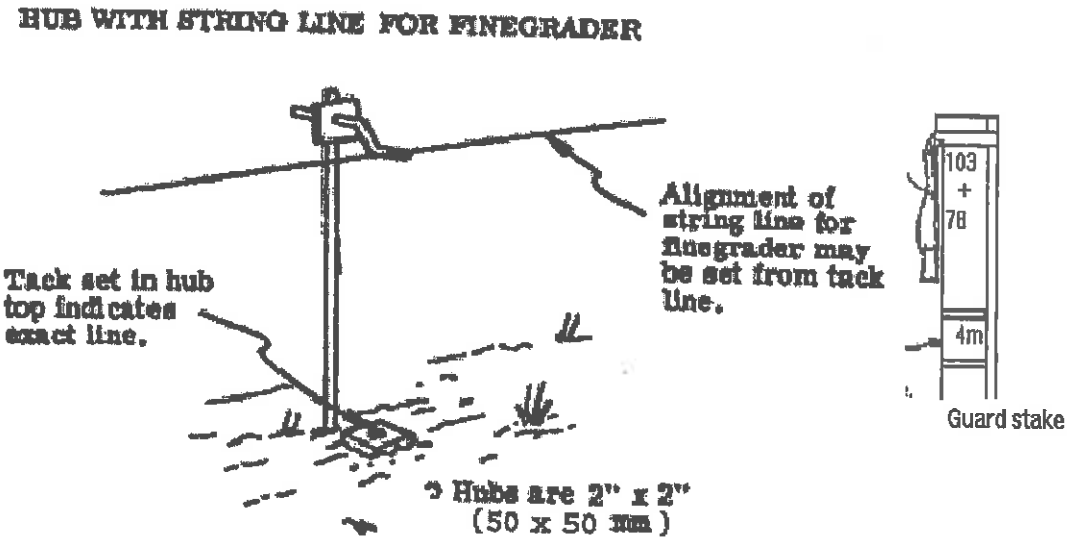
All grade stakes on the job must be referenced to the same point. However, the reference point will vary from job to job. They may be referenced to the top of the finished subgrade for example, or they may be referenced to the profile grade. You will need to check with the survey crew to be sure what the grade stakes are referenced to.

Guard stakes are placed by the grade stakes to protect and locate them. The guard stakes may be marked in different ways. Study the examples shown below.

HUBS

Hubs are set for line at the same offset as the grade stakes. Tacks set in the hub tops form a "tack line" which indicates the exact line for the subgrade to follow. Hubs are used especially in connection with cement-treated subgrades.

On divided highways, hubs usually are set on the high side. Hubs should be set before the subgrade work begins. Normally, they are driven flush with the ground level, and are <u>not</u> set to grade.



QUIZ

Who will set stakes for subgrade operations? _____.

What is the name for the stakes used to control line? _____.

Stakes help to maintain close control in checking the _____and _____of the subgrade.

What is the maximum interval for setting the stakes along the roadway? _____.

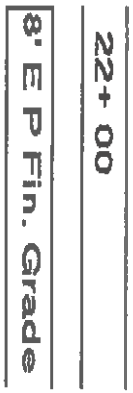
Grade stakes may be referred to as _____.

What is the offset of the grade stake identified by the guard stake shown at right? ____ from _____.

What will be the offset for the hubs?

Which of the following phrases applies to hubs?

____ A. Normally driven flush with the ground level
____ B. Set to profile grade
____ C. Not set to grade
____ D. Set along subgrade centerline.



How is the exact line indicated on the hubs? _____
_____
_____
_____

INSPECTING THE EXISTING SURFACE

The embankment surface to be stabilized or treated must comply with the plan and specification requirements before the beginning of subgrade operations. As the Inspector, it will be your responsibility to check for this compliance.

STABILIZATION

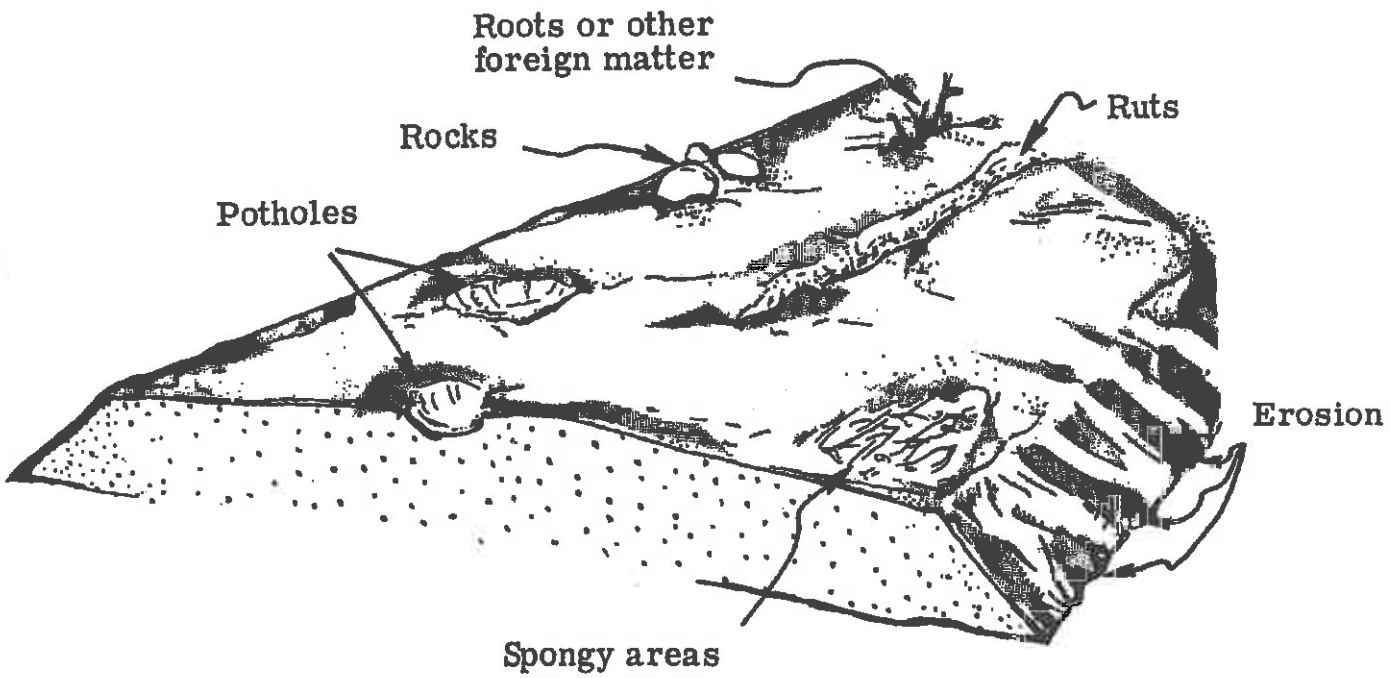
When the subgrade is to be stabilized, the embankment surface must be finished to the lines, grade and cross section shown in the plans, with the specification tolerances. The Contractor will check the elevation of the top of the embankment or the cut section before subgrade operations begin, but you must check it also to see that it meets the requirements. Embankment finishing operations are discussed in the Earthwork Inspection training course. Also, before any stabilizing material is spread on the subgrade, the roadbed must be brought to a plane approximately parallel to the plane of the proposed finished subgrade surface.

CEMENT TREATMENT

The requirements mentioned above under STABILIZATION apply also to roadbeds which will be cement-treated. In addition, roadbeds to be cement-treated must be firm enough to support the equipment without distortion or displacement. Any soft or yielding areas must be corrected before operations begin.

When cement-treated subgrade is constructed of central plant-mixed material, the underlying roadbed must be moist when the material is spread.

Many defects in the existing roadbed surface can be visually detected. You hopefully will never see an existing surface as bad as the one shown below -- but you <u>will</u> see the individual defects frequently.



All defects must be corrected before the beginning of subgrade operations.

INSPECTION EQUIPMENT AND MATERIALS CHECKLIST

As an Inspector, another important pre-construction preparation for you to make is that of checking to be sure you have all the inspection equipment and materials you will need. The following list serves as a summary of the items you should have:

- Plans, Special Provisions and Standard Specifications book;
- Project Sampling and Testing Guide Schedule;
- field books and tally books;
- report blanks;
- tape and rule; and
- shovel, pick and posthole digger.

Be sure that you have all the equipment and materials on the checklist. We will discuss them individually, as they come up in the course. In addition, you also should have access to the Construction Manual and the Manual on Uniform Traffic Control Devices. This latter document contains the minimum traffic control procedures that should be observed on the project.

CONTRACT DOCUMENTS

SUPPLEMENTAL SPECIFICATIONS TO THE STANDARD SPECIFICATIONS

Revisions to the standard specifications are being made all the time. These revisions initially show up in contracts in the form of Special Provisions. When enough of these standard special provisions accumulate, they are printed in booklet form. This booklet is called Supplemental Specifications to the Standard Specifications.

SPECIAL PROVISIONS

When unusual problems or conditions arise during the design or development of a project and special instructions are necessary, these will be covered by Special Provisions which are included only in the contracts of projects to which they apply.

SUPPLEMENTAL SPECIAL PROVISIONS

When last minute changes are required after the special provisions have been completed, Supplemental Special Provisions are issued to everyone having a set of special provisions.

DISCREPANCIES

The order of ranking authority of all contract documents -- necessary to resolve discrepancies (from highest to lowest) -- is supplemental special provisions, special provisions, contract plans, design standards, supplemental specifications, and standard specifications.

QUIZ

The roadbed surface to be stabilized or treated must comply with the _____and _____ requirements before the beginning of subgrade operations.

Who is responsible for checking for this compliance? _____.

Before any stabilizing material is spread on the subgrade, the roadbed must be brought to a plane approximately _____to the plane of the proposed finished subgrade surface.

Why must roadbeds be firm prior to cement treatment? _____.

When cement-treated subgrade is constructed of central plant-mixed material, the underlying roadbed must be _____when the material is spread.

Which of the following are defects that must be corrected before the beginning of subgrade operations?

____ A. Crowns	____C. Ruts	____E. Spongy Areas
____ B. Potholes	____D. Hubs	____F. Roots

List the equipment and materials you should have for subgrade inspection:

Number the following documents according to governing order -- with 1 being the highest, 2 the next highest and so on:

____ A. Supplemental Special Provisions	____ B. Contract Plans	____ C. Special Provisions
____ D. Standard Specifications	____ E. Supplemental Specifications.	

Name the document that contains the minimum traffic control procedures that should be observed on the project: _____.

As an Inspector, should you have access to a Construction Manual?_____.

ANSWERS TO QUESTIONS

Page 2-4

- the contractor
- hubs
- line; grade
- 50 feet (15 m)
- "blue tops"
- 8 feet, (2.4m) from the edge of pavement; the same 8' (2.4 m), from edge of pavement)
- A, C
- by tacks driven in the tops of the hubs

Page 2-9

- plans; specifications
- DOT Inspector
- parallel
- to support stabilization equipment without distortion or displacement
- moist
- B, C, E, F
- plans, special provisions and standard specifications; project sampling and testing guide schedule; field books and tally books; report blanks; tape and rule; shovel, pick and posthole digger
- A. 1
  B. 3
  C. 2
  D. 5
  E. 4
- Manual on Uniform Traffic Control Devices

CHAPTER THREE

Materials Inspection and Control

CONTENTS

3

MATERIALS INSPECTION AND CONTROL

The materials used in subgrade stabilization and cement treatment must meet the specification requirements in order to produce strong and durable subgrades. Proper materials inspection and control will ensure that the materials meet the requirements.

STABILIZING MATERIALS

TYPES OF MATERIALS

The types of materials used to stabilize subgrades can be divided into three groups: commercial, local, and existing base. We will discuss each of these.

Commercial - As you learned in Chapter One, the Contractor has the option of using commercial or local materials.

Allowable commercial materials include commercial limerock, limerock overburden, stone screenings and crushed shell. These materials have certain chemical and physical requirements outlined in the Standard Specifications. Because of these requirements, the materials must be sampled and tested. We will say more about the sampling and testing in a few pages.

Specifications - Because of these requirements, the materials must be sampled and tested. We will say more about the sampling and testing in a few pages.

Local - Local materials for use in stabilizing subgrades must be high-bearing soils -- like sand-clay material. Like the commercial materials, local materials have to meet certain requirements shown in the specifications.

Existing Base - Sometimes the plans call for the use of materials from an existing base course. This may occur for either type of stabilization. These existing materials may form all of the stabilizing additives or only a portion of them.

The existing base material must be used before any additional commercial or local materials are spread. The Engineer will direct the locations, placing and distribution of the base material.

Often, the existing base is used to maintain traffic through the construction area. Because of this, the removal of any section of existing base will not be required until the need for it in maintaining traffic is fulfilled.

Materials from an existing base are not considered for payment as commercial materials.

SOIL SURVEYS

The Department performs soil surveys partly to show what materials are suitable for use in embankments and subgrades. The results of soil surveys are shown on Soil Survey and Cross Section sheets in the plans. You should know that the soil survey determines only what materials may be suitable for use in subgrade stabilization -- it does not guarantee that the materials will achieve the required results.

The Contractor determines what material or combination of materials to use to obtain the required bearing values. As an Inspector, you should be sure that only suitable materials are used. A Soil Survey sheet is shown below. Study it and then take the quiz on the next page.

STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION
MATERIALS AND RESEARCH

DATE OF SURVEY: 1/20 - 2/15/94
SURVEY MADE BY: LYON, HEBERLING & KIRKLAND
SUBMITTED BY: T. N. PUCKETT, P.E.

PROJECT NO. : 06010-1505 PREL.
06010-3505 CONST.

DISTRICT: FIRST
ROAD NO.: S.R. 35
COUNTY: HARDEE

CROSS SECTION SOIL SURVEY FOR THE DESIGN OF ROADS

SURVEY BEGINS STA. : 400+00 SURVEY ENDS STA. : 554+00

STRATUM NO.	ORGANIC CONTENT: NO. OF TESTS	ORGANIC CONTENT: % ORGANIC	ORGANIC CONTENT: MOISTURE CONTENT	SIEVE ANALYSIS RESULTS % PASS: NO. OF TESTS	#10 MESH	#40 MESH	#60 MESH	#100 MESH	#200 MESH	ATTERBERG LIMITS (%): NO. OF TESTS	LIQUID LIMIT	PLASTIC INDEX	AASHTO GROUP	DESCRIPTION	CORROSION TEST RESULTS: NO. OF TESTS	RESISTIVITY Ohms-cm	CHLORIDE ppm	SULFATES ppm	pH
1	--	-------	------	--	------	------	------	------	------	--	------	------	---	Rock Base Asphaltic Concrete	--	----------	-------	-------	-------
2	--	-------	------	4	98-97	93-77	88-28	36-46	18-3	--	------	N.P.	A-3	SUBGRADE (Gray & Tan Sand w/trace Silt, L.R. & Shell)	--	----------	-------	-------	-------
3	7	3.8-6.5	------	7	100-96	96-86	71-35	48-24	27-13	--	------	N.P.	A-2-4	FILL (Dark Brown Sand w/some Silt & trace L.R.)	7	43,000-34,000	58-48	72-98	6.2-5.4
4	3	1.5-1.8	------	4	100-94	93-71	90-50	82-33	48-37	4	38-25	9-5	A-4	Gray and Brown Silty Sand w/trace Clay and L.R.	4	25,000-23,000	120-58	95-84	6.8-8.4
5	--	-------	------	3	100	100-99	98-85	80-75	34-30	3	44-42	15-11	A-2-7	Tan and Light Gray Silty Sand w/some Clay and trace Shell	3	5,000-5,500	120-58	215-154	8.2-7.9
6	3	10.2-40.9	28-60	--	------	------	------	------	46-38	3	23-25	12-10	A-6	MUCK (Dark Brown Silty Sand w/some Clay	--	----------	-------	-------	-------
7	--	-------	------	3	100	98-88	78-73	69-60	56-51	3	61-55	33-28	A-7	Yellow and Gray Silty Sandy Clay	--	----------	-------	-------	-------
8	3	10.3-90.8	28-58	3	100-99	99-97	97-88	96-77	18-10	--	------	N.P.	A-3	MUCK (Brown Sand w/some Organic and trace Shell)	3	30,000-23,000	120	180-110	8.2-6.8

EMBANKMENT AND SUBGRADE MATERIAL

STRATA BOUNDARIES ARE APPROXIMATE MAKE FINAL CHECK AFTER GRADING.
WT = WATER TABLE ENCOUNTERED.
GNE = GROUND WATER NOT ENCOUNTERED.

The material from Stratum Number 1 is Rock Base under Asphaltic Concrete.

The material from Stratum Number 2 appears satisfactory for use in the embankment when utilized in accordance with Index 505.

The material from Stratum Number 3 appears satisfactory for use in the embankment when utilized in accordance with Index 505. However, this material is likely to retain excess moisture and be difficult to dry and compact. It should be used in the embankment above the water level existing at the time of construction. This material may not be used in the subgrade portion of the roadbed due to its organic content.

The material from Strata Numbers 4 and 5 are Plastic material and shall be removed in accordance with Index 505. It may be placed above the existing water level (at the time of construction) to within 4 feet of the proposed base. It should be placed uniformly in the lower portion of the embankment for some distances along the project rather than full depth for short distances.

The material from Stratum Number 6 is MUCK/A-8 material and shall be removed in accordance with Index 505.

The material from Stratum Number 7 is High Plastic material and shall be removed in accordance with Index 505. It may be used within the project limits as indicated in Index 505 only when excavated within the project limits and is not to be used when obtained from outside the project limits.

The material from Stratum Number 8 is MUCK/A-8 material and will be removed during clearing and grubbing.

REVISIONS

ROADWAY SOILS SURVEY

QUIZ

Commercial materials for subgrade stabilization include: _____

_____

_____

Local materials for stabilization must be _____.

When the existing base material is to be incorporated into the subgrade, should it be used before or after other stabilizing additives have been mixed in? _____.

Who determines what material or combination of materials to use to obtain the required bearing values?

_____.

How should the muck/A-8 material be removed? _____.

SAMPLING

To determine whether or not materials are suitable for use in subgrade stabilization, samples must be obtained and submitted to District Laboratory. These samples can be divided into two groups: initial (source) samples and job control samples.

Initial samples are obtained and tested in order to approve the materials at their source. These samples, therefore, are obtained before hauling and mixing begin. As an Inspector, you will not be responsible for obtaining and submitting them. They are sampled at the source by Testing personnel.

Job control samples are obtained and tested in order to verify that the same materials are being used and that the materials continue to meet the requirements. Job control samples should be taken directly from the road. You will be responsible for job control sampling.

SAMPLING, TESTING AND REPORTING GUIDE

To obtain and submit samples of stabilizing materials, you must follow the Department's Sampling, Testing and Reporting Guide. The Guide contains frequencies, samples sizes, test names, designations of report forms and work performed and materials used on Department projects.

The Sampling, Testing and Reporting Guide consist of two sections: the Material Acceptance and Minimum Sampling Schedule and the Testing and Reporting Guide.

We will cover both parts by reproducing the explanations preceding each section and by showing a page from each section. Look over the explanations, study the sample pages and take the quizzes that follow.

MATERIAL ACCEPTANCE AND MINIMUM SAMPLING SCHEDULE

L (Level) This abbreviation stands for "level of sample." By "level of sample" we are referring to one of the three categories of sampling and testing which comprise the sampling and testing program. These three categories are defined as job control, Independent Assurance and/or acceptance, so there will be a "J", "I", or "A" in this column depending upon the category or level being implemented.

Pay Item The term "Pay Item," as used in any of the schedules utilized in our computerized materials certification system, refers to the numbers which identify a contract pay item and which reference a section of the Standard Specifications or Special Provisions.

Matl. No. An abbreviation for "Material Number." This is an arbitrary number assigned to each "Material Name" as part of an identifying process when compiling the List of Materials. When a sample is being obtained, the person sampling should note the "Material Number" for that particular material and write it in the required space on Sample Transmittal Card 691-07A which is being used with the Contract Certification System. The alphabetical designation immediately following the material number denotes the number of samples or actions required. Each different letter indicates a separate action or sample; however, the appearance of the same letter four times such as A1, A2, A3, A4 means that four separate tests are to be performed on one sample -- not that four samples are to be obtained.

Matl. Name This obviously describes the material to be sampled, tested, verified, etc.

A field description of the material must be shown on the sample Transmittal Card (691-07A).

Frequency The material sampling frequency is applicable to state and federal aid projects, except "TOPICS"* projects.

*TOPICS means Traffic Operations Programs to Increase Capacity and Safety. There is available "A Guide Schedule for Sampling and Testing at a Reduced Frequency" applicable to small quantities of materials delivered intermittently to large projects and contracts covering TOPICS, safety, rest areas, and other small projects.

Methods of this item relates to the sample of material being Acceptance checked for specification compliance and simply states the basis upon which acceptance or rejection is made.

THE FOLLOWING LIST GIVES EXAMPLES OF METHODS OF ACCEPTANCE USED

Approved List - A list of acceptable material as established from initial certification of vendor, or manufacturer's processing, and periodic test to assure continued substantial conformity to the Department's Specifications.

Certified Mill Analysis - This is a manufacturer's or supplier's report of test which is attested to by the manufacturer or supplier as representing material which has been supplied to the Department.

Commercial Testing Laboratory - Any approved private testing agency offering inspection and testing services.

DOT Hammer Mark or Commercial Laboratory Hammer Mark - An identity used on pretest timber products. Hammer leaves identifying mark on materials considered acceptable by the Inspector applying the mark.

DOT Label - A pretested material identity consisting of a printed gum label attached to the materials or container.

DOT Seal - Railroad car seals used to identify a pretested material.

DOT Stamp - One method of identifying pretested materials. Method generally employs use of rubber stamp and ink pad; however, stencil and paint are acceptable.

MATERIAL DESCRIPTION / SAMPLE - TEST NAME / LAB / TEST / SAMPLE SIZE	L MAT	METHOD OF ACCEPTANCE / SAMPLE FREQUENCY / SAMPLE LOC. / REPORT / WORKSHEET		BY
STAB SUGRADE & SHLD - FBV	A 010C	TEST		
E - DENSITY IN PLACE		1/LIFT/500' SECTION	ROADWAY	PP
SOIL F1-T238 N/A		02022 697-01		PP
M - DENSITY IN PLACE		1/LIFT/150 M1 SECTION	ROADWAY	PP
SOIL F1-T238 N/A		02022 697-01		PP
STAB SUGRADE & SHLD - FBV	A 010D	INSPECTION BY FIELD PROJ PERS		
E - CHECK UNIFORM MIX/DEPTH		1/8' WIDTH/100' RDWY	ROADWAY	PP
SOIL S-180-4 4-IN HOLE		19901 N/A		PP
M - CHECK UNIFORM MIX/DEPTH		1/2.4M1 WIDTH/30M1 RDWY	ROADWAY	PP
SOIL S-180-4 10CM HOLE		19950 N/A		PP
STAB SUGRADE & SHLD - FBV	I 010F1	TEST		
E - F.B.V.		1/ROADWAY MILE	ROADWAY	DL
SOIL F5-517 1 QT		15001 700-15		CL
M - F.B.V.		1/1.6 ROADWAY KM	ROADWAY	DL
SOIL F5-517 1 LI		15051 700-15		CL
STAB SUGRADE & SHLD - FBV	I 010F2	TEST		
E - PROCTOR (MODIFIED)		1/ROADWAY MILE	ROADWAY	DL
SOIL F5-521 2 BAGS		15001 697-19		CL
M - PROCTOR (MODIFIED)		1/1.6 ROADWAY KM	ROADWAY	DL
SOIL F5-521 2 BAGS		15051 697-19		CL
STAB SUGRADE & SHLD - FBV	I 010G	TEST		
E - DENSITY IN PLACE		1/ROADWAY MILE	ROADWAY	DL
SOIL F1-T238 N/A		02022 697-01		DL
M - DENSITY IN PLACE		1/1.6 ROADWAY KM	ROADWAY	DL
SOIL F1-T238 N/A		02022 697-01		DL
STABILIZING MATERIALS-LOCAL	A 440A1	TEST		
E - PLASTIC INDEX		1/SOURCE	MINE/RDWY	DL
SOIL F1-T090 0.5 BAG		15001 697-17		DL
M - PLASTIC INDEX		1/SOURCE	MINE/RDWY	DL
SOIL F1-T090 0.5 BAG		15051 697-17		DL
STABILIZING MATERIALS-LOCAL	A 440A2	TEST		
E - LIQUID LIMIT		1/SOURCE	MINE/RDWY	DL
SOIL F1-T089 0.5 BAG		15001 697-17		DL
M - LIQUID LIMIT		1/SOURCE	MINE/RDWY	DL
SOIL F1-T089 0.5 BAG		15051 697-17		DL
STABILIZING MATERIALS-LOCAL	A 440B1	TEST		
E - LIQUID LIMIT		2/EXISTING RDWY MILE	ROADWAY	PP
SOIL F1-T089 0.5 BAG		15001 697-17		DL
M - LIQUID LIMIT		2/EXISTING 1.6 RDWY KM	ROADWAY	PP
SOIL F1-T089 0.5 BAG		15051 697-17		DL

LEGEND: E=ENGLISH M=METRIC A=ACCEPTANCE I=INDEPENDENT ASSURANCE

Revised: 05/14/95

QUIZ

What worksheet should be used to report material 010C stabilized Subgrade and Shoulder? _____.

What is the frequency for sampling material number 010D ? _____.

Samples of material number 010D are of what level? _____.

What size job control sample should you obtain for Proctor tests on stabilized subbase? _____.

Who should obtain and submit samples of material number 440 B1? _____.

Now, look over the explanation and example page from the Testing and Reporting Guide portion of the Sampling, Testing and Reporting Guide on the next three pages. Then, try the quiz on page 3-14.

TESTING AND REPORTING GUIDE

Requisition from State Warehouse - Refers to the stamped copy of the originator's request for material from the Department's warehouse. The test results for the requisitioned material are transcribed from records maintained in the warehouse.

Specification - Refers to the Department's Standard Specifications for Road and Bridge Construction, and/or the Special Provisions released with the approved plans, and/or notes or details on approved plan or shop drawing.

Test - Indicates a test is utilized in evaluating the material sample.

Approved Source - Verification that the material is shipped from a Department approved source.

Approved Type - Refers to material complying with the type specified in the specifications or plans and carries the markings or identification data, if specified.

Certification - This is a manufacturer's or supplier's certification that the material supplied meets Department specification requirements. One copy is retained in the Project File and one copy is forwarded to Gainesville for the CL Project Files.

NOTE: In the foregoing definitions, the word "pretest" appears. This term applies to testing which is accomplished prior to stockpiling, or warehousing a material which will eventually be used in a construction project. The above methods of acceptance have nothing to do with pretesting procedures.

Sample Size - The required quantity of the material to enable the necessary test or tests to be performed on that particular sample.

By - This column will contain letter "PP", "DL", "BL" or "CL" which have related meanings "Project Personnel," "District Laboratory," "Branch Laboratory" and "Central Laboratory" and designates the responsibility for sampling/testing/inspection activity. The information in the "By" column is stacked vertically with the top line designating the sampling responsibility and the next line down designating the testing responsibility.

Sample/Test Name - Tells the kind of test to be performed. Usually states the test name in shortened form or states the commonly used term for the test.

Test - The identifying number for the corresponding test name. This could be a test method, a Standard Specification article number stating what measurement must be performed, or a non-FDOT specification listing required properties of a material so that the certification can be verified. Numerical prefixes have the following meaning:

1. AASHTO Procedures
2. Federal Standards (Procedure or Requirement)
3. ASTM Procedure
4. American Welding Society
5. FDOT Procedure
6. Equipment Manufacturer Procedure
7. American Wood Preservers
8. The Asphalt Institute.

Report Form - The DOT report form, or recording form, where tests results are documented.

Work Sheet - The form used (when required) by Project Personnel or the laboratories to record data and calculate test results.

LAB (Laboratory) - The individual laboratory within the Central Laboratory (BM&R) having primary responsibility for review and revision of sampling and testing methods and frequencies.

MATERIAL DESCRIPTION / SAMPLE - TEST NAME / LAB / TEST / SAMPLE SIZE	L MAT	METHOD OF ACCEPTANCE / SAMPLE FREQUENCY / SAMPLE LOC. / REPORT / WORKSHEET		BY
STAB MATL-SHELL-LOCAL,COMMER	A 423A3	TEST		
E - LIQUID LIMIT		1/BARGE OR 1200 TONS	ROADWAY	PP
SOIL F1-T089 0.5 BAG		15001 697-17		DL
M - LIQUID LIMIT		1/BARGE OR 1100 MT	ROADWAY	PP
SOIL F1-T089 0.5 BAG		15051 697-17		DL
STAB MATL-SHELL-LOCAL,COMMER	A 423A4	TEST		
E - PLASTIC INDEX		1/BARGE OR 1200 TONS	ROADWAY	PP
SOIL F1-T090 0.5 BAG		15001 697-17		DL
M - PLASTIC INDEX		1/BARGE OR 1100 MT	ROADWAY	PP
SOIL F1-T090 0.5 BAG		15051 697-17		DL
STAB MATL-SHELL-LOCAL,COMMER	I 423F1	TEST		
E - GRADATION		1/BARGE OR 4800 TONS	ROADWAY	DL
SOIL F1-T027 0.5 BAG		15001 696-19		CL
M - GRADATION		1/BARGE OR 4500 MT	ROADWAY	DL
SOIL F1-T027 0.5 BAG		15051 696-19		CL
STAB MATL-SHELL-LOCAL,COMMER	I 423F2	TEST		
E - % PASSING 200 SIEVE		1/BARGE OR 4800 TONS	ROADWAY	DL
SOIL F1-T011 0.5 BAG		15001 696-19		CL
M - % PASSING 200 SIEVE		1/BARGE OR 4500 MT	ROADWAY	DL
SOIL F1-T011 0.5 BAG		15051 696-19		CL
STAB MATL-SHELL-LOCAL,COMMER	I 423F3	TEST		
E - LIQUID LIMIT		1/BARGE OR 4800 TONS	ROADWAY	DL
SOIL F1-T089 0.5 BAG		15001 697-17		CL
M - LIQUID LIMIT		1/BARGE OR 4500 MT	ROADWAY	DL
SOIL F1-T089 0.5 BAG		15051 697-17		CL
STAB MATL-SHELL-LOCAL,COMMER	I 423F4	TEST		
E - PLASTIC INDEX		1/BARGE OR 4800 TONS	ROADWAY	DL
SOIL F1-T090 0.5 BAG		15001 697-17		CL
M - PLASTIC INDEX		1/BARGE OR 4500 MT	ROADWAY	DL
SOIL F1-T090 0.5 BAG		15051 697-17		CL
STAB SUBGRADE & SHOULDERS	A 020A1	TEST		
E - L.B.R.		4/LIFT/RDWY MILE	ROADWAY	PP
SOIL F5-515 2 BAGS		15001 700-15		DL
M - L.B.R.		4/LIFT/1.6 RDWY KM	ROADWAY	PP
SOIL F5-515 2 BAGS		15051 700-15		DL
STAB SUBGRADE & SHOULDERS	A 020A2	TEST		
E - PROCTOR (MODIFIED)		4/LIFT/RDWY MILE	ROADWAY	PP
SOIL F5-521 2 BAGS		15001 700-15		DL
M - PROCTOR (MODIFIED)		4/LIFT/1.6 RDWY KM	ROADWAY	PP
SOIL F5-521 2 BAGS		15051 700-15		DL

LEGEND: E=ENGLISH M=METRIC A=ACCEPTANCE I=INDEPENDENT ASSURANCE

Revised: 05/14/95

QUIZ

What test is performed on material number 423A4? _____.

What is the test number for Modified Proctor tests? _____.

Who performs the tests on material number 423F1? _____.

What is the test number for liquid limit tests? _____.

GO ON TO Sample Transmittal Card.

Sample Transmittal Card

For each sample you send to the Lab, you must complete and attach a Sample Transmittal Card (Form 675-050-04).

Look over the examples shown here carefully. Then, go on to TEST REPORTS.

FORM 691-07A
11/84

STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION

F.O. OR JOB NO. 77580136006 ACC. NO. OR LINE ITEM NO. 11 1601 11
MATERIAL NO. 0208 SAMPLE NO. W0004
DATE SAMPLED 072487 STA FROM 8+00LR
STA TO 16+00LR SAMP FROM 7+00LR
CONTRACT 11566 SAMPLED BY W.A. Dodd
MATERIAL DESC. Stabilizing Material, Local - Bay Sand
ROAD NO. S-434 DISTRICT NO. 5 COUNTY Seminole
INTENDED USE OR PART OF STRUCTURE PLACED Stabilized Subgrade
MANUFACTURER OR PRODUCER (NOT JOBBER) Fla Sand Co
SOURCE (PLACE FROM WHICH SHIPMENT WAS MADE) Sand Hill Fla PIT NO. 18-013
QUANT REP — GRADE — BATCH NO. —
LOT NO. — LAB NO. — DESIGN MIX NO. —
SLUMP — % AIR — D.O.T. PLANT NO. —
PRODUCERS: CMT. — F.A. — C.A. —
RETARDANT — FLY ASH —
REMARKS:
SUBMITTED BY: J.M. BerKely ADDRESS: Box 224 Bartow Fl

FORM 691-07A
11/84

STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION

F.O. OR JOB NO. 77580136006 ACC. NO. OR LINE ITEM NO. 11 1601 11
MATERIAL NO. 020A SAMPLE NO. W0051
DATE SAMPLED 072487 STA FROM 320+00RR
STA TO 328+00RR SAMP FROM 325+18RR
CONTRACT 11566 SAMPLED BY M. G. Birch
MATERIAL DESC. Stabilized Subgrade & Shoulder 1BR Brown Sand LR
ROAD NO. S-434 DISTRICT NO. 5 COUNTY Seminole
INTENDED USE OR PART OF STRUCTURE PLACED Stabilized Subgrade
MANUFACTURER OR PRODUCER (NOT JOBBER) —
SOURCE (PLACE FROM WHICH SHIPMENT WAS MADE) — PIT NO. —
QUANT REP — GRADE — BATCH NO. —
LOT NO. — LAB NO. — DESIGN MIX NO. —
SLUMP — % AIR — D.O.T. PLANT NO. —
PRODUCERS: CMT. — F.A. — C.A. —
RETARDANT — FLY ASH —
REMARKS: Lift # 1
SUBMITTED BY: C.B. Ralston ADDRESS: Box 75 Chipley Fl

TEST REPORTS

Results of tests performed on roadway materials are shown on test reports issued by the Lab. As an Inspector, you should be familiar with the information contained in the reports.

On the facing page are two test reports for materials submitted to and tested by the District Lab.

The page from STRG is shown here for a material that is to be used as a Stabilizing material. This particular material was approved for use as a stabilizing additive.

Look over the report briefly, then go on.

FLORIDA DEPARTMENT OF TRANSPORTATION PAGE 12
SAMPLING, TESTING, AND REPORTING GUIDE BY DESCRIPTION

MATERIAL DESCRIPTION / SAMPLE - TEST NAME / LAB / TEST / SAMPLE SIZE	L MAT	METHOD OF ACCEPTANCE / SAMPLE FREQUENCY / SAMPLE LOC. / REPORT / WORKSHEET		BY
STAB SUBGRADE & SHLD - FBV	A 010C	TEST		
E - DENSITY IN PLACE		1/LIFT/500' SECTION	ROADWAY	PP
SOIL F1-T238 N/A		02022 697-01		PP
M - DENSITY IN PLACE		1/LIFT/150 M1 SECTION	ROADWAY	PP
SOIL F1-T238 N/A		02022 697-01		PP
STAB SUBGRADE & SHLD - FBV	A 010D	INSPECTION BY FIELD PROJ PERS		
E - CHECK UNIFORM MIX/DEPTH		1/8' WIDTH/100' RDWY	ROADWAY	PP
SOIL 5-180-4 4-IN HOLE		19901 N/A		PP
M - CHECK UNIFORM MIX/DEPTH		1/2.4M1 WIDTH/30M1 RDWY	ROADWAY	PP
SOIL 5-180-4 10CM HOLE		19950 N/A		PP
STAB SUBGRADE & SHLD - FBV	I 010F1	TEST		
E - F.B.V.		1/ROADWAY MILE	ROADWAY	DL
SOIL F5-517 1 QT		15001 700-15		CL
M - F.B.V.		1/1.6 ROADWAY KM	ROADWAY	DL
SOIL F5-517 1 LI		15051 700-15		CL
STAB SUBGRADE & SHLD - FBV	I 010F2	TEST		
E - PROCTOR (MODIFIED)		1/ROADWAY MILE	ROADWAY	DL
SOIL F5-521 2 BAGS		15001 697-19		CL
M - PROCTOR (MODIFIED)		1/1.6 ROADWAY KM	ROADWAY	DL
SOIL F5-521 2 BAGS		15051 697-19		CL
STAB SUBGRADE & SHLD - FBV	I 010G	TEST		
E - DENSITY IN PLACE		1/ROADWAY MILE	ROADWAY	DL
SOIL F1-T238 N/A		02022 697-01		DL
M - DENSITY IN PLACE		1/1.6 ROADWAY KM	ROADWAY	DL
SOIL F1-T238 N/A		02022 697-01		DL
STABILIZING MATERIALS-LOCAL	A 440A1	TEST		
E - PLASTIC INDEX		1/SOURCE	MINE/RDWY	DL
SOIL F1-T090 0.5 BAG		15001 697-17		DL
M - PLASTIC INDEX		1/SOURCE	MINE/RDWY	DL
SOIL F1-T090 0.5 BAG		15051 697-17		DL
STABILIZING MATERIALS-LOCAL	A 440A2	TEST		
E - LIQUID LIMIT		1/SOURCE	MINE/RDWY	DL
SOIL F1-T089 0.5 BAG		15001 697-17		DL
M - LIQUID LIMIT		1/SOURCE	MINE/RDWY	DL
SOIL F1-T089 0.5 BAG		15051 697-17		DL
STABILIZING MATERIALS-LOCAL	A 440B1	TEST		
E - LIQUID LIMIT		2/EXISTING RDWY MILE	ROADWAY	PP
SOIL F1-T089 0.5 BAG		15001 697-17		DL
M - LIQUID LIMIT		2/EXISTING 1.6 RDWY KM	ROADWAY	PP
SOIL F1-T089 0.5 BAG		15051 697-17		DL

LEGEND: E=ENGLISH M=METRIC A=ACCEPTANCE I=INDEPENDENT ASSURANCE
Revised: 05/14/95

The Test Report for Stabilized Subgrade and Shoulders shown here shows the bearing values obtained for samples of stabilized Subgrade. These samples were submitted after the Subgrade mixing operation took place.

Notice that the minimum design L.B.R. of 40 is achieved. Therefore, the mixed Subgrade material meets the bearing value requirements.

FLORIDA DEPARTMENT OF TRANSPORTATION PAGE 26

FORM: 115-01 DATE: 9/29/87

TEST REPORT FOR STAB. SUBGRADE & SHOULDERS

CQR0137

PROJECT NO: 92506-3602 W.P.NO: 5125626 40

MATERIAL NO: 020A SAMPLE NO: J0015 DATE SAMPLED: 09/21/87

STATION FROM: 539+93.69 STATION TO: 546+92.51 SAMPLE FROM: 544+50

LAB NO: D8995 TESTED BY: SD ON 09/25/87 PASS/FAIL STATUS: P

PAY ITEM NO(S): 1 160 4

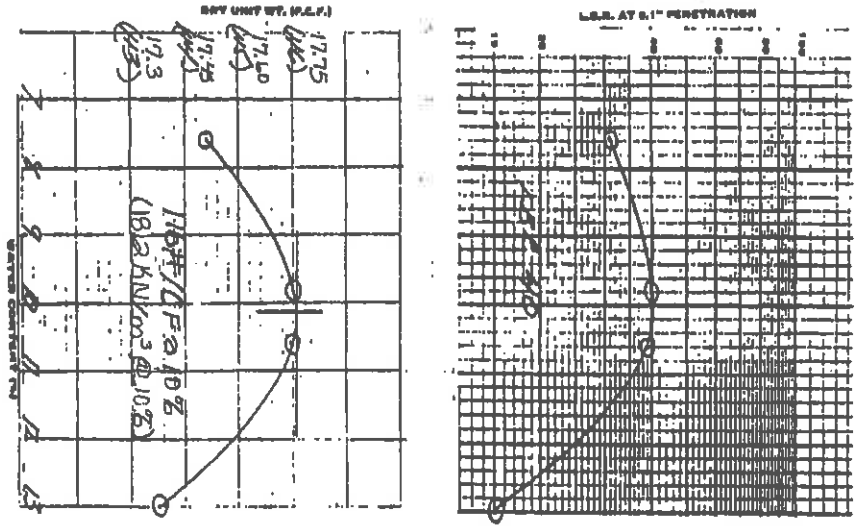
DISTRICT: 5 CONTRACT: 16365 ROAD NO: C0535

SOURCE: N/A PLANT NO: QUANTITY: 0.00

PRODUCER: INTENDED USE: SUBGRADE

JOB CONTROL RESULTS

QUAL	TYPE OF TEST/MEASUREMENT	RESULT	MINIMUM	MAXIMUM
	MAXIMUM DENSITY (MODIFIED)	116.0000 PCF		
	OPTIMUM MOISTURE	10.0000 PCT		
	LIMEROCK BEARING RATIO	40.0000 PCT	40.0000	



QUIZ

Initial samples are obtained and tested to approve the materials at their _____.

Job control samples must be taken from:

____ A. The roadway
____ B. Railroad cars
____ C. Haul trucks
____ D. Stockpiles.

Samples of stabilizing materials are submitted to _____.

Where will you find sampling frequencies, sample sizes, etc? _____.

Use this excerpt from the Sampling, Testing and Reporting Guide to answer the questions on the next page:

QUIZ, continued

STABILIZING MATERIALS-LOCAL	A 440A1	TEST			
E - PLASTIC INDEX		1/SOURCE		MINE/RDWY	DL
SOIL F1-T090	0.5 BAG	15001	697-17		DL
M - PLASTIC INDEX		1/SOURCE		MINE/RDWY	DL
SOIL F1-T090	0.5 BAG	15051	697-17		DL
STABILIZING MATERIALS-LOCAL	A 440A2	TEST			
E - LIQUID LIMIT		1/SOURCE		MINE/RDWY	DL
SOIL F1-T089	0.5 BAG	15001	697-17		DL
M - LIQUID LIMIT		1/SOURCE		MINE/RDWY	DL
SOIL F1-T089	0.5 BAG	15051	697-17		DL
STABILIZING MATERIALS-LOCAL	A 440B1	TEST			
E - LIQUID LIMIT		2/EXISTING RDWY MILE		ROADWAY	PP
SOIL F1-T089	0.5 BAG	15001	697-17		DL
M - LIQUID LIMIT		2/EXISTING 1.6 RDWY KM		ROADWAY	PP
SOIL F1-T089	0.5 BAG	15051	697-17		DL

LEGEND: E=ENGLISH M=METRIC A=ACCEPTANCE I=INDEPENDENT ASSURANCE

Revised: 05/14/95

Should project personnel sample material number 440 A1? _____.

What will material numbers A 440 B1 and A 440 B2 be tested for? _____.

What size sample of material number A 440 B1 should be submitted? _____.

QUIZ, continued

Use the completed Sample Transmittal Card at right to answer the questions below.

FORM 681-07A
11/84

STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION

P.O. OR JOB NO. 3608013902 (2)
ACC. NO. OR LINE ITEM NO. 1/1/6/01 (11)
MATERIAL NO. 441B (15)
SAMPLE NO. T0105 (23)
DATE SAMPLED 03/19/75 (14)
STA TO (30)
STA FROM (18)

CONTRACT 11534
SAMPLED BY A.C. Briggs
MATERIAL DESC. Stabilizing Material Limerock-Grey Limestock
ROAD NO. S-318 DISTRICT NO. 5 COUNTY Marion
INTENDED USE OR PART OF STRUCTURE PLACED Stabilized Subgrade
MANUFACTURER OR PRODUCER (NOT JOBBER) Florida Crushed Stone Co.
SOURCE (PLACE FROM WHICH SHIPMENT WAS MADE) Center Hill, Fla. PIT NO. 18-058
QUANT REP GRADE BATCH NO.
LOT NO. LAB NO. DESIGN MIX NO.
SLUMP % AIR D.O.T. PLANT NO.
PRODUCER'S: CMT. F.A. C.A.
RETARDANT FLY ASH
REMARKS:

SUBMITTED BY: F.G. Garfield ADDRESS: 1340 Elm St, Fort Lauderdale

Describe the material comprising this sample? _____

What was the location of the sampling? _____

What was the sample number? _____

CEMENT TREATMENT MATERIALS

Like the materials used in subgrade stabilization, the materials for cement-treated subgrade must meet certain requirements. You must follow the Sampling , Testing and Reporting Guide in obtaining and submitting samples of the separate materials used in cement treatment. In this section, we will discuss briefly each of the cement treatment materials.

CEMENT

Portland Cement Type I is used in treating subgrades. Samples that you submit to the Lab will be tested for many things, including strength, air content and chemical make-up. Again, you are not responsible for the testing, only for the sampling.

However, you do have responsibilities in the general area of being sure that the cement is handled and stored properly. The requirements for handling and storing Portland Cement are discussed in the Standard Specifications. You should become familiar with them. Basically, the cement must be kept clean and dry. Moisture can cause caking, lumps and a partial setting of cement. Cement thus damaged must be rejected.

SOIL

The soil for cement-treated Subgrade must consist of:

- natural material in the roadway;
- select soil that has been placed in the roadbed; or
- a combination of natural and select materials:

The Engineer will indicate which materials may be used and in which proportions.

The material to be used must not contain gravel or stone retained on a 2 inch (50 mm) sieve or more than 45 % retained on a No. 4 (4.75 mm) sieve.

As an Inspector, your main concern is with the design spread -- the planned rate of cement application -- in kilograms (pounds) per square meter (square yard).

QUIZ

What kind and type of cement is used in cement-treated subgrades? _____.

Basically, for you to be sure that it is handled and stored properly, cement must be _____.

What is your main concern with soil-cement designs _____.

WATER

The water applied to soil-cement mixtures must meet the chemical and physical requirements discussed in the Standard Specifications. Basically, the water must be clean and practically free of oil, acid, alkali, chlorides, organic matter and other harmful substances.

Water from city water supplies or other sources which are approved by a public health department may be accepted without being tested. Water from all other sources must be sampled, tested and approved before use.

As an Inspector, then, you should:

- verify that the water comes from an approved source; or
- obtain and submit samples for testing.

As always, follow the Sampling, Testing and Reporting Guide.

ASPHALT

Asphaltic material -- cut-back or emulsified -- is applied to treated subgrades. The coating of the Subgrade with asphalt holds in the moisture needed to cure the soil-cement mixture.

Consult the Sampling, Testing and Reporting Guide for the details of sampling.

LIME

Lime stabilization may be required in some cases prior to cement treatment.

QUIZ

If the water to be used in a cement treatment job comes from a city's water supply, may it be used without testing? _____.

What should you do if the water to be used comes directly from a free-flowing stream? _____.

Why is asphaltic material applied to cement-treated subgrades? _____.

Which of the following materials are used for curing treated subgrades?

____ A.	Slurry Seal	____ B.	Emulsified Asphalt
____ C.	Asphalt Cement	____ D.	Cut-back asphalt

The results of soil surveys are shown on _____and _____ sheets in the plans.

Who determines what material or combination of materials is used to obtain the required bearing values? _____.

Is sand-clay material an example of a commercial material that may be used in Subgrade stabilization? _____.

When the existing base material is to be incorporated into the Subgrade, should it be used before or after other stabilizing additives have been mixed in? _____.

Where will you find frequencies for sampling, sample sizes, etc? _____.

What should you complete and attach to each sample you send to the Lab? _____.

List the three basic materials used in cement-treated subgrades: _____, _____, and _____.

ANSWERS TO QUESTIONS

Page 3-5

- limerock; limerock overburden; stone screenings; crushed shells
- high-bearing soils -- like sand-clay material
- before
- contractor
- In accordance with Index 500

Page 3-10

- 697-01
- (4 per lift/1.6 roadway km)
- job control
- 2 bags
- project personnel

Page 3-14

- plastic index
- F5-521
- district lab
- F1-T089

Page 3-18

- source
- A
- district lab
- Sampling, Testing and Reporting Guide

Page 3-19

- no, district lab personnel
- liquid limit and plastic index
- 0.5 bag

Page 3-20

- grey limerock stabilizing material
- station 61 + 56.96 (202 + 00) 38' left of B/L Survey
- A0005

Page 3-22

- Portland cement Type I
- clean; dry
- to know the design spread

Page 3-24

- yes
- obtain and submit samples for testing
- to allow the Subgrade to cure (to hold in moisture)
- B, D
- soil survey; cross section
- contractor

Page 3-24 (contd.)

- no, it is local material
- before
- Sampling, Testing and Reporting Guide
- Sample Transmittal Card
- cement, soil, water

CHAPTER FOUR

Stabilized Subgrades

CONTENTS

4

STABILIZATION SUBGRADES

INTRODUCTION

Subgrade stabilization consists of spreading stabilizing additives on the roadbed (when necessary) and mixing, compacting and finishing the upper portion of the roadbed to the required bearing value and density. The following list contains some new information, but basically is a review of points we have covered in earlier chapters:

- Stabilizing additives may consist of commercial, local or existing base material B or a combination of these.
- There are two types of stabilization B designated B and C. The type of stabilization determines the method of determining compliance with the bearing value requirements. Both types are discussed in detail in the Standard Specifications.
- The bearing value requirements may be based on the Limerock Bearing Ratio Method or the Florida Soil Bearing Test B depending on the type of stabilization used.
- Maximum particle size for subgrade material should not exceed 3 ½ inches (90mm.).

In this chapter, and for the rest of the course, we will emphasize Type B stabilization.

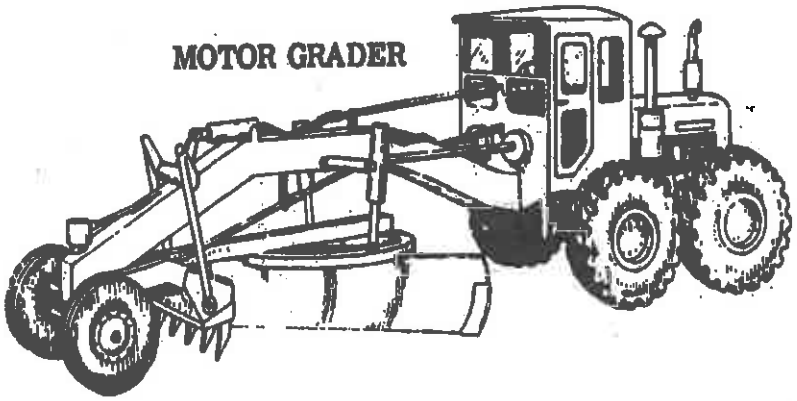
We will begin by looking briefly at the equipment typically used. Then we will discuss the construction, inspection and documentation procedures. We also will talk briefly about stabilized subbase construction.

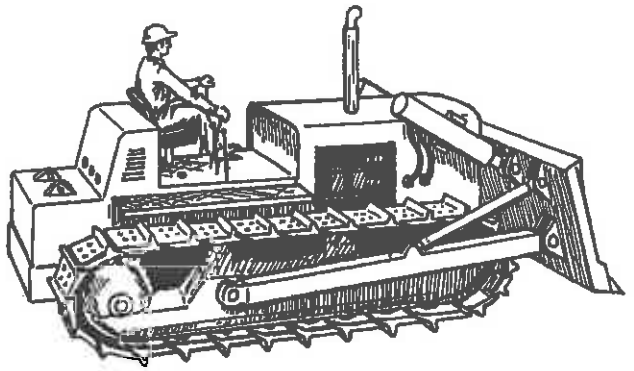
EQUIPMENT

For the purposes of our discussion, subgrade stabilization equipment can be divided into three groups: application equipment, mixing equipment, and compaction and finishing equipment. The equipment we will discuss is typical, but you likely will see other types of equipment on subgrade stabilization jobs. There are few specific requirements for the equipment, and the Contractor is free to select the amounts and types he wants. Therefore, as an Inspector, you will not be inspecting the equipment itself, but will be verifying that the desired results are obtained by the equipment. Of course, you should notice any equipment in bad condition because such equipment will likely produce poor results and call this to the attention of the Contractor.

APPLICATION EQUIPMENT

The equipment used to haul, apply and spreads stabilizing additives must be able to transport and apply the materials efficiently and spread them uniformly over the area to be stabilized. Typical application equipment includes haul trucks, bull dozers and motor grades. However, commercial stabilizing materials normally must be spread by mechanical spreaders.



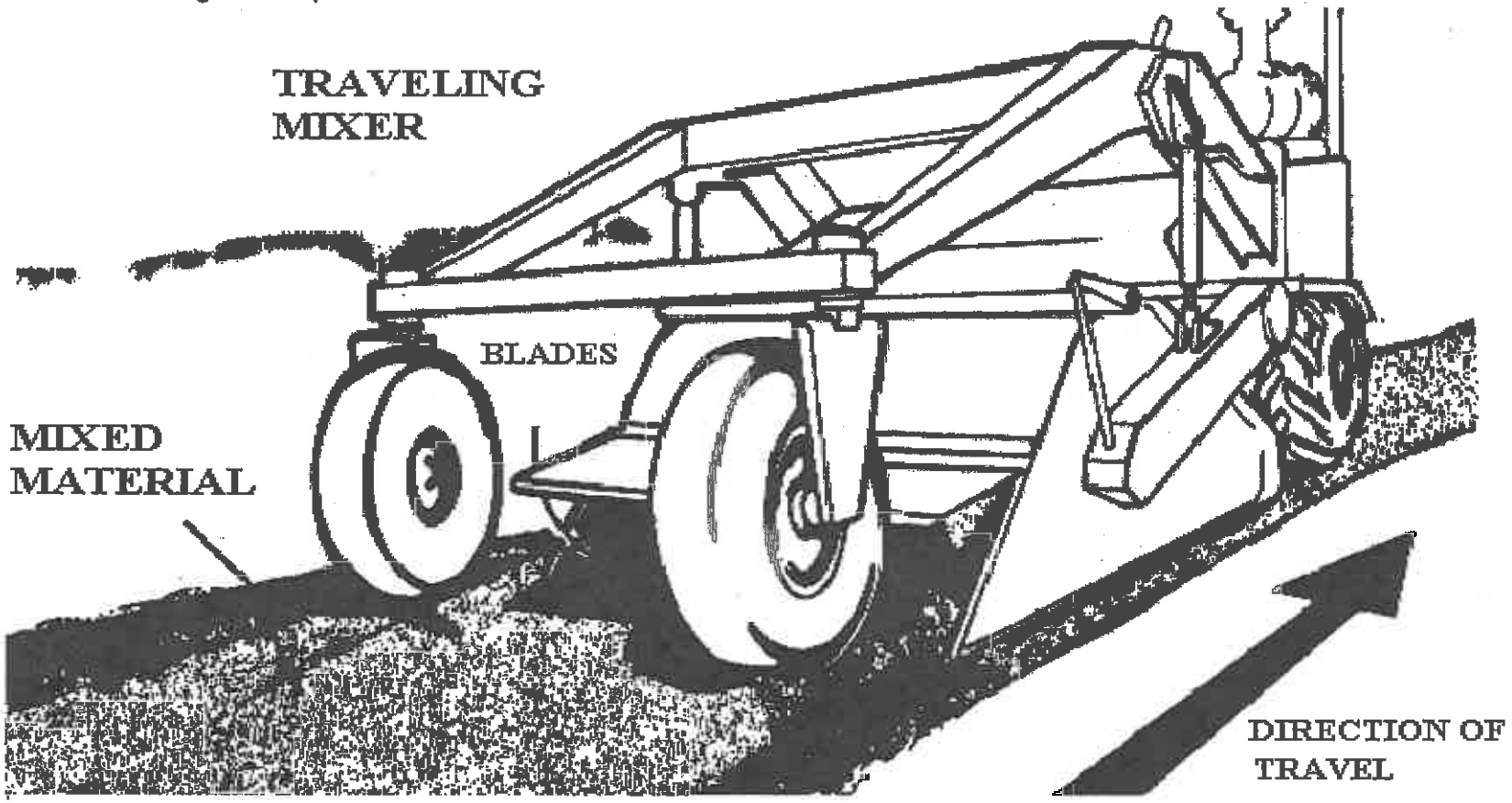


BULLDOZER

MIXING EQUIPMENT

Whether or not stabilizing additives are applied to the roadbed, the area to be stabilized must be mixed thoroughly to the designated limits. The specifications require that the mixing to be done with rotary tillers or other equipment meeting the Engineer's approval.

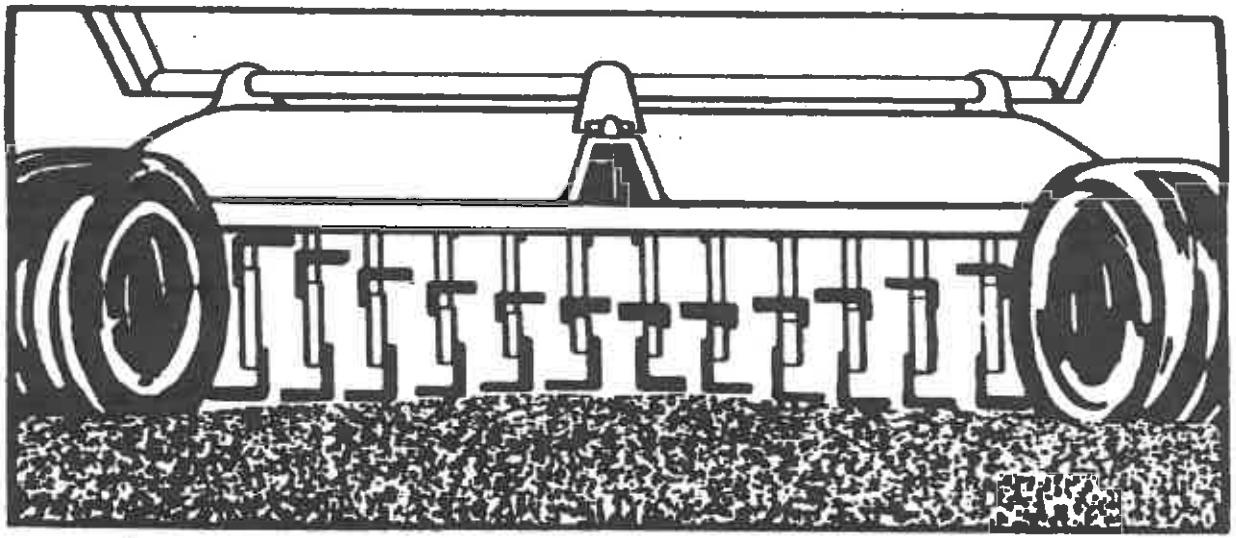
One type of mixing equipment is shown below: a traveling mixer. The rotary tillers have blades that mix the roadbed materials thoroughly in place. More than one pass is necessary to mix the full subgrade width. More than one pass may be necessary to mix the full subgrade depth.



The mixer can be adjusted to different mixing depths.

Besides the traveling mixer, rotary tillers, motor graders and similar types, the Contractor may choose to mix the subgrade materials is an approved plant. In any case, the roadbed materials must be thoroughly mixed throughout the entire depth and width of the stabilizing limits.

BLADES OF TRAVELING MIXER

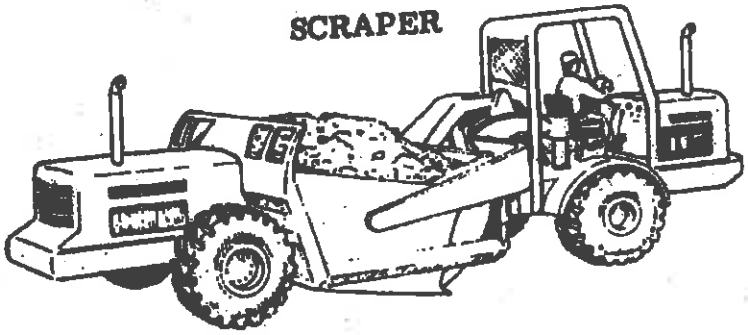


COMPACTION AND FINISHING EQUIPMENT

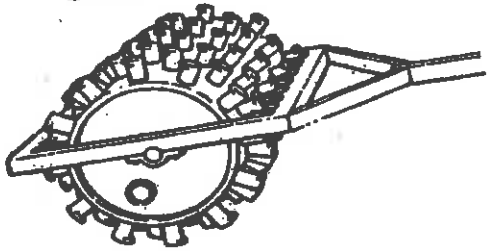
Compaction and finishing equipment are necessary to obtain the required density, lines grades, and cross section for the stabilized subgrade.

Earthmoving equipment - such as the scraper - or heavy rollers such as the sheepfoot roller often are used to compact the lower portion of the subgrade without removing the top layer.

SCRAPER

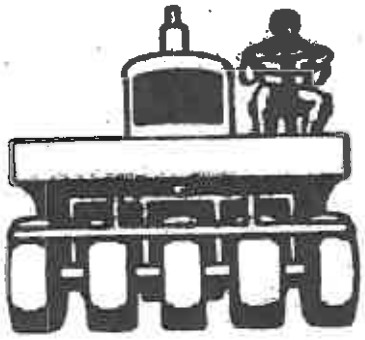


SHEEPSFOOT ROLLER



Lighter, rubber-tired traffic rollers usually are effective on the top 6-inches (150mm.) layer of the stabilized subgrade.

TRAFFIC ROLLER



Motor grades are commonly used to finish the subgrade to the lines, grades and cross sections shown on the plans.

QUIZ

What is your concern with the equipment used in subgrade stabilization operations? _____.

Which of the following can be considered application equipment for subgrade stabilization?

___ A. Bulldozer
___ B. Haul Truck
___ C. Motor Grader
___ D. Sheepfoot Roller

The specifications require that mixing be done with_____ or other approved equipment.

May subgrade materials be mixed in an approved plant?_____.

The top 160mm. layer of stabilized subgrade may be effectively compacted by _____.

CONSTRUCTION OPERATIONS

Once the necessary pre-construction preparations have been made as we discussed in Chapter Two the actual construction work may begin. Subgrade to be stabilized mixing uniformity, particle size limitation, compaction and other desired results. When the required and desired results are not achievable in a one-course operation, the Project Engineer will direct the processing be done in more than one course.

BASIC SEQUENCE

The basic sequence of construction and inspection activities is:

- spreading;
- mixing;
- checking;
- sampling;
- compacting; and
- finishing (the proper final subgrade elevation should be achieved.

We will discuss each step of the sequence in turn. First, let's discuss the application and spreading of the stabilizing materials.

SPREADING

When additive stabilizing materials are necessary, they must be spread uniformly over the area to be stabilized. The uniformity of spreading is important, as it affects the subsequent of mixing and thus the strength of the entire stabilized subgrade.

Remember, in Type B Stabilization, the Contractor has the option of using either commercial or local stabilizing additives. He also determines the quantities of material to be added to achieve the required LBR value. The Contractor should notify the Project Engineer of the source and the approximate quantity of stabilizing material he intends to add.

The applied stabilizing materials must be blended to a plane parallel to the bottom of the base spread uniformly to the full width of the section to be stabilized.

As we mentioned earlier, when materials from an existing base are used in the stabilizing at a particular location, all of such materials must be placed and spread before other stabilizing materials are added.

Sometimes, it may not be necessary to apply stabilizing materials to the roadbed. The existing soils alone or in combination with select high-bearing soils obtained from the regular earthwork operations may have the required bearing value without the addition of stabilizing materials. As we mentioned in Chapter One, in areas where the natural soils meet the bearing value requirements, the only work necessary before final testing is the thorough mixing of the in-place soils to produce a homogenous mixture.

MIXING

Mixing should be accomplished by rotary tillers or other approved equipment whether in place or in a plant. Mixing is a necessary step even when the existing soil has the required LBR value without the addition of stabilizing materials. The only exception to this requirement is when the existing subgrade is of limerock. In this case stabilization operations will likely be waived altogether.

The subgrade materials must be thoroughly mixed by the approved equipment until the blended mix is uniform in texture throughout the width and depth of the course being processed. As we mentioned, stabilization may be done in one or more course.

If you observe poor mixing, checking the condition of the mixing equipment. Also, closely observe the methods for operating the equipment. Adjustments will be required to achieve proper mixing. After mixing the subgrade, the Contractor should walk it down to seal and hold down the material. Walking down the subgrade is done by bulldozers and motor graders.

When the mixing is completed, all particles of material within the stabilized area must be small enough to pass a 3½ inch (90mm.) ring. Any particles not meeting this requirement must be removed from the stabilized area or be broken down in order to meet the requirement. As an Inspector, you should make visual and hand checks during and after mixing to be sure that this requirement is met.

To inspect for adequate mixing width and depth, you should follow the procedures that we will discuss after the quiz beginning on the next page.

QUIZ

Are subgrade sometimes stabilized in more than one course? _____.

Put the following construction and inspection steps in the correct order, numbering them 1 through 6:

__ A. Checking __ B. Mixing __ C. Finishing __ D. Sampling __ E. Compacting __ F. Spreading

The most important thing about spreading additive stabilizing materials is that they be spread _____
_____

Under Type B Stabilization, who determines the quantity of material to be added to the subgrade to achieve the required LBR value? _____.

What should the Contractor tell the Project Engineer in regard to the stabilizing material he intends to add?
_____and _____.

The applied stabilizing materials must be bladed and spread:

___ A. In no fewer than three passes
___ B. Uniformly to the full width of the section to be stabilized
___ C. To a plane parallel to the bottom of the base
___ D. To a depth of 508 mm. by rotary tillers.

When materials from an existing base are used in the stabilizing, they should be placed and spread _____
_____other stabilizing materials are added.

Can the natural (existing) soils in the roadbed sometimes meet the bearing value requirements without the addition of stabilizing materials? _____.

After being mixed, the subgrade soils should be uniform in texture and blend throughout the _____
_____ and the _____of the course being processed.

The stabilized subgrade particles must be small enough to pass a _____ring. How can you check for this?
_____.

CHECKING

Although hand and visual checks may be enough to ensure the proper blending and maximum particle size of the stabilized materials, you will have to do some measuring to inspect the subgrade width and depth. The Contractor also checks the subgrade width and depth behind the mixer during the mixing operation.

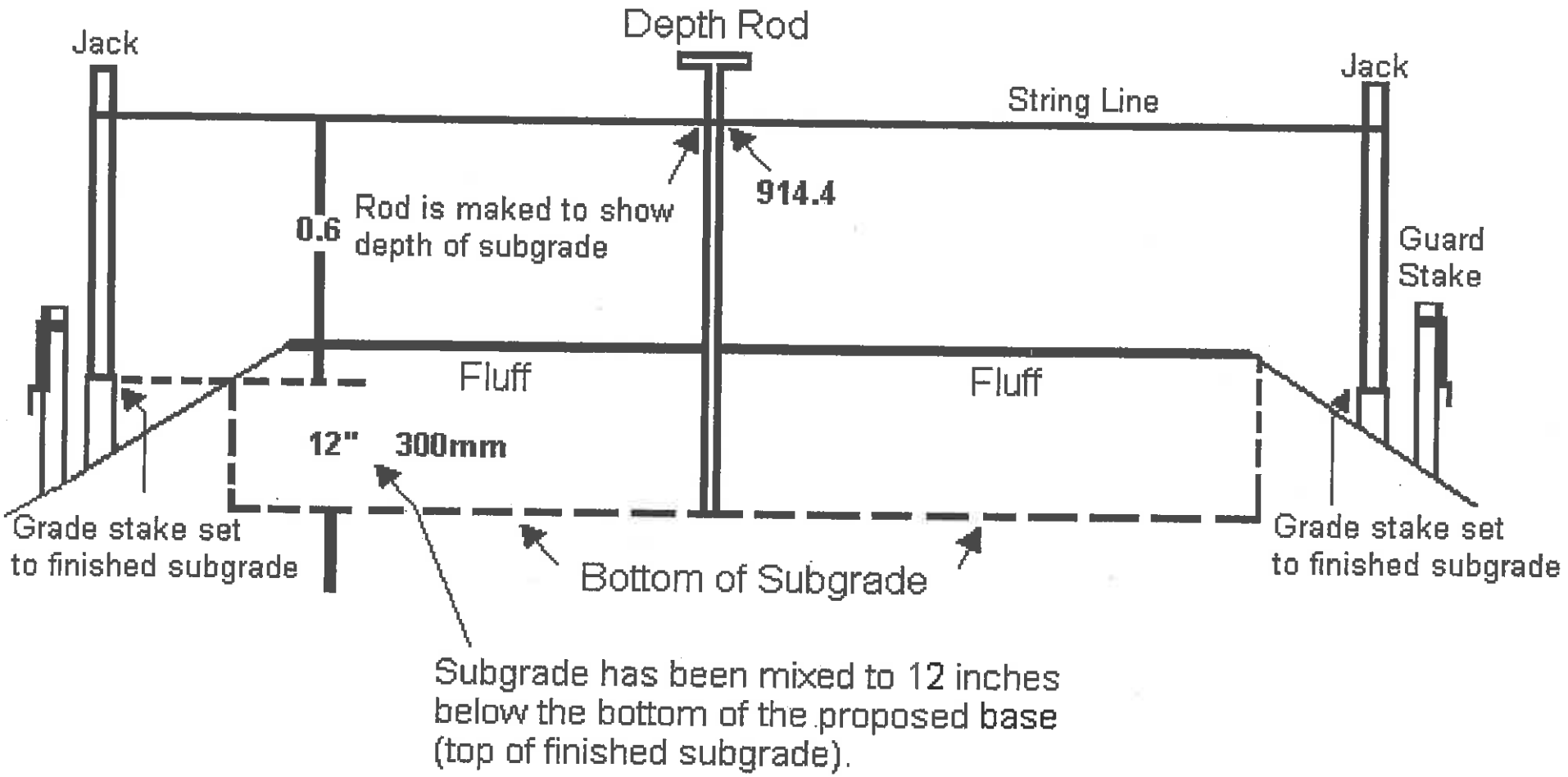
These checks should be performed at maximum Intervals of 100' (30m.). Also, be sure that you check the width and depth at any location where the subgrade appears to be deficient in one or both.

Checking Width. To check the width of the stabilization, use the string line and jack method (as discussed on the next page) at the same time you check the depth.

Checking Depth. At this point, depth checks are made as rough checks of the mixing depth. The important thing is for the bottom of the mixed subgrade to be at the proper elevation. A good tool for checking depth is a smooth metal rod about 4' (1.2m) long. For convenience of use, a handle may be welded on one end of the rod. To indicate subgrade depth, a tape showing the minimum and maximum depth limits may be attached to a rod or a rule may simply be held against the rod while measuring. Probe is one of the several methods used to check mix depth. If required test pits should be dug to checked the depth of mixing. Also, posthole diggers should be used to check mix uniformity and ensure proper depth. The depth-checking procedure is illustrated on the next page. The depth rod is used in conjunction with a string line and jacks (elevation stakes). Jacks are simply wood laths that can be used to set a string line at a convenient distance say, 2' (0.6m.) above the grade stakes. The jacks are marked at their 2' (0.6m.) points and are set on the grade stakes on opposite sides of the 2' (0.6m.) points on the jacks. The depth rod is probed into the subgrade and the depth is observed at different points across the roadbed.

In our example, the subgrade has been mixed to the proper depth (elevation) of at least 12" (300 mm.) below the bottom of the proposed base (top of finished subgrade). The 3' (914.4 mm.) indicated on the depth rod includes 2' (0.6m) of jack distance and 1' (.3m.) of subgrade below the bottom of the proposed base. The actual subgrade thickness will be reduced somewhat by the compaction and finishing operations.

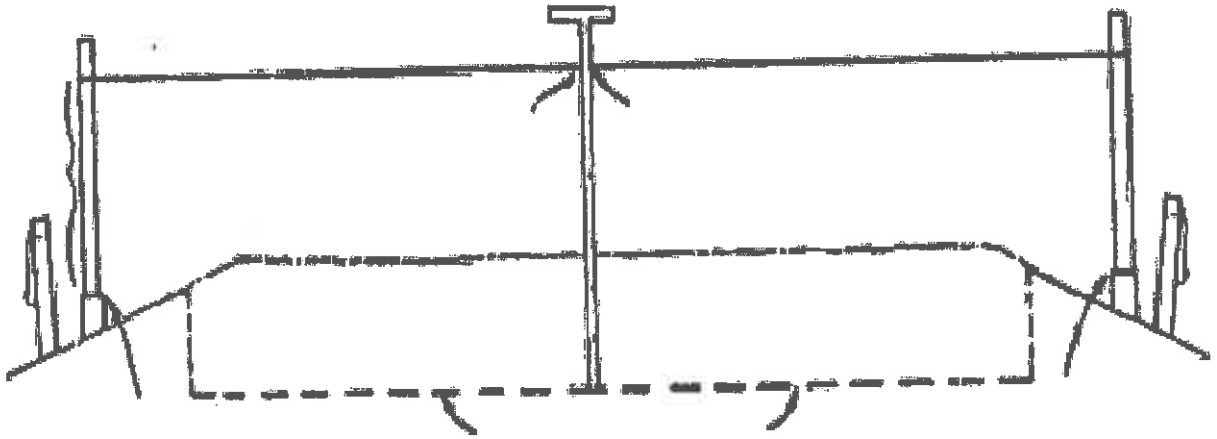
Another way of checking the depth is by using a posthole digger to dig a hole to the bottom of the subgrade. Then, a rule is inserted in to the hole to measure the depth. For the results of these depth checks, study the diagram below:


Jack
Depth Rod
Jack
String Line
914.4
0.6
Rod is maked to show
depth of subgrade
Guard
Stake
Fluff
Fluff
12"
300mm
Grade stake set
to finished subgrade
Bottom of Subgrade
Grade stake set
to finished subgrade
Subgrade has been mixed to 12 inches
below the bottom of the proposed base
(top of finished subgrade).

QUIZ

Width and depth checks should be performed at maximum intervals of_____.

Using the diagram which follows, answer the next two questions.



What is the subgrade depth at this point_____below the bottom of the proposed base (top of finished subgrade).

SAMPLING

After you check the stabilized subgrade width and depth - and after the subgrade is "walked down" - it is time to submit samples of the material. Samples must be submitted to the District Soils Lab for two purposes:

- to determine the maximum density and optimum moisture values for the subgrade material. After compaction, moisture-density tests must be performed on the completed subgrade to see if the specification requirements are met. Moisture-density sampling and testing procedures are covered in the Moisture-Density Testing and Control training course.

- to determine if the mixed subgrade materials has the required Limerock Bearing Ratio value.

As an Inspector, it will be your responsibility to obtain and submit these samples. Follow the Sampling, Testing and Reporting Guide as we discussed in Chapter Three. Place the samples in the bags provided by the Department, and complete and attach Sample Transmittal Cards.

The results of Limerock Bearing Ratio Test are reported by the Lab to the project on Test Reports, as we discussed before. An example of the Test Report for Stabilized Subgrade and Shoulders is shown at the right. Notice the L.B.R. test value of 40 obtained by the Lab. The "pass/fail status" blank at the top verifies that the sample passes the minimum design lime rock bearing ratio in this case, 40.

Note also that this report shows the optimum moisture and maximum density values for this material.

FLORIDA DEPARTMENT OF TRANSPORTATION PAGE 26

FORM: 115-01 DATE: 9/29/87

TEST REPORT FOR STAB. SUBGRADE & SHOULDERS

C0R0137

PROJECT NO: 92506-3602 W.P.NO: 5125626 40

MATERIAL NO: 020A SAMPLE NO: J0015 DATE SAMPLED: 09/21/87

STATION FROM: 539+93.69 STATION TO: 546+92.53 SAMPLE FROM: 544+50

LAB NO: D8995 TESTED BY: SD ON 09/25/87 PASS/FAIL STATUS: P

PAY ITEM NO(S): 1 160 4

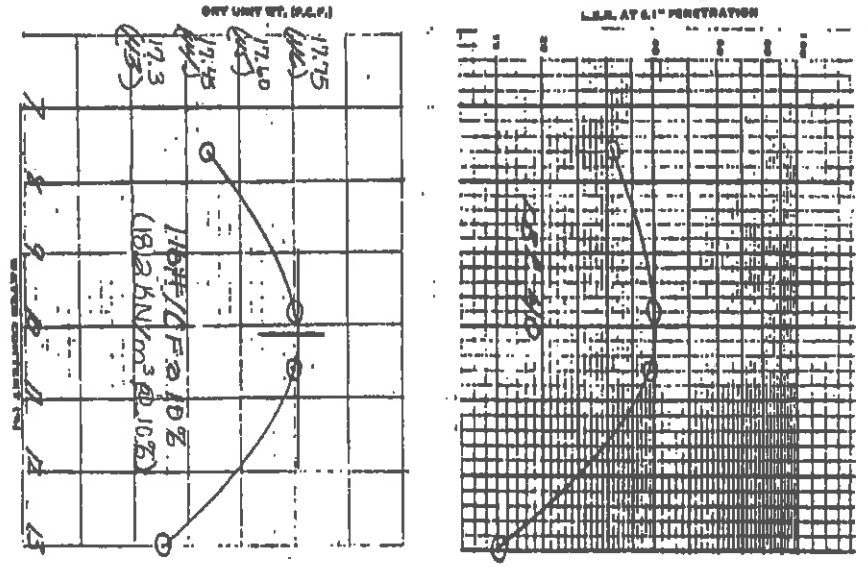
DISTRICT: 5 CONTRACT: 16305 ROAD NO: C0535

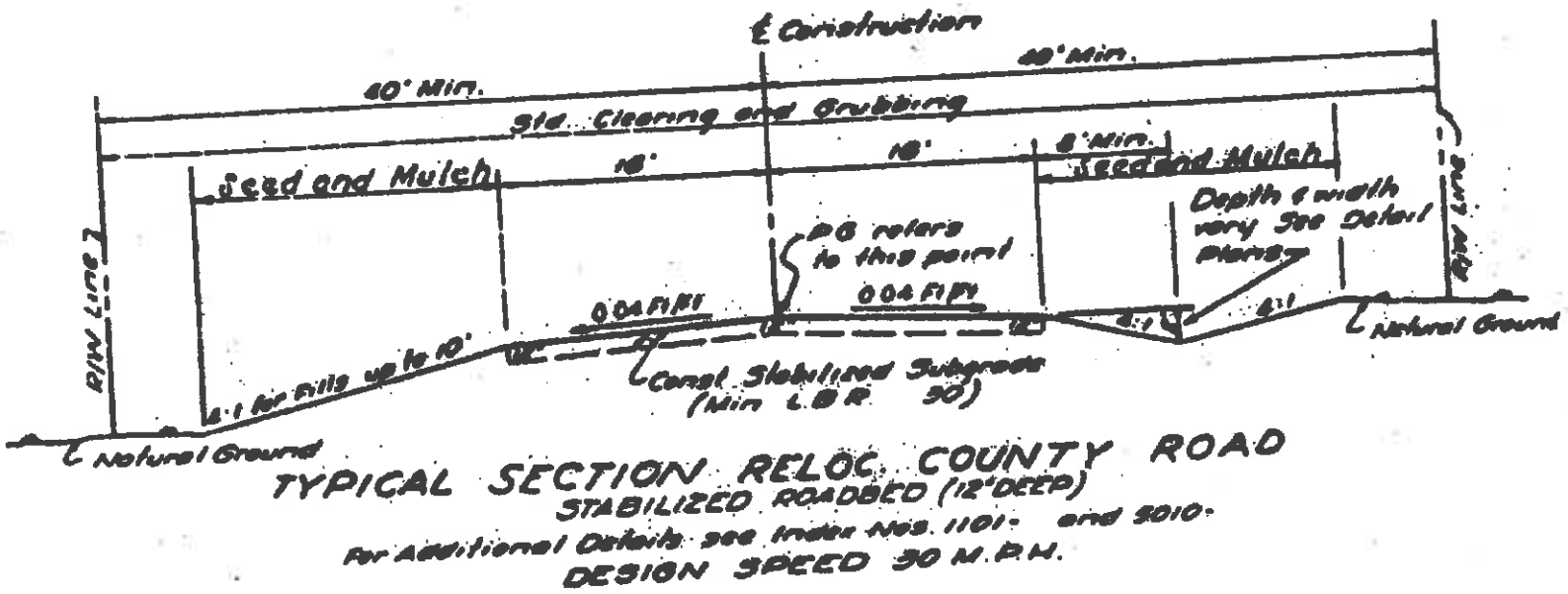
SOURCE: N/A PLANT NO: QUANTITY: 0.00

PRODUCER: INTENDED USE: SUBGRADE

JOB CONTROL RESULTS

QUAL	TYPE OF TEST/MEASUREMENT	RESULT	MINIMUM	MAXIMUM
	MAXIMUM DENSITY (MODIFIED)	116.0000 PCF		
	OPTIMUM MOISTURE	10.0000 PCT		
	LIMEROCK BEARING RATIO	40.0000 PCT	40.0000	





Minimum design L.B.R's are shown in the typical sections of the plans. Find the "Min. L.B.R." in the typical section below.

"Under-tolerances" are allowed for the specified bearing values. The under-tolerances are shown below, as taken from the Standard Specifications.

SPECIFIED BEARING VALUE	UNDERTOLERANCE
LBR 40	5.0
LBR 35	4.0
LBR 30 (and under)	2.5
All Florida Bearing Values	5.0

Sample submitted for maximum density and optimum moisture determinations are termed "Proctor" samples, after the name of the test performed on them.

Test results will be reported to the project on Test Report, like the one shown below. A graph showing the moisture-density curve is included in the report.

Notice the density of 116 pounds per cubic foot (1858kg per cubic meter) and the optimum moisture of 10 percent on this report. The results of moisture-density tests to be performed on the compacted subgrade will be compared to these laboratory values.

FLORIDA DEPARTMENT OF TRANSPORTATION PAGE 26

FORM: 115-01 DATE: 9/29/87

TEST REPORT FOR STAB. SUBGRADE & SHOULDERS

CORD137

PROJECT NO: 92506-3602 F.P.NO: 5125626 40

MATERIAL NO: 020A SAMPLE NO: J0015 DATE SAMPLED: 09/21/87

STATION FROM: 539+93.69 STATION TO: 546+92.5J SAMPLE FROM: 544+50

LAB NO: 08995 TESTED BY: SO ON 09/25/87 PASS/FAIL STATUS: P

PAY ITEM NO(S): 1 160 4

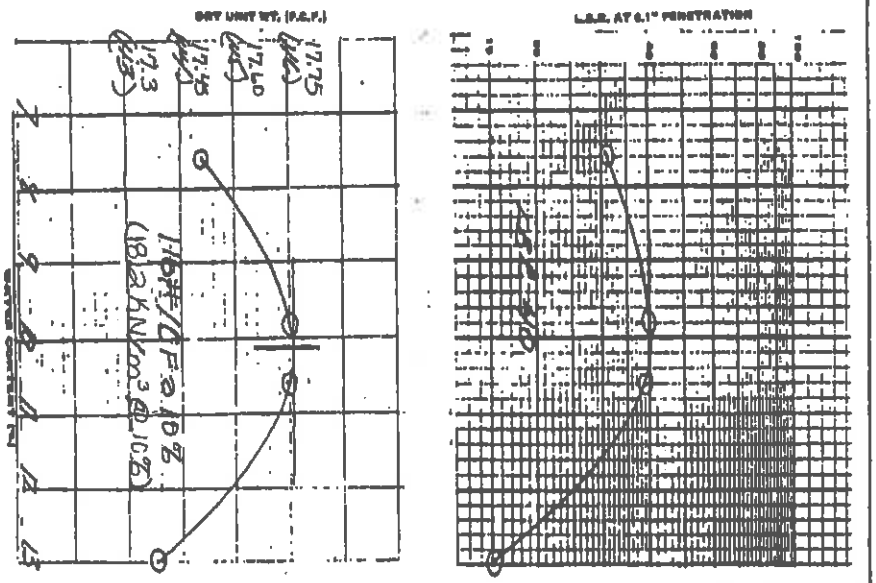
DISTRICT: 5 CONTRACT: 16365 ROAD NO: C0535

SOURCE: N/A PLANT NO: QUANTITY: 0.00

PRODUCER: INTENDED USE: SUBGRADE

JOB CONTROL RESULTS

QUAL	TYPE OF TEST/MEASUREMENT	RESULT	MINIMUM	MAXIMUM
	MAXIMUM DENSITY (MODIFIED)	116.0000 PCF		
	OPTIMUM MOISTURE	10.0000 PCT		
	LIMEROCK BEARING RATIO	40.0000 PCT	40.0000	



You should take note of the following points concerning sampling for L.B.R. and Proctor tests.

- The sampling frequencies shown in the Sampling, Testing and Reporting Guide are the minimum frequencies. You must also obtain and submit samples whenever the stabilized subgrade materials change. Change in materials will result in different L.B.R's and maximum density and optimum moisture values.

- Approximately four to five days are necessary for the Lab to perform the required tests and send out the results. (four to five days : one day to dry, one day to soak and compact, 48 hours to sit in the soak tank)

- While there are different specified bearing values, the minimum acceptable density for stabilized subgrade is 98 percent of the maximum (lab) density (modified proctor).

Okay, test yourself on this discussion of sampling by taking the quiz on the following page.

QUIZ

Samples of material from Type B Stabilization must be submitted to the Lab and tested to determine the:

___ A. Optimum moisture
___ B. Percent of maximum density
___ C. L.B.R.
___ D. Florida bearing value
___ E. Maximum density.

Are L.B.R. samples submitted to the Lab after compaction of the subgrade? _____.

Where can you find the required minimum design L.B.R.'s? _____.

Proctor samples are tested for _____ and _____.

In addition to sampling at the minimum frequencies shown in the Sampling, Testing and Reporting Guide, you should also obtain samples when _____,

What is the approximate number of days required by the District Lab to test samples and send out the results?
_____.

What is the minimum acceptable density for stabilized subgrades? _____.

COMPACTING AND FINISHING

The contractor may or may not begin compaction before test results come back from the Lab. Whether he does or doesn't depends on the operation. For, example, the Contractor may go ahead with mixing the subgrade down the road. Or, he may begin compacting the already mixed sections.

In general, compacting should begin after the mixing operation has been completed and after the requirements for bearing value, uniformity of mixing and maximum particle size have been met.

When test results indicate that certain areas do not meet the bearing value shown in the plans, remixing will be necessary or more stabilizing materials will need to be spread and mixed in to subgrade before compaction. Any remixing should be done throughout the area covered by the field sample. Such reprocessing must be done for the full subgrade width and for a distance of 50 feet (15m.) beyond the limits of the deficient area. Again, the Contractor will decide how much additional stabilizing material to spread.

Using equipment as we referred to earlier, the Contractor must compact the entire subgrade for the full width and depth so that density at any location will meet the specification requirement. The only exceptions to these requirements are: 1) areas to be subsequently incorporated into a base course under the same contract; 2) the upper 6" (150mm) of area to be grassed under the same contract. These areas must be compacted to a reasonably firm condition, as directed by the Project Engineer.

After compaction, the subgrade must be shaped to conform with the finished lines, grades and cross sections shown in the plans. This finishing work is usually performed by motor graders.

STABILIZED SUBBASE

As was mentioned in Chapter One, stabilized subbase construction may be called for by the plans. Basically, stabilized subbase involves the additional strengthening of the upper portion of the stabilized subgrade. Stabilized subbase is constructed in the following steps:

1. After the mixing of the stabilized subgrade and the determination that the bearing value requirements have been meet, the subgrade surface must be shaped to the approximate finished grade of the subgrade and to plane approximately parallel to the plane of the proposed finished surface.

2. The subgrade is then compacted to provide a firm surface for the equipment.

3. Commercial stabilizing material is spread to a minimum loose depth 3" (75mm.), according to the regular procedures for applying subgrade stabilizing additives.

4. The subbase is then mixed to the depth shown in the plans, following normal subgrade mixing procedures. A tolerance of 1" (25mm.) in excess of the plan depth is allowed in this mixing. No additional tests for bearing value will be made.

5. Compaction and finishing procedures are the same as those just discussed for subgrade stabilization.

The completed subbase is then checked and maintained as we will discuss in the next few page.

QUIZ

Is it permissible for the Contractor to begin compaction before test results come back from the Lab? _____.

Generally, compaction should begin after mixing is completed and the requirements are met for

___ A. Density
___ B. Uniformity of mixing
___ C. Bearing value
___ D. Maximum particle size.

What will need to be done when test results indicate that certain areas of the stabilized subgrade do not meet the bearing value shown in the plans? _____.

After compaction, the stabilized subgrade must be shaped to conform with the finished_____and _____shown in the plans.

When stabilized subbase is called for, commercial stabilizing material is spread to a minimum loose depth of _____.

A tolerance of_____ in excess of the plan depth is allowed in subbase mixing.

Are additional bearing value tests performed on samples of stabilized subbase? _____.

INSPECTION OF COMPLETED SUBGRADE

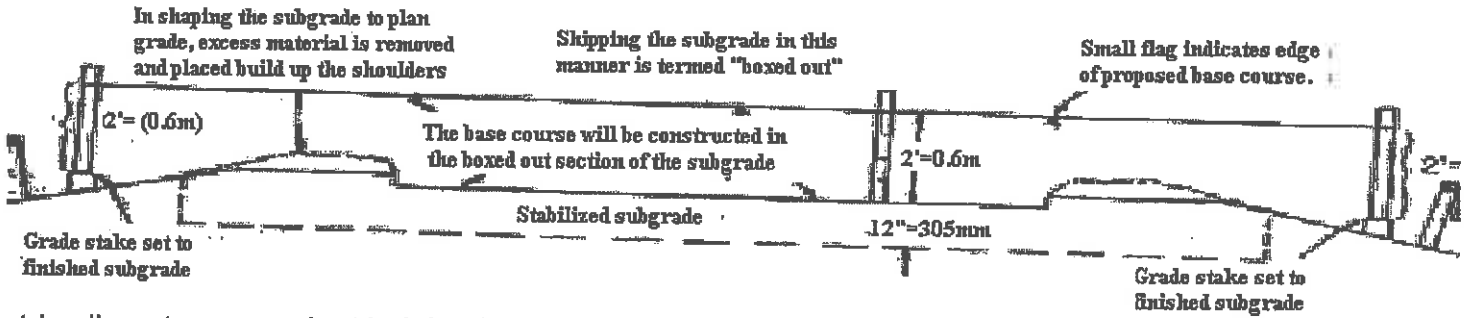
After the compacting and finishing operations have been completed, the stabilized subgrade must be inspected to ensure the proper:

- depth and templet (width, line and grade);
- density; and
- maintenance.

As an Inspector, it will be your responsibility to verify that the subgrade meets all requirements. Let's discuss this individually.

DEPTH AND TEMPLET

To ensure that the completed subgrade has the proper depth and templet, use a string line and jack set-up as we discussed earlier. Only, this time, a rule or other measuring stick may be used measure down from the string line instead of the metal probe. After the compacting and finishing operations, the stabilized subgrade will usually look like the one below.



By setting the string line at a convenient height above each grade stake, measurements can easily be made down to the finished subgrade surface. In the example above, measurements of 2' (0.6m) should be obtained across the surface - if the subgrade has been properly shaped.

To check the lines of the completed subgrade, little flags or other markers can be attached to the string line at the appropriate points such as the edges of the proposed base course in the above example.

QUIZ

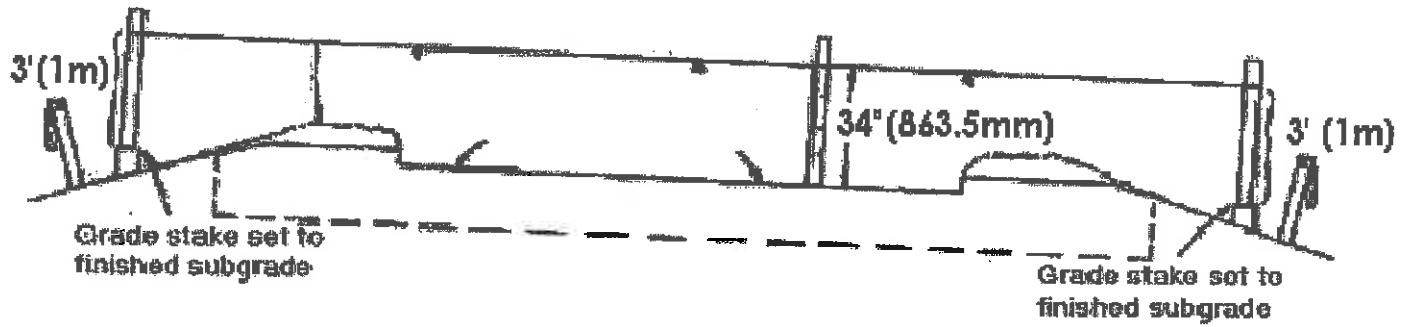
List the inspections that are performed after stabilized subgrade is completed:

_____.

_____.

_____.

If the string line in the illustration below is set1m above the grade stakes, and the rule measure 863.6mm from string line to surface, is the subgrade built to plan grade at the point? _____.



DENSITY

The completed stabilized subgrade must have a density of at least 98 percent of the maximum laboratory density (modified Proctor).

The completed subgrade will be tested in one layer up to a maximum of 12" (300mm.). For thickness greater than 305mm. such as for curb pads more than one test is needed. The subgrade must pass the density requirement before base course or pavement construction begins. As an Inspector, you must ensure that the Contractor corrects any failing areas.

MAINTENANCE

Even after you determine that the completed subgrade meets the templet, depth and density requirements, you must perform one more inspection. You must see the Contractor maintains the subgrade properly until the subsequent base or pavement is in place. Basically, this involves observing that the subgrade is kept free of ruts, depressions and any damage resulting from equipment operation, rain, etc.

QUIZ

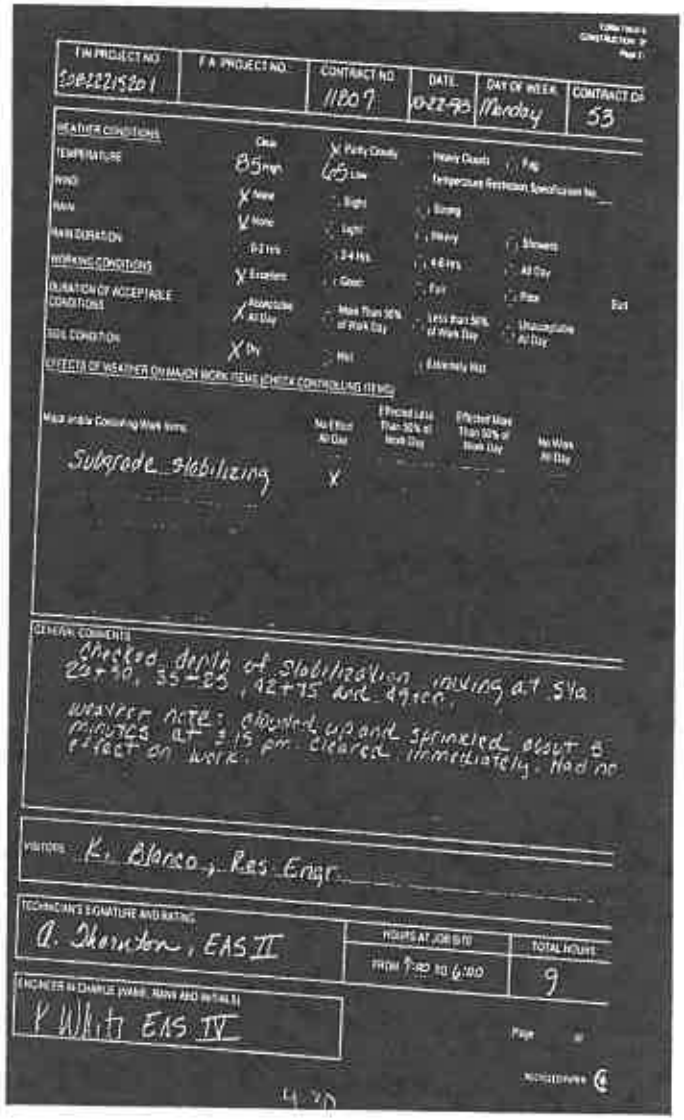
How can the completed subgrade depth and templet be inspected? _____
_____
_____.

Must all layers and locations in the completed subgrade pass the density requirements before base course or pavement construction begins? _____.

For how long must you see that the Contractor maintains the completed subgrade properly? _____
_____.

DOCUMENTATION

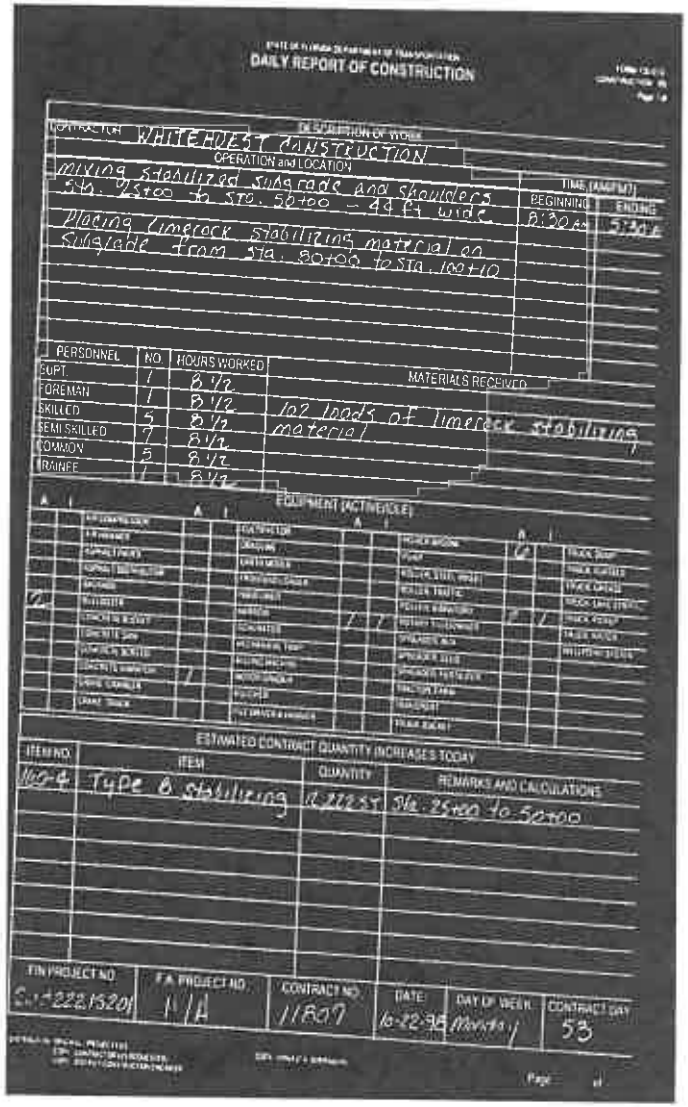
Subgrade stabilization work must be properly documented on a daily basis. As an Inspector, you will be responsible for writing and submitting a Daily Report of Construction, as shown at right.



The Daily Reports are compiled at the project office into a weekly dairy to document all the work on the project.

You should write accurate, neat and complete reports.

Study the examples shown here.



QUIZ

The type of subgrade stabilization determines:

___ A. The required percentage of maximum density.
___ B. The basic of payment for the work.
___ C. The requirements for the type of stabilizing additives.
___ D. The weight of the compaction rollers.
___ E. The method for determining compliance with the bearing value requirements.

What is the main concern with the equipment used in subgrade stabilization operations? _____.

Subgrade mixing must be done with _____ or other approved equipment.

May subgrade be stabilized more than one course? _____.

Should sampling for L.B.R. and Proctor tests be done before or after mixing? _____.

Who determines the amount of material to be added Type B Stabilized Subgrade to achieve the required L.B.R. value?
_____.

Describe how the applied stabilizing materials must be bladed and spread:_____
_____.

Do the natural (existing) soils in the roadbed sometimes meet the bearing value requirement without the addition of stabilizing materials? _____.

When materials from a existing base are used in the stabilizing, when should they be placed and spread in relation to the other stabilizing materials to be added? _____.

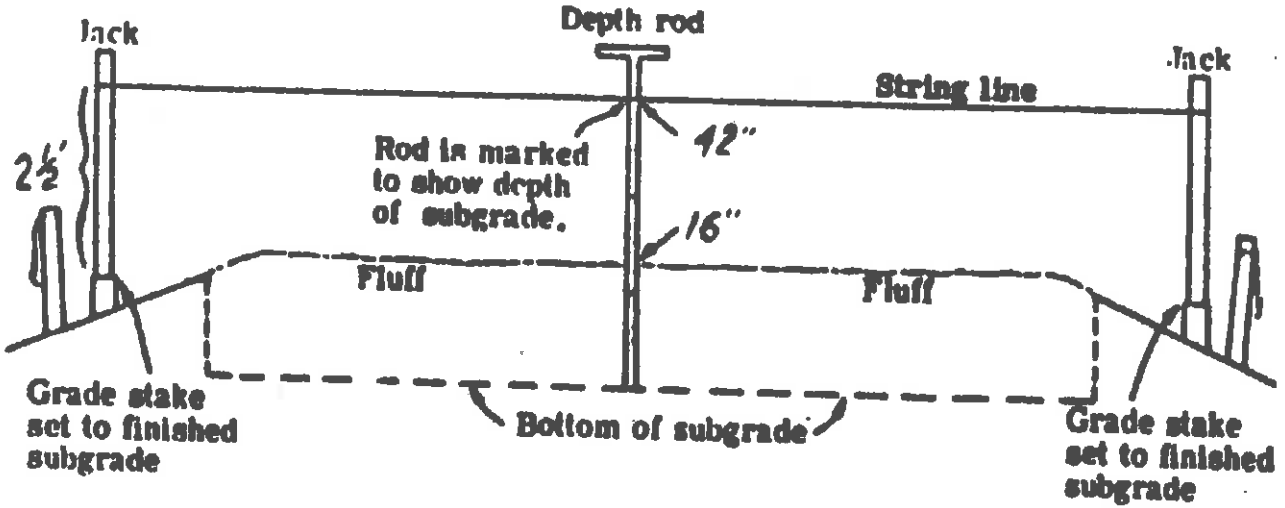
Is mixing always necessary even when the existing soil has the required L.B.R. value without the addition of stabilizing materials? _____.

Stabilized subgrade particles must be small enough to pass a _____.

What checks can you perform to verify this? _____.

Width and depth checks should be performed at maximum intervals of _____?

Look at the mixed subgrade below. What is the subgrade depth at the depth rod? _____



Where can you find the required minimum design L.B.R.'s? _____

You should obtain and submit stabilized subgrade samples according to the minimum frequencies of the _____
And also whenever? _____

What is the density requirement for stabilized subgrade? _____

What will need to be done when test results indicate that certain areas of the stabilized subgrade do not meet the bearing value shown in the plans? _____

Additional bearing value tests are **not** performed on samples of stabilized subbase. True or False? _____

What do you write at the end of each day's operation? _____

HOW DID YOU DO ON THIS QUIZ? IF YOU COULD NOT ANSWER ALL OF THE QUESTIONS CORRECTLY, YOU NEED TO REVIEW CERTAIN PARTS OF THIS CHAPTER. DO SO BEFORE GOING ON TO THE NEXT CHAPTER. RETAKE THE QUIZZES AS NECESSARY TO TEST YOURSELF. WHEN YOU ARE READY, BEGIN CHAPTER FIVE, CEMENT-TREATED SUGBRADE.

ANSWER TO QUESTIONS

Page 4-7

- that it obtains the desired results
- A, B, C
- rotary tillers
- yes
- traffic (rubber-tired) rollers

Page 4-13

- 100' (30 m)
- 12" (300 mm)

Page 4-19

- A, E
- Yes
- Typical sections of the plans
- Optimum moisture content, maximum density
- Whenever the stabilized subgrade materials change
- 4 to 5 days
- 98 percent of maximum lab density (modified proctor)

Page 4-25

- depth and templet; density maintenance
- no, it's 50.8mm above plan grade

Page 4-10

- yes
- A. 3, B. 2 ,C. 6, D. 4, E. 5, F. 1
- uniformly
- contractor
- the source; approximate quantity
- C
- before other stabilizing materials are added
- yes
- width and depth of the course being processed
- 90 mm; visual and hand check

Page 4-22

- yes
- B, C, D
- remix subgrade; spread and mix more stabilizing material into subgrade lines;
- grade; cross section
- 75mm
- 25.4
- no

Page 4-27

- by using a rule to measure from a string line subgrade surface
- yes
- until the subsequent base or pavement is placed

ANSWER TO QUESTIONS, continued

Page 4-29

- E
- that it obtains the desired results
- rotary tillers
- yes
- after
- contractor
- Uniformly to the full width of the section to be stabilized and a plan parallel to the bottom of the base
- yes
- before the other material
- yes

Page 4-30

- 90 mm; hand and visual
- 30 m
- 305 mm
- typical sections of the plans
- Sampling, Testing and Reporting Guide: subgrade materials change

Page 4-31

- 98 percent of maximum laboratory density (modified proctor)
- remix subgrade; spread and mix more stabilizing material into the subgrade
- true
- Daily Report of Construction

CHAPTER FIVE

Cement-Treated Subgrades

CONTENTS

5

CEMENT-TREATED SUBGRADES

INTRODUCTION

Cement-treated subgrades are constructed by combining portland cement with the soil. The combination must be uniformly mixed, moistened, compacted, finished and cured.

We discussed the materials used in cement treatment - portland cement Type I, soil, and water - in Chapter Three. The design application rate for the cement will normally be shown as pounds of cement per square yard of area. Your job will be to ensure that the cement is spread at the design rate.

Of course there's much more to inspecting cement-treated subgrade operations. Before we discuss all of the construction, inspection and documentation procedures, let's look briefly at the equipment commonly used in cement-treated subgrade construction.

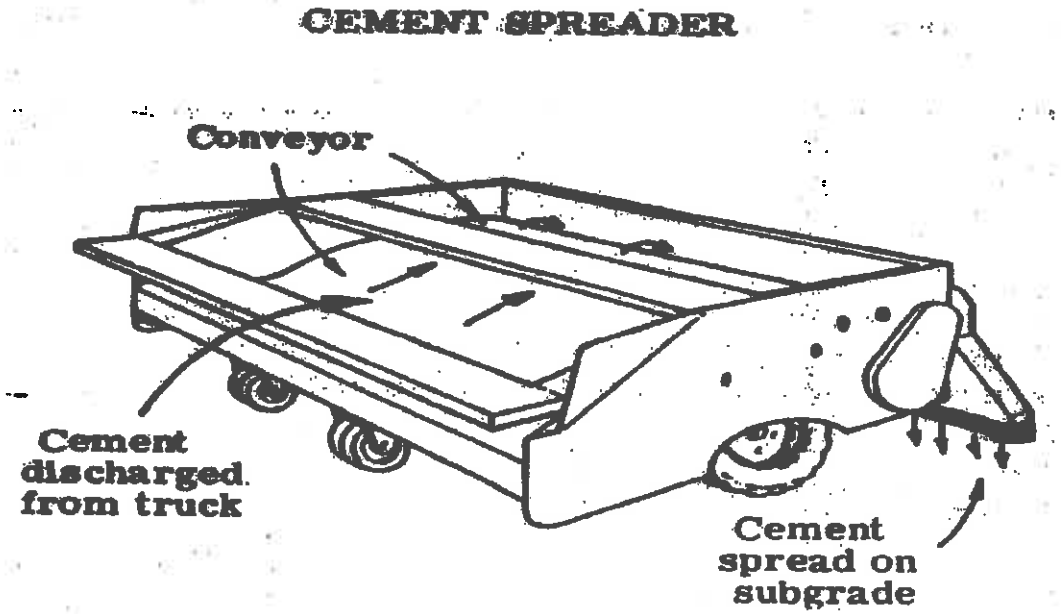
EQUIPMENT

The equipment used in cement-treated subgrade construction can be divided into five groups; application equipment, mixing equipment, compaction equipment, finishing equipment, and curing equipment. As with stabilization equipment, cement treatment equipment can be of any type - as long as it is in good, safe condition and produces the desired results. We will start with the application equipment.

APPLICATION EQUIPMENT

Cement spreaders - like the one shown on the next page - attach to the back of cement transports. As the transports move along the subgrade they discharge the cement into the spreaders. The spreaders can then apply the cement to the subgrade.

Water often must be added to the subgrade before and after the soil and cement are mixed. Gravity-type water trucks spread the water uniformly and at a controllable rate. Water trucks should be free of leaks.



MIXING EQUIPMENT

The soil and cement must be thoroughly and uniformly mixed by one of two methods: in-place mixing or central plant mixing.

Like the mixer used in stabilization mixing, this mixer can be adjusted to mix to different depths in the subgrade.

By the central plant methods, the soil and cement are mixed in a batch or continuous-mix-type pugmill and hauled by trucks to the job. The mixture is then spread by an approved mechanical spreader.

QUIZ

What is the main thing you are interested in from soil-cement designs? _____

_____

Soil and cement should be mixed by one of two methods. List them:

1. _____.

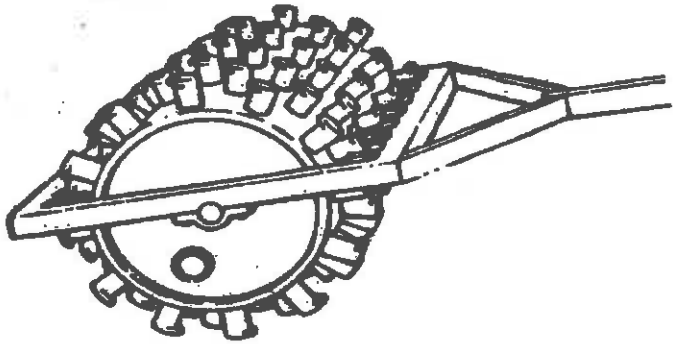
2. _____.

COMPACTION EQUIPMENT

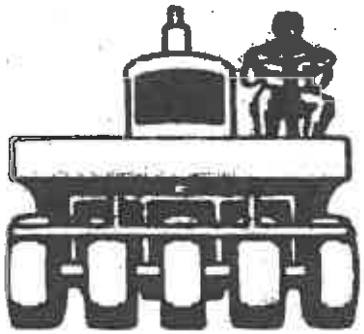
Sheepsfeet, vibratory and rubber-tired (traffic) rollers are typical compaction equipment for cement-treated subgrades.

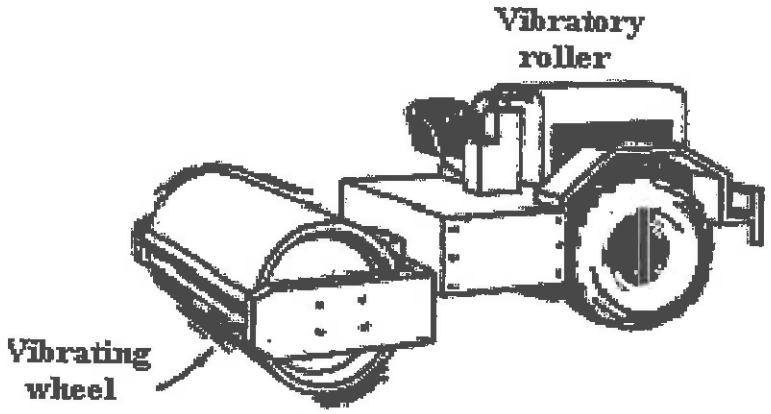
Different soil-cement blends may require different types and combinations of equipment in order to obtain the specified density.

SHEEPSFOOT ROLLER



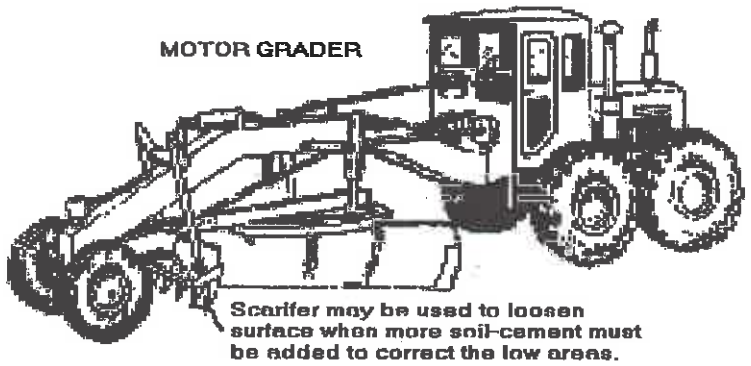
TRAFFIC ROLLER





FINISHING EQUIPMENT

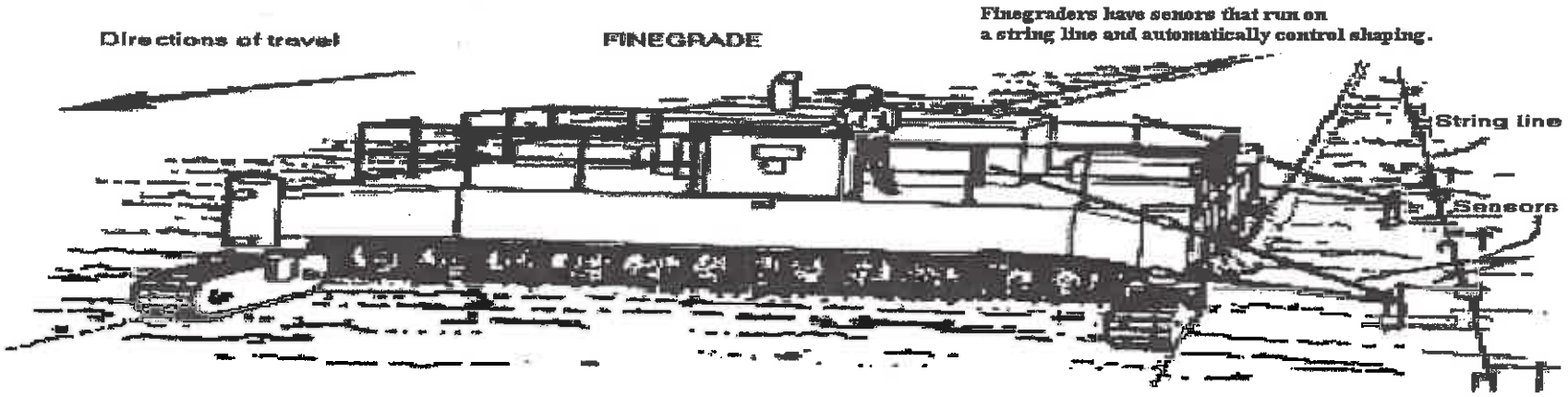
Motor graders or finegraders are used to shape the compacted cement-treated subgrades to the lines, grades and cross section shown in the plans.



CURING EQUIPMENT

Finally, asphalt distributors are used to apply a coating of asphalt which keeps the subgrade from drying. The protection from drying enables the cement-treated subgrade to cure.

Asphalt distributors must be able to apply the asphalt in a uniform coat.



QUIZ

List three of typical compaction equipment used on cement-treated subgrade:

1. _____.
2. _____.
3. _____.

Fine-graders have _____ that run on a string line and automatically control the shaping.

What equipment is used to apply a curing coat that keeps the subgrade from drying?

_____.

The equipment used in cement-treated subgrade construction should:

___ A. Operate safely
___ B. Produce the desire results
___ C. Be in good condition
___ D. Weigh no more than four tons.

Now proceed to CONSTRUCTION OPERATIONS.

CONSTRUCTION OPERATIONS

Once the necessary pre-construction preparations have been made - as we discussed in Chapter Two - the actual construction work may begin. If you do not remember those preparations, review Chapter Two now.

BASIC SEQUENCE

This is the basic sequence of construction and inspection activities for cement-treated subgrade:

- marking spread distances;
- spreading;
- mixing and moistening;
- checking;
- performing field Proctor tests;
- compacting;
- finishing; and
- making construction joints.

We will cover each of these steps.

MARKING SPREAD DISTANCES

Before the cement can be spread on the roadbed, stakes should be set to mark the spread distance for each transport load of cement. These distances are based on the amounts of cement contained in the transports, the spread width, and the design application rate for the cement.

For example, suppose a certain transport holds 15 tons (13.5MT) - 30,000 pounds (13,636 kg) - of cement. The cement will be spread in a 24-foot (7.2m wide) subgrade at a rate of 30 pounds/yd^2 (13.6 kg/m5). What is the spread distance for this particular transport?

Follow these formulas:

Weight of cement+ Application Rate = Total square yards (meters) to be covered.
Total square yards to be covered) spread width (feet) = spread distance
(Total square meters to be covered) spread width (meters) = spread distance.

The example calculations look like this:

(30,000) lbs 30 lbs/ sq. yard = 1000.0 sq. yards
(1,000 sq. yds. 9 sq.ft./sq. yd.) 24ft.=375 ft.)

(**NOTE**: Our example is just one way to calculate the spread distance. You will probably learn other methods on the job.)

The spread distance for this transport is 375' (114.3m). Stakes marking the beginning and ending points for this spread should be set along the subgrade.

As an inspector, you should set these stakes before cement spreading is to begin. Of course, these stakes are only temporary markers and do not need to be of any specific dimensions or have any information written on them. Also, you can use as few as two stakes over and over again. Simply remove the back (beginning) stake and set it for the next ending stake - in leapfrog fashion.

To document the cement spread and account for the cement delivered (the cement is a separate pay item), you should collect the certified scale (delivery) tickets for the transport trucks or railroad cars. On rare occasions you will have to observe the actual weighing of transport trucks.

A spread sheet can be worked up containing all the information about spreading the cement. As you receive each delivery ticket, you can record the weight of the cement, compute the spread distance for that load, and mark the distance with stakes.

A spreadsheet is shown on the next page.

Study the spread sheet below. Then, read the explanation on the preceding page.

CEMENT-TREATED SUBGRADE

TRK. NO.	STA. TO STA.	LBS. PER. SQ. YD.	TOTAL SQ. YD.	LBS. APPLIED	THEO. LBS.	PAY QTY. LBS.	PAY QTY. TONS	TIME
404	311+00- Truck no. 404 308+73	34	682	23,202	34	23,202	11.60	7:30am
411	308+73 Truck no. 411 304+16	34	1,372	46,640	34	46,640	23.32	8:00 am
416	304+16 Truck no. 416 299+61	34	1,366	46,440	34	46,440	23.22	8:45 am
424	299+61 Truck no. 424 295+05	34	1,369	46,540	34	46,540	23.77	9:30 am
311	295+05 Truck no. 311 290+36	34	1,406	47,820	34	47,820	23.91	10:15 am
343	290+36 Truck no. 343 285+76	34	1,379	46,880	34	46,880	23.44	11:00am
345	285+76 Truck no. 345 281+07	34	1,406	47,820	34	47,820	23.91	11:45am
304	281+07 Truck no. 304 276+38	34	1,408	47,880	34	47,880	23.94	12:30 pm
417	276+38 Truck no. 417 271+74	34	1,391	47,280	34	47,280	23.64	1:15 pm
338	271+74 Truck no. 318 267+13	34	1,384	47,040	34	47,040	23.52	2:00 pm
	TOTAL		13,183			447,542	223.77	
	REMARKS							

As each truck arrives at the job, collect its delivery ticket and record the truck number.

1. Record the weight of the cement shown on the delivery ticket, in pounds.

2. List the design application rate(Theoretical Pounds)-- in this case, 34 pounds per square yard.

3. Now, to find the total square yards to be covered, divide number 2 by number 3. For truck number 404: 23,202lbs. 34lbs./sq.yd. = 682 sq. yds.

4. To find the spread distance, multiply the answer from # 4 by 9 sq. ft./sq. yd. and divide by the width of spread (in feet). In this case, the spread width is 27 feet. So, [(682sy)(9sf/sy)] / 27 feet =227.3 feet. The spread distance is 227 feet. Since the spreading will begin at station 311+ 73. For the next spread distance, the stake at station 308+73 will serve as the starting stake.

5. If all the load of cement is spread at the desired width and from stake to stake, the actual application is the same as the theoretical 34 pounds per square yard.

6. The amount of cement spread is the pay quantity.

7. You should record the time that each spread begins.

QUIZ

How are spread distances marked? _____.

Spread distance are based on the:

___ A. Amount of water that will be spread
___ B. Type of spreader used
___ C. Spread width
___ D. Design application rate for the cement
___ E. Amounts of cement contained in the transport

A certain transport holds 38,500 pounds of cement. The design application rate is 32 pounds/yd ^{2}. The subgrade is 24' wide. What is the spread distance for this particular transport? _____ (to the nearest foot). Use the space below for calculating your answer.

CEMENT TREATED SUBGRADE
DATE 6-26-75

TRK NO.	STA. TO STA.	LBS. PER. SQ. YD.	TOTAL SQ. YD.	LBS APPLIED	THEO. LBS.	PAY QTY. LBS	PAY QTY. TONS	TIME
404	311+ 00- 308+73	34	682	23,202	34	23,202	11.60	7:30am
411	308+73 304+16	34	1,372	46,640	34	46,640	23.32	8:00am
416	304+16 299+61	34	1,366	46,440	34	46,440	23.22	8:45am
424				46,540	34			

Using the spread sheet excerpt above, complete the (Total Sq.) Yd. and Sta. To Sta. Blanks for trucks number 424. The subgrade width is 8.2m.

QUIZ (con't)

Total Sq. Yd. _____.

Sta. to Sta. _____.

What should you collect from each cement transport as it arrives at this job? _____.

What kind of cement should be used for cement-treated subgrades?_____.

Is the cement a separate pay item? _____.

SPREADING

The cement for cement-treated subgrades may either be spread directly on the roadbed (to subsequently be mixed in place with the soil) or be mixed with soil in a central plant first and then spread on the roadbed. In this course, we will emphasize the mixed-in-place method, the more common of the two.

On some jobs cement treatment is performed in conjunction with lime treatment. Briefly, lime is applied and mixed into a roadbed to break down clay-type soils and make them friable (granular). When the two operations are performed on the same job, the cement spreading in any area must not begin until at least seven days have passed since the lime treatment was completed.

The moisture percentage in the soil at the time the cement is spread must not exceed the amount necessary to achieve a uniform and well mixed soil-cement combination during the mixing operations. This translates into some basic guidelines: The moisture content for clay soils should not exceed the optimum moisture content for the soil-cement mixture. For sandy soils, the moisture content should be within two percentage points above or below the optimum moisture content. The Engineer may designate other moisture ranges for other types of soils. Optimum moisture contents are determined by field tests, which we will discuss later in this chapter.

Cement must be spread uniformly on the roadbed and at the application rate determined by the Engineer.

Weather conditions must be taken into consideration during cement treatment operations. Naturally, the spreading of cement or soil-cement mixtures must not take place during rain, since the soil's moisture content is so critical. Spreading of cement in high winds should also be avoided. The wind will blow some of the cement off the subgrade and will otherwise interfere with a uniform application. Cement should not be spread if the temperature may fall below 32°F (2°c) within 24 hours or unless the air temperature is at least 40°F (4°c) in the shade and rising. As an Inspector, you must always observe weather condition and any limitations they impose on the cement treatment operations.

As we mentioned a few pages ago, you should collect the delivery tickets from the cement transport drivers as the trucks arrive on the job. Again, these tickets help you to inspect and document the spread and account for the amounts of cement used. As we have said, you may collect delivery tickets for railroad cars, and - in rare cases - you may have to observe the weighing of individual trucks.

There is one final responsibility you have in regard to spreading operations. At the start of each day, you should verify that the spreading equipment is adjusted properly to spread at the design application rate. To check spreader adjustment, place a 1-square yard piece of canvas on the roadbed in front of the spreader. Have the spreader begin application, passing over the canvas. Then pick up the corners of the canvas and work the cement into the center. Weigh the canvas by hanging it from a scale (the canvas may have rings in the corners for this purpose) or by placing it on a small platform scale. The weight of the canvas should be subtracted from the total weight of the canvas plus cement to obtain the net weight of the cement. This weight is the actual application rate. If the actual application rate is not the same as the design rate, adjustments should be made to the spreader. As an Inspector, you should make these rate checks at least daily - when the spreading begins - and whenever you feel that the actual rate differs from design rate, and when the design rate changes.

The canvas checks, in combination with your marking of the spread distances, should give you adequate control over the spreading operation.

QUIZ

When cement treatment follows lime treatment, what minimum amount of time should pass between the completion of the lime treatment and the beginning of the cement treatment? _____.

What is the proper moisture content for sandy soils before cement application? _____.

Cement may be spread:

___ A. During rain
___ B. At temperature of 4.4°C in shade and rising
___ C. In high winds
___ D. At any rate within 20% of design rate.

A canvas check reveals that the actual application rate is 30 pound/ sq yard. The design rate is 34 pounds per square yard. What should be done? _____.

If you could not answer the question in this quiz, re-read pages 5-15 and 5-16. We will discuss mixing and moistening next.

MIXING AND MOISTENING

After the cement has been spread it must be mixed in place with the soil. The mixed subgrade must then be brought to the proper moisture content in order to be compacted to the required density. The requirements for the mixing and moistening operations are summarized below:

Mixed in Place

- The entire subgrade width should be mixed in a single operation, when possible.
- Mixing may be done to the full depth in one course - as long as the cement and water can be thoroughly mixed with soil and the required density can subsequently be obtained. Otherwise, the subgrade must be mixed in multiple courses. When mixed in more than one course, the subgrade must have sufficient bonding between courses.
- Mixing must begin within 30 minutes after the cement is spread. The soil and cement are initially mixed just enough to prevent the formation of cement balls when water is added. Then, water is added as necessary, and the subgrade is remixed. Sometimes additional water is still needed. During the moistening - and after all the water has been added - mixing must continue until a uniform, well mixed subgrade is obtained
- If too much water is added to certain areas, the subgrade should be manipulated (aerated) by remixing or blading to reduce the moisture to within the desirable rage. Excessive concentrations of water in the subgrade must always be avoided.

Central Plant Mixing

As we have indicated, central plant mixing is less common than in-place mixing, but we will discuss the basic procedures here. As an Inspector of subgrade operations, you may be required to help inspect the plant operations. In any case, you will be responsible for inspecting the road operations. You should be aware of the following points:

The soil, cement and water must be mixed in a pugmill of either the batch or continuous-mix type. The plant must have feeding and metering devices that accurately proportion the soil, cement and water in the quantities specified. All the materials must be mixed for least 30 seconds.

- The mixtures must be hauled to the job in a truck with protective covers and be spread on the moistened subgrade in a uniform layer by an approved spreader. Dumping of the mixture in piles or windrows upon the subgrade will not be permitted. There is a time limit of 30 minutes between placement of the mixture in adjacent passes of the spreader.

- When Portland concrete pavement will be constructed on the subgrade, the Contractor must plan his operations so that the joint between adjacent passes of the spreader will be offset at least 1 foot from the proposed longitudinal joint in the concrete pavement.

- Layers of soil-cement mixtures must be uniform in thickness and surface contour and of such quantity that the completed subgrade will conform to the grade and cross section.

Checking

Okay. We have discussed the general mixing and moistening procedures. But what are your specific responsibilities during the phase of cement treatment? Of course, you must ensure that the general and basic requirements just discussed are met. Also, you must check the mixed subgrade for proper depth and uniformity of mixing. These checks are similar to the ones performed on stabilized subgrades.

Depth

The depth of the cement-treated subgrade will be specified on the plans. To check the depth during mixing operations, follow the same procedures described on pages 4-13 and 4-14 using a smooth metal rod, jacks and sting line. Review those pages now, if necessary to remember the procedure. You should check the depth at 100' (30m.) minimum intervals during and after the mixing operations.

Uniformity of Mixing

To check the uniformity of mixing, use a posthole digger to remove a full-depth sample of soil-cement mixture. Observe the thoroughness of the blend - to verify that the cement and soil are completely mixed together. Also look for any cement balls or lumps of soil. There should be no soil particles larger than 1 inch in diameter, and a minimum of 80% of the particles should pass the No. 4 sieve -- exclusive of gravel and stone.

PERFORMING FIELD PROCTOR TESTS

When inspecting stabilized subgrade operations, you submit samples of the mixed subgrade materials to the District Lab for maximum density optimum moisture content and bearing value tests. On cement-treated jobs, however, time is critical- because the cement begins to set as soon as it is mixed with the soil. Therefore, maximum density and optimum moisture values must be determined immediately in the field.

For this reason you will perform field Proctor tests on samples of the soil-cement mixture. A district Lab representative will spend two or three days with you on the job at the beginning of the project to teach you the test procedures. Thereafter, you will perform field Proctor tests for the job and use the test results - the maximum density and optimum moisture values - for determining whether or not the compacted subgrade meets the moisture-density requirements.

We will discuss compaction operations after you take the quiz beginning on the next page.

QUIZ

When possible, the entire subgrade width should be mixed in:

___ A. a single operation.
___ B. five minutes.
___ C. a central plant.

May subgrade mixing be done to full depth in one course if mixing and density requirements can be met? _____.

Mixing must begin within _____ minutes after the cement is spread.

The soil and cement are initially mixed just enough to:_____.

What can be done to the subgrade whenever the moisture content exceeds the specified level? _____.

By the central plant method, all the materials must be mixed for at least _____.

What is the time limit for placement of the central plant mixture in adjacent passes? _____.

Is the dumping of soil-cement mixture in piles or windrows on the subgrade acceptable? _____.

What should you use to check the depth of cement-treated subgrade? _____.

What tool should you use in check for uniformity of mixing? _____.

For cement-treated subgrades, where are the maximum density and optimum moisture values determined? _____.

Who makes these determinations?_____.

How will you learn the field Proctor test procedures?_____.

COMPACTING

The compaction of the cement-treated subgrade should begin immediately after mixing is completed. In no case should more than 60 minutes elapse between the last mixing pass and first compaction pass at a particular location.

The moisture content at the start of compaction should not be more than two percentage points above or below the optimum moisture content.

While there are no special requirements for the compaction equipment, the operation itself should proceed in an orderly and efficient manner to obtain a uniform compaction of the entire subgrade. The subgrade must be compacted to at least 95 percent of the maximum density.

FINISHING

After compaction, the surface of the subgrade must be shaped to the lines, grades and cross section shown in the plans. In areas needing additional soil-cement mixture to comply with the above requirement, the areas must first be lightly scarified - loosened. Scarifying enables the added mixture to bond with the surface. If scarifying is not done, compaction planes - slippage surfaces - will form when the area is rolled. The scarifying can be done with a spring-tooth harrow, spike drag or other approved device. Once the deficient area is scarified, the mixture is spread and compacted to the specified density. The rolling should continue until all rutting stops.

During the finishing operation, the moisture content of the surface material must be maintained at not less than two percentage points below optimum.

If the subgrade is to be trimmed to final elevation with an automatically controlled finegrader, the subgrade surface just before the trimming must be parallel to, and not in excess of ½ inch (13mm.) above the finished elevation of the subgrade.

In summary, the compaction and finishing operations should produce a smooth, dense surface, free of compaction planes, cracks, ridges or loose material.

MAKING CONSTRUCTION JOINTS

At the end of the day's construction, a straight transverse construction joint must be formed in the cement-treated subgrade. Construction joints are made by cutting back into the completed work to form a vertical face. The joint should be located so as exclude all of that part of the subgrade at the end of the run which does not meet the requirements.

For example, the end of the run probably will not have the proper thickness, depth, uniformity of mixing or density. Such material should be wasted,

As an Inspector, observe construction to verify 1) that a straight, vertical-face joint is formed and 2) that the end portion of the run not meeting the requirements is excluded.

QUIZ

When is the earliest that compaction can be started after mixing has been completed? _____. When is the latest? _____.

Cement-treated subgrade must be compacted to a least _____percent of the maximum density.

Areas of the subgrade that need additional soil-cement in order to comply with the plans must first be lightly _____.

Which of the following are desirable in a finished cement-treated subgrade?

___ A. ridges
___ B. smoothness
___ C. cracks
___ D. compaction planes
___ E. dense surface
___ F. loose material

Construction joints are made by cutting back into the complete work to form a _____.

With the compaction and finishing operation completed, you are ready to inspect the finished subgrade.

Go on to the next page.

INSPECTION OF FINISHED SUBGRADE

Even after the compaction and finishing are completed. You will have work to do. You will be responsible for:

- testing and checking the finished surface - to ensure that the finished subgrade meets the requirements for density, line, grade, cross section and thickness.

- inspecting the curing operations - to ensure that the finished subgrade is protected from drying and allowed to cure.

TESTING AND CHECKING

As we mentioned above, the finished subgrade must be tested and checked to see if it meets the requirements for density, line, grade, cross section and thickness. Let's discuss how you will determine if each requirement is met. First, for density.

Density. As you know, cement-treated subgrades must be compacted to at least 95 percent of the maximum density that you will determine by field Proctor tests. You can find moisture-density test procedures discussed in the Earthwork Inspection training course. Follow the frequencies shown in the Sampling, Testing and Reporting Guide. Any failing areas must be corrected by the Contractor.

Line, Grade and Cross Section. The templet line, grade and cross section of the finished cement-treated subgrade may checked by using a string line, jacks and rule as covered in Chapter Four.

Crowns may be checked by means of a templet cut to the required crown and placed on the subgrade surface.

The checks should be made as soon as possible after the compaction and finishing operation - and no later than the beginning of the day after the completion of any subgrade section.

All areas higher or lower than the plan grade must be corrected immediately. High spots can be bladed down. Low areas must be corrected by removing and replacing the subgrade to full depth.

Thickness. Test holes must be dug or drilled and measured to determine finished subgrade thickness.
Subgrade of up to a 6-inch specified thickness must not have deficiencies greater than 1/2 inches (13mm.).

The tolerance for subgrade over a 6" (150mm) specified thickness is 1" (25mm.) of deficiency.

Deficiencies in thickness greater than the above guidelines must be corrected by removing the deficient areas full depth and replacing them with subgrade of the specified thickness. This work will be done at the Contractor's expense.

QUIZ

What must be done about areas that fail density tests? _____.

Should subgrade surface areas higher or lower than plan grade be corrected? _____.

How are thickness checks made? _____.

Subgrade up to a 6"(150mm) specified thickness must not have deficiencies greater than?
_____.

NOW, GO ON TO CURING.

CURING

Just as portland cement concrete must be allowed to cure, so must cement-treated subgrades. "Curing" is the means of sealing the water in so that it can react with the cement (a chemical process called "hydration") to bond the soil particles together in a firm, strong, durable mass. For hydration to take place, sufficient moisture must be present in the subgrade throughout the curing period. If the subgrade were allowed to dry, the soil-cement mixture would not attain the desired strength, and shrinkage would occur causing cracks and a weak subgrade.

To allow cement-treated subgrade to cure, a thin coating of liquid asphaltic material is sprayed on them by asphalt distributors. The asphalt coating holds in the subgrade moisture.

Even before the asphaltic material is applied, curing is taking place. Because of this, the moisture content of the subgrade must be controlled. While finishing and surface correction operations are being done, the subgrade surface must be sprinkled to keep it moist. As an Inspector, you should be sure that the Contractor keeps the surface moist until the asphaltic material is applied. Also, at the time the asphalt is applied, the subgrade surface must be dense and free of loose and foreign material.

Two types of asphaltic material are specified for use as curing coats: cut-back asphalt, Grade RC-70 and emulsified asphalt, Grade SS-1.

The specification ranges for applying these materials are:

- cut-back asphalt: 0.15 to 0.25 gallon per square yard (0.70 to 1.1 L/m^2)
- emulsified asphalt: 0.2 to 0.25 gallons per square yard (0.91 to 1.13 L/m^2)

The actual rate of application will be specified in the plans or by the Engineer. As an Inspector, there are three things you should especially verify:

- Application of the asphalt at the specified rate;
- complete, uniform coverage of the subgrade surface; and
- Sanding the asphaltic material with an acceptable aggregate

After the finishing operations, traffic should not generally be allowed on the subgrade for seven days. This is considered necessary time for proper curing of the subgrade. The only exceptions to the "no traffic" requirement are the equipment necessary to make subgrade corrections or to apply water or asphalt - and this equipment must not have tire contact pressing greater than 45 pounds per square inch(317kg/m^5).

The curing coat itself must either "cure" before traffic is allowed on the subgrade surface or be sanded. The sand prevents tires from picking up or displacing the asphalt, and should be spread at a rate of about 10 pounds of clean sand per square yard.

After the seven-day curing period, the subgrade may be opened to traffic provided that it is either protected or sufficiently hard to avoid being marred or distorted. Haul trucks carrying central-mixed concrete must never be allowed to run on completed cement-treated subgrades.

The Contractor must maintain the completed subgrade properly until the overlying course of materials is placed. Should any repair or patching be necessary they must be made the full depth of the subgrade. In no case should repairs be made by adding a thin layer of soil-cement to the completed work. The Contractor may, at his option, make full-depth repairs to small or minor areas such as to manholes, inlets or the like, with Class I Concrete.

In summary, as an Inspector you must be sure that once the cement-treated subgrade is properly finished, it is cured and maintained satisfactorily until the base or pavement is constructed on it.

QUIZ

The chemical process by which the soil, cement and water react together to become a firmly boned mass is called _____.

What would happen if the cement-treated subgrade were allowed to dry too quickly?

_____.

How is moisture retained in the subgrade before asphalt is applied?

_____.

How long is the curing period? _____.

What three things should you verify during curing coat application?

1. _____.
2. _____.
3. _____.

GO ON TO DOCUMENTATION.

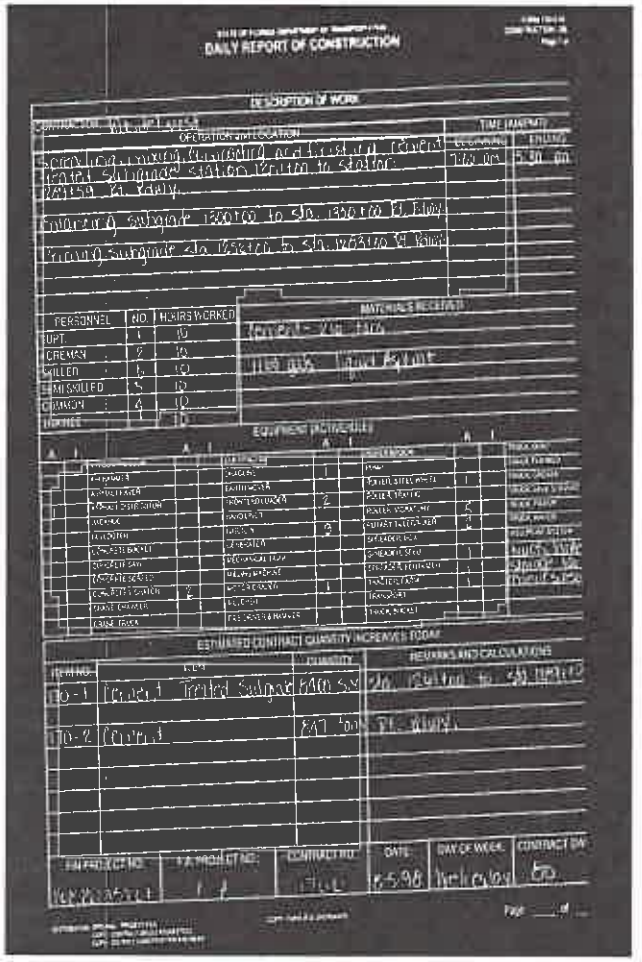
DOCUMENTATION

Cement-treated subgrade work must be properly documented on a daily basis - the same as subgrade stabilization.

You will be responsible for writing and submitting a Daily Report of Construction. As you know, the Daily Report is compiled at the project office into a weekly diary to document all the work on the project.

Always remember to write accurate, neat and complete reports.

Study the example shown to the right.


DAILY REPORT OF CONSTRUCTION

DESCRIPTION OF WORK

PERSONNEL	NO.	HOURS WORKED
SUPT.	1	10
FOREMAN	2	10
SKILLED	6	10
SEMI-SKILLED	5	10
COMMON	4	10
OPERATOR		10

MATERIALS RECEIVED

EQUIPMENT (ACTIVE/IDLE)

ESTIMATED CONTRACT QUANTITY INCREASES TODAY

ITEM NO.	DESCRIPTION	QUANTITY	REMARKS AND CALCULATIONS
10-1	Cement Treated Subgrade	6400 SY	
10-2	Cement	241 Ton	

FM PROJECT NO.	F.A. PROJECT NO.	CONTRACT NO.	DATE	DAY OF WEEK	CONTRACT DAY
			6-5-98		

QUIZ

What is the main thing to look for on soil-cement designs? _____.

Soil and cement can be mixed in two ways:_____and _____.

Is there any specified compaction equipment for use on cement-treated subgrade? _____.

What types of equipment are typically used to finished the subgrade? _____.

Why are asphalt distributors used in connection with cement treatment operations? _____.

List three general requirements for all equipment used in subgrade operations:

1. _____
2. _____
3. _____

QUIZ, continued

Using the spreadsheet excerpt below, complete the "Total Sq. Yd." and "Sta. To Sta." blank for truck number 311. The subgrade width is 8.2m.

CEMENT – TREATED SUBGRADE

DATE 6-26-75

TRK. NO.	STA. TO STA.	LBS. PER SQ. YD.	TOTAL SQ. YD.	LBS. ACCUED	THEO. LBS.	PAY QTY. LBS.	PAY QTY. TONS	TIME
401	307+20 – 308+75	34	682	23,202	34	23,202	11.60	7:30 AM
411	308+75 304+48	34	1,372	46,610	34	46,610	23.32	8:00 AM
418	304+48 299+81	34	1,366	46,440	34	46,440	23.22	8:45 AM
424	299+81 295+85	34	1,369	46,540	34	46,540	23.27	9:30 AM
311				47,820	34			

Total Sq. Yd. _____.

Sta. to Sta. _____.

How are spread distances marked? _____.

Why is it important to document the amount of cement used? _____.

What should you collect and refer to in documenting cement quantities? _____.

Can cement for cement-treated subgrade be spread five days after lime stabilization? _____.

QUIZ, continued

A Canvas check of the cement spread is performed. The canvas plus cement weighs 16.4kg. The canvas alone weighs 1.9kg. What was the application rate? _____.

If possible, should the entire width of the subgrade be mixed in one operation? _____.

Mixing must begin within _____after the cement is spread.

Is it good for the subgrade moisture content to be 10 percent above optimum during mixing? _____.

What can be done to the subgrade whenever the moisture content exceeds the specified level?
_____.

When mixed in a central plant, the soil and cement must be mixed for at least _____.

Should you check the depth of cement-treated subgrade during mixing operations? _____.

Who determines the maximum density and optimum moisture values for soil-cement mixtures?_____.

In no case should more than _____minutes elapse between the last mixing pass and the first compaction pass at a particular location.

Cement-treated subgrade must be compacted to at least _____.

During finishing operations, areas needing to be corrected by the addition of soil-cement mixture must first be lightly _____.

Should subgrade surface areas higher or lower than plan grade be corrected? _____.

The types of asphalt to be used as curing material are _____ asphalt, Grade RC-70, and
_____ asphalt, Grade SS-1.

ANSWERS TO QUESTIONS

Page 5-4
- design application rate for the cement
- 1. In-place mixing; 2. central plant mixing

Page 5-7
- sheepsfoot rollers; vibratory rollers; traffic rollers
- sensors
- asphalt distributor
- A
- B

Page 5-12
- With stakes
- C, D, E
- 4498.2' (1371.4m)

Page 5-13
- 1144.6m^2 (1368 $yd^{2)}$
- 91 + 32 (123) to 89 + 93 (182)
- certified scale (delivery) tickets
- Portland Cement Type I
- Yes

Page 5-16
- Seven
- within 2 percentage points above or below optimum moisture content
- B
- Spreader should be adjusted

Page 5-20
- A
- Yes
- 30
- Prevent the formation of cement balls when water is added
- 30 seconds
- 30 minutes
- No
- From the district lab
- Representative on the job

Page 5-23
- immediately; no later than 60 minutes
- 95
- scarified
- B
- E
- Vertical face

Page 5-26

- Contractor must correct them
- yes
- by digging or drilling hole in subgrade and measuring it
- 12.5mm.

Page 5-31

- design application rate for the cement
- in-place; in a central plant
- no
- motor graders; finegraders
- to apply curing material
- be in good condition; operate safely; produce desired results

Page 5-33

- 14.5 kg/m^2
- yes
- 30 minutes
- no
- it can be aerating by mixing or balding
- 30 second
- yes
- inspector
- 60
- 95% of maximum density
- sprinkled to keep moist
- lower
- cut-back, emulsified

Page 5-29

- hydration
- desired strength would not be obtained and shrinkage would occur
- by sprinkling
- seven days
- application at specified rate; complete, uniform coverage; sanding with acceptable aggregate

Page 5-32

- 12664.8 ft^2 (1177.2 m^2)
- 89 + 93 (182) to 88 + 50 (138)
- with stakes
- to calculate the actual spread and account for pay quantity
- delivery tickets
- yes

CHAPTER SIX

Basic Information and Preconstruction Preparations for Base Operations

CONTENTS

BASIC INFORMATION AND PRECONSTRUCTION PREPARATIONS

FOR BASE OPERATIONS
TYPES OF BASE COURSES

The Standard Specifications describe nine different types of base courses:

- limerock,
- limerock stabilized,
- shell stabilized,
- sand-clay,
- soil-cement,
- local rock,
- shell, and
- hot bituminous.

Not all of these types of bases are frequently constructed. For example, due to environmental concerns, shell is generally not available for roadway construction. Also, some of the bases are built very similarly to the others. For example, shell bases are constructed much like limerock bases. Reworked limerock and local rock bases also are built like limerock bases. Limerock stabilized and shell stabilized bases - while seldom constructed - can be treated like Type B stabilization (discussed in the subgrade chapter of this course) and like limerock bases. Similarly, soil-cement bases are constructed like the cement-treated Concrete Paving Inspection training course.

In short - after eliminating the infrequently built bases and those covered in other training courses - only two of the nine types of base courses remain: limerock and sand-clay. These are the types of base course construction we will concentrate on in this course.

However, we should take a brief overview of each of the nine base courses - so that you will be somewhat familiar with each.

So, let's begin with limerock bases.

LIMEROCK

Limerock base courses are constructed on prepared subgrades. They are constructed of limerock from either the Ocala or Miami Oolite formations. Basically, limerock is spread in one or more courses, compacted, finished and primed.

Typically, a bulldozer or grader is used to spread the limerock.

Rollers then compact the limerock to the required density. Motorgraders are used to shape and finish the base. The finished base is then primed with a bituminous material to seal the surface.

REWORKED LIMEROCK

Reworking a limerock base consists of reworking - or widening and reworking - an existing limerock base, including:

- preparing the existing surface;
- adding new limerock as required
- spreading, shaping and compacting the work; and
- priming the reworked base.

LOCAL ROCK

A local rock course is constructed by scarifying, shaping and compacting a roadbed that consists of existing local rock in place. A prime coat is then applied.

LIMEROCK STABILIZED

Limerock stabilized bases are built by stabilizing the roadbed soil by adding and mixing in limerock. The mixture is then shaped, compacted and primed. This work is similar to Type B Stabilization.

SAND-CLAY

Sand-clay base courses are constructed of naturally blended sand-clay or mixed sand and clay. They are built on prepared subgrades, following the basic operations already referred to: spreading, mixing, shaping, compacting, finishing and priming.

SHELL

Base construction using oyster shell is mainly a thing of the past because of the environmental regulations that have restricted removal of the shell from the ocean, gulf bays. Local shell (including coquina) in above-water sources is found in several areas along the east and west coasts and is suitable for shell base construction. This construction is similar to limerock base construction.

SHELL STABILIZED

Shell stabilized base course are built basically like limerock stabilized bases -only, the stabilizing material is shell rather than limerock.

SOIL-CEMENT

Soil-cement base courses are constructed of soil, cement and water. The construction is similar to the cement-treated subgrade operations discussed in the chapters about subgrade: spreading and mixing in the cement with the roadbed soil - followed by moistening, finishing and priming for curing purpose.

HOT BITUMINOUS

Hot bituminous base courses are constructed of hot-mixed, hot-laid bituminous mixture. The operations include subgrade preparation, tacking, laydown (paving) and compaction. Asphaltic Concrete Paving Inspection discusses the tacking, construction and inspection procedures that pertain to this type of base course.

QUIZ

How many different kinds of base courses are described by the Standard Specifications?
_____.

Which of the following statements concerning shell and shell-base construction are true?

_____ A. Shell base construction is similar to limerock base construction.
_____ B. Environmental regulations have restricted the removal of shell from the ocean, gulf and bays.
_____ C. Local shell (including coquina) in above-water sources is suitable for shell base construction.
_____ D. The use of oyster shell in base construction is mainly a thing of the past.

Does all base course construction include the application of prime (or curing) materials?_____.

Reworked limerock and local rock bases are constructed basically like _____.

Limerock stabilized and shell stabilized base courses are constructed much like _____ and _____ limerock bases.

Must sand-clay base courses be constructed of only naturally blended sand-clay? ___.

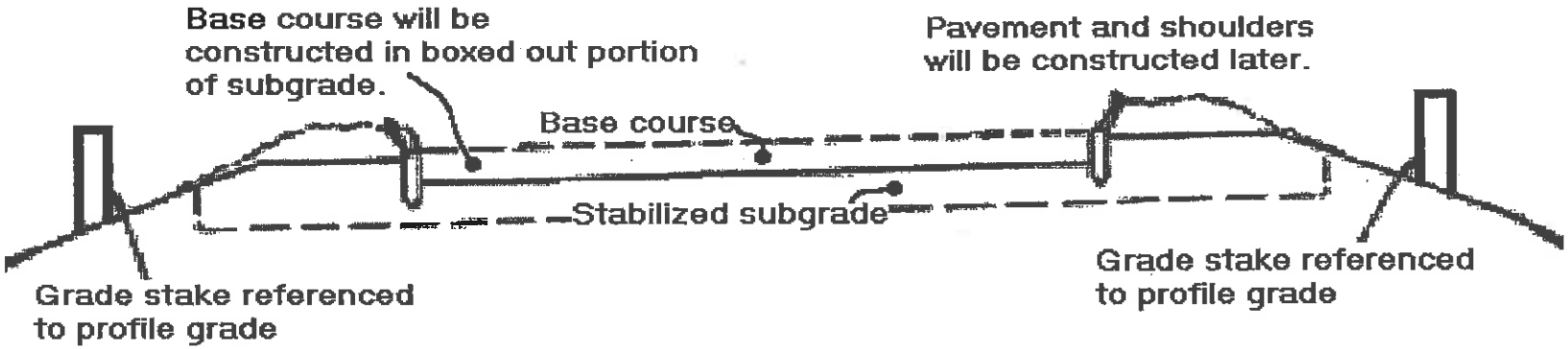
Which of the following are included in hot bituminous base course operations?

A. subgrade preparation
B. taking
C. laydown (paving)
D. compaction

STAKING

One typical staking procedure is illustrated below. Grade stakes referenced to the profile grade were set before subgrade operations began. They were used in guiding the
construction of the subgrade and will be used in constructing the base course and pavement as well.

As you learned in the chapter about subgrade, grade stakes may also be referenced to the finished subgrade or the finished base course, instead of the profile grade of the finished roadway.



For example, another typical procedure is shown below. The grade stakes were referenced to the finished subgrade and were used in guiding the subgrade operations. To guide the base course construction, blue tops were set after the base material was placed and balanced. They are referenced to the top of the finished base course. The blue tops may be set on the edge of the base as shown below - or may be offset, for example, 03m.

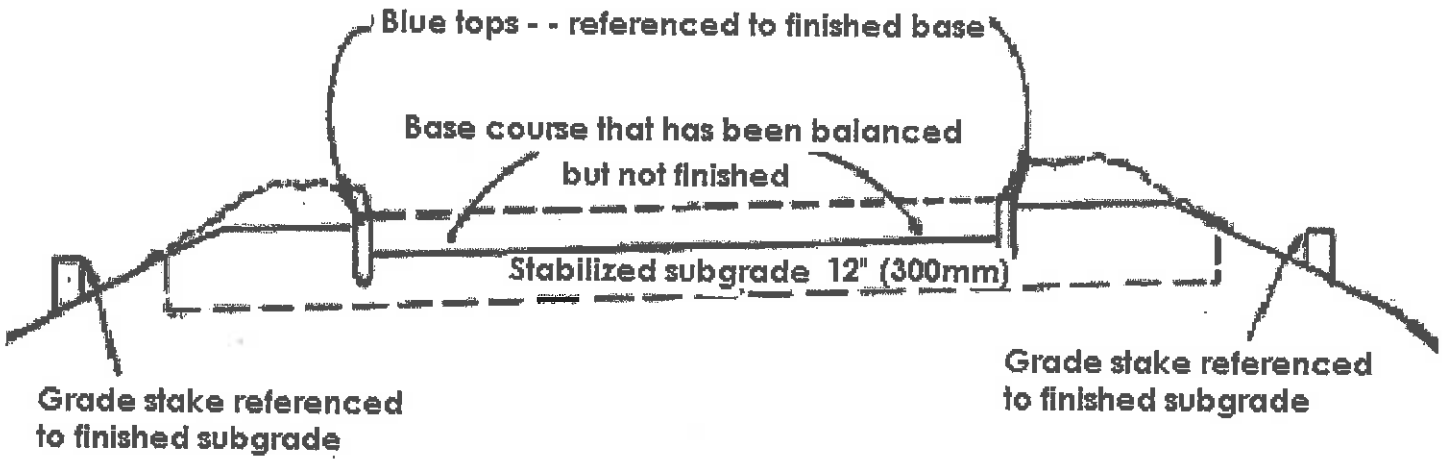
Blue tops often are covered up during construction and must be exposed in order for the motor grader operation to just clip over the top.

As an Inspector, be sure that the stakes are set - whether by the State or Contractor's survey party - and are maintained in position and followed by the construction operation. As with subgrade inspection, the grade stakes are used in making string line checks of base course construction.

INSPECTING
THE SUBGRADE

Before any base material is applied, the subgrade must meet grade and cross-sectional requirements, have the specified density, be firm and unyielding and be in generally good condition. As an Inspector of base course construction, it will be your responsibility to inspect the subgrade before base operations begin.

On projects where it is your job to inspect both subgrade and base course construction, you already will have inspected the finished subgrade. Often, however, different Inspectors are assigned to the two stages of construction. In these cases, you - the Base Course Inspector - should never assume that the Subgrade Inspector on the finished subgrade has completed



every aspect of his inspection and, subsequently, the following should be completed by you:

- string line check for grade and cross section;
- verification that specific density was reached; and
- visual inspection of the general subgrade condition.

MEETING WITH THE CONTRACTOR

The Project Engineer and the Inspector should meet with the Contractor before the beginning of base course operations. The purpose of this meeting is to discuss the requirements for the work and the proposed plan of operations.

The types, sources and proportions of the required base materials should be included in the discussion. Incoming materials must be from approved sources.

Be sure that all questions are answered before the work begins, and that any points of conflict are resolved.

QUIZ

Before any base material is applied, the subgrade must meet _____ and _____ requirements, be firm and _____, have a specified _____, and be in generally good condition.

Who is responsible for verifying that these requirements are met? _____.

If you did not inspect the subgrade operations, should you assume that the subgrade meets all requirements? _____.

You should meet with the Project Engineer and the Contractor to discuss the _____ and _____.

Included in the discussions should be the _____, _____ and _____ of the required base materials.

Incoming materials must be from _____sources.

ANSWERS TO QUESTIONS

Page 6-5

- nine
- all of them
- no; hot bituminous base course
- limerock bases
- Type B stabilized subgrade
- no; the sand and clay may be mixed
- all of them

Page 6-9

- grade; cross sectional; unyielding; density
- base inspector
- no
- requirements for the work; proposed plan of operations
- types; sources; proportions
- approved

CHAPTER SEVEN

Limerock Base Courses

CONTENTS

7

LIMEROCK BASE COURSE

Limerock is the most widely used base material in Florida. The reasons for its extensive use are:

- It is a local material.
- It is abundant.
- It is economical to construct.
- It has adequate bearing capacity
- It may be salvaged for re-use on reconstructed projects.

Limerock is available from two geologic formations in the State: Miami Oolite and Ocala. All you need to know about these formations is that limerock from either formation may be used, but limerock of only one formation may be used on any contract.

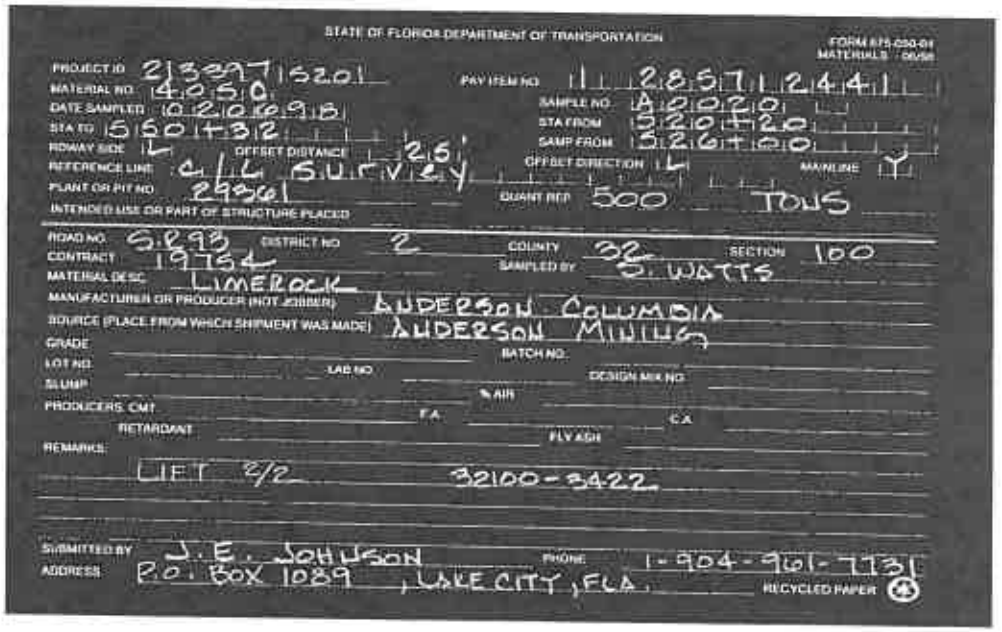
In our discussion of limerock base course, we will cover the following areas:

- material acceptance and control;
- equipment;
- construction operations;
- inspection and testing procedures; and
- documentation

Priming will be discussed in Chapter Ten.

MATERIAL ACCEPTANCE AND CONTROL

As with almost all roadway materials, limerock for base course must be sampled, tested and approved during construction for job control.


STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION

FORM 675-030-01
MATERIALS 06/98

PROJECT ID 213297 5201
MATERIAL NO 405 0
DATE SAMPLED 10 2 05 09 B
STA TO 150 1+32
ROWAY SIDE L
OFFSET DISTANCE 25'
REFERENCE LINE C/L SURVEY
PLANT OR PIT NO 29956
INTENDED USE OR PART OF STRUCTURE PLACED

PAY ITEM NO 285 7124 4
SAMPLE NO A202 10
STA FROM 132 0+20
SAMP FROM 132 6+00
OFFSET DIRECTION L
MAINLINE Y
QUANT REP 500 TONS

ROAD NO S-893
DISTRICT NO 2
COUNTY 32
SECTION 100
CONTRACT 19754
SAMPLED BY S. WATTS
MATERIAL DESC LIMEROCK
MANUFACTURER OR PRODUCER (NOT JOBBER) ANDERSON COLUMBIA
SOURCE (PLACE FROM WHICH SHIPMENT WAS MADE) ANDERSON MINING
GRADE
LOT NO
LAB NO
BATCH NO
SLUMP
DESIGN MIX NO
PRODUCERS CMT
% AIR
F.A.
C.A.
RETARDANT
FLY ASH
REMARKS
LIFT 2/2
32100-3422

SUBMITTED BY J. E. JOHNSON
PHONE 1-904-961-7731
ADDRESS P.O. BOX 1089, LAKE CITY, FLA.
RECYCLED PAPER

SOURCE APPROVAL

The Central Lab publishes a list of the approved sources - by pit number - around the State. As an Inspector, when you learn of the Contractor's proposed source of limerock, contact the District Lab. They will inform you if the pit is on the approved list. If not on the list, the pit will have to be visited by Central Lab personnel so that they can obtain samples for testing. Remember, no limerock should be placed as base material until its source is approved. All delivery tickets must be stamped certified by the producer.

JOB CONTROL

Although you are not responsible for obtaining initial (source) samples for pit approval, you will have to sample the limerock for job control.

In obtaining and submitting these samples, follow the Sampling, Testing and Reporting Guide - as we discussed in Subgrade Inspection. Each in-place sample that you obtain should consist of limerock taken from several spots in a small area of the base course across the roadway. (FM 5-504, 4.1.5 Roadway)

Complete a Sample Transmittal Card for each sample and attach it to the sample container. Be sure to indicate the source (pit number) of the limerock.

During construction operations you should make visual checks of the limerock before it is spread - to ensure that it has the proper gradation.

QUIZ

Which of the following are not reasons for the extensive used of limerock as a base material?

___ A. It is economical to construct.
___ B. It may be salvaged for re-use on reconstructed projects.
___ C. It can be stabilized with Portland cement.
___ D. It does not need testing before use.
___ E. It is a local material.
___ F. It has adequate bearing capacity.

May the Contractor use either Miami Oolite limerock or Ocala limerock on the job?_____.

May the Contractor use both on the same job? _____.

Limerock must be tested during construction for _____.

What should you do when you learn of the Contractor's proposed source of limerock?
_____.

The Central Lab published a list of the _____ around the State.

Each job control sample of lime rock that you obtain should consist of material taken from:

___ A. a haul truck.
___ B. only one spot in the base course.
___ C. three levels of the window.
___ D. several spots in a small area of the base course.

GO TO PROCTOR SAMPLES

PROCTOR SAMPLES

Limerock - just like other base, subgrade and embankment materials - must be sampled and tested to determine the maximum density and optimum values for the compacted base course. Usually, you will be required to sample the limerock for the Proctor tests. In some cases, the samples will be taken from the pit by lab personnel.

LIMEROCK TEST REPORTS

The results of a test performed on samples of limerock are reported to the project on Test Report for Limerock Materials (Form 16001 English, 16051 Metric.)

The report shows whether the sample passed or failed the tests, and whether the limerock is accepted or rejected for use in the base.

A sample Report is shown on the next two pages. Study the information thoroughly.

FLORIDA DEPARTMENT OF TRANSPORTATION

FORM: 160-51 DATE: 10/31/01

TEST REPORT FOR BASE-LIMEROCK MATERIALS

CQRO137

FIN PROJ: 210541-1-52-01 MNG DIST: 02 COUNTY: 35 SECTION: 010
MATERIAL NO: 405A SAMPLE NO: A0001 DATE SAMPLED: 02/23/01
STATION FROM: 101+23.00 STATION TO: 118+84.00 SAMPLE FROM: 117+00
ROADWAY SIDE: C OFFSET DIST.: 010.0 M1 OFFSET DIR.: L
MAINLINE FLAG: Y REFERENCE LINE: C/L CONST
LAB NO: 0563-S TESTED BY: 2D ON 02/28/01 PASS/FAIL STATUS: P
PAY ITEM NO(S): 12285706

DISTRICT: 02 CONTRACT: 20938 ROAD NO: SR 10
SOURCE: PIT PLANT NO: QUANTITY: 5,167.40 M2
PRODUCER: INTENDED USE: RDWY BASE (DETOUR)

ACCEPTANCE

QUAL	TYPE OF TEST/MEASUREMENT	RESULT	MINIMUM	MAXIMUM
	MAXIMUM DENSITY (MOD)	1858.0000 KG3		
	OPTIMUM MOISTURE	12.0000 PCT		
	MATERIAL DESCRIPTION	LIMEROCK		
	PASS 90.0 MM SIEVE	100.0000 PCT		
	TEST METHODS	F5-521		
	RESPONSIBLE ENGINEER	T.J. RUELKE		

FLORIDA DEPARTMENT OF TRANSPORTATION

FORM: 160-01 DATE: 10/31/01

TEST REPORT FOR BASE-LIMEROCK MATERIALS

CQRO137

FIN PROJ: 210789-2-52-01 MNG DIST: 02 COUNTY: 37 SECTION: 010
MATERIAL NO: 405A SAMPLE NO: A0001 DATE SAMPLED: 07/17/01
STATION FROM: 535+69.00 STATION TO: 564+34.00 SAMPLE FROM: 547+69
ROADWAY SIDE: R OFFSET DIST.: 018.0 LF OFFSET DIR.: R
MAINLINE FLAG: Y REFERENCE LINE: C/L OF SURVEY
LAB NO: 2005-S TESTED BY: 2D ON 07/19/01 PASS/FAIL STATUS: P
PAY ITEM NO(S): 1 285701

DISTRICT: 02 CONTRACT: 21148 ROAD NO: SR 10
SOURCE: ROADWAY PLANT NO: 37112 QUANTITY: 2,865.00 FT
PRODUCER: ASPHALT TECHNOLOGIES (MINE) INTENDED USE: WIDENING BASE

ACCEPTANCE

QUAL	TYPE OF TEST/MEASUREMENT	RESULT	MINIMUM	MAXIMUM
	MAXIMUM DENSITY (MOD)	116.0000 PCF		
	OPTIMUM MOISTURE	13.0000 PCT		
	MATERIAL DESCRIPTION	LIMEROCK		
	TEST METHODS	F5-521		
	REMARKS	ENTERED 7/20/01		
	REMARKS	LIFT 1/2		
	RESPONSIBLE ENGINEER	T.J. RUELKE		

QUIZ

Limerock material reports show whether the samples _____ or _____ the tests, and whether the limerock is _____ or _____ for use in the base.

Who normally obtains samples of limerock for Proctor tests? _____.

GO ON TO EQUIPMENT

EQUIPMENT

The equipment used in construction limerock base courses can be divided into three groups: hauling and spreading equipment, compaction equipment and finishing equipment. Since we will discuss priming operations in separate chapter, we will also talk about priming equipment later.

As the Base Inspector, your main concern with all construction equipment is that it:

- is in good condition;
- can be operated safely; and
- produces the desired results.

The equipment should be in good condition so that it will produce the desired results and not delay the operations because of breakdowns.

The equipment must be capable of safe operation so that the Contractor, State personnel, and the public can work and travel safely.

Finally, the equipment must produce the desired results so that strong, stable and lasting base course can be constructed according to the plans, specifications and special provisions.

Let's look briefly at the equipment, beginning with the hauling and spreading equipment.

HAULING AND SPREADING EQUIPMENT

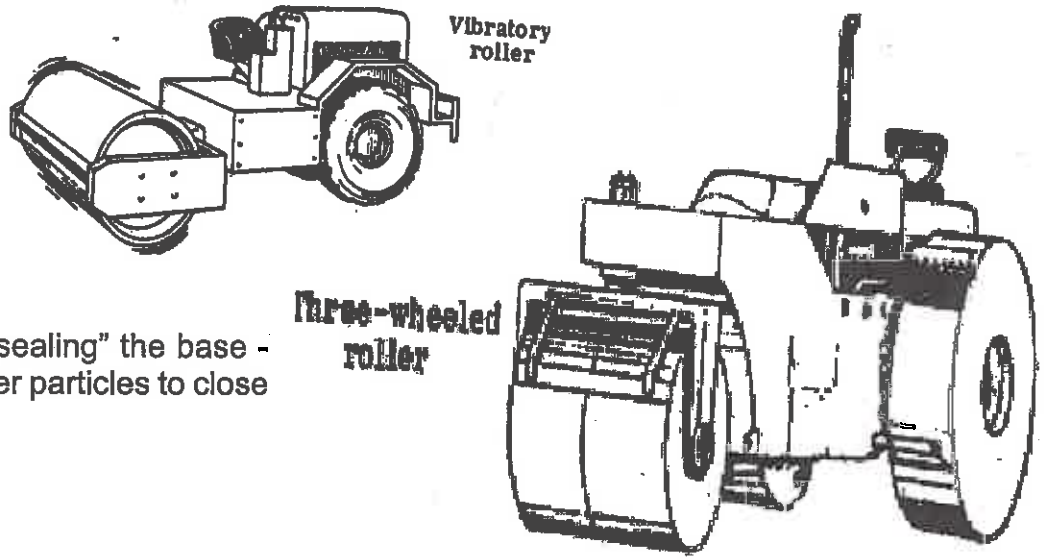
Limerock is transported to the jobsite by haul trucks and dumped. It is spread with bulldozers or graders to a uniform thickness.

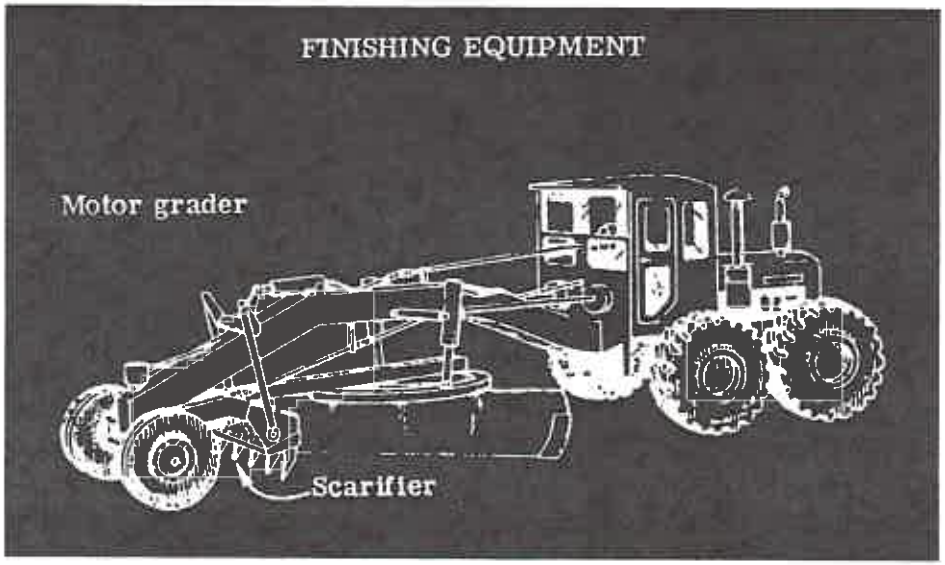
COMPACTION EQUIPMENT

The equipment used to compact limerock base courses is not specified, but vibratory, three-wheeled, and traffic rollers are typical.

Most of the compaction is achieved by the vibratory or three-wheeled rollers.

Traffic (rubber-tire) rollers are especially useful for "sealing" the base - knitting the finer particles into the spaces among larger particles to close the base course surface.





FINISHING EQUIPMENT

Finishing equipment is used to shape the compacted base course to the proper grade and cross section and to smooth the base surface. Some shaping also is done before compaction.

Shaping is usually done by motor graders. The scarifying attachment on the grader above is used to loosen the base surface so that shaping can be accomplished.

Three-wheeled rollers and traffic rollers are used to further compact and seal the base surface.

QUIZ

The types of compaction equipment shown on the preceding page are especially useful for the _____base.

Which of the following are usually used to compact limerock bases?

___ A. three-wheeled rollers.
___ B. grid rollers.
___ C. vibratory rollers.
___ D. sheepsfoot rollers.

Finishing equipment is used to _____ the compacted base courses to the proper grade and cross section and to _____ the base surface.

GO TO CONSTRUCTION OPERATIONS AND INSPECTION.

CONSTRUCTION OPERATIONS AND INSPECTION

Before limerock base course construction begins, the subgrade must be inspected to ensure compliance with the requirements for grade, cross section, density and general condition. In connection with our discussion here, we should emphasize the following:

- The subgrade should be moist - to prevent moisture loss from the limerock during compaction operations.
- Any spongy or loose areas in the subgrade must be corrected by aerating or replacing the unsuitable materials with approved material - and then reshaping the corrected areas and compacting them to the required density.

GENERAL SEQUENCE

With the subgrade in proper condition, the base construction operations may begin. The general sequence of limerock base course is:

- hauling and dumping
- spreading
- sampling and checking
- compacting
- testing; and
- finishing

We will discuss each step in sequence beginning with hauling and dumping.

HAULING AND DUMPING

Haul trucks transport the limerock to the jobsite and dump it in position to be spread. Bulldozers and graders are used to spread the material. The trucks must be driven on the subgrade to some extent but hauling on the unprotected subgrade should be minimized. The limerock should be transported to the dumping point over rock previously placed, and then dumped on the end of the preceding limerock.

As an Inspector, you should observe the results of hauling. Watch for rutting, displacement, etc. Damage to the subgrade during hauling will affect the quality of the base.

SPREADING

Spreading the limerock means distributing it evenly over the subgrade to a roughly uniform thickness. The term "balancing" refers to achieving an even distribution and uniform thickness.

"Laying" thickness is the thickness of the spread limerock before it is compacted. The base course thickness specified by the plans is the compacted thickness. The Contractor must determine the proper laying thickness that will compact to the specified thickness shown in the plans, depth checks should be performed properly

When the plan thickness of the base is greater than 6 inches (150mm), the base must be constructed in two courses. If the Contractor can demonstrate and if approved by the Engineer, thick base courses up to 8" (200mm.) thickness may be used. The first course should be approximately half the total thickness of the finished base, and must be compacted to the required density before the second course is placed. The cross section templet of the first course should closely approximate that of the finished base. Also, the surface of the first course may require a light application of water just before limerock is spread for the second course. The spreading, balancing and shaping of the second course should be done in the same manner as they were for the first course. Care should be taken to ensure that the density of the first course is not disturbed by the operations of the second course.

The width of spread for the limerock should equal the width of the paved area plus 3 inches (75m) on each side. This extra width allows for the tapering of the limerock at the edges. The tapered areas will not have the same thickness as the rest of the spread. The extra width should be measured for payment. No checking of density should be done in the extra width

QUIZ

Why should the subgrade be moist before limerock is spread? _____.

Describe two ways in which spongy or loose areas in the subgrade can be corrected:

1. _____.
2. _____.

Should hauling over the subgrade be encouraged? _____.

Limerock bases must be constructed in two courses when the plan base thickness is greater than _____.

How thick should the first course be? _____.

What may the surface of the first course require just before limerock is spread for the second course? _____.

Care should be taken to ensure that the _____ of the first course is not disturbed by the operations of the second course.

Which of the following statements concerning the extra widths of spread beyond the width of the paved area are true?

___ A. Should be 75mm wide on each side.
___ B. Should be measured for payment.
___ C. Should be provided at no additional cost to Department.
___ D. Should be checked for width, depth and density.

SAMPLING AND CHECKING

During spreading operations you will be involved with sampling and checking the limerock.

Sampling

Job control samples of the limerock must be obtained and sent to the District Lab for testing. Review your responsibilities in the area by re-reading page 7-3.

Checking

The spread limerock must be checked for the following:

- width;
- depth (thickness);
- segregation; and
- foreign matter.

The Contractor should make depth (thickness) checks as the limerock is spread. This will ensure that the proper laying thickness is achieved.

As an Inspector, you may also make random depth checks. For example, when a double course (two lifts) of limerock is being spread, you can check the thickness of the first lift to be sure that it is correct (approximately half of final course thickness).

Segregation in the spread limerock should be watched for very closely. Segregation is the separation of the larger limerock particles from the finer particles. In other words, these areas do not have a uniform gradation of particle sizes. Such areas, if left in the base, will not compact properly and may eventually cause roadway defects. As an Inspector, watch for segregated areas and bring it to the attention of the Contractor. The segregated material will have to be removed and replaced with properly graded limerock.

While you are watching for segregation, observe any foreign materials. These may include clumps of dirt, clay, vegetation, or just about anything other than the limerock. Such materials, if left in the base, could also weaken the course.

QUIZ

The spread limerock should be checked for _____.

Should the Contractor check the depth of the limerock as it is spread? _____.

Which of the following can lead to roadway weaknesses?

___ A. Segregated areas in base.
___ B. Optimum moisture.
___ C. Non-uniform base thickness.
___ D. Laying thickness greater than compacted thickness.
___ E. Foreign materials mixed in with limerock.

COMPACTING

Compacting means rolling the limerock with the type of equipment discussed earlier in order to obtain the required density in the base course. Strength and durability of the base course are directly related to the density.

The Contractor is free to determine the types and numbers of compaction equipment he will use and the patterns they will follow. Again, your main concern as an Inspector is that adequate density is obtained throughout the base course.

However, there are procedures that should be followed before and during compaction:

Single-Course Bases. After the spreading and balancing are completed, the entire surface should be scarified and then shaped so that the required grade and cross section will be obtained after compaction.

Double-Course Bases. After spreading and balancing are completed, the entire surface should be scarified and then shaped so that the required grade and cross section will be obtained after compaction.

Widening Strips. Limerock widening strips may be constructed to increase the width of existing roadways. Sometimes the regular compaction equipment cannot compact the widening strips because of the narrow trenches they are in. Equipment such as vibratory compactors or trench rollers may be needed. The Project Engineer must approve such equipment before it is used. In addition, he may require that the haul truck help in the compaction by running one pair of wheels on the widening strips. The haul trucks should not be used, however, until the widened sections have reached the elevation of the existing pavement surface.

CONTROLLING AND TESTING FOR MOISTURE DENSITY

You already should be familiar with importance of moisture-density testing and control from the Earthwork Inspection training course or from your own experience. Let's talk about the elements of controlling and testing for moisture and density on limerock bases.

Moisture Content

Moisture content is one of the basic factors that affect compaction. Limerock base courses should be kept as near to their optimum moisture contents as possible in order for the required density to be obtained. Wetting or drying will be mixed into the

base uniformly to the full width and depth of the course being compacted. Drying can be accomplished by manipulating (aerating) the limerock, and should likewise be done to the full width and depth of the course being compacted.

As you conduct moisture tests, you may need to inform the Contractor of the moisture content of the base. Normally, however, this is only necessary when the density fails. Most motor grader operators are experienced and know by sight, feel and workability whether or not the base has the proper moisture content.

Density

As soon as the base has the proper moisture content, it can be compacted. The Standard Specifications show the minimum percentages of maximum density to which the base must be compacted are 98% for the traveled roadway and 95% for areas outside the traveled roadway (crossovers, turnouts, etc.). As you remember, the maximum density and optimum moisture values will be furnished to you by the Lab.

During final compaction operations, when blading is necessary in some areas to obtain the true grade and cross section, you should run the density test after the compacting of these areas is completed. Follow the minimum frequencies of the Sampling, Testing and Reporting Guide in running the moisture-density tests.

QUIZ

Which of the following should be done to the first course of a double-course base before the second course is placed?

___ A. compacted to the required density.
___ B. tested for density with passing results.
___ C. bladed to a surface cross section approximately parallel to that of the finished base.
___ D. mixed with the top layer of the subgrade.

Widening strips may require equipment such as _____ or _____ for compaction operations. The Project Engineer also may require_____ to run one pair of wheels along the strips.

Wetting or drying of the base - to obtain the proper moisture content for compaction should be done to the full _____and _____ of the course being compacted.

GO TO FINISHING

FINISHING

Finishing operations include the shaping, trimming and rolling necessary to leave the limerock base at the proper grade, cross section and surface condition. We can also include here any repair needed to correct defects discovered during compaction and finishing operations. These defects may include:

- areas of failing density;
- areas not to grade
- wet, spongy areas;
- scabs;
- cracks and checks; and
- contamination.

As you must be sure that all such defects are properly repaired, let's briefly discuss each problem.

Areas of Failing Density

Different things may lead to insufficient density in certain areas: Maybe the moisture contents were not correct, or maybe not enough rolling was done on those areas. Whatever the cause, the Contractor must correct the problem. Based on the cause, different correction procedures may be needed: wetting, drying reshaping, recompacting, etc.

Areas Not to Grade

Areas of the base that are too high can be trimmed to grade. In some cases, sub base may have to be removed to get the required base thickness. Areas that are too low will need additional limerock. These areas must be scarified and have the new material added. Then reshaping, compacting, and finishing can take place.

Wet, Spongy Areas

Wet, spongy areas can usually be repaired by scarifying, aerating, reshaping and recompacting. Sometimes more limerock should be added.

Scabs

Scabs (laminated areas) occur when thin surface sections of limerock do not bond with the underlying rock. These areas can loosen and break away just like real scabs. A common cause of scabs is the improper adding of limerock to areas not up to grade. In such places, as we mentioned, the surface must first be scarified so that the added limerock will mix in and bond with the existing rock.

Another cause of scabs may be foreign objects in the base. Whatever the cause, you must be sure that these defects are properly corrected by scarifying, reworking and recompacting the areas.

Scabs may be detected visually or audibly. They sound hollow when walked on or struck with a pick or shovel.

Cracks and Checks

Cracks and checks appearing in the compacted base course may be caused by the underlying limerock being too wet. When the underlying rock dries, the surface cracks due to shrinkage.

Contamination

Contamination of limerock base occurs when subgrade materials become mixed with base material. To correct the situation, the Contractor should dig out and remove the mixed materials. He should reshape and compact the area.

Repairs of contaminated and other defective base course areas must be done without additional pay to the Contractor. The correcting of defects is part of finishing the limerock base course to comply with the plans' special provisions and specifications.

Traffic Rolling

In addition to final shaping and repair of defects, finishing operations include sealing the base course. This is accomplished by traffic rollers. The rubber tires seal the base, leaving a smooth, hard surface.

QUIZ

May both Miami Oolite limerock and Ocala limerock be used in the same limerock base course? _____.

Limerock is tested during construction for _____.

Will you, as a Base Inspector, obtain initial (source) limerock samples? _____.

The Central Lab publishes a list of the _____ around the State.

What should you do when you learn of the Contractor's proposed source of limerock?

_____.

The form Base Material-Limerock shows:

___A. the recommended equipment for compaction.
___B. whether the sample passed or failed the tests.
___C. whether the limerock is accepted or rejected.
___D. the maximum density and optimum moisture.

Who obtains samples of limerock Proctor tests? _____.

Which of the following are basic requirements for all equipment used in constructing limerock base courses?

___A. be capable of safe operation.
___B. have steel treads.
___C. weigh less than 10.8MT.
___D. be in good condition.
___E. produce desired results.

QUIZ, continued

Which of the following are commonly used to compact limerock bases?

___ A. grid rollers.
___ B. three-wheeler
___ C. sheepsfoot rollers.
___ D. scrapers.
___ E. traffic rollers.

Should the Contractor avoid hauling over the subgrade when possible? _____.

Why should the subgrade be moist before the limerock is spread? _____.

Why should you observe hauling on the subgrade? _____.

Limerock bases must be constructed in two courses when the plan base thickness is greater than _____.

Which of the following are true about the first course of a double-course limerock base?

___ A. should be compacted and tested for density before the second course is placed.
___ B. should always be a maximum of 75mm thick.
___ C. may require a light application of water before the second course is placed.
___ D. should be about half the total thickness of the finished base.
___ E. should have a cross section approximately parallel to that of the finished base.

The width of limerock bases should be equal to the width of the paved area plus _____ on each side.

Should these extra-width strips be treated for density? _____.

Be measured for payment? _____.

QUIZ, continued

Which of the following are not activities that can be included in a general description of the finishing operations?

___ A. repairing
___ B. trimming
___ C. laminating
___ D. shaping
___ E. bridging
___ F. rolling.

What are two causes of failing densities? 1. _____. 2. _____.

Besides seeing scabs, you can detect them by the _____they make when walked on or struck with a tool.

Besides being caused by the improper adding of limerock to areas not up to grade, scabs can also result from:

___ A. too much subgrade moisture.
___ B. foreign objects in the base.
___ C. string line checks.
___ D. widening strips.

Contamination of the limerock base occurs when_____ becomes mixed with _____.

Cracks and checks in a compacted base course may be caused by the underlying limerock being too wet. Another cause of cracking and checking may be _____.

Traffic rollers are used mainly to _____ the base course.

HOW DID YOU DO ON THIS QUIZ? IF YOU FOUND THAT YOU ARE WEAK IN CERTAIN AREAS, RE-READ THE PARTS OF THE CHAPTER THAT GAVE YOU TROUBLE. RETAKE QUIZZES TO TEST YOURSELF ON THIS MATERIAL. PROCEED TO CHAPTER EIGHT - SAND-CLAY BASE COURSES - WHEN YOU ARE READY.

ANSWERS TO QUESTIONS

Page 7-4

- C & D
- Yes
- No
- Smoothness
- contact district lab
- approved sources (pits)
- D

Page 7-9

- sealing
- A, C
- shape; smooth

Page 7-14

- width; depth (thickness); segregation; foreign matter
- yes
- A, C, E

Page 7-20

- no
- job control
- no
- approved sources (pits)
- contact district lab
- B, C
- base inspector
- A, D, E

Page 7-6

- passed, failed, accepted, rejected
- base inspector

Page 7-12

- to prevent moisture loss from the rock during compaction
- by aerating, reshaping and compacting the area; by replacing the unsuitable material then reshaping and compacting the area
- no
- 6 inches (250 mm)
- about half the total thickness of the finished base
- a light application of water
- density
- A, B

Page 7-17

- A, B, C
- vibratory compactor; trench rollers; haul trucks
- width; depth

Page 7-21

- B, E
- yes
- to prevent moisture loss from the lime rock during compaction
- to be sure that the subgrade is not damaged
- 6 inches (250 mm)
- A, C, D, E
- 3 inches (75 mm)

Page 7-21 (con't)

- no
- yes

Page 7-22

- C, E
- improper moisture content; not enough rolling
- hollow sound
- B
- subgrade materials; base materials
- defects in the subgrade
- seal

CHAPTER EIGHT

Sand-Clay Base Courses

CONTENTS

8

SAND-CLAY BASE COURSES

Sand/clay base courses are constructed mainly in Florida's panhandle located in the northwestern part of the State. In this area, sand and clay are plentiful, while limerock is not common.

When mixed in specified proportions, or when occurring naturally, the sand and clay can be used to construct strong, durable bases. The construction steps are similar to those for other types of base courses: placing, mixing, compacting, finishing and priming.

In this chapter, our discussion of the construction and inspection of sand-clay base courses will cover the following areas:

- materials acceptance and control;
- equipment;
- construction operations;
- inspection and testing procedures; and
- documentation.

Priming, as we mentioned earlier in the courses, will be discussed in Chapter Ten.

MATERIALS ACCEPTANCE AND CONTROL

Just like limerock, the materials for sand-clay base courses must be sampled, tested and approved before and during construction.

SOURCE APPROVAL AND PIT OPERATIONS

The District Lab obtains and tests initial (source) samples of sand and clay to approved the materials for use in base construction. The sources of the sand and clay pits may be furnished by the State or the Contractor. The plans may indicate pits that may be used, but the contractor still has the option of using the State-located pits or finding his own.

In the case of State-furnished pits, the Department will obtain any necessary property easement, but the Contractor must provide and maintain all the necessary haul roads.

Other requirements of the Contractor for the use of material pits include:

- The materials must be removed from the pits according to the stakes set by State Survey crews.
- The excavation must be neat, staying within the staked limits and leaving the area in a condition satisfactory to the Project Engineer.
- Where pit bottoms are above the normal water table, they must be shaped to a regular grade that will prevent water from ponding.

There are different situations in which the sand and clay may be found:

- natural sand/clay. The sand and clay may be found in a natural blend that meets the requirements for the job.
- Different strata. The sand and clay may be found in the same pit, but in different strata. These strata will have to be excavated and blended together.

- separate sources. The sand and clay may be found in separate pits. The blending and mixing of these materials must be done entirely on the road.

The latter two situations are more common than the first, but all three are acceptable and can result in properly constructed sand-clay bases. Your job as an Inspector is to see that:

- the pits are properly staked and control grades are established before excavating begins.
- the excavation is done according to the stakes and the established control grades.
- the proper equipment and procedures are used, depending on the situation of the sand and clay.
- the proper proportion of sand and clay are excavated and blended - whether at the pit or on the road.

We mentioned that the District Lab obtains and tests source samples of the sand and clay. If the results of the tests are satisfactory, the Lab approves the pits and issues the "blend" for the sand and clay.

A blend gives the proportion in which the materials must be combined to produce a mixture that will result in a strong, stable base course.

As you learned on the preceding page, one of your inspection responsibilities is to ensure that the specified blend of sand and clay is maintained during construction.

We also mentioned that you must be sure that the proper equipment and procedures are used in excavating the pits. This means that you should check the pits periodically. Observe that the excavating is being done according to the staking and grade controls. Also note whether or not the Contractor is using the proper equipment, as we will discuss in the next section of the chapter. When the pits contain separate strata of sand and clay that must be blended, be sure that the equipment rakes the full face of the cut in order to get enough of each material. At the road, watch for rocks, sticks, clay balls, etc. in the material. When these things get into the clay, the pit excavating is probably not being done properly. The equipment is getting into areas of the pit that contain unsuitable materials. In such cases, be sure to inform the Project Engineer who needs to ask the Contractor to correct the problem.

JOB CONTROL

As an Inspector, you must obtain job control samples of the mixed sand and clay at the road and submit them to the District Lab. The material will be tested for compliance with physical requirements - such as gradation, liquid limit and plasticity index - and for L.B.R. and Proctor values. Test reports will be issued by the Lab.

Always follow the correct sampling procedures. Refer to the Sampling, Testing and Reporting Guide and complete the necessary Sample Transmittal Cards. By now, you should be familiar with these procedures.

QUIZ

Who furnishes the material pits for sand and clay? _____.

When the plans indicate material pits, is the Contractor required to use them?_____.

Who performs the initial (source) sampling and testing?_____.

When the materials and the pit are approved, the Lab issues the _____ for the sand and clay.

Who obtains and submits job control samples of the sand and clay?_____.

The materials must be removed from the pits according to the _____set by the State survey crew.

As an Inspector, are you responsible for seeing that the proper proportions of sand and clay are excavated and blended? _____

Briefly describe the conditions in which the sand and clay may be found: _____.

When the pits contain separate strata to be blended, you should be sure that the equipment _____ _____in order to get enough of each material.

At the road, watch the materials for undesirable:

___ A. sand
___ B. sticks
___ C. clay balls
___ D. moisture
___ E. rocks

GO TO EQUIPMENT

EQUIPMENT

The equipment used in construction sand-clay base courses can be divided into five groups: excavating, hauling, spreading, mixed compacting, and finishing. As with all equipment used in base construction, the general requirements are as follows:

- the equipment is in good condition;
- the equipment operates safely; and
- the equipment produces the desired results.

Let's look at the equipment used by each type group.

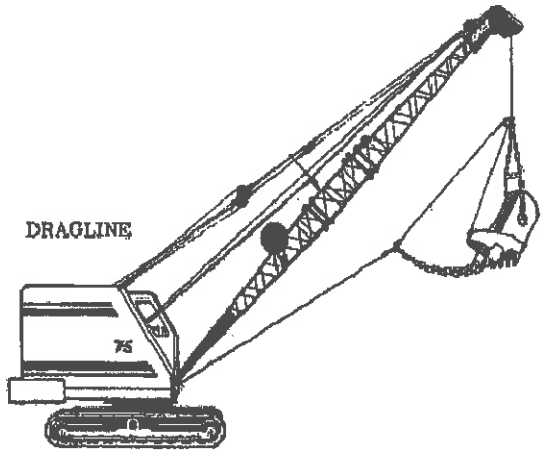
EXCAVATING EQUIPMENT

The purpose of excavating equipment is to extract sand and clay from the pits and load it into haul trucks. Depending on the situation of the sand and clay, different excavating equipment is used.

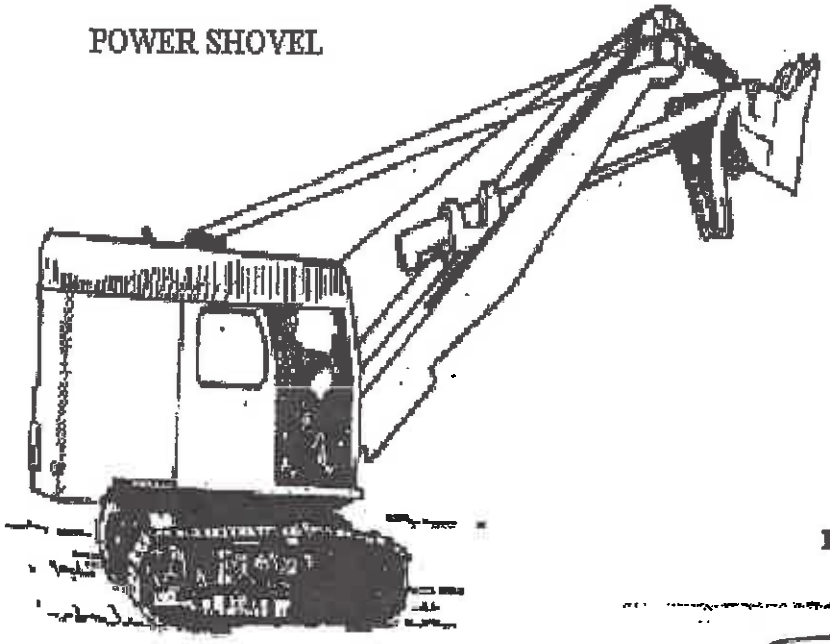
When the pits have strata to be blended, excavating should be done with a front-end loader or power shovel as shown below. As we mentioned earlier, this equipment must rake the full face of the cut in order to remove enough material from each of the strata. You should be sure that the power shovels or front-end loaders have working ranges large enough to excavate the entire face of the cut.

When the sand and clay are to be excavated from separate pits, the excavating usually is done by power shovels, front-end loaders or draglines. Draglines - like the one shown below - are not permitted in raking the faces of stratified cuts.

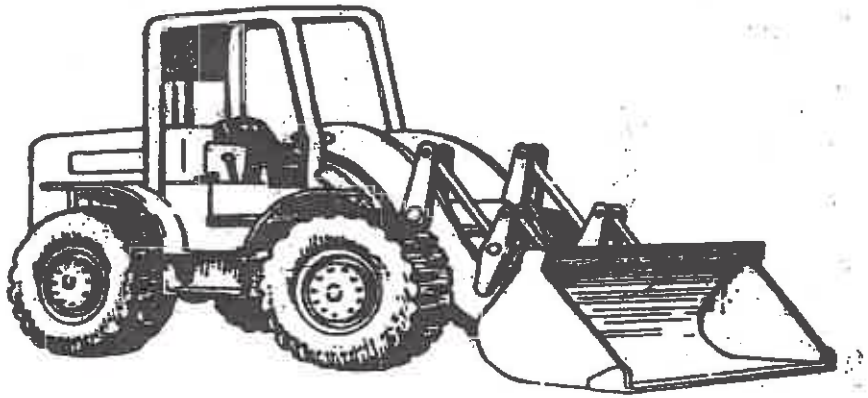
The Contractor may use equipment of his choosing to excavate pits having natural blends of sand and clay. Usually, the equipment chosen includes the types mentioned above.



POWER SHOVEL



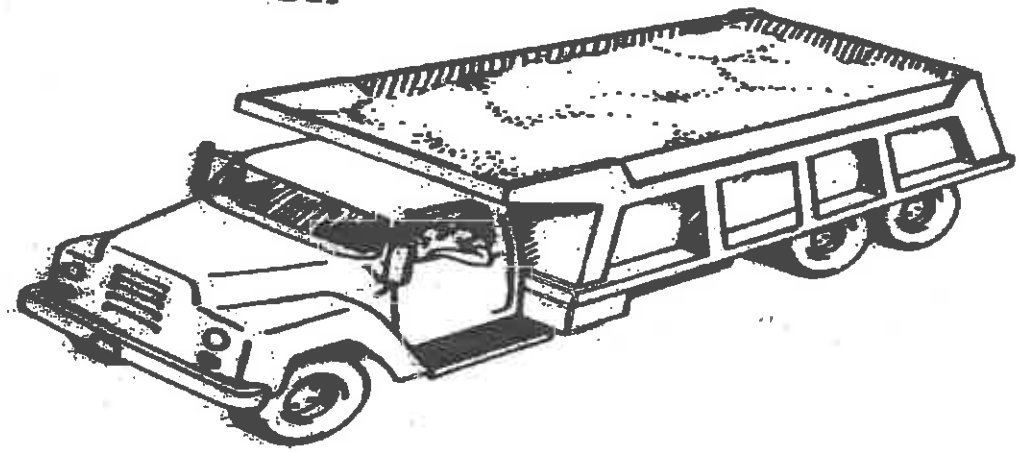
FRONT-END LOADER



HAULING AND SPREADING EQUIPMENT

The sand and clay generally are hauled to the job site by trucks. Usually, the material is dumped directly on the subgrade.

HAUL TRUCK



Material dumped directly on the subgrade is spread by bulldozers and/or motor graders. The motor graders should be self-propelled, rubber-tired, and of sufficient size and weight to do the work properly. As you will see, motor graders are key pieces of equipment used in several steps of the operation.

MIXING EQUIPMENT

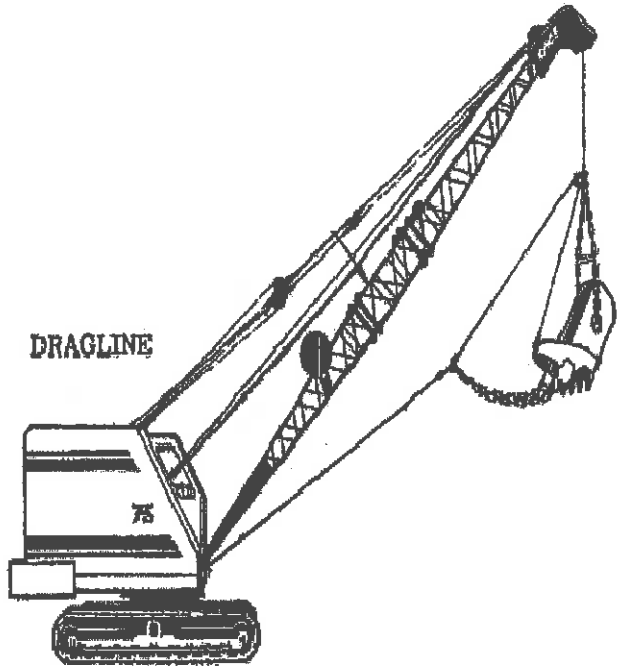
When the base material is a natural blend, there are several types of equipment that can mix sand/clay properly. Various combinations of pulvi-mixers, rotary tillers, motor graders and disk harrows are used.

When the sand and clay come from separate pits, or when the pit has strata to be blended, the Contractor will normally use motor graders and double-gang disk harrow.

QUIZ

The equipment used in constructing sand-clay bases should be in good condition, operate safely and _____.

Should the equipment shown at right be used in a pit where strata of sand and clay must be blended?_____.



Material dumped directly on the subgrade is usually spread by _____ and _____.

Which of the following normally would be used to mix the material when the sand and clay come from separate pits?

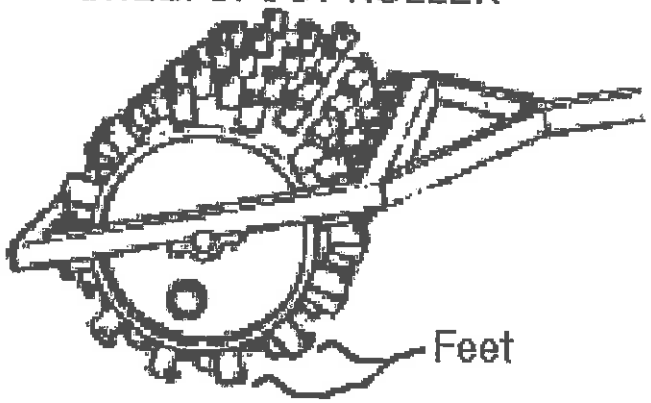
___ A. sheepsfoot rollers.
___ B. motor graders.
___ C. rotary tillers.
___ D. disc harrow.

COMPACTION EQUIPMENT

The sheepsfoot roller, as shown to the right, is the most commonly used piece of compaction equipment on sand-clay base courses. It is used for the initial rolling and achieves most of the required compaction.

Final rolling is normally done by traffic rollers, to achieve the final compaction, sealing and smoothing of the base surface.

SHEEPSFOOT ROLLER

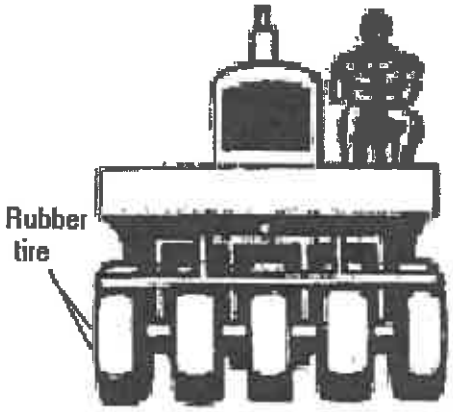


TRAFFIC ROLLER

FINISHING EQUIPMENT

Finishing begins after the sheepfoot roller "walks out" of the base. That is, as the base becomes denser, the feet of the sheepfoot roller penetrate the base less - until they eventually walk out of the base material.

At this time, the base must be brought to the approximate plan grade and cross section by blading with motor graders. The final rolling referred to above is then performed by traffic rollers. After final rolling, some additional blading will be necessary to bring the base to the plan grade and cross section.



CONSTRUCTION OPERATIONS AND INSPECTION

Before sand-clay base construction begins, the subgrade must be inspected to ensure that it meets the requirements for grade, cross section, density and general condition. We discussed these inspections in Chapter Six.

GENERAL SEQUENCE

With the subgrade in proper condition, the base construction operations may begin. The general sequence of construction and inspection operations for sand-clay base course is:

- hauling and spreading
- sampling and checking
- finishing
- checking
- compacting
- mixing
- testing and

Let's go through all the operations, beginning with hauling and spreading.

HAULING AND SPREADING

As we said earlier, the sand and clay normally are hauled to the jobs site in trucks and dumped directly on the subgrade. The spreading usually is done by bulldozers or motor graders and it should be done according to one of two cases discussed below.

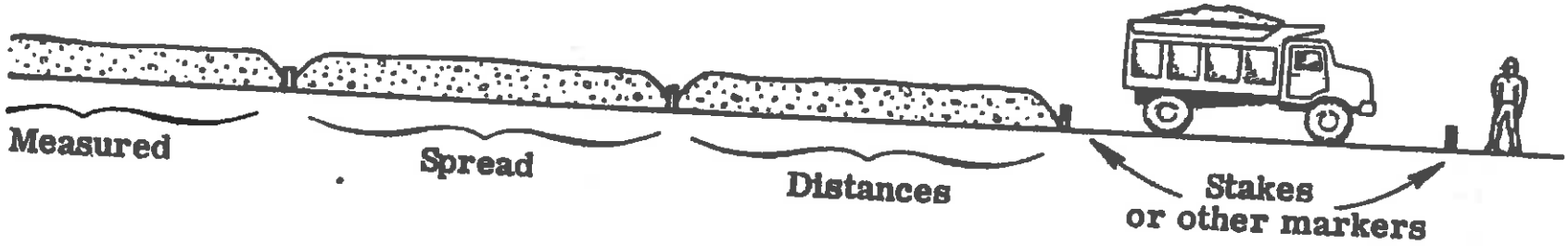
Case1 - This case involves the use of natural blends of sand-clay or of blended strata of sand clay. Neither type of mixture needs additional sand or clay. Either type may be dumped directly on the subgrade and spread should be continuously checked by the you and the Contractor to ensure that the finishing base will have the thickness and shape required by the typical section.

Final base thickness, of course, should be shown in the plans.

Case 2 - Case 2 covers the use of sand and clay which must be hauled in from separate pits. The sand and clay must be dumped on the subgrade, spread in successive layers and mixed in place. The Project Engineer will determine the order in which the sand and clay should be placed and the depth of each layer. Usually the clay layer is spread first, then the sand.

Marking Spread Distances

To ensure the proper uniform thickness of loosely spread sand and clay, the spread distances should be marked on the subgrade as shown above.



As an Inspector, seeing that spread distances are marked will be one of your responsibilities. In order to mark these distances, you will need to know the volumes of the individual haul trucks. Let's look at an example.

Suppose a haul truck carrying sand has a capacity of 12 cubic yards (9.1cubic meters). The designated lose thickness of the sand is 4" (1.016mm,) and the width of the course is 12' (3.6m). What is the spread distance for the truckload?

First, multiply the depth of spread by the width:
0.33 foot (4 inches) x12 feet = 4 square feet
[0.1016 (3.6m)] = 0.37 square meters

Then, divide the trucks capacity by the above product:
truck capacity = 12 cubic yards = 324 cubic feet
spread distance = 324 cubic feet = 4 square feet = 81 feet
spread distance = 9.1 cubic meters = 0.37 square meters = 26.4 meters

The spread distance, then, is 81 feet (24.6m). As long as the width and loose depth of spread remain the same, you can simply divide each truck's capacity by 4 square feet to obtain the spread distance.

CHECKING

After the dumping and spreading, and before the mixing, certain checks must be performed. As an Inspector, you should check:

- the proportions of sand and clay (when they are hauled from separate pits and placed in separate layers).
- the loose depth (thickness) and uniformity of spread.

Proportions of Sand and Clay

To check the proportions of sand and clay, keep a tally of the truckloads hauled from each pit and observe the relative thickness of the materials as they are spread. Recheck your spread-distance calculations to verify the correct proportioning.

Loose Depth and Uniformity of Spread

Use a rule or other measuring device to check the loose depth of spread frequently. Remember, the base course must have sufficient loose thickness so that it will have the proper final thickness after compaction. Make enough depth measurements to satisfy yourself that the material has been spread evenly over the entire length and width of the section. Be sure that any areas deficient in thickness are corrected by adding more material before mixing begins.

QUIZ

Which piece of equipment is normally used on sand-clay bases to achieve the final compaction, sealing and smoothing of the base surface? _____.

Finishing begins after the sheepsfoot roller _____ of the base.

Spreading should begin:

__ A. as soon as possible after the materials are dumped on the subgrade.
__ B. no sooner than 10 hours after the materials are dumped on the subgrade
__ C. within five hours after the materials are dumped on the subgrade.

How should the material covered under Case 2 be spread? _____.

When the sand and clay are spread in successive layers, which are usually spread first? _____.

A haul truck has a capacity of 11 cubic yards (8.4m;). The base course is to be 12' (3.6m). The Project Engineer has designated a loose depth of spread of 3 inches (75mm). What should be the spread distance (to the nearest foot) for this truckload?_____feet.

Who is responsible for seeing that spread distances are marked? _____.

To verify the proper proportioning of sand and clay, you should recheck your_____.

Besides the proportions of sand and clay, what else should you check the spread material for?
_____.

MIXING

The sand and clay must be thoroughly mixed to produce a uniform, homogenous mixture with no lumps or concentrations of one material. Material that is thoroughly mixed and properly proportioned according to the design can be compacted to the required density and will have the required bearing value.

General Procedures

The base materials should be mixed as soon as possible after being dumped and spread in order to take advantage of the "pit moisture" in the material. Delay allows moisture to escape, making the mixing more difficult to mix and reducing the moisture content to below optimum.

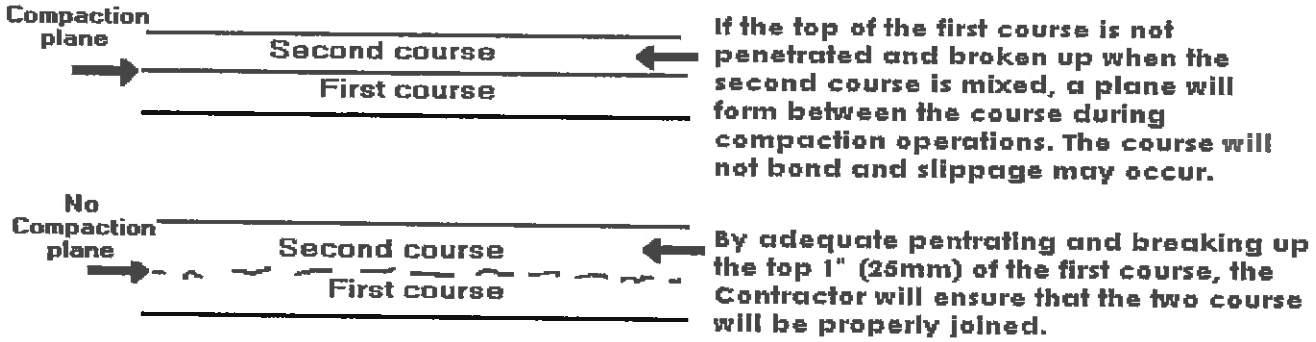
All sand-clay materials must be mixed - including natural blends. Natural blends are easier to mix because they are already somewhat blended in their natural state. As we mentioned in the equipment section, various combinations of pulvimixers, rotary tillers, motor graders and disk harrows may be used to mix natural blends. The mixing should be done to the full width and depth of the course.

When the sand and clay are obtained from separate pits, or when the pit has strata to be blended, the Contractor should use only motor graders and double-gang disk harrow to do the mixing. The disk harrow should continuously mix and cut while the grader forms windrows and moves the material back and forth across the subgrade. The procedure should be repeated until a homogenous mix is obtained.

Multiple-Course Bases

When the specified compacted base thickness is greater than 6"(150mm), the base must be constructed in two or more courses. Multiple-course construction for thicker bases ensures that there will be adequate mixing and compaction of the entire base.

The separate courses should be approximately equal in thickness. As each succeeding course is placed, the equipment should penetrate and break up at least the top 1"(25mm) of the underlying course. This procedure ensures that the individual course will be properly joined together, avoiding the formation of compaction planes as shown on the next page.



SAMPLING AND CHECKING

After the sand and clay are spread and mixed, you must obtain samples of the mixture and perform another check.

Sampling

As we said early in this chapter, you will be responsible for obtaining and submitting job control samples of the mixed sand and clay. The district Soils Lab will test these samples for gradation, liquid limit, plasticity index, L.B.R., maximum density, the percent of sand, silt and clay, and optimum moisture. Test reports from the Lab will show the results of the tests.

Your main concern are that the materials pass the tests and are accepted, and that maximum density and optimum moisture values are obtained and used in determining whether the moisture-density requirements are subsequently met. The Proctor test results normally come back in about two days after you submit the samples.

Checking

Although the Lab will be testing the sand-clay samples, you should check the thoroughness of the mixing. Make visual and hand checks frequently, observing whether or not the sand and clay have been completely blended and mixed into a homogenous mixture.

QUIZ

Thoroughly mixed and properly proportioned sand-clay material:

___ A. will have the required bearing value.
___ B. will have concentrations of sand.
___ C. can be compacted to the required density.
___ D. will have clay balls.

The base materials should be mixed as soon as possible after being dumped and spread in order to take advantage of the _____.

Natural blends of sand and clay do not have to be mixed. True or False? _____.

How should sand and clay from separate pits or sand and clay blended in a stratified pit be mixed?
_____.

When the specified compacted base thickness is greater than _____ the base must be constructed in two or more courses.

The separate courses should be approximately equal in thickness. True or False? _____.

What procedure should be followed to join separate courses together and avoid the formation of compaction planes?
_____.

How should you check the thoroughness of the mixing? _____.

COMPACTING

After the sand and clay are thoroughly mixed and the Lab approves the mixture, compaction may begin. The Contractor should start the compaction right away, unless the blend is a borderline case. That is, if it is possible that the proportions of sand and clay are not what they should be, the Contractor will want to wait for the results of the tests for L.B.R, Proctor and clay to the materials. In any case, compaction is usually achieved by sheepsfoot rollers. Passes are made until the rollers' feet walk out of the base material.

During compaction, and as you perform moisture-density tests, you should keep the Contractor informed of the moisture content of the base. Note carefully the moisture content at which the maximum density is obtained and use this percentage as a guide for the subsequent compaction of other sections.

Adjustments often are needed in the moisture content of the base. When watering is necessary, the water must be uniformly mixed in by disking to full base depth. In multiple-course construction, you should be sure that wetting/disking operations in an overlying course do not disturb the density of the underlying course. An alternate way of watering is to make a uniform application, at night, allowing the moisture to settle in and become throughout the base by the next morning.

If the base is too wet, the materials should be aerated to allow the excess moisture to evaporate. Aerating usually is done by windrowing and harrowing provided enough care is taken to prevent the breakdown of the material, if its integrity is affected the material must be removed. Care must be taken to control the water content. The solution of letting it dry under the sun, scarifying, aerating, or adding new material is never better than proper planning. Being that base material is very susceptible to changes in moisture, study each situation for the following:

1) If heavy rains are expected, every effort must be made to prevent washouts.

2) If not firm, yielding, or spongy, too much water was used in that area.

3) The improper equipment was used and vibration caused water to be pumped up from lower layers.

4) The retained water in the underlayers was not allowed to escape the roadway.

Then, the material is bladed back, usually in two or three layers. Each layer must be compacted following its placement. During the mixing and compacting, the Contractor should take precautions to prevent washouts of the base. At the end of each working day - especially on days when rains are expected - he should seal the entire area being worked by lightly compacting the top of the base. Traffic rollers work well for this sealing.

As we have mentioned, traffic rollers are normally used in the final stages of compacting –to smooth, seal and obtain final compaction of the finished base course.

QUIZ

In borderlines cases, the Contractor may want to wait for the results of the tests for _____, _____, and _____ _____before beginning compaction.

One way of adding water to sand-clay base in order to adjust the moisture content is to mix in the water uniformly by _____ to the full base depth.

Aerating usually is done by _____ and _____.

What should the contractor do to prevent washouts? _____.

TESTING

The compacted base course must be tested for moisture content and density according to the procedures discussed in the Earthwork Inspection training course. You should follow the minimum test frequencies in the Sampling, Testing and Reporting Guide. Remember, the frequencies shown in the Guide are minimum frequencies. As an Inspector, you can and should perform tests whenever and wherever you feel they are necessary to determine the actual density and moisture content of the base.

The minimum density requirements for sand-clay bases are 98 percent of the maximum density for the travel portion of the base and 95 percent for areas outside the travel roadway (crossovers, turnouts, etc.).

For multiple-course bases, the moisture-density tests must be run on each separate layer. In other words, before each succeeding layer is placed, the underlying layer must be tested.

We mentioned the importance of keeping the Contractor informed of the moisture content at all times. Moisture is critical in sand-clay bases, and its uniformity throughout the materials is absolutely necessary. Ideally, the moisture content should be maintained at a percentage point or two below optimum during the compaction operations.

FINISHING

After the sheepsfoot roller walks out of the base, the top of the bases should be brought to the plan grade and cross sectioned by grading.

The final rolling - usually done by traffic rollers (as seen on the following page). follows the blading. This final rolling achieves the final compaction and seals and smoothes the base surface.

Additional blading will be necessary to trim high areas and rework low areas of the bases. When completed, the finishing operations should produce a base course complying with the plan grade and cross section.

As with limerock base courses, watch out for scabbing during the finishing of sand-clay bases. As you recall, scabbing is chiefly caused by pushing material into low areas and compacting it to bring the areas up to grade. Be sure that the Contractor properly prepares low areas by scarifying them before adding material and compacting it.

QUIZ

Are the frequencies shown in the Sampling, testing and Reporting Guide maximum frequencies for testing? _____.

The travel portion of sand-clay base courses must be compacted to at least _____ percent to the maximum density.

For multiple-course bases, the moisture-density tests must be run on:

___ A. alternate
___ B. the final course only.
___ C. each separate layer.

Ideally, the moisture content of sand-clay bases should be maintained at _____during compaction operations.

The plan calls for 203.2mm sand-clay base course. At one point you measure the thickness of the complete base and find it to be 193.6mm. Is the base within the thickness tolerance at this point? _____.

When the plans indicate material pits, does the Contractor have the option of using them or finding his own? _____.

When the materials and the pits are approved, the Lab issues the _____for the sand and clay.

Briefly describe the three conditions in which sand and clay may be found:
1. _____.
2. _____.
3. _____.

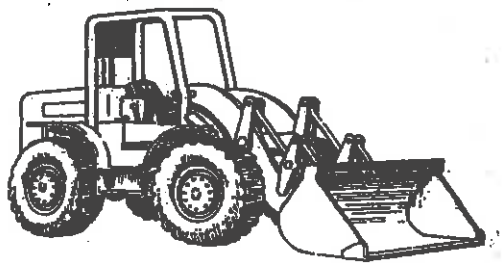
QUIZ, continued

How should the excavating equipment remove material from the separate strata in a pit?

_____

_____

FRONT-END LOADER



Can the equipment shown to the right be used in excavating material from different strata in a cut? _____.

What equipment typically is used in spreading the sand and clay?

_____.

Which of the following should be used to mix the sand and clay when these materials come from separate pits?

___ A. motor graders.
___ B. sheepsfoot roller.
___ C. jersey boxes.
___ D. rotary tillers.
___ E. disk harrows.

Should spreading begin as soon as possible after the materials are dumped on the subgrade? _____.

When the sand and clay are spread in separate layers, who should determine the order in which they are placed?

_____.

Which is usually spread first? _____.

A haul truck has a capacity of 9.5m. The base material is to be spread to a loose thickness of 100mm. The base course is to be 3.6m. What should be spread distance (to the nearest foot) for this truckload? _____.

QUIZ, continued

How can you verify the correct proportioning of the sand and clay (when they are placed in separate layers)? _____.

Besides checking the depth of the spread material, you should check for _____ of spread.

Should natural blends of sand-clay be mixed on the roadway? _____.

You are inspecting sand-clay base construction in which the sand and clay come from separate pits. During the mixing operations, a disk harrow is used to continuously mix and cut the material. How should the motor grader be used? _____.

One way of adding water to sand-clay base in order to adjust the moisture content is to mix in the water by disking. What is an alternate way? _____.

Aerating is done reduce the moisture content of base materials. How is the aerating usually accomplished? _____.

What should the contractor do to prevent washouts? _____.

Should you ever perform moisture/density tests more frequently than indicated in the Sampling, Testing and Report Guide? _____.

The traveled portion of sand-clay base courses must be compacted to at least _____ percent of maximum density. Crossovers and turnouts should be compacted to at least _____ percent of maximum density.

Should you perform density tests on the first course of a multiple-course base? _____.

QUIZ, continued

During compaction operations, the moisture content of sand-clay bases should be maintained at:

___ A. the optimum percentage plus seven percentage points.
___ B. saturation.
___ C. a percentage point or two below optimum
___ D. five percentage points below optimum.

What will happen if the Contractor fails to scarify a low area before placing and compacting new material in it?

_____.

ANSWERS TO QUESTIONS

Page 8-6

- contractor or DOT
- no
- district lab
- blend
- base inspector
- stakes
- yes
- natural blend in the pit; different strata of same pit; separate pits
- rakes the full face of the cut
- B, C, E

Page 8-10

- produce the desired results
- no (front-end loaders and power shovels should be used)
- bulldozers; motor graders
- B
- D

Page 8-15

- traffic roller
- walks out
- A
- in separate layers
- clay
- 99
- inspector
- spread distance calculations
- proper depth (thickness and uniformity of spread)

Page 8-18

- A, C
- pit moisture
- false
- disk harrows should continuously mix and cut while the graders from windrows and move the materials back and across the subgrade
- 150mm
- true
- as succeeding course is placed, equipment should penetrate and break up at least the top inch of underlying course
- by making visual and hand checks

Page 8-21

- L.B.R.; Proctor; clay requirements
- disking
- windrowing; harrowing
- seal the entire area being worked each day

Page 8-23

- no, minimum
- 98
- C
- a percentage point or two below optimum
- yes
- yes
- blend
- natural blend in one pit; different strata of same; separate pits

Page 8-24

- by raking the full face of the cut
- yes
- bulldozers; motor graders
- A,E
- Yes
- Project Engineer
- Clay
- 84

Page 8-25

- recheck your spread distance calculations
- uniformity
- yes
- to form windrows and move the material back and forth across the subgrade
- apply water uniformly at night
- by windrowing and harrowing
- seal the entire area being worked each day
- yes
- 98;95
- yes

Page 8-26

- C
- scabbing

CHAPTER NINE

Final Inspection of Base Courses

CONTENTS

9

FINAL INSPECTION OF BASIC COURSES

INSPECTION OF COMPLETED BASES

Completed limerock base courses must be inspected and checked for defects, surface irregularities and depth (thickness). Let's discuss these different checks and inspections.

DEFECTS INSPECTION

You should inspect the completed base course for the defects we discussed in connection with finishing operations. Of course, it is better to discover such defects while construction is still in progress. That's why we discussed the repair for such defects in connection with finishing the base. Still, even when most of the defects are found and corrected early, you should keep watching for others while observing templet and straightedge checks.

TEMPLET AND STRAIGHTEDGE CHECKS

Templets and straightedges are used to find surface irregularities greater than ¼" (6mm) in the completed base course. All areas higher or lower than ¼" (6mm) from the plan grade of the finished base must be corrected.

Templets are made of wood or metal and are cut to the required crown of the completed base course. A templet is shown in the diagram below:

Templets are placed transversely on the base at frequent intervals. Templet checks are made at a minimum of 50 foot intervals. Of course, the surface should be checked at any points that appear to have irregularities.

Sometimes it is difficult to use templets for checking the base in curb and gutter (municipal) sections. In these cases, string lines should be used instead of the templets. The Inspector should obtain the Project Engineer's approval for this substitution.

Fifteen-foot straightedges are used to check for surface irregularities longitudinally. The straightedge should be placed parallel to the centerline at 50 foot (15mm) intervals.

Sometimes the backs of templets are used as straightedges. This is acceptable - in fact desirable - since the templets normally are much longer than 15 feet (4.57m). This means that 3 @ (5.mm) irregularities are more noticeable. Of course, the requirement is that a 4.572m straightedge be used.

All surface irregularities greater than 3 inches (75mm) must be corrected by:

- scarifying;
- removing or adding rock as required;
- reshaping; and
- recompacting

Sound familiar? This is the same basic procedure we discussed earlier for repairing defects.

DEPTH CHECKS

The final depth or thickness of the base should be determined by measuring through holes made in the limerock. The holes must not be less than 3" (75mm) in Diameter. They should be made at the intervals specified in the Sampling, Testing and Reporting Guide, and at various points on the cross section.

Areas of the completed base that are deficient in thickness by more than 2@ (10 mm) must be corrected by scarifying and adding limerock. The correction must be made for a distance of 100'(30m) in each direction from the edge of the deficient area. The entire area must be compacted properly and shaped to the required thickness and cross section.

In certain special cases, deficient area may be left in place - if it is determined that they will not seriously reduce the strength of the base course. Approval for leaving the areas in place must come from higher authority, and payment will not be made for these areas.

The Contractor should perform the surface irregularity and depth checks and you should closely observe. Be sure that you are satisfied that the specification requirements have been met, and document the results of the checks in a field book.

FINAL BORING

After you and Project Engineer are satisfied that the course has the proper density, grade, width, thickness, etc., you should make final boring to determine average thickness. The average thickness of the base is used in calculating the total square yards of limerock base course that will be paid for.

Measure the hole to the nearest 1/10 of an inch (2.5mm) and record the results in a field book. Follow the frequency shown in the Sampling, Testing and Reporting Guide. When Finishing, turn in you field book to the Project Engineer. Test results will be put into a computer to calculate the average thickness.

Notify the District Lab when you have finished a section of base course (before you make the final boring, if possible). They will have to make an independent assurance inspection for thickness measurements.

QUIZ

Once you've watched for scabs, cracks and other defects during finishing operations, should you stop looking for them after the base course is completed? _____.

Templets and straightedges are used to find _____.

All areas of the base surface that are higher or lower than _____must be corrected.

Templets are made of _____ or _____and are cut to the required _____ of the completed base course.

_____ instead of templets - may be used to check for surface irregularities in curb and gutter sections.

Which of the following statements about straightedges are true?

___ A. should not be under 4.5m long.
___ B. should be placed transversely on the completed base course.
___ C. should be at least 6.0m long.
___ D. should be placed parallel to the centerline.

Thickness checks should be made through holes not less than _____in diameter.

Areas of the completed base course that are deficient in thickness by more than _____ must be corrected for a distance of _____in each direction from the edge of the deficient area.

Final boring are made to determine _____, which in turn is used in calculating the total area of completed base course to be paid for.

GO TO DOCUMENTATION.

DOCUMENTATION

Base course construction, just like all other work, must be well documented. Documentation is part of your overall inspection activities.

You should document base course construction by completing the Daily Report of Construction and making entries in one or more field books. Typical entries in field books include the results of depth and surface irregularity checks and final boring. In setting up your field book entries, use a format that is neat and well organized. Make accurate and complete notations, being sure to indicate date, location and results.

You are familiar with Daily Reports of Construction from the chapter about subgrade. These Reports are used to compile the Daily and Weekly Project Diaries at the project office. An example of a Report completed for limerock base course construction is shown on the next page. Study the Report shown on the next page, then go on to the next chapter.

STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION

DAILY REPORT OF CONSTRUCTION

FORM 700-010-1
CONSTRUCTION - DR
Page 1 of 2

DESCRIPTION OF WORK

CONTRACTOR: WHITEHURST

OPERATION and LOCATION	TIME (AM/PM?) BEGINNING	ENDING
Placing bottom course limerock base Sta. 70+25 to 90+95	11:00 Am	5:30 pm
Placing top course limerock base Sta. 65+50 to 78+00		
Grading and boxing subgrade Sta. 78+00 to 113+00		

PERSONNEL	NO.	HOURS WORKED
SUPT.	1	10
FOREMAN	2	10
SKILLED	6	10
SEMI SKILLED	10	10
COMMON	5	10
TRAINEE	0	0

MATERIALS RECEIVED: Limerock base material

EQUIPMENT (ACTIVE/IDLE)

	AIR COMPRESSOR	1		DOZER		WATER BROOM	1		TRUCK DUMP
	AIR HAMMER			DRAGLINE		PUMP			TRUCK FLATBED
	ASPHALT PAVER			EARTH MOVER		ROLLER, STEEL WHEEL	1		TRUCK GRAVEL
	ASPHALT DISTRIBUTOR			FRONT END LOADER	1	ROLLER, TRAFFIC			TRUCK LOWBOY STEPSIDE
	BACKHOE			GRADER		ROLLER, VIBRATORY	1		TRUCK PICKUP
	BULLDOZER			HARROW		ROTARY TILLER/MIXER			TRUCK WATER
	CONCRETE BUCKET			OSCILLATOR		SPREADER, DRY			WELLPOINT SYSTEM
	CONCRETE SAW			MECHANICAL TAMP		SPREADER, MULCH			
	CONCRETE MIXER			MOTOR GRADER		SPREADER, FERTILIZER			
	CONCRETE VIBRATOR	1		MOTOR SWEEPER		TRACTOR, FARM			
	CRANE, CRAWLER			MULCHER		TRANSPORT			
	CRANE, TRUCK			PILE DRIVER & HAMMER		TRUCK, BUCKET			

ESTIMATED CONTRACT QUANTITY INCREASES TODAY

ITEM NO.	ITEM	QUANTITY	REMARKS AND CALCULATIONS
200-1-3	Limerock base	5,139 SY	Bottom course
200-1-3	Limerock base	3,472 SY	Top course

FIN PROJECT NO.	F.A. PROJECT NO.	CONTRACT NO.	DATE	DAY OF WEEK	CONTRACT DAY
20022215201	N/A	11706	2-10-99	Friday	75

Page ___ of ___

STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION
FORM 700-010-1
CONSTRUCTION - DR
Page 2 of 2

FIN PROJECT NO.	F.A. PROJECT NO.	CONTRACT NO.	DATE	DAY OF WEEK	CONTRACT DAY
20022215201	N/A	11706	2-10-99	Friday	75

WEATHER CONDITIONS: ○ Clear ☒ Partly Cloudy ○ Heavy Clouds ○ Fog
TEMPERATURE: 78 High 55 Low ☐ Temperature Restriction Specification No:
WIND: ☒ None ○ Slight ○ Strong
RAIN: ☒ None ○ Light ○ Heavy ○ Showers
RAIN DURATION: ○ 0-2 hrs. ○ 2-4 hrs. ○ 4-6 hrs. ○ All Day
WORKING CONDITIONS: ☒ Excellent ○ Good ○ Fair ○ Poor ○ Bad
DURATION OF ACCEPTABLE CONDITIONS: ☒ Acceptable All Day ○ More Than 50% of Work Day ○ Less than 50% of Work Day ○ Unacceptable All Day
SOIL CONDITION: ☒ Dry ○ Wet ○ Extremely Wet

EFFECTS OF WEATHER ON MAJOR WORK ITEMS (CHECK CONTROLLING ITEMS)

Major and/or Controlling Work Items	No Effect All Day	Effected Less Than 50% of Work Day	Effected More Than 50% of Work Day	No Work All Day
Limerock Base	☒	○	○	○
	○	○	○	○
	○	○	○	○
	○	○	○	○
	○	○	○	○
	○	○	○	○

GENERAL COMMENTS: Limerock sample taken A0016 thru A0019
Density taken on subgrade Sta. 90+00 to Sta. 113+00

VISITORS:

TECHNICIAN'S SIGNATURE AND RATING: S. Walls EAS III

HOURS AT JOB SITE: FROM 8am TO 5pm

TOTAL HOURS: 8

ENGINEER IN CHARGE (NAME, RANK AND INITIALS): A. Kavadas EAS IV

Page ___ of ___

RECYCLED PAPER

ANSWERS TO QUESTIONS

Page 9-5

- no
- surface irregularities
- 5mm
- wood; metal; crown
- string lines
- A, D
- 75 mm
- 12.5mm; 30m
- average thickness

CHAPTER TEN

Prime Coats

10

PRIME COATS

INTRODUCTION

Prime coats are protective bituminous coatings applied to finished base courses. Prime coats consist of a thin layer of liquid asphalt (bituminous) material covered by a light application of sand. All base course except hot bituminous base requires prime coats. You will also see "sand-seal coat" construction. Sand-seal coats are really just a special type of prime coat.

In this chapter, we will divide our discussion into following area:

- material acceptance and control;
- equipment;
- construction operations;
- inspection procedures; and
- documentation.

GO TO MATERIALS ACCEPTANCE AND CONTROL.

MATERIALS ACCEPTANCE AND CONTROL

There are two materials that must be approved and controlled for prime coats: the bituminous material and the cover aggregate (sand).

BITUMINOUS MATERIAL

Types of Prime

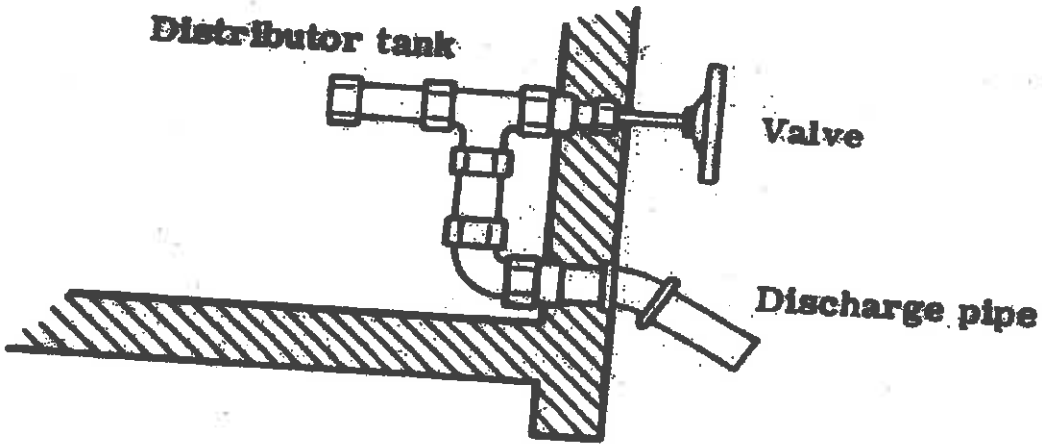
The Standard Specifications designate the following liquid bituminous materials for prime:

- cut-back asphalt;
- emulsified asphalt; and
- other types of material as may be called for in the plans or special provisions.

The Contractor may use any of the types of material referred to above, unless a specific material is required by the plans or special provisions. Types other than those specified above may be allowed if the Contractor can show that they perform just as well.

All bituminous materials must meet the specification requirements. As an Inspector, you will obtain and submit job control samples of the prime to the Central Lab. We will talk about sampling procedures next.

SAMPLING DEVICE



Sampling Procedures

You obtain samples of bituminous material through sampling devices – spigots -attached to the distributor tanks. The FDOT Field Sampling and Testing Manual (in Methods FM 1T040) shows two approved types of sampling devices that you will encounter. One of these devices is shown in a simple diagram above. For more details, consult the Field Manual.

Samples are discharged from distributor tanks into sample containers. These containers must be new, clean and dry. They should not be washed or rinsed.

Different sample containers should be used for different bituminous materials - according to the Sampling, Testing and Reporting Guide.

To obtain samples of prime, follow the steps listed below:

1. Be present when the distributor arrives at the project. Draw off at least one gallon of material from the spigot (sampling device) before taking your sample. Drawing off one gallon or more of material ensures that your sample is representative. The gallon that has been drawn off should be properly discarded.

2. Now, draw off enough material to fill the sample container. You also will be required to obtain a check sample. Take it right off the sample. Do not transfer sampling from one container to another.

3. Seal the sample container immediately. Emulsion jar lids should be sealed with masking tape. Any spilled material on the containers should be cleaned off with a dry cloth, not with a solvent.

4. Complete a Sample Transmittal Card, attach it to the container and send the sample to the Laboratory.

Obtain your sample of prime material according to the Sampling, Testing and Reporting Guide. In addition to obtaining and submitting samples of the prime, you must also collect the delivery tickets that have certification stamps.

These stamped delivery tickets certify that the materials met State specifications at the source. Transfer the information on the delivery tickets to the Sample Transmittal Cards, and then submit the tickets with the Daily Reports to the project office.

COVER AGGREGATE

The only requirement for the sand used as cover aggregate on prime coats is that it be clean. In other words, the sand must be free of foreign materials - especially clay balls. during the spread and left on the prime.

You will not be required to obtain and submit samples of sand for cover aggregate.

QUIZ

Prime coats are _____ coating applied to finished base courses.

According to the Standard Specification, which of the following may be used for prime:

___ A. asphalt cement.
___ B. emulsified asphalt.
___ C. cut-back asphalt.
___ D. other types of material as may be called for in the plans or special provisions.

You obtain sample of prime through _____ attached to the _____.

Sample containers must be new, clean and _____.

What should you do immediately before drawing off a sample of prime from a distributor tank?

_____.

What should you seal sample containers? _____.

What should you complete and attach to sample containers? _____.

What must you collect and submit with your Daily Reports? _____.

What is the requirement for sand used as cover aggregate? _____.

Okay? Now, go to **Equipment.**

EQUIPMENT

The equipment used in prime coat operations include:

- cleaning equipment;
- water truck;
- asphalt equipment; and
- traffic roller.

We will discuss each type of equipment, however we will concentrate on the asphalt distributor.

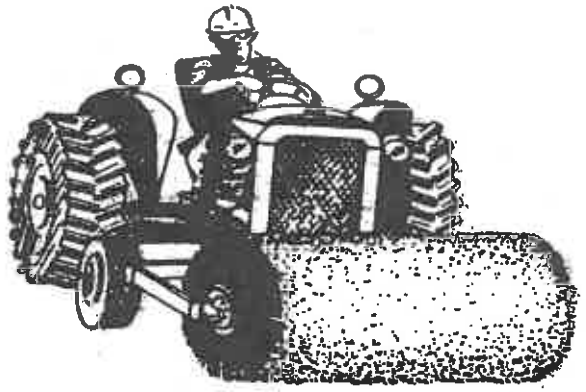
CLEANING EQUIPMENT

Cleaning equipment is used to sweep the base surface before the prime is applied. All loose material, dust, dirt, caked clay and other foreign material must be removed to full width of application. Leaving these materials on the surface would prevent the prime from bonding to the base. Particular care must be taken in cleaning the outer edges of the width to be primed. One type of cleaning equipment is the power broom, an example of which is shown above

WATER TRUCK

If the base surface is quite dry, water may be sprinkled on it lightly from a water truck. Then the base is rolled (by traffic rollers) before priming takes place. A gravity-type water truck is shown at right:

ASPHALT DISTRIBUTOR



An Asphalt Distributor is the combination of a storage tank and a truck. The truck is insulated and equipped with a heating system that can heat the asphalt uniformly and safely within specified temperature limits. These limits are set to provide the best application of hot liquid asphalt as the truck moves along the roadway.

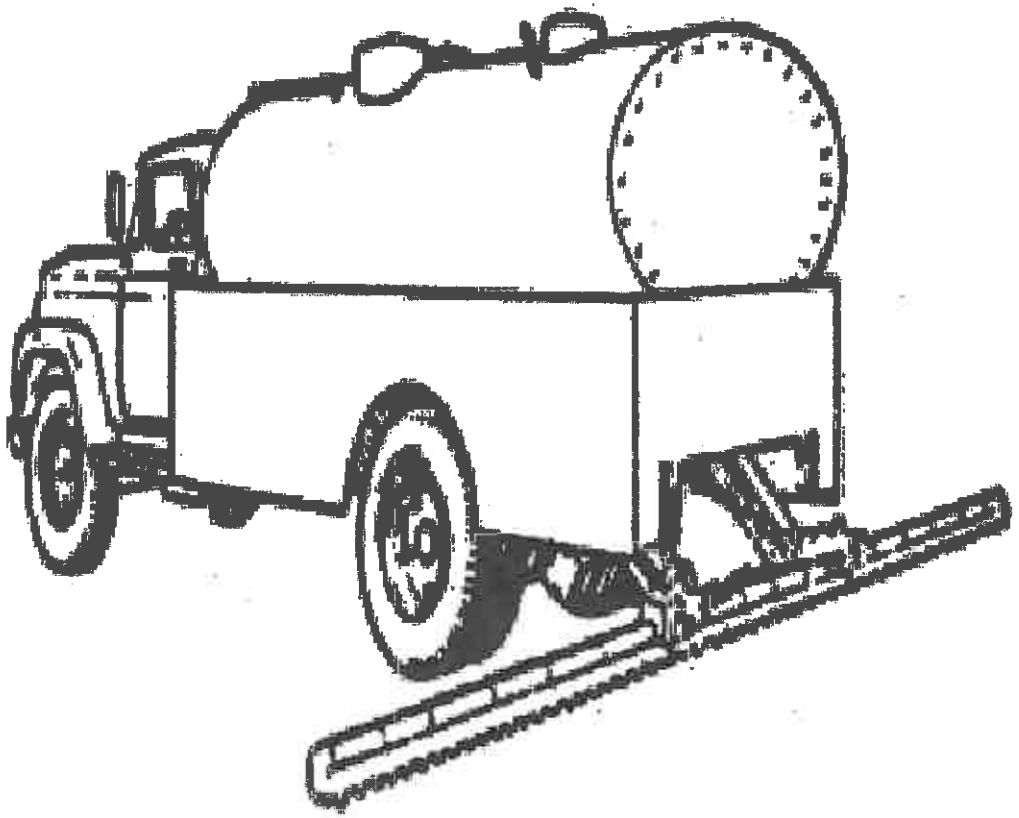
Now let's discuss the individual parts and requirements of asphalt distributors. First we will discuss distributor calibration.

Calibration

Asphalt distributor tanks use calibration charts in order to determine the quantities of bituminous material supplied by them. Each distributor has a calibration chart which is used to convert measurements of the distributor's contents into gallons of bituminous material.

As an Inspector, you must verify that every distributor has its calibration chart. Check the calibration number on the chart and be sure that the distributor has the same number stamped on it. The chart will indicate where the stamp is located on the distributor, how to measure the distributor tank and how to convert the measurements to gallons. We will discuss measuring distributor tanks and using calibration charts later in the chapter.

ASPHALT DISTRIBUTOR



Sampling Device

Asphalt distributors must have serviceable discharge pipes or spigots from which samples of the prime can be taken. You saw an example of such a sampling spigot on page 10-3.

Tires

Asphalt distributors must have pneumatic tires wide enough to avoid breaking the bond of forming ruts in the base surface.

QUIZ

Before the prime is applied, the base surface must be _____.

Particular care must be taken in cleaning the_____of the width to be primed.

_____ may be sprinkled lightly on the base before the priming takes place.

Asphalt distributor tanks are:

___ A. insulated
___ B. calibrated
___ C. refrigerated
___ D. heated.

How should you verify that the correct calibration chart is being used with the distributor?
_____.

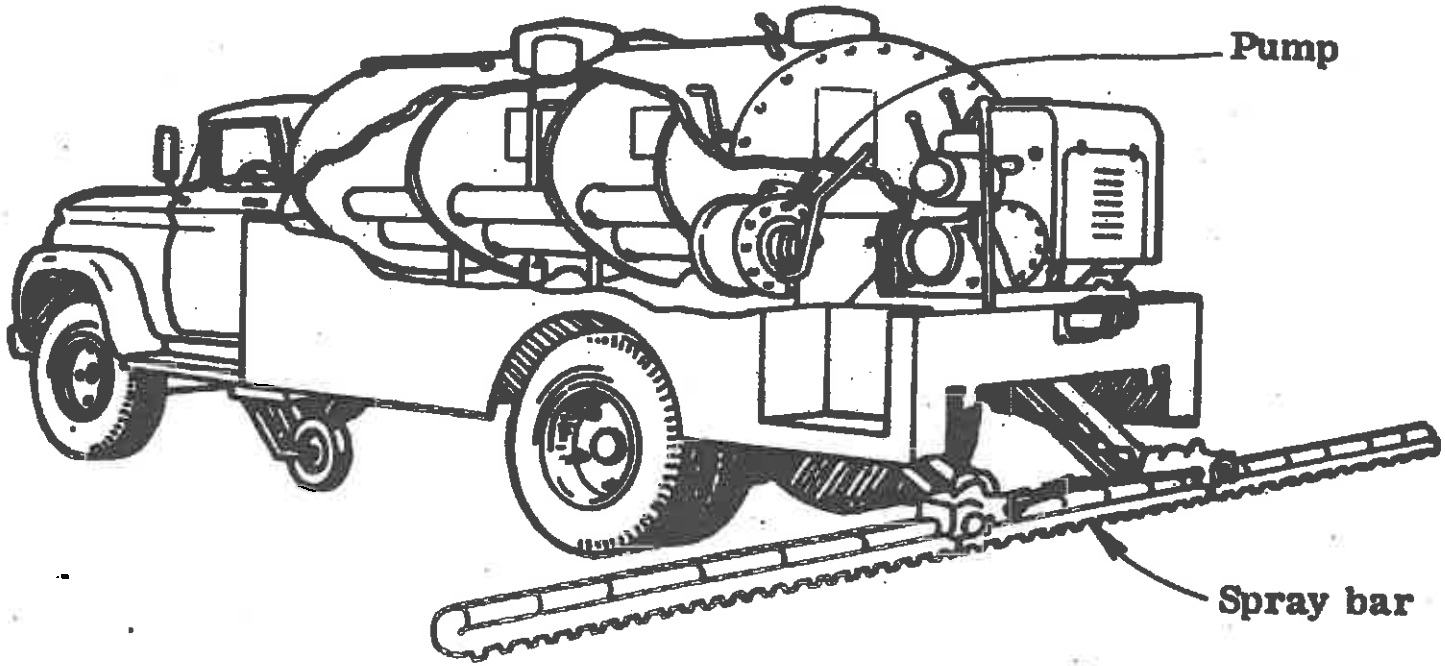
Calibration charts are used to convert tank measurements into _____of bituminous material.

How are samples of bituminous material obtained from distributor tanks?
_____.

Who obtains these samples? _____.

Thermometers

The temperature of the bituminous material has to be with specified range at the time of application. Because of this, there must be some way of checking the temperature. These thermometers measure the average temperature of the bituminous material in the tank. It is an average temperature because the material in the tank is circulating.



Circulation System

The circulation system uses a pump to exert a uniform pressure which is registered on a gauge on the distributor. The uniform pressure:

- circulates material in the tank;
- sprays material through the spray bar or hand spray; and
- draws material back into the tank from the spray bar or hand spray.

QUIZ

The thermometer measures the average temperature of the bituminous material because the material is _____ uniformly through the tank.

Prime is forced from the tank by the _____.

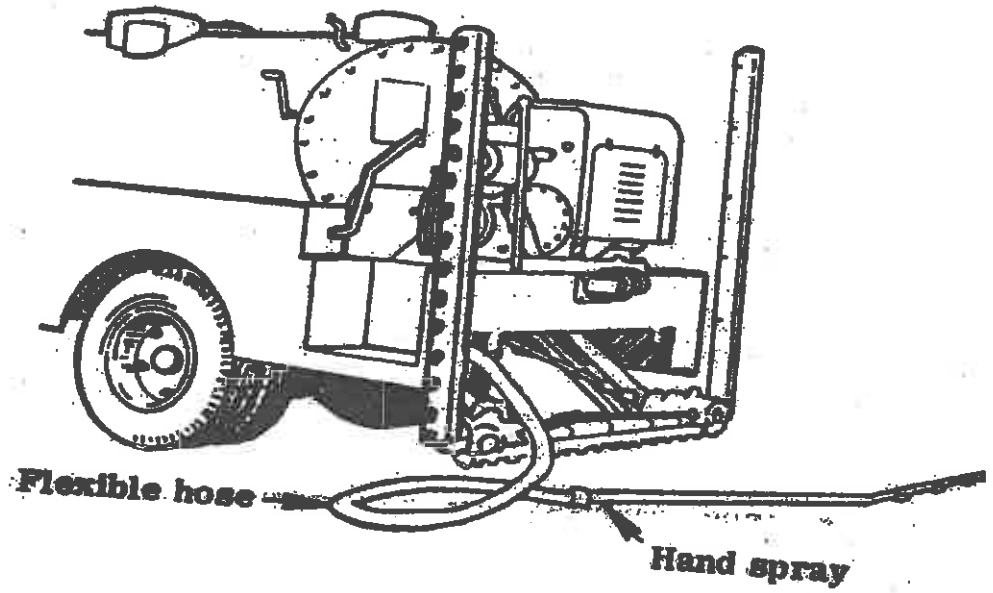
To check pump pressure, refer to the _____ on the distributor.

Next, we will talk about the Application Equipment.

Application Equipment

Prime usually is applied to the roadway through a spray bar with pressure nozzles. The spray bar folds out and can be extended to various application widths. By opening and closing specific nozzles, different spray widths are obtained. Spray bars also are adjustable vertically, to increase or decrease the distance between the spray and the road surface.

The nozzles themselves have requirements too. The distance between the centers of the openings of the outside nozzles must be equal to the width of the application required within a tolerance of two inches. The nozzles should be parallel to each other and at an angle of approximately 15 degrees to the spray bar. The nozzles should be clean and open. It will be necessary before making the initial application of prime.



In some area where the spray bar cannot be used, prime may be applied through a hose connected to the pump discharge. On the end of the hose is a hand spray. The hand spray should be used for priming confined or small areas only.

Whichever means are used to apply the prime, the asphalt distributors must be able to apply it at controlled, uniform rates.

Tachometer

The bituminous material application rate depends on the spread of the speed of the distributor and the pump (spray) pressure. Both should be held constant to obtain uniform coverage. Holding a constant speed is much easier if the driver can refer to an accurate tachometer.

Be sure the truck has a tachometer capable of accurately registering truck speed in ft/sec (m/sec). The tachometer should be visible to the driver. Tachometers are operated by a wheel independent of the truck wheels, often called a bitumeter.

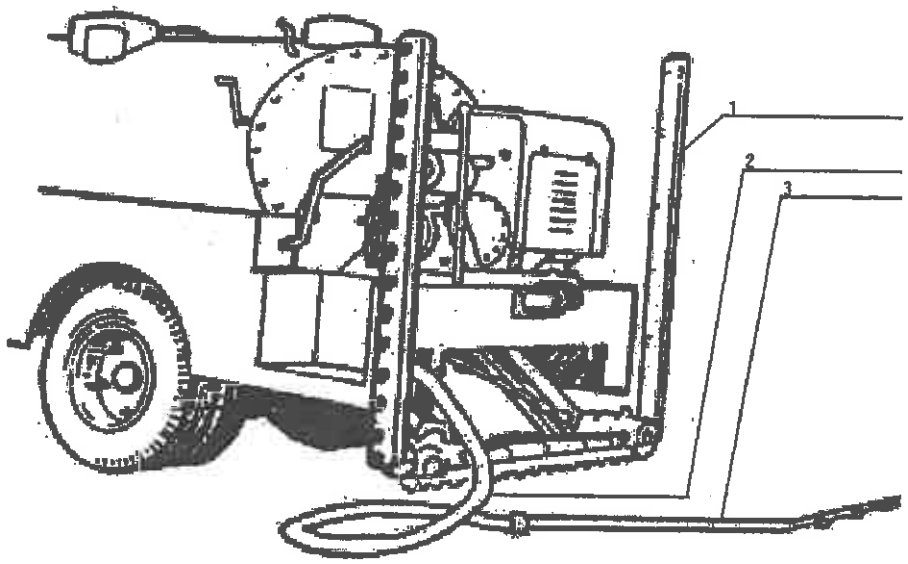
Quiz

Label Parts 1,2, and 3:

1._____

2._____

3. _____



Are spray bars vertically adjustable? _____.

Prime is sprayed into confined areas with a _____.

Asphalt distributors must be able to apply prime at _____ and _____rates.

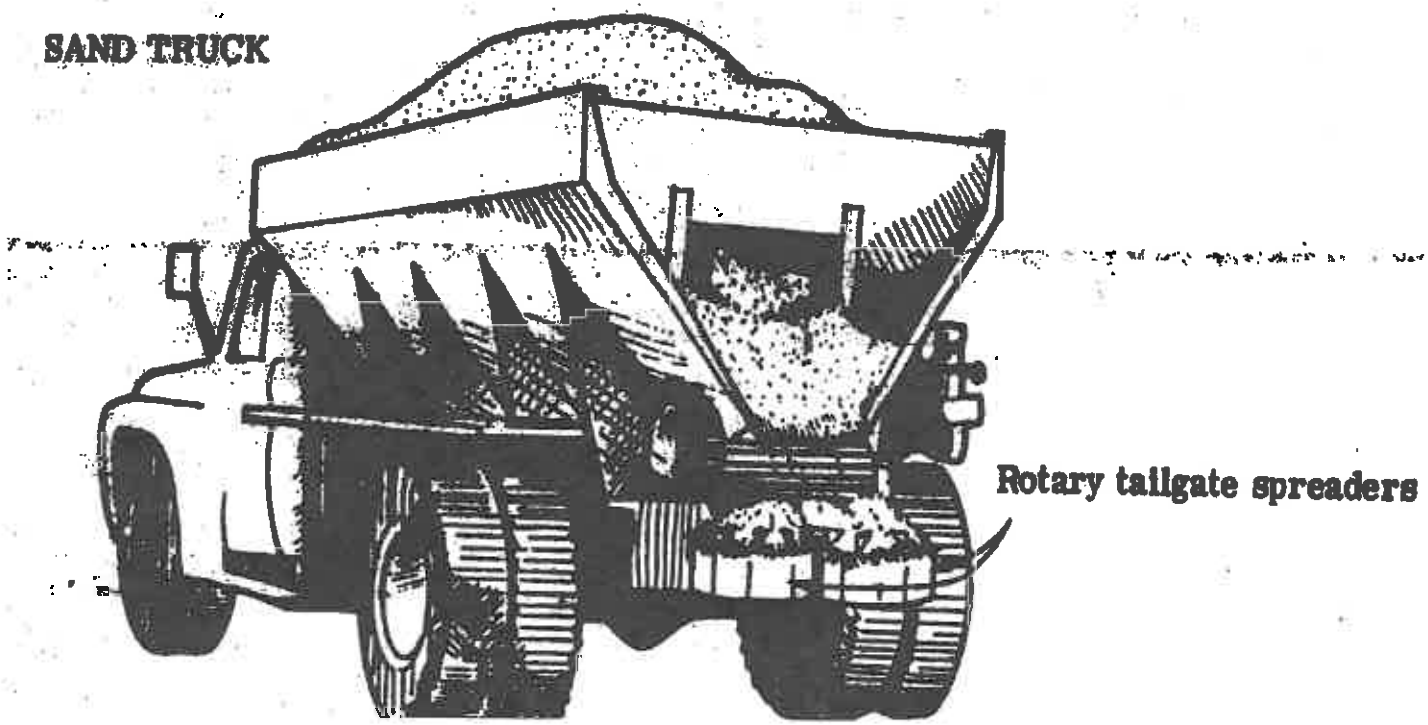
A wheel independent of all truck wheels can be used to operate the _____. The independent wheel often is called a _____.

The prime application rate depends on _____.

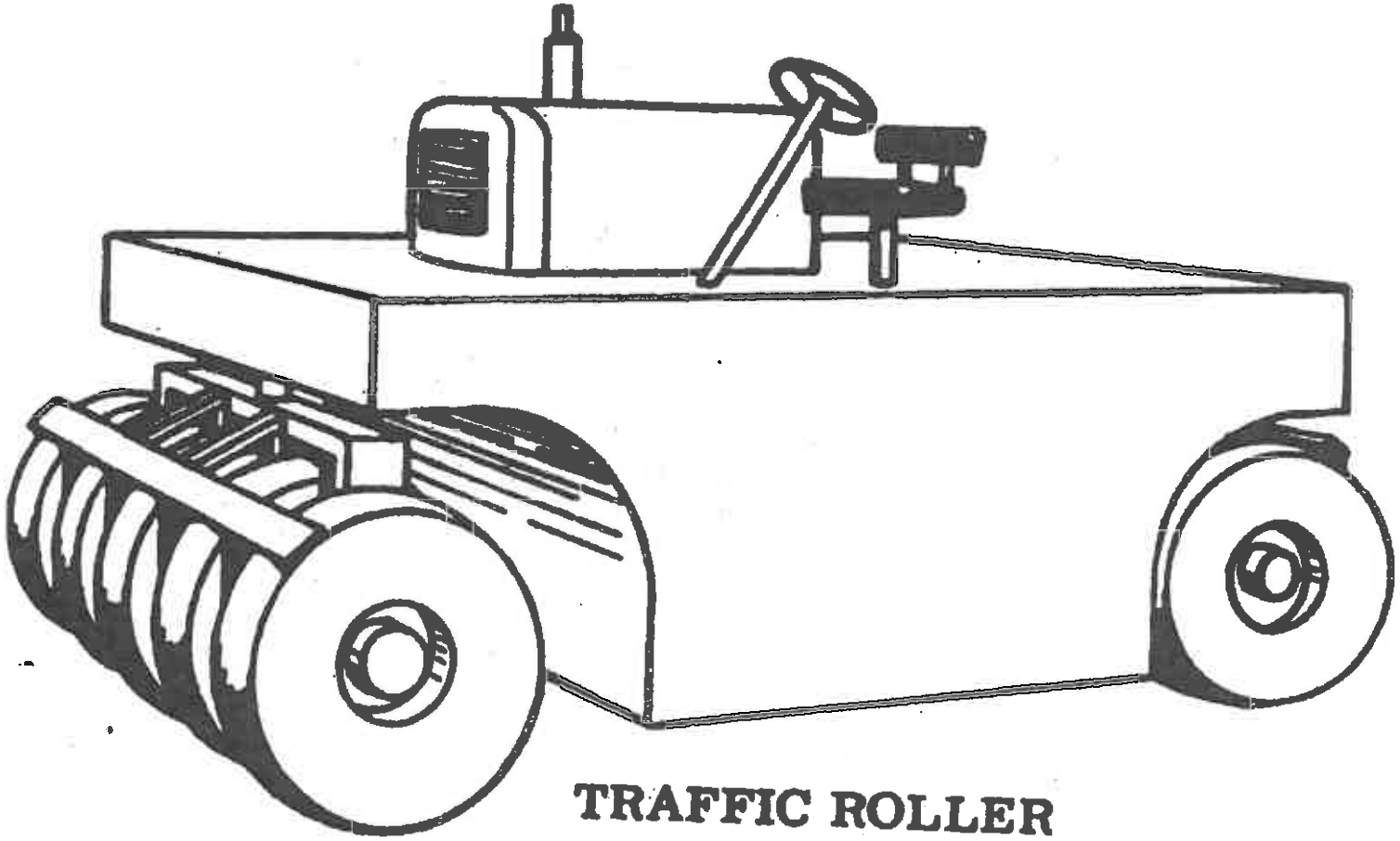
GO on to SPREADING EQUIPMENT.

SPREADING EQUIPMENT

The sand-cover aggregate must be spread uniformly over the primed bases. Usually, the sand is spread by rotary tailgate spreaders. These spreaders are specially equipped trucks that both haul and spread the sand. At the rear of such trucks the sand is funneled onto spinning blades that throw the sand evenly onto the surface of the primed base.



Traffic rollers are used to roll the primed and sanded base. The rollers help to work the particles into the prime so that they will stick. This also aids in curing the prime more rapidly.



TRAFFIC ROLLER

QUIZ

What is the main requirement for the spreading of the sand on primed bases? _____.

Usually, the sand is spread by _____spreaders.

_____ rollers are used to roll the primed base.

CONSTRUCTION OPERATIONS AND INSPECTION

To discuss the prime coat construction operations and your inspection of them, we will divide this section into the following areas:

- preparation for priming;
- asphalt distributor operations; and
- sanding and rolling.

PREPARATIONS FOR PRIMING

We can further divide the preparations for priming into several areas:

- base condition and moisture content;
- weather limitation;
- application rate and temperature; and
- protection of surrounding surfaces.

Let's start with Base Condition and Moisture Content,

Base Condition and Moisture Content

As we said earlier, before prime coat is applied, the base should be cleaned of all loose material, dust, dirt, caked clay and other foreign material that would prevent good bond from forming between the prime and the base course surface. In addition, the base surface itself must be in good condition, having met all the requirements discussed previously in this course for finished bases.

Moisture content is also important. The moisture content of base course at the time of prime application should not be greater than 90 percent of the optimum moisture. The Project Engineer will determine whether or not the moisture content is proper from the moisture/density tests.

Weather Limitations

The weather conditions should also be proper when priming begins. The air temperature in the shade must be above 40°C. Naturally, prime should not be applied during or soon after rains, as the water will prevent the proper application of the prime. Likewise, high winds will interfere with the spreading of the prime. Good judgment should be used in deciding whether or not all weather conditions are satisfactory for priming.

Application Rate and Temperature

Enough prime must be applied to base courses to completely cover the surface with a thin film but not so much that the prime will run to the edge and puddle. Normally, an application of about 0.1 to 0.2 gallon/ per square yd (0.5 to 0.9 liter per square meter) will work depending on the type of base. Local conditions, however, may require an increase or decrease from this range.

The Standard Specification stipulate the minimum application rate for the different base courses. Limerock bases, for example, require an application rate of not less than 0.1 gallons per square yd (0. 5 liter/m^2). Sand-clay bases, however, must be primed at not less than 0.2 gallons/square yd (0.7L/m^2).

The responsibility for designating the application rate lies with the Project Engineer. The Contractor must apply the prime at the designated rate, and you must verify that he does so.

We mentioned earlier that the prime must be heated to a designated temperature for application. The specification range of temperatures for prime is between 100°F (40°C) and150° F (65°C). The Project Engineer will specify the best temperature to ensure a uniform distribution of the prime.

Protection of Surrounding Surfaces

Where the prime is applied adjacent to curbs, gutters and other concrete structures, the concrete structures and the concrete surface must be covered with heavy paper or otherwise protected as approved by the Project Engineer. Any bituminous material sprayed on such surfaces must be cleaned off immediately. The exception to this rule is when the concrete surfaces are to be subsequently covered by a bituminous wearing course-in which case the surface does not need to be protected from the priming.

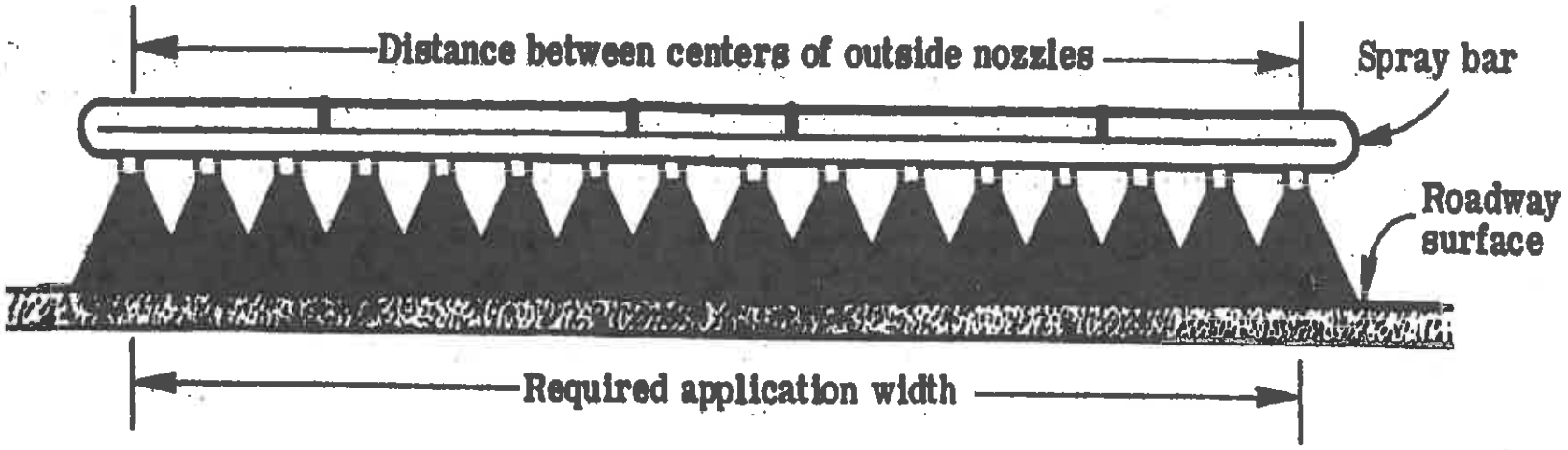
ASPHALT DISTRIBUTOR OPERATIONS

Distributors used to apply prime must be capable of applying it at correct rate uniformly along the entire width and length of the spread. While it is the Contractor's responsibility to obtain satisfactory prime coats, you should be able to recognize good and bad jobs and be familiar with procedure and equipment conditions that cause them. You will have to ensure that good prime coats are applied.

Application Method

The distributor spray bar connected to the pump discharge on the distributor has several pressure nozzles that should distribute the liquid asphalt evenly as the distributor moves along. As we mentioned earlier in the chapter, the distance between the center of the opening of the outside nozzle must be equal to the width of application require within a tolerance of 50.0mm. The application width can be adjusted by closing or opening nozzles.

All the spray nozzles should be opened uniformly to achieve a uniform coverage. Also, all the nozzles must be clean, unclogged and adjusted properly. Nonuniform nozzle openings and clogged nozzles will produce a un-uniform prime coat with streaks of thickly and thinly covered or bare pavement. Often the Contractor will 'blow out" the spray bars to be sure that all nozzles are open and adjusted properly.



Earlier we said that uniform prime application could be achieved by holding the speed of the distributor and the pump (spray) pressure constant. From the preceding discussion we see that nozzle cleanness and proper adjustment are also necessary in obtaining prime coverage.

In summary, we can say that uniform prime coats can be achieved consistently when:

1. The prime is heated to the correct temperature;
2. The spray equipment is clean and properly adjusted;
3. The spray pressure is correct and constant; and
4. The speed of the distributor is correct and constant.

Visually, you will recognize good prime coats by their thin, uniform appearance. We will discuss how to determine actual application rates and quantities after the quiz.

QUIZ

Which of the following should be cleaned from the base surface before priming begins?

___ A. dirt
___ B. loose material
___ C. dust
___ D. old tire
___ E. caked clay
___ F. flattened piece of metal

The moisture content of base courses at the time of the prime application should not be greater than _____.

Should you allow priming to begin if the air temperature, in the shade, is 8.3°C and other weather conditions are satisfactory? _____.

Should enough primer be applied so that of it will run off the base? _____.

Would 0.31 L/square meter prime normally be enough for lime rock bases? _____.

Who will designate the prime application rate? _____.

What is the specification range of temperatures for heating prime? _____.

Before priming begins, what should be done to the curb and gutter that will not be covered by a bituminous course? _____.

The application width of the spray bars can be adjusted by _____.

Uniform prime coats can be achieved when:

___ A. the spray equipment is clean and properly adjusted.
___ B. the spray pressure is correct and constant.
___ C. the spray bar is raised 150mm.
___ D. the primer is heated to the correct temperature.
___ E. the speed of the distributor is correct and constant.

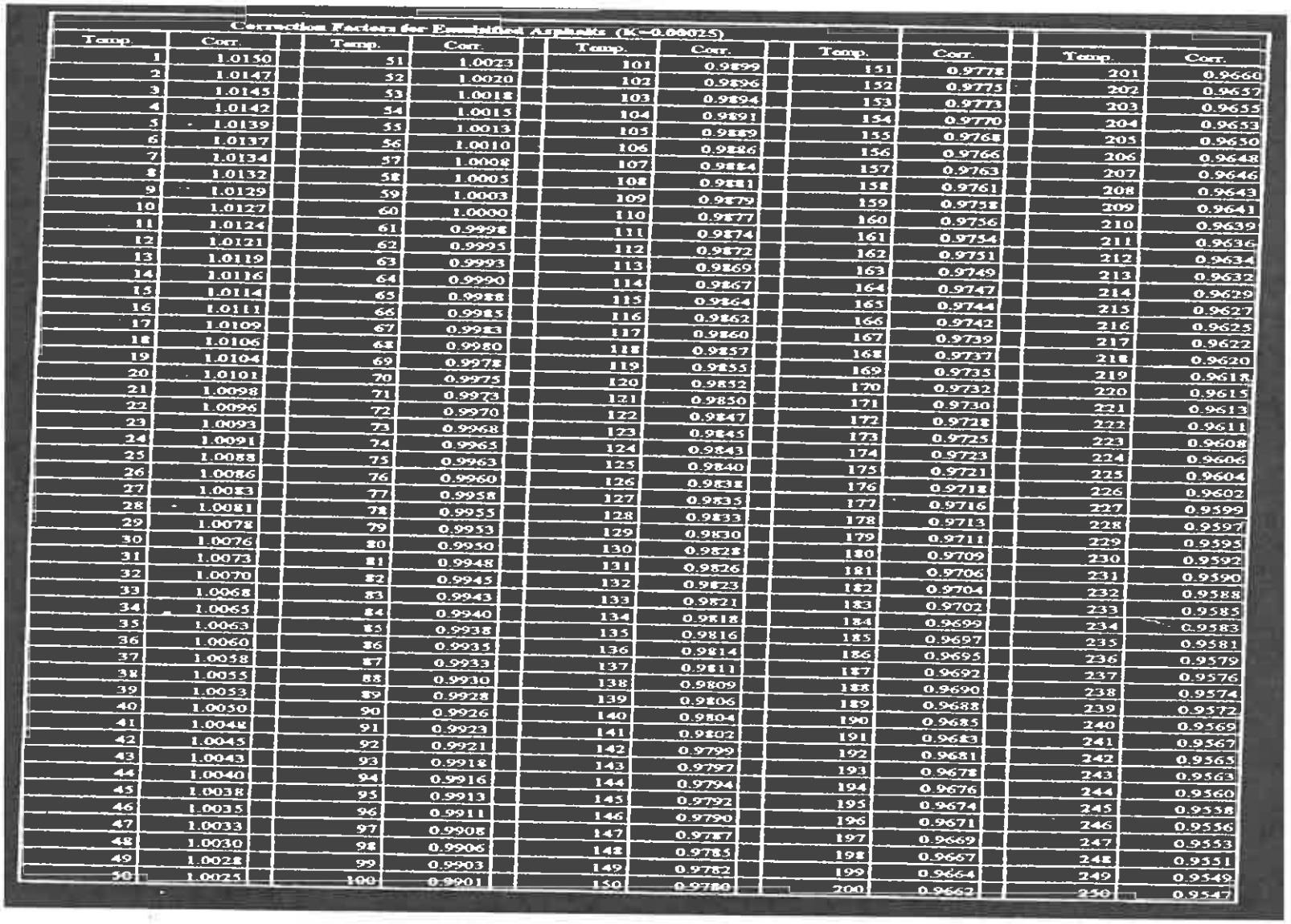
GO TO APPLICATION RATES AND QUANTITIES

Application Rates and Quantities

In inspecting priming, you often will need to determine the actual rate at which the prime is being applied. To find the correct application rate, you must consider the temperature of the bituminous material. As we have said, the prime in the distributor is heated for use. When prime is heated it expands. For example, 100 gallons (378.5 L) prime at 100°F (37.7° C) will have a volume of about 105 gallons (397.4 L) when heated to 200°F (93.3°C). When large quantities of bituminous material are involved, the differences are, of course, much greater.

To standardize the measuring of volumes of bituminous material, all quantities are based on the volumes of the material at 60°F (15.5°C). The department provides three tables with correction factors for converting volumes of bituminous material at any temperature to the 60° F (15.5°C) volumes. The different tables are for the different types and grades of liquid bituminous materials used in road and highway construction in the State.

The correction table for converting volumes of emulsified asphalt, Grade RS-2, is Table III and is shown on the next page. Look it over briefly now. Then go on to the following page.



Correction Factors for Emulsified Asphalts (K=0.00075)

Temp.	Corr.	Temp.	Corr.	Temp.	Corr.	Temp.	Corr.	Temp.	Corr.
1	1.0150	51	1.0023	101	0.9899	151	0.9778	201	0.9660
2	1.0147	52	1.0020	102	0.9896	152	0.9775	202	0.9657
3	1.0145	53	1.0018	103	0.9894	153	0.9773	203	0.9655
4	1.0142	54	1.0015	104	0.9891	154	0.9770	204	0.9653
5	1.0139	55	1.0013	105	0.9889	155	0.9768	205	0.9650
6	1.0137	56	1.0010	106	0.9886	156	0.9766	206	0.9648
7	1.0134	57	1.0008	107	0.9884	157	0.9763	207	0.9646
8	1.0132	58	1.0005	108	0.9881	158	0.9761	208	0.9643
9	1.0129	59	1.0003	109	0.9879	159	0.9758	209	0.9641
10	1.0127	60	1.0000	110	0.9877	160	0.9756	210	0.9639
11	1.0124	61	0.9998	111	0.9874	161	0.9754	211	0.9636
12	1.0121	62	0.9995	112	0.9872	162	0.9751	212	0.9634
13	1.0119	63	0.9993	113	0.9869	163	0.9749	213	0.9632
14	1.0116	64	0.9990	114	0.9867	164	0.9747	214	0.9629
15	1.0114	65	0.9988	115	0.9864	165	0.9744	215	0.9627
16	1.0111	66	0.9985	116	0.9862	166	0.9742	216	0.9625
17	1.0109	67	0.9983	117	0.9860	167	0.9739	217	0.9622
18	1.0106	68	0.9980	118	0.9857	168	0.9737	218	0.9620
19	1.0104	69	0.9978	119	0.9855	169	0.9735	219	0.9618
20	1.0101	70	0.9975	120	0.9852	170	0.9732	220	0.9615
21	1.0098	71	0.9973	121	0.9850	171	0.9730	221	0.9613
22	1.0096	72	0.9970	122	0.9847	172	0.9728	222	0.9611
23	1.0093	73	0.9968	123	0.9845	173	0.9725	223	0.9608
24	1.0091	74	0.9965	124	0.9843	174	0.9723	224	0.9606
25	1.0088	75	0.9963	125	0.9840	175	0.9721	225	0.9604
26	1.0086	76	0.9960	126	0.9838	176	0.9718	226	0.9602
27	1.0083	77	0.9958	127	0.9835	177	0.9716	227	0.9599
28	1.0081	78	0.9955	128	0.9833	178	0.9713	228	0.9597
29	1.0078	79	0.9953	129	0.9830	179	0.9711	229	0.9595
30	1.0076	80	0.9950	130	0.9828	180	0.9709	230	0.9592
31	1.0073	81	0.9948	131	0.9826	181	0.9706	231	0.9590
32	1.0070	82	0.9945	132	0.9823	182	0.9704	232	0.9588
33	1.0068	83	0.9943	133	0.9821	183	0.9702	233	0.9585
34	1.0065	84	0.9940	134	0.9818	184	0.9699	234	0.9583
35	1.0063	85	0.9938	135	0.9816	185	0.9697	235	0.9581
36	1.0060	86	0.9935	136	0.9814	186	0.9695	236	0.9579
37	1.0058	87	0.9933	137	0.9811	187	0.9692	237	0.9576
38	1.0055	88	0.9930	138	0.9809	188	0.9690	238	0.9574
39	1.0053	89	0.9928	139	0.9806	189	0.9688	239	0.9572
40	1.0050	90	0.9926	140	0.9804	190	0.9685	240	0.9569
41	1.0048	91	0.9923	141	0.9802	191	0.9683	241	0.9567
42	1.0045	92	0.9921	142	0.9799	192	0.9681	242	0.9565
43	1.0043	93	0.9918	143	0.9797	193	0.9678	243	0.9563
44	1.0040	94	0.9916	144	0.9794	194	0.9676	244	0.9560
45	1.0038	95	0.9913	145	0.9792	195	0.9674	245	0.9558
46	1.0035	96	0.9911	146	0.9790	196	0.9671	246	0.9556
47	1.0033	97	0.9908	147	0.9787	197	0.9669	247	0.9553
48	1.0030	98	0.9906	148	0.9785	198	0.9667	248	0.9551
49	1.0028	99	0.9903	149	0.9782	199	0.9664	249	0.9549
50	1.0025	100	0.9901	150	0.9780	200	0.9662	250	0.9547

We will discuss how the above table as to how it is used to make temperature-volume corrections.

Let's say the primer in the distributor is at 150°F (65.5°C). The beginning measurement showed that there were 350 gallons (1324.8 L) in the tank. When the ending measurement was taken, there were 300 gallons (1135.6L) left in the tank. This means that 50 gallons (189.2L) at 150°F (65.5°C) were used. To convert 50 gallons (189.2L) at 150°C to gallons at 60°F (15.5C) you would:

1. Go to table.
2. Find 150°F (65.5°C) in the TEMP (temperature) column. (Notice that you read the table from left to right.)
3. Find the corresponding correction factor in the column to the right of 150°F (65.5°C). It is 0.9780.

To convert 50 gallons (189.2L) at 150°F (65.5°C) to gallons at 60°F (15.5°C), multiply 50 gallons (189.2L) by 0.9780.

50 gallons (189.2L) @ 0.9780 = 49 gallons (185.4 L)

This means that 50 gallons (189.2L) at 150°F (65.5°C) is equal to 49 gallons (158.4 L) at 60F(15.5°C). Got that?

Let's see. Check yourself by taking the quiz on the next page.

QUIZ

When prime is heated it _____.

To what temperature do you correct volumes of liquid bituminous material? _____.

Your beginning measurement shows 2857.9L. Your ending measurement shows 2687.6L. The prime is at _____ temperature.

Did you get the correct answer for the quiz problem? If not, did you:

1. Find that there were 170.3 liters used at a temperature of 60°C?
   2857.9 - 268.6 = 170.3L

2. Find that the correction factor for 60°C is 0.9804?
   TEMP. CORR.
   60°C 0.9804

3. Multiply 170.3 by 0.9804?
   170.3@ 0.9804 rounded to 166.5L.

Once you've found the number of gallons used at 15.5°C, you can determine the application rate in gallons per square yard. But first, you must calculate the square yards covered.

For example, the beginning station of the priming operations is 3+96 and the ending station is 7+62. The difference between the two is 366.0m. Right? (7+62 -3+96= 365.0m.) This means that 366.0m linear feet have been coated with prime. If the width is 3.65, 1337.7 sq.m. have been covered.

366.0m @ 3.65m = 1337.7sq.m

To get square yards, divide square feet by 9.

$$\frac{\text{1337.7 sq. m}}{\text{0.8361 m5 sq. m}} = \text{1,600 sq. m}$$

The formula for finding the application rate of prime is:

$$\text{Gallons per square yard} = \frac{\text{gallons of prime at 15.5°C}}{\text{square meter covered}}$$

For example, Liter per square meters = $\frac{\text{1029.6L at 15.5°C}}{\text{1,600 square meters}} = 0.17$

QUIZ

Using the following preceding information, answer the questions below:

The prime in a distributor tank is at 56.1°C. Your starting measurement shows that 5413.1 L of material are in the tank. After a 3.6m strip of roadway between stations 17+00 and 23+59 is primed, there are 3626.4L remaining in the tank.

How many gallons of prime at 15.5°C were applied? _____ (nearest whole Liter) (Use the correction table.)

How many square meters of roadway were primed _____.

What was the application rate? _____(nearest hundred of a Liter per square meter).

Measurement of Prime in Distributors

You know how to correct quantities of liquid bituminous materials to their 60°F (15.5°C) volumes using the correction tables. Also, you know how to determine application rates by dividing gallons of prime 60°F (15.5°C) by the square yards covered. However, we need to back up for a moment. Just how do you measure the amount of prime contained in the distributors? We will discuss that now.

Using Calibration Charts: As you know, we must determine the quantity of prime in the distributor at the Start of the operation and again at the end of the operation. You recall our discussion of distributor calibration charts earlier in this chapter. Each distributor must have one and it must be made and/or approved by the State Materials Office and Research.

The charts record depth measurements of the prime in the distributors to exact quantities (liter) of material. The charts are in the form of computer printouts, although you may actually use smaller copies of the charts in the field. Each chart consists of several pages.

The first page of a typical calibration chart is shown on the next page. Look it over and carefully read the explanation that follows on page 10-38.

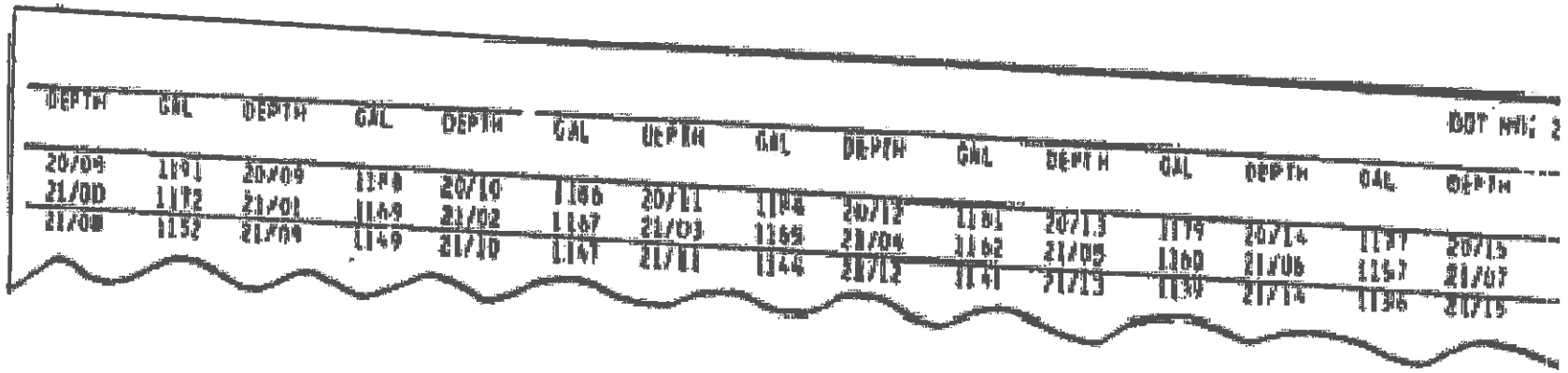
Notice the following information especially:

- This calibration chart pertains to a specific tank - No. DOT 2027. For verification that the correct chart is used with this distributor tank, compare the tank number in the one stamped on the left rear bumped of the distributor.
- Data concerning the owner, make, dimensions and calibration of the tank are provided.
- Starting with "*NOTE," instructions are given as to how and where to measure the tank:
  - All measurements may be made from the top of the dome to the prime and only when the tank is level.
  - Measurements must be made in inches and sixteenths of an inch. These measurements represent the number of gallons remaining in the tank.
  - The tank must be tilted and drained in order to obtain a measurement equaling zero gallons.

Can you read and understand the chart on the previous page? Notice the circled figures at the bottom. The 2/03 means 2 3/16 inches (55.5mm). Right? When your measurement from the top of the dome to the surface of the prime is 2 3/16 inches (55.5mm), there are 1647 gallons (6234.5liter) of prime in the tank. Now try the quiz on the next page.

QUIZ

Shown below is a section of page from the calibration chart we just discussed. If you measured the prime in Tank No. DOT 2027 as 21 14/16 inches (555.5mm), how much bituminous material is the tank?



Who makes and/or approves calibration charts? _____

Which of the following describes the proper way to measure in Tank No. DOT 2027?

___ A. from top of dome to bottom of tank
___ B. from bottom of dome to surface of material
___ C. from top of dome to surface of material
___ D. when tank is tilted
___ E. when tank is level

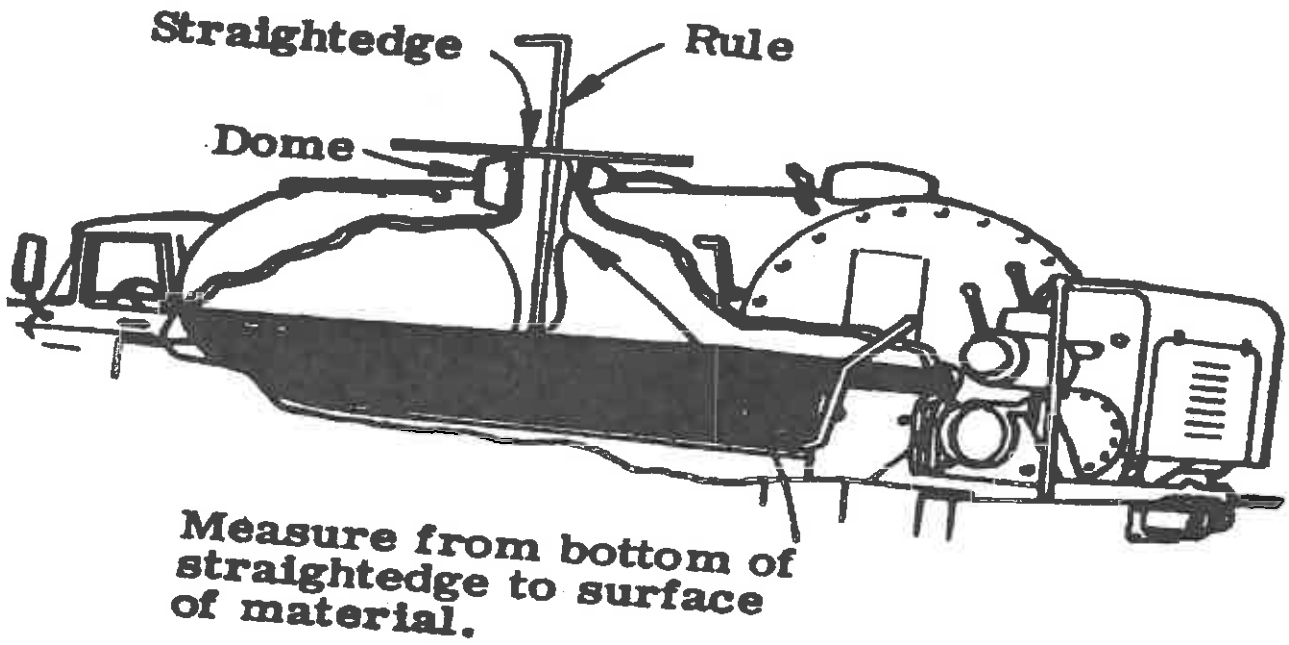
Taking the Measurements : To measure from the top of the talk dome to the surface of the bituminous material, you should use a straightedge and a ruler in the following manner:

1. Being sure that the tank is level, lay the straightedge across the center of the open dome.

2. Measure from the bottom of the straightedge to the surface of the material. (The bottom of the straightedge is at the same level as the top the dome.) Be sure to just touch the surface of the material.

3. Read the measurement in millimeters to the nearest millimeter.

This diagram illustrates the procedures. Follow the same steps in taking both starting and ending measurements.



QUIZ

When measuring the level of prime in a tank, lay the straightedge _____.

You should use a _____ to measure from the _____ of the straightedge to the _____ of the prime.

Read your measurements to the nearest _____ of a _____.

Record of Bituminous Materials

As an Inspector, you will be required to document the application of prime by completing a Record of Bituminous Materials (Form 600-090-90)

The Record of Bituminous Materials is simple to complete. Its completion involves the same procedures as listed below and which we have discussed in this section of Chapter Ten. The procedures begin with:

- verifying that the correct calibration charts are used with the distributor tanks;
- measuring the starting and ending depths of bituminous material in the tanks;
- using calibration charts to determine quantities of material based on material depth;
- calculating quantities of prime applied to roadway;
- correcting heated quantities of prime to their volumes at 60°F (15.5°C)
- calculating square yards covered and application rates.

Study the complete example Record of Bituminous Materials on page 10-33.

Refer to the form on the previous page and note the following:

- Project-related information must be entered at the top of the form including the Type of Construction, the Data Delivered (date prime is applied) and the Correction Table used.

- The Delivery (Ticket) No. And DOT Calibration Tank No. Must be record

- The Before (starting) and After (ending) tank measure must be entered, to the nearest sixteenth of an inch (tenth of mm), and the calibration chart be consulted to determine the number of gallons in the at each time.

- The Temperature of the heated prime must be recorded.

- The Net Gallon (Liter) (HOT) must be determined by subtracting the After Gallon (Liter) from the Before Gallons (Liter) Band entered.

- Correction Table III must be consulted to determine and record the Correction Factor.

- The Net Gallon (Liter) (HOT) must be corrected by the GALLON (Liter) @ 15.5°C (60°F) by multiplying the Net Gallons (liter) (HOT) by the Correction Factor - and entered.
- If a sample of prime is obtained, the sample number must be recorded.
- The Sq. Yds. (Sq. m) covered by the prime must be computed and entered.
- The Spread (application rate) must be calculated by dividing Gallon (Liter) @ 15.5°C (60°F) by Sq. Yds. (Sq. m.) covered and recorded.
- Your signature must be added at the bottom of the form.
- Enter any necessary remarks needed to clarify your work such as the station numbers between which priming was done.

SHEET 1 OF 1

STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION

RECORD OF BITUMINOUS MATERIALS

FORM [illegible] ESTIMATES [illegible]

STATE JOB NO		CONTRACT NO	GRADE OF ASPHALT	TYPE OF CONSTRUCTION	SPECS	TABLE
208222 1520		11706	RC-70	Prime Coat	1996	—

1 DATE DELIVERED		6-23-98						
2 DELIVERY OR INVOICE NO		06453						
3. DOT CALIBRATION TANK NUMBER		2266						
MEASUREMENT BEFORE UNLOADING (Tank Level)	4. INCHES	19-01						
	5 GALLONS	1195						
	6. GROSS WEIGHT	—						
MEASUREMENT AFTER UNLOADING (Tank Level)	7. INCHES	38-08						
	8 GALLONS	378						
	9. TARE WEIGHT	—						
10. TIME OF MEASUREMENT AFTER UNLOADING	A.M. P.M.	A.M. P.M.	A.M. P.M.	A.M. P.M.	A.M. P.M.	A.M. P.M.	A.M. P.M.	A.M. P.M.
11. TEMPERATURE (N/A IF WEIGHTS USED)		140°						
12. NET GALLONS (HOT)		817						
13. NET WEIGHT		—						
14. CORRECTION FACTOR BASED ON TEMPERATURE		.9804						
15. D.O.T. DETERMINED SPECIFIC GRAVITY		—						
16. WEIGHT CONVERSION FACTOR		—						
17. GALLONS @ 60°F		801						
18. SAMPLE NO		—						
19. SQ. YDS. COVERED		5340						
20. SPREAD		0.15						
21. STORAGE TANK NO. DELIVERED TO								
22. INSPECTOR'S SIGNATURE		R Shipman						

23. REMARKS:

Sta. 22+30 to Sta. 62+35
12' width of Spread

NOTE:
- LINE NOS. 4, 5, 7, 8, 11, 12, & 14 ARE NOT USED WHEN CONVERTING FROM WEIGHTS TO VOLUME.
- LINE NOS. 6, 9, 13, 15, & 16 ARE NOT USED WHEN CONVERTING FROM LINEAR TANK MEASUREMENTS TO VOLUME.

PAGE TOTALS GALLONS @ 60°F

RECYCLED PAPER

QUIZ

Refer to the completed Record of Bituminous Materials on the preceding page to answer the following questions:

How many different days are reported in this record? _____.

How many different asphalt distributors were involved? _____.

Why was the Correction Factor different on May 7? _____.

The Spread on May 8 has not been determined and recorded. Calculate it.

_____.

SHEET 1 OF 1

STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION

RECORD OF BITUMINOUS MATERIALS

FORM 850-09
ESTIMA
0

STATE JOB NO.	CONTRACT NO.	GRADE OF ASPHALT	TYPE OF CONSTRUCTION	SPECS	TABLI
20822216201	11706	RS-2	Prime Coat	1996	/

1. DATE DELIVERED		5-5-98	5-6-98	5-6-98	5-6-98	5-7-98	5-8-88
2. DELIVERY OR INVOICE NO.		03969	03984	03983	03982	03981	03980
3. DOT CALIBRATION TANK NUMBER		17416	17416	1801	17416	17416	1801
MEASUREMENT BEFORE UNLOADING (Tank Level)	4. INCHES	19-01	14-12	11-01	20-09	25-00	24-10
	5. GALLONS	1195	1355	1482	1135	950	966
	6. GROSS WEIGHT	—	—	—	—	—	—
MEASUREMENT AFTER UNLOADING (Tank Level)	7. INCHES	38-08	20-09	23-12	25-00	38-00	31-09
	8. GALLONS	378	1135	1003	950	398	666
	9. TARE WEIGHT	—	—	—	—	—	—
10. TIME OF MEASUREMENT AFTER UNLOADING		3:10 A.M. P.M.	2:00 A.M. P.M.	1:30 A.M. P.M.	2:40 A.M. P.M.	4:00 A.M. P.M.	5:30 A.M. P.M.
11. TEMPERATURE (N/A IF WEIGHTS USED)		140°	140°	140°	140°	135°	140°
12. NET GALLONS (HOT)		817	220	479	185	552	300
13. NET WEIGHT		—	—	—	—	—	—
14. CORRECTION FACTOR BASED ON TEMPERATURE		.9804	.9804	.9804	.9804	.9816	.9804
15. D.O.T. DETERMINED SPECIFIC GRAVITY		—	—	—	—	—	—
16. WEIGHT CONVERSION FACTOR		—	—	—	—	—	—
17. GALLONS @ 60°F		801	216	470	181	542	294
18. SAMPLE NO.		—	—	—	—	—	—
19. SQ. YDS. COVERED		4,450	1,269	2,763	1,068	3,009	1,635
20. SPREAD		0.18	0.17	0.17	0.17	0.18	
21. STORAGE TANK NO. DELIVERED TO							
22. INSPECTOR'S SIGNATURE		R. Hysen	R. Hysen	R. Hysen	R. Hysen	R. Hysen	R. Hysen

23. REMARKS:

NOTE: - LINE NOS. 4, 5, 7, 8, 11, 12, & 14 ARE NOT USED WHEN CONVERTING FROM WEIGHTS TO VOLUME.
- LINE NOS. 6, 9, 13, 15, & 16 ARE NOT USED WHEN CONVERTING FROM LINEAR TANK MEASUREMENTS TO VOLUME.

PAGE TOTALS-GALLONS @ 60°F

RECYCLED PAPER

SANDING AND ROLLING

As soon as possible after the prime is applied to the base, the sand should be spread. Your main concern with the sand application is that it is uniform. Every part of the primed base should be covered.

As we mentioned, the sand usually is spread by rotary tailgate spreaders.Traffic rolling should closely follow the spreading operation. The rolling will continue until all the sand that the prime will take has a chance to stick and shows no tendency to be picked up.

All excess sand should be swept off the base as it is no longer is of any use. In fact, leaving it to the base is detrimental because it will absorb water and delay the further curing of the prime. By "curing" we mean the process by which the prime sets and forms a tight, impenetrable coating on the base. The power broom we saw earlier is effective in removing the excess sand.

DOCUMENTATION

We have already covered one part of the documentation of prime coat operations, that is completing the Record of Bituminous Materials. Information from the Record is used to complete the Daily Report of Construction for priming.

QUIZ

Prime coats are _____coating applied to the finished base course.

Is cut-back asphalt an acceptable prime material? _____.

When you obtain samples of prime you should first draw off and waste at least _____ of the material. What does this procedure ensure? _____.

Sample containers for prime should be:

___ A. clean
___ B. cloth
___ C. dry
___ D. old

What can you find on delivery tickets that will help you in completing Sample Transmittal Cards?
_____.

The sand used for spreading on primed bases must be _____.

Particular care must be in cleaning the _____ of the width to be primed.

Should all asphalt distributors be calibrated? _____.

How should you verify that the correct calibration chart is being used with the distributor?
_____.

To check distributor pump pressure, refer to the _____ on the distributor.

Areas inaccessible to the spray bars may be primed through _____.

Asphalt distributors must be capable of applying prime at controlled and _____.

Usually sand is spread by _____ spreaders.

The moisture content of base courses at the time of prime applications should not be greater than:

___ A. 90 percent of the optimum moisture.
___ B. 17 percent.
___ C. 105 percent of optimum moisture.

It is not raining. There is no strong wind. The air temperature is 38°F (3.3°C) in the shade. All other weather conditions are excellent. May priming begin? _____.

Is a prime application rate of 0.12 gallon (0.54 L/m5) per square yard usually enough for sand-clay bases? _____.

The _____ will designate the rate.

By opening or closing nozzles the _____ of spray bars can be adjusted.

When prime is heated it _____.

To what temperature are volumes of liquid bituminous materials corrected? _____.

Using the following information, answer the next three questions:

The prime in a distributor tank is heated to 125° F(51.6°C). Your starting measurement shows the 1,215 gallons (4599.2 L) of material are in the tank. After a 12-foot (3.6m) strip of roadway between stations 32+24 and 37+64 is primed, there are 738 gallons (2793.6L) remaining in the tank.

How many gallons of prime at 60°F (15.5°C) were applied? _____ (nearest whole Gallon/ Liter) (Use the table on page 10-31.)

How many square yards (square meters) of roadway were primed? _____.

What was the application rate? _____ (nearest hundredth of a Gallon/ Liter per square yard/square meter)

Shown below is a section of a page from a calibration chart. If you starting measurement of the tank were in mm, and your ending measurement were 20 9/16 inches (52.2mm), and your ending measurement were 21 6/16 inches (542.9mm), how much bituminous material was used? _____.

Who makes and/or approves calibration charts? _____.

Where do you document prime coat operations? _____.

YOU HAVE COMPLETED THE TRAINING COURSE IN SUBGRADE AND BASE INSPECTION. BEFORE TAKING THE EXAMINATION, YOU WILL WANT TO QUIZ YOURSELF ON THE ENTIRE COURSE. CHAPTER ELEVEN AND THE REVIEW QUIZ WILL SERVE THIS PURPOSE.

ANSWERS TO QUESTIONS

Page 10-6

- protective bituminous
- B,C,D
- sampling devices (spigots); distributor tanks
- dry
- draw off and waste at least one gallon (3.7Liter)
- immediately
- Sample Transmittal Card
- delivery tickets
- it must be clean

Page 10-9

- cleaned
- outer edges
- water
- A,B,D
- check to see that the calibration number on the chart is the same as the one stamped on the distributor
- gallons
- through a discharge pipe or spigot
- inspector

Page 10-11

- circulating
- uniform pressure
- gauge

Page 10-13

- 1. spray bar
  2. flexible hose
  3. hand spray
- Yes
- hand spray
- controlled; uniform
- tachometer; bitumeter
- pump pressure

Page 10-16

- Dial, it must be spread uniformly
- Circulated, rotary tailgate
- Pump, traffic

ANSWERS TO QUESTIONS (con't)

Page 10-21

- All of them
- Spray bar, 90 percent of the optimum moisture
- Yes
- No
- No
- Project Engineer
- Between 100°F (37.7°C) and 150°F (65.5°C)
- Uniform cover with heavy paper or otherwise protect tachometer; bitumeter
- Closing or opening nozzles
- A, B, D, E

Page 10-29

- State Materials Office
- A, D, E

Page 10-35

- four
- two
- the temperature of the prime was 5° lower than on the other day
- 0.18 (gallons per square yard), 0.57 liter/m^5

Page 10-25

- expands
- 15.5°C (60°C)
- 44°C

Page 10-27

- 464
- 2409
- 0.7

Page 10-31

- across the center of the open dome
- ruler; bottom; surface
- sixteenth; inch

Page 10-38

- protective bituminous
- Yes
- One liter, that the sample is representative
- A,C
- certification stamps
- clean
- outer edges
- yes
- check to see that the calibration number on the chart is the same as the one stamped on the distributor
- gauge

ANSWERS TO QUESTIONS (con't)

Page 10-39

- hand sprays
- uniform
- rotary tailgate
- A
- no
- no
- Project Engineer
- application width
- expands

Page 10-40

- 15.5°C (60°F)
- 1775.3 Liters
- 1973.2 sq. m.
- 0.63
- 117.3 Liter
- Bureau of Materials and Research
- Record of Bituminous Materials; Daily Report

CHAPTER ELEVEN

Review Quiz

The things you learned in this course are going to help you do a better job as an Inspector. This Review Quiz is designed to help you know how well you have learned. It is also designed to prepare you for the Examination.

Listed below are instructions on how to take the quiz.

1. Do not take this quiz immediately after you finish the course.

2. Do not cram the night before you take the quiz. Remember that the objective is not to test your memory. The objective is to help you evaluate how well you have learned the material and how well you can think through your everyday work problems.

3. When you take this quiz, make sure that you will not be disturbed for about an hour.

4. Attempt all questions.

5. You may refer to the course material if you get stuck on a question. But first try to reason out the problem.

6. Finally, keep track of your wrong answers. Instructions on how to grade yourself following the Review Quiz are at the end of this chapter: If you score less than 90% on the quiz, do not be disappointed. Go back and study the course materials once again and then reattempt the quiz.

GOOD LUCK!

REVIEW QUIZ

Subgrade operation can be divided into basic types. List them. _____.

Which of the following vary according to the type of subgrade stabilization performed?

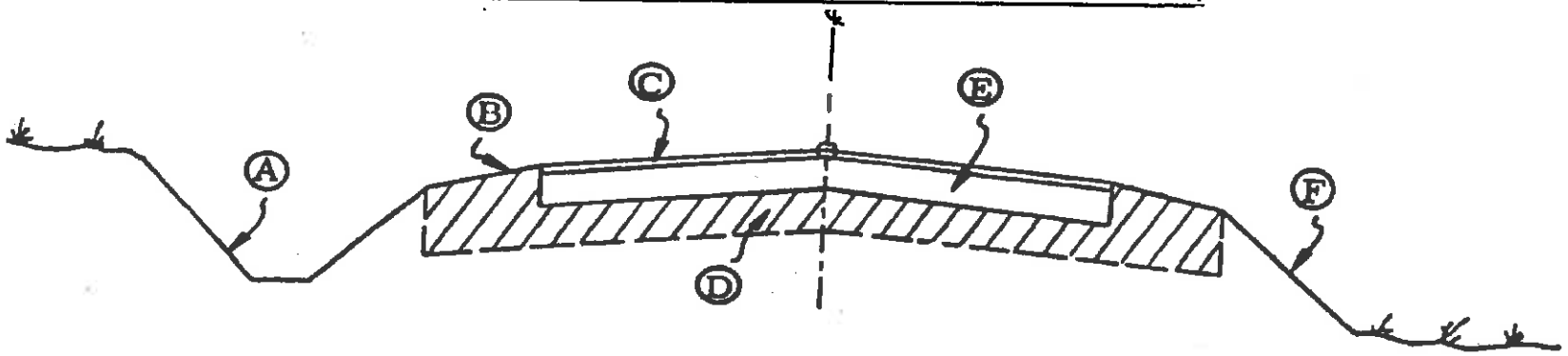
___ A. the type of finishing equipment
___ B. the method of determining compliance with the bearing requirements
___ C. the use of commercial or local materials
___ D. the depth of which the subgrade is stabilized
___ E. the basic of payment for the work

The following description is for which type of subgrade stabilization?

The Contractor may use either commercial or local materials. He will not be paid separately for the stabilizing materials he uses. The bearing value determinations are made by the L.B.R. Method. Type_____ stabilization.

Which letter indicates the subgrade in the typical section below? _____.

"E" represents the _____.



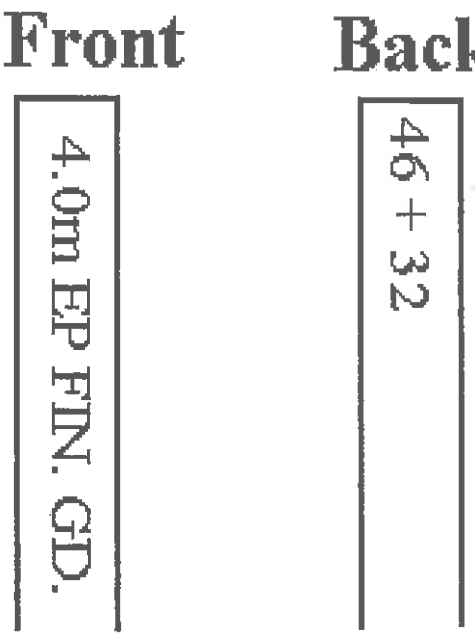
Who will set stakes for subgrade operations? _____.

What is the name for the stakes used to control line? _____.

Stakes help to maintain close control in checking the_____ and _____of the subgrade.

On a curve, what is the maximum interval for setting the stakes along the roadway? _____.

Grade stakes may be referred to as _____.



What is the offset of the grade stake identified by the guard stake shown at right?_____ from _____. What will be offset for the hubs on this job? _____.

How is the exact line indicted on the hubs? _____.

The embankment surface to be stabilized or treated must comply with the _____ and _____ requirements before the beginning of subgrade operations.

Who is responsible for verifying this compliance? _____.

Before any stabilizing material is spread on the subgrade, the roadbed must be brought to a plane approximately _____to the plane of the proposed finished subgrade surface.

When cement-treated subgrade is constructed of central plant-mixed material, the underlying roadbed must be _____ when the material is spread.

Number the following documents according to governing order - with 1 being the highest, 2 the next highest and so on:

___ A. Contract Plans
___ B. Supplemental Special Provisions
___ C. Special Provisions
___ D. Standard Specifications
___ E. Supplement Specifications

When the existing base material is to be incorporated into the subgrade, should it be used before or after other stabilizing additives have been mixed in? _____

Who determines what material or combination of materials to use to obtain the required bearing values? _____.

Where will you find frequencies for sampling, sample sizes, etc.? _____.

STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION

FORM 675-050-04
MATERIALS - 06/96

PROJECT ID: 213397 15201 PAY ITEM NO: 160

MATERIAL NO: 491A SAMPLE NO: AQ019

DATE SAMPLED: 05/13/98 STA FROM: N/A

STA TO: N/A SAMP FROM: 53+62

RDWAY SIDE: R OFFSET DISTANCE: 075 OFFSET DIRECTION: R MAINLINE: Y

REFERENCE LINE: C/L Survey

PLANT OR PIT NO: 18-023 QUANT REP: 1/5th sample

INTENDED USE OR PART OF STRUCTURE PLACED: stabilized subgrade

ROAD NO: SR 93 DISTRICT NO: 2 COUNTY: 37 SECTION: 100

CONTRACT: 18754 SAMPLED BY: S. Watts

MATERIAL DESC: Stabilizing material - limerock

MANUFACTURER OR PRODUCER (NOT JOBBER): Anderson Columbia

SOURCE (PLACE FROM WHICH SHIPMENT WAS MADE): Anderson Mining

GRADE: BATCH NO:

LOT NO: LAB NO: DESIGN MIX NO:

SLUMP: % AIR:

PRODUCERS: CMT: F.A: C.A:

RETARDANT: FLY ASH:

REMARKS: 32100-3422

SUBMITTED BY: John T. Collins PHONE: 1-904-961-7050

ADDRESS: Lake City, Construction

RECYCLED PAPER

Using the completed Sample Transmittal Card above, answer the questions below.

What is the material number for this material? _____.

What was the location of the sampling? _____.

What is the intended use for this material? _____.

What kind and type of cement is used for cement-treated subgrade? _____.

If the water to be used in a cement-treatment job comes from a city's water supply, may it be used without testing?

_____.

What should you do if the water to be used comes directly from a free-flowing stream?

_____.

The results of soil surveys are shown on _____ and _____ sheets in the plans.

Is sand-clay material an example of a local material that may be used in subgrade stabilization? _____.

Stabilizing additives may consist of:

___ A. existing base material.
___ B. local material.
___ C. commercial material.
___ D. a combination of the above.
___ E. all of the above.

May subgrade materials, for stabilization or cement treatment , be mixed in an approved plant? _____.

Subgrade mixing must be done with _____ or other approved equipment.

The most important thing about spreading additive stabilizing materials is that they be spread _____.

Under Type B Stabilization, who determines the quantity of material to be added to the subgrade to achieve the required LBR value? _____.

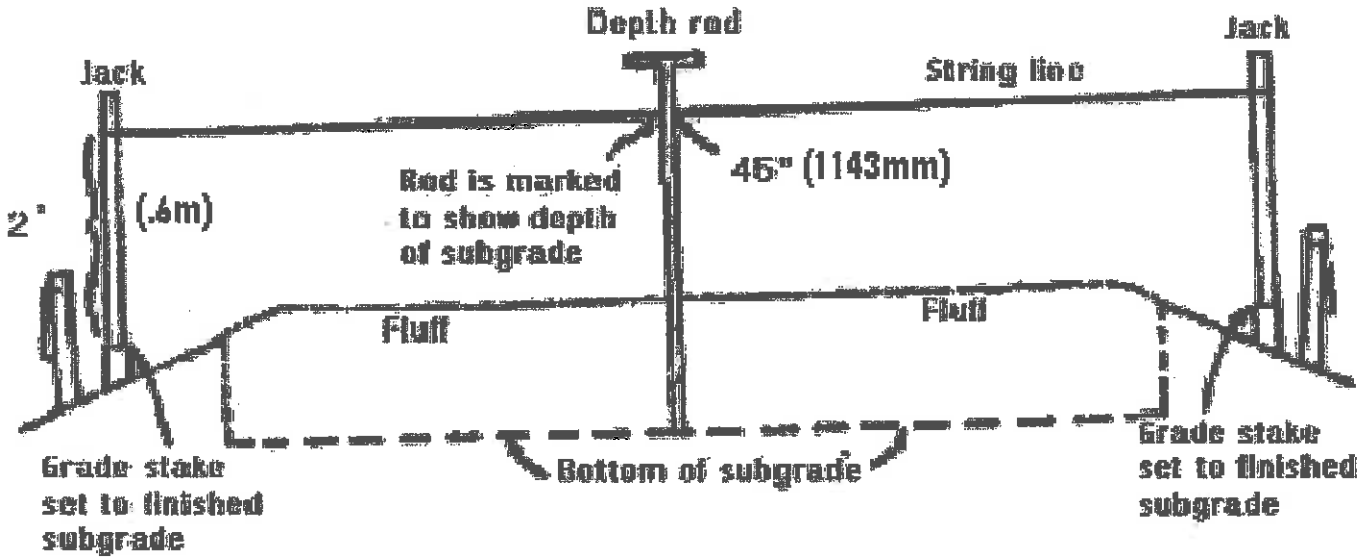
Can the natural (existing) soils in the roadbed sometimes meet the bearing value requirements without the addition of stabilizing materials? _____.

Mixing is necessary even when the existing soil has the required LBR value without the addition of stabilizing materials. True or False? _____.

The stabilized subgrade particles must be small enough to pass a _____ring. How can you check for this? _____.

Width and depth checks should be performed at maximum intervals of _____.

Using the diagram below, answer the next question.



What is the subgrade depth at this point? _____below the bottom of the proposed base (top of finished subgrade). Is the above subgrade depth satisfactory? ____

Sample of material from Type B stabilized subgrade must be submitted to the Lab and tested to determine the:

___ A. maximum density
___ B. LBR
___ C. FBV
___ D. percent of maximum density
___ E. optimum moisture

Refer to the Standard Specifications excerpt and the typical section here. If test results on samples of the stabilized subgrade material from State road S-158 are 44 and 38, do the samples pass the minimum design LBR? _____.

Are LBR samples submitted to the Lab before compaction of the subgrade? _____.

In addition to sampling at the minimum frequencies shown in the Sampling, Testing and Reporting Guide, you should also obtain samples when _____.

What is the general minimum acceptable density for stabilized subgrades? _____.

Generally, compaction should begin after mixing is completed and the requirements are met for:

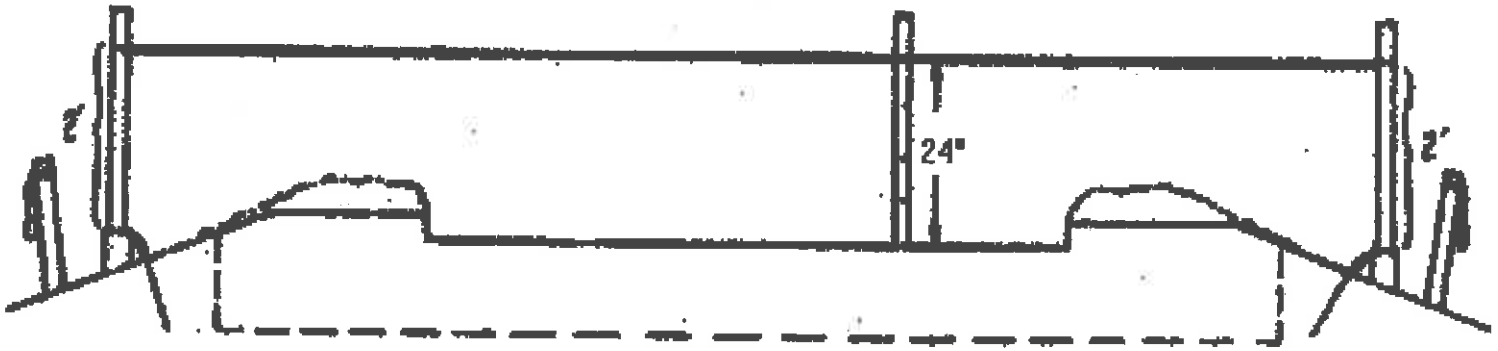
___ A. uniformity of mixing.
___ B. bearing value.
___ C. final shaping
___ D. maximum particle size.
___ E. density.

What test will be done to indicate that certain areas of the stabilized subgrade do not meet the bearing value shown in the plans?_____.

Are additional bearing value tests performed on samples of stabilized subbase? _____.

If the string line in the illustration below is set 2 feet above the grade stakes, and the rule measures 24 inches from string line to surface, is the subgrade built to plan grade at that point?_____

How can the completed subgrade depth (thickness) be inspected?_____



Must all layers and locations in the completed subgrade pass the density requirement before base course or pavement construction begins? _____.

For how long must you see that the Contractor maintains the completed subgrade properly? _____.

What is the main thing you are interested in from soil-cement designs? _____.

List three typical compaction equipment used on cement-treated subgrade:

1. _____.
2. _____.
3. _____.

List three general requirements for all equipment used in subgrade operations:

1. _____.
2. _____.
3. _____.

How are spread distances marked? _____.

Using the spread sheet excerpt above, complete the "Total Sq. Yd." and "Sta. to Sta." blanks for truck number 411. The subgrade width is 27 feet.

Total Sq. Yd - _____

Sta. to Sta. - _____

A certain transport holds 19,214.4kg of cement. The design application rate is 13.6kg.The subgrade is 6.4m wide. What is the spread distance for this particular transport (to nearest meter)? _____.

CEMENT-TREATED SUBGRADE
DATE 6/26/75

TRK. NO.	STA. TO STA.	LBS. SQ. YD.	TOTAL SQ. YD.	LBS. APPLIED	THEO. LBS	PAY QTY. LBS.	PAY QTX. LBS.	TIME
404	311 +00 – 308 + 73	34	682	23,202	34	23,202	11.60	7:30 A.M.
411				46,640	34			

What should you collect from each cement transport as it arrives at the job? _____.

Cement should not be spread:

___ A. during rain
___ B. at steady air temperature of 1.6◦C
___ C. in high winds
___ D. at the design application rate

When cement treatment follows lime treatment, what minimum amount should pass between the completion of the lime treatment and the beginning of the cement treatment? _____.

A canvas check of the cement spread is preformed. The canvas plus cement weigh 17.6 kg. The canvas alone weigh 2.0kg. What is the application rate? _____.

When possible, the entire subgrade width should be mixed in:

___ A. three or more passes
___ B. a single operation
___ C. five minutes
___ D. a cement plant

May subgrade mixing be done to full depth in one course - if mixing and density requirements can be meet?_____.

Normally, mixing must begin within _____minutes after the cement is spread.

What can be done to the subgrade whenever the moisture content exceeds the specified level?

_____.

By the central plant method, all the materials must be mixed for at least _____.

What is the time limit for placement of the central-plant mixture in adjacent passes? _____.

Is the dumping of soil-cement mixture in piles or windows on the subgrade acceptable? _____.

What should you use to check the depth of cement-treated subgrade? _____.

What tool should you use in checking for uniformity of mixing?_____.

In a mixed, cement-treated subgrade, there should be no soil particles larger than ____.

For cement-treated subgrade, where are the maximum density and optimum moisture values determined?

_____.

Who makes these determinations? _____.

When is the earliest that compaction can be started after mixing has been completed?

_____ . When is the latest? _____.

Cement-treated subgrades must be compacted to at least _____ percent of the maximum density.

Areas of the subgrade that need additional soil-cement mixture in order to comply with the plans must first be lightly

_____.

Should cement-treated subgrade surface higher or lower from plan grade be corrected? _____.

How is moisture retained in the subgrade before asphalt is applied? _____.

How long is the curing period?_____.

What three things should you verify during curing coat application?

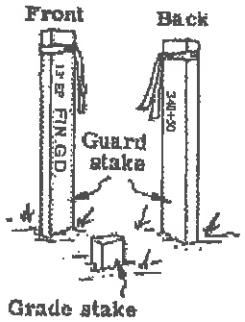
1. _____
2. _____
3. _____

How many different kinds of base courses are included in the Standard Specifications? _____.

The purpose of a base course is to _____.

For tangent sections, the maximum interval for setting the stakes along the roadway is _____ feet.

Generally, grade stakes are offset _____feet from the edge of mixing operations.



Is the grade stake above referenced to the top of the finished subgrade?_____.

The grade stake is 13 feet from the _____.

If you are to be the Base Inspector and did not inspect the subgrade operations, should you assume that the subgrade meets all the requirements? _____.

Must spongy areas and ruts in the subgrade be corrected <u>before</u> the beginning of base course operations? _____

Do the contract plans govern over the special provisions? _____.

Incoming materials for base course construction must be from sources that are:

___ A. nearby
___ B. approved.
___ C. inspected by the Base Course Inspector
___ D. stratified.

May both Oolite limerock and Ocala limerock be used in the same limerock base course? _____.

The _____ publishes a list of the approved limerock sources (pits) around the State.

What should you do when you learn of the Contractor's proposed source of limerock?

_____.

Base Material-Limerock reports show:

___ A. whether the limerock is accepted or rejected.
___ B. the maximum density and optimum moisture.
___ C. whether the samples passed or failed the tests.
___ D. the loose depth of spread for each course.

Are three-wheeled (steel) rollers and traffic rollers usually used to compact limerock bases?_____.

The subgrade should be moist before the limerock is spread in order to prevent _____.

You should observe limerock hauling on the subgrade to be sure that _____.

When the plan thickness of limerock base course is greater than 6" (150mm), the base must be constructed:

__ A. within forms.
__ B. in two courses.
__ C. within 10 days.

Which of the following are true about the first course of a double-course limerock base?

___ A. should be compacted and tested for density before the second course is placed
___ B. should always be a maximum of 75mm (3") thick
___ C. may require a light application of water before the second course is placed
___ D. should be about half the total thickness of the finished base
___ E. should have a cross section templet approximately that of the finished base.

The spread limerock must be checked for:

__ A. calibration
__ B. segregation
__ C. foreign matter
__ D. depth

Should the Contractor check the depth of the limerock as it is spread? _____

When the base is moistened or died - to obtain the proper moisture content for compaction - the work should be done to the full _____ and _____ of the course being compacted.

How can you detect scabs in the base course? _____.

When additional limerock must be placed in a low area to bring it up to grade, the existing surface must first be _____.

What tools are used to check limerock and sand-clay bases for surface irregularities? _____.

All areas of the limerock or sand-clay base that is higher or lower than _____ must be corrected.

Areas of completed limerock base courses that are deficient in thickness by more than _____ must be corrected for a distance of _____ in each direction from the edge of the deficient area.

In sand-clay base operations, when the materials and pit are approved, the Lab issues the _____for the sand and clay.

Briefly describe the three conditions in which the sand and clay may be found: 1. _____
2. _____ 3. _____

How should the excavating equipment remove the material from separate strata in a pit?

_____.

Should a dragline be used to excavate sand-clay material from different strata in cut? ___. How about a power shovel? ___

What equipment is generally used in spreading the sand and clay? _____.

Which of the following should be used to mix the sand and clay when these materials come from separate pits?

___ A. motor graders
___ B. pulvimixers
___ C. Jersey boxes
___ D. rotary tillers
___ E. disk harrows

When the sand and clay are spread in separate layers, who should determine the order in which they are placed? _____ What is usually spread first? _____.

A haul truck has a capacity of 13 cubic yards (9.9m). The base material is to spread to loose thickness of 5 inches (127mm). The width of spread is to be 12 feet (3.6m). What should be the spread distance (to the nearest foot) for this truckload? _____.

What is a good way for you to verify the correct proportioning of sand-clay? _____.

Besides checking the depth of the spread material, you should check for _____ of spread.

Should natural bends of sand-clay be mixed in place on the roadway? _____.

You are inspecting sand-clay base construction in which the sand and clay come from separate pits. During the mixing operations, a disk harrow is used to continuously mix and cut the material. How should the motor grader be used?

_____.

One way of adding water to a sand-clay base in order to adjust the moisture content is to apply the water uniformly at night. What is an alternative way? _____.

How is the moisture content of sand-clay base material reduced? _____.

What should the Contractor do to prevent washouts? _____.

The traveled portion of sand-clay base must be compacted to at least _____ percent of maximum density. Crossovers and turnouts should be compacted to at least _____ percent of maximum density.

Should you perform density tests on the first course of a multiple-course base?_____.

During compaction operations, the moisture content of sand-clay bases should be maintained at:

___ A. the optimum percentage
___ B. saturation.
___ C. a percentage point or two below optimum
___ D. five percentage points below optimum.

What will result if the Contractor fails to scarify a low area before placing and compacting new material in it? _____.

A straightedge check reveals an area 5/8 inch above the surrounding base. Should this area be corrected? _____.

An under-tolerance of _____ is allowed for the final thickness of sand-clay base courses.

Prime coats are protective _____ coatings applied to finished base courses.

Is cut-back asphalt an acceptable prime material?_____.

When you obtain samples of prime, you should first draw off and waste at least ____ of the material. What does this procedure ensure? _____.

Sample containers for prime should be new, clean and _____.

Where do the certification stamps for the prime material appear? _____.

What are the requirements for the sand spread on primed bases? _____.

Should all asphalt distributors be calibrated? _____.

How should you verify that the correct calibration chart is being used with the distributor?_____.

How should you check the distributor's pump pressure? _____.

Asphalt distributors must be capable of applying prime at controlled and _____ rates.

Usually sand is spread by _____ spreaders.

The moisture content of base course at the time of prime application should not be greater than:

__ A. 90 percent of the optimum moisture. __ B. 10 percent. __ C. 105 percent of optimum moisture.

It is not raining. There is no strong wind. The air temperature is 43◦F (6.1 C) in the shade. All other weather conditions are excellent. May priming begin? _____.

Is a prime application rate of 0.15 gallons per square yard (0.67Liter/m5 per square meter) usually enough for sand-clay bases? _____. The _____ will designate the rate.

The application width of spray bars is adjusted by _____.

When prime is heated it: ___ A. contracts. ___ B. solidifies. ___ C. cures. ___ D. expands.

To what temperature are volumes of liquid bituminous material corrected?_____.

Using the information below, and the calibration chart and correction table excerpts on the next page, complete the Record of Bituminous Materials on the following page.

The prime in distributor tank #2027 is heated to 48.8°C for application. Your starting measurement of the prime in the tank is 20-9/16 and your ending measurement is 635mm even. The roadway is primed in a 3.6m width from station 25+38 to station 27+82.

Depth	Gallons	Depth	Gallons	Depth	Gallons	Depth	Gallons	Depth	Gallons	Depth	Gallons	Depth	Gallons	Depth	Gallons
18 /0	1167	18 /1	1165	18 /2	1163	18 /3	1162	18 /4	1160	18 /5	1158	18 /6	1156	18 /7	1154
18 /8	1152	18 /9	1150	18 /10	1148	18 /11	1146	18 /12	1144	18 /13	1142	18 /14	1140	18 /15	1138
19 /0	1137	19 /1	1135	19 /2	1133	19 /3	1132	19 /4	1130	19 /5	1128	19 /6	1127	19 /7	1125
19 /8	1123	19 /9	1122	19 /10	1120	19 /11	1118	19 /12	1117	19 /13	1115	19 /14	1113	19 /15	1112
20 /0	1110	20 /1	1108	20 /2	1107	20 /3	1105	20 /4	1103	20 /5	1102	20 /6	1100	20 /7	1098
20 /8	1097	20 /9	1095	20 /10	1093	20 /11	1092	20 /12	1090	20 /13	1088	20 /14	1087	20 /15	1085
21 /0	1083	21 /1	1082	21 /2	1080	21 /3	1078	21 /4	1076	21 /5	1074	21 /6	1072	21 /7	1070
21 /8	1068	21 /9	1066	21 /10	1064	21 /11	1062	21 /12	1060	21 /13	1058	21 /14	1057	21 /15	1055
22 /0	1053	22 /1	1052	22 /2	1050	22 /3	1048	22 /4	1047	22 /5	1045	22 /6	1043	22 /7	1042
22 /8	1040	22 /9	1038	22 /10	1037	22 /11	1035	22 /12	1033	22 /13	1032	22 /14	1030	22 /15	1028
23 /0	1027	23 /1	1025	23 /2	1023	23 /3	1022	23 /4	1020	23 /5	1018	23 /6	1015	23 /7	1013
23 /8	1010	23 /9	1008	23 /10	1005	23 /11	1003	23 /12	1000	23 /13	998	23 /14	997	23 /15	995
24 /0	993	24 /1	992	24 /2	990	24 /3	988	24 /4	987	24 /5	985	24 /6	983	24 /7	982
24 /8	980	24 /9	978	24 /10	976	24 /11	974	24 /12	972	24 /13	970	24 /14	968	24 /15	966
25 /0	964	25 /1	962	25 /2	960	25 /3	958	25 /4	956	25 /5	954	25 /6	952	25 /7	950
25 /8	948	25 /9	946	25 /10	944	25 /11	942	25 /12	940	25 /13	938	25 /14	937	25 /15	935
26 /0	933	26 /1	932	26 /2	930	26 /3	928	26 /4	927	26 /5	925	26 /6	923	26 /7	922
26 /8	920	26 /9	918	26 /10	915	26 /11	913	26 /12	910	26 /13	908	26 /14	905	26 /15	903
27 /0	900	27 /1	898	27 /2	896	27 /3	894	27 /4	892	27 /5	890	27 /6	888	27 /7	886
27 /8	884	27 /9	882	27 /10	880	27 /11	878	27 /12	876	27 /13	874	27 /14	872	27 /15	870
28 /0	868	28 /1	866	28 /2	864	28 /3	862	28 /4	860	28 /5	858	28 /6	856	28 /7	854
28 /8	852	28 /9	850	28 /10	848	28 /11	846	28 /12	844	28 /13	842	28 /14	840	28 /15	838
29 /0	836	29 /1	834	29 /2	832	29 /3	830	29 /4	828	29 /5	826	29 /6	824	29 /7	822
29 /8	820	29 /9	818	29 /10	816	29 /11	814	29 /12	812	29 /13	810	29 /14	808	29 /15	806
30 /0	804	30 /1	802	30 /2	800	30 /3	798	30 /4	796	30 /5	794	30 /6	792	30 /7	790
30 /8	788	30 /9	786	30 /10	784	30 /11	782	30 /12	780	30 /13	778	30 /14	777	30 /15	775
31 /0	773	31 /1	772	31 /2	770	31 /3	768	31 /4	767	31 /5	765	31 /6	763	31 /7	762
31 /8	760	31 /9	758	31 /10	756	31 /11	754	31 /12	752	31 /13	750	31 /14	748	31 /15	746
32 /0	744	32 /1	742	32 /2	740	32 /3	738	32 /4	736	32 /5	734	32 /6	732	32 /7	730
32 /8	728	32 /9	726	32 /10	724	32 /11	722	32 /12	720	32 /13	718	32 /14	718	32 /15	714
33 /0	712	33 /1	710	33 /2	708	33 /3	706	33 /4	704	33 /5	702	33 /6	700	33 /7	698
33 /8	697	33 /9	695	33 /10	693	33 /11	692	33 /12	690	33 /13	688	33 /14	687	33 /15	685
34 /0	683	34 /1	682	34 /2	680	34 /3	678	34 /4	675	34 /5	673	34 /6	670	34 /7	668
34 /8	665	34 /9	663	34 /10	660	34 /11	658	34 /12	658	34 /13	654	34 /14	652	34 /15	650
35 /0	648	35 /1	648	35 /2	644	35 /3	642	35 /4	640	35 /5	638	35 /6	636	35 /7	634
35 /8	632	35 /9	630	35 /10	628	35 /11	626	35 /12	624	35 /13	622	35 /14	620	35 /15	618
36 /0	617	36 /1	615	36 /2	613	36 /3	612	36 /4	610	36 /5	608	36 /6	607	36 /7	605
36 /8	603	36 /9	602	36 /10	600	36 /11	598	36 /12	596	36 /13	594	36 /14	592	36 /15	590
37 /0	588	37 /1	586	37 /2	584	37 /3	582	37 /4	580	37 /5	578	37 /6	576	37 /7	574
37 /8	572	37 /9	570	37 /10	568	37 /11	566	37 /12	564	37 /13	562	37 /14	560	37 /15	558
38 /0	556	38 /1	554	38 /2	552	38 /3	550	38 /4	548	38 /5	546	38 /6	544	38 /7	542
38 /8	540	38 /9	538	38 /10	536	38 /11	534	38 /12	532	38 /13	530	38 /14	528	38 /15	526
39 /0	524	39 /1	522	39 /2	520	39 /3	518	39 /4	516	39 /5	514	39 /6	512	39 /7	510
39 /8	508	39 /9	506	39 /10	504	39 /11	502	39 /12	500	39 /13	498	39 /14	496	39 /15	494
40 /0	492	40 /1	490	40 /2	488	40 /3	486	40 /4	484	40 /5	482	40 /6	480	40 /7	478
40 /8	477	40 /9	475	40 /10	473	40 /11	472	40 /12	470	40 /13	468	40 /14	467	40 /15	465
41 /0	463	41 /1	462	41 /2	460	41 /3	458	41 /4	458	41 /5	454	41 /6	452	41 /7	450
41 /8	448	41 /9	446	41 /10	444	41 /11	442	41 /12	440	41 /13	438	41 /14	436	41 /15	434
42 /0	432	42 /1	430	42 /2	428	42 /3	426	42 /4	424	42 /5	422	42 /6	420	42 /7	418
42 /8	417	42 /9	415	42 /10	413	42 /11	412	42 /12	410	42 /13	408	42 /14	407	42 /15	405
43 /0	403	43 /1	402	43 /2	400	43 /3	398	43 /4	396	43 /5	394	43 /6	392	43 /7	390
43 /8	388	43 /9	386	43 /10	384	43 /11	382	43 /12	380	43 /13	378	43 /14	376	43 /15	374
44 /0	372	44 /1	370	44 /2	368	44 /3	368	44 /4	364	44 /5	362	44 /6	360	44 /7	358
44 /8	356	44 /9	354	44 /10	352	44 /11	350	44 /12	348	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

SHEET 1 OF 1

STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION

RECORD OF BITUMINOUS MATERIALS

FORM 675-030-09
EITUMA
4

STATE JOB NO.	CONTRACT NO.	GRADE OF ASPHALT	TYPE OF CONSTRUCTION	SPECS	TABL.
20822152021	11706	RS-2	Prime Coat	1996	

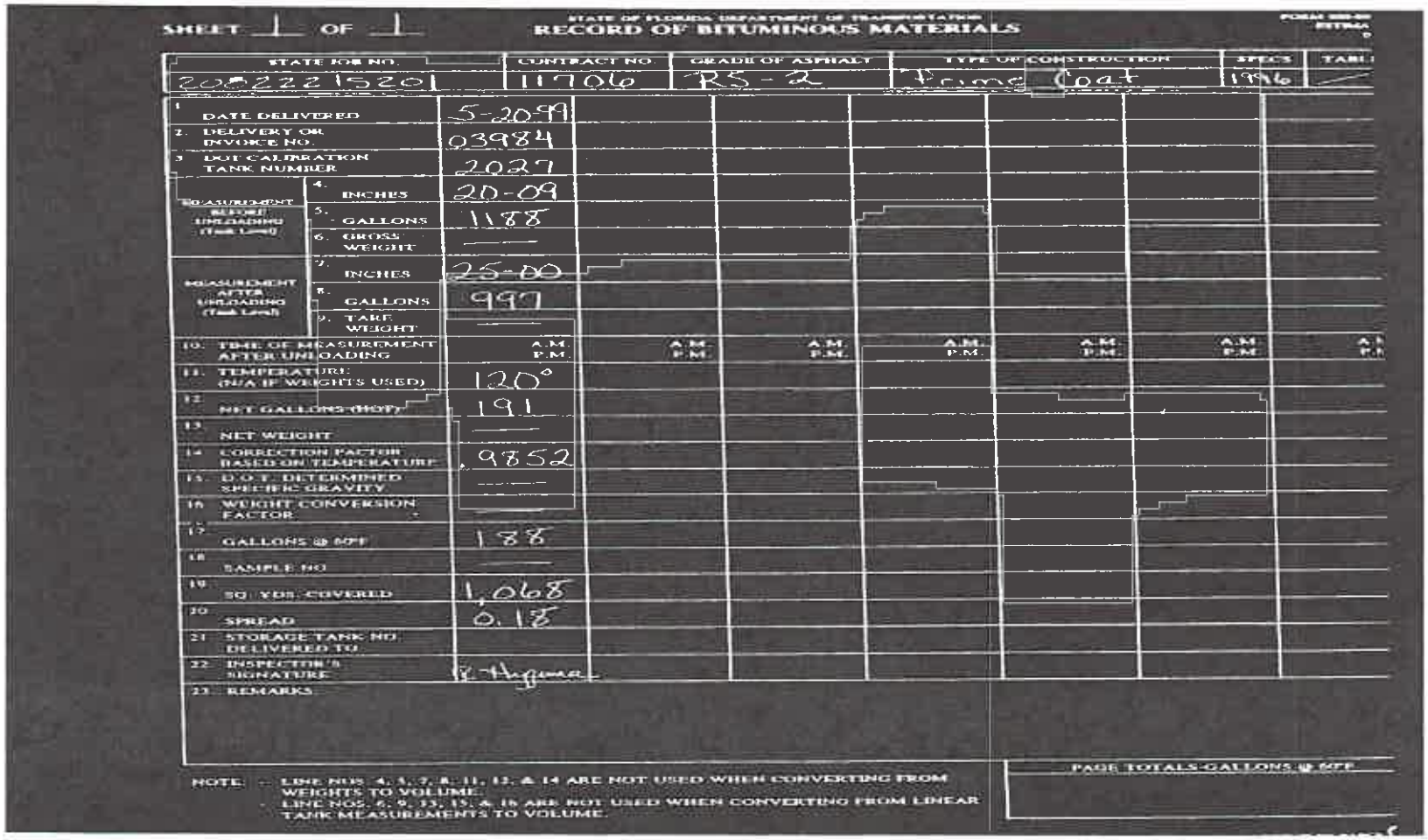
1. DATE DELIVERED		5-12-98						
2. DELIVERY OR INVOICE NO.		03984						
3. DOT CALIBRATION TANK NUMBER		2027						
MEASUREMENT BEFORE UNLOADING (Tank Level)	4. INCHES							
	5. GALLONS							
	6. GROSS WEIGHT							
MEASUREMENT AFTER UNLOADING (Tank Level)	7. INCHES							
	8. GALLONS							
	9. TARE WEIGHT							
10. TIME OF MEASUREMENT AFTER UNLOADING		A.M. P.M.	A.M. P.M.	A.M. P.M.	A.M. P.M.	A.M. P.M.	A.M. P.M.	A.M. P.M.
11. TEMPERATURE (N/A IF WEIGHTS USED)								
12. NET GALLONS (HOT)								
13. NET WEIGHT								
14. CORRECTION FACTOR BASED ON TEMPERATURE								
15. D.O.T. DETERMINED SPECIFIC GRAVITY								
16. WEIGHT CONVERSION FACTOR								
17. GALLONS @ 60°F								
18. SAMPLE NO.								
19. SQ. YDS. COVERED								
20. SPREAD								
21. STORAGE TANK NO. DELIVERED TO								
22. INSPECTOR'S SIGNATURE								

23. REMARKS:

NOTE:
- LINE NOS. 4, 5, 7, 8, 11, 12, & 14 ARE NOT USED WHEN CONVERTING FROM WEIGHTS TO VOLUME.
- LINE NOS. 6, 9, 13, 15, & 16 ARE NOT USED WHEN CONVERTING FROM LINEAR TANK MEASUREMENTS TO VOLUME.

PAGE TOTALS-GALLONS @ 60°F

RECYCLED PAPER



SHEET 1 OF 1

STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION

RECORD OF BITUMINOUS MATERIALS

STATE JOB NO.	CONTRACT NO.	GRADE OF ASPHALT	TYPE OF CONSTRUCTION	SPECS	TABLE
20022215201	11706	RS-2	Prime Coat	1996	

1. DATE DELIVERED		5-20-99							
2. DELIVERY OR INVOICE NO.		93984							
3. DOT CALIBRATION TANK NUMBER		2027							
MEASUREMENT BEFORE UNLOADING (Tank Level)	4. INCHES	20-09							
	5. GALLONS	1188							
	6. GROSS WEIGHT	—							
MEASUREMENT AFTER UNLOADING (Tank Level)	7. INCHES	25-00							
	8. GALLONS	997							
	9. TARE WEIGHT	—							
10. TIME OF MEASUREMENT AFTER UNLOADING		A.M. P.M.	A.M. P.M.	A.M. P.M.	A.M. P.M.	A.M. P.M.	A.M. P.M.	A.M. P.M.	A.M. P.M.
11. TEMPERATURE: (N/A IF WEIGHTS USED)		120°							
12. NET GALLONS (BBLS)		191							
13. NET WEIGHT		—							
14. CORRECTION FACTOR BASED ON TEMPERATURE		.9852							
15. D.O.T. DETERMINED SPECIFIC GRAVITY		—							
16. WEIGHT CONVERSION FACTOR									
17. GALLONS @ 60°F		188							
18. SAMPLE NO.		—							
19. SQ. YDS. COVERED		1,068							
20. SPREAD		0.18							
21. STORAGE TANK NO. DELIVERED TO									
22. INSPECTOR'S SIGNATURE		[signature]							
23. REMARKS									

NOTE: - LINE NOS. 4, 5, 7, 8, 11, 13, & 14 ARE NOT USED WHEN CONVERTING FROM WEIGHTS TO VOLUME.
- LINE NOS. 6, 9, 13, 15, & 16 ARE NOT USED WHEN CONVERTING FROM LINEAR TANK MEASUREMENTS TO VOLUME.

PAGE TOTALS-GALLONS @ 60°F

NOW, TO GRADE YOURSELF ON THE QUIZ REVIEW QUIZ, TOTAL YOUR INCORRECT ANSWERS. THERE ARE ABOUT 200 ANSWERS IN THE QUIZ.

IF YOU SCORED LESS THAN 90%-- THAT'S MORE THAN 20 INCORRECT ANSWER - GO BACK AND STUDY THE PARTS OF THE COURSE THAT GAVE YOU TROUBLE. THEN, THEN TAKE THE REVIEW QUIZ AGAIN. WHEN YOU CAN ANSWER THE REVIEW QUIZ QUESTIONS CORRECTLY, YOU SHOULD HAVE NO TROUBLE WITH THE EXAMINATION.

ANSWERS TO QUIZ

Page 11-2

- stabilization; cement treatment
- B
- B
- D
- base course

Page 11-3

- contractor's survey party
- hubs
- width; depth
- 7.62m
- blue tops
- 4m; edge of pavement; 4m
- tack set in hubs tops
- plan; specification

Page 11-4

- inspector
- parallel
- moist
- A 3, B 1, C 2
- Before
- Contractor
- Sampling, Testing and Reporting Guide

Page 11-5

- 441 A
- 153 + 62, centerline of right roadway

Page 11-6

- Stabilizing material
- Portland Cement Type I
- Yes
- Obtain and submit sample for testing
- Soil survey; cross section
- yes
- E
- Yes
- Rotary tillers

Page 11-7

- uniformly
- contractor
- Yes
- True
- 3 ½" (90mm); by making visual and remix subgrade or spread and mix stabilizing material into hand checks
- 100' (30m)

Page 11-8

- 330mm; yes
- A, B, E

Page 11-9

- Yes
- Yes
- the subgrade materials change
- 98% of maximum density
- A, B, D
- Remix subgrade or spread and mix more stabilizing material into subgrade
- No

Page 11-11

- sheepsfoot roller; vibratory roller; traffic roller
- be in good condition; operate safely; produce desired result
- stakes
- 418.1m; 94+10 to 92+70
- 605 feet (185 m)

Page 11-13

- B
- Yes
- 60 minutes
- it can be aerated by remixing or blending
- 30 seconds
- 30 minutes
- no
- smooth metal rod; jack; stringline
- posthole digger

Page 11-10

- Yes
- By digging holes with a position digger and measuring depth
- Yes
- until the subsequent base or pavement is in place
- design application rate for cement

Page 11-12

- delivery ticket
- A. B. C
- seven days
- 34.3 lbs/sq.yd (18.6 kg/sq.m)

Page11-14

- 1" diameter
- in the field
- inspector
- immediately; no later than 60 minutes
- 95
- scarified
- yes
- by sprinkling
- seven days

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- application at specified rate; complete, uniform coverage; sanding of asphaltic material with acceptable aggregate
- nine
- support the pavement
- 50
- 3
- no, to the profile grade
- edge of pavement
- no
- yes

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- the subgrade is not damaged
- B
- A,C,D,E
- B,C,D
- Yes
- Width; depth

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- no; yes
- bull dozers; motor graders
- A, E
- Project Engineer; clay
- 70'
- by rechecking the spread-distance calculations
- uniformity
- yes

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- No
- B
- No
- Central Lab
- contact district lab
- C
- yes
- moisture loss from the limerock

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- by the hollow sound they make when walked on or struck with a tool
- scarified
- templets; 8m straightedge
- 1/4" (6mm)
- 1/2" (12.5mm); 100' (30m)
- blend
- natural blend in one pit; different strata in same pit; separate pit
- by raking the full face of the cut

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- to form windows and move the material back and forth across the subgrade
- add water and disk to full base depth
- by aerating (windrowing and harrowing)
- seal the entire area being worked each day
- 98; 95
- yes
- C

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- a scab
- yes
- 15.2mm
- bituminous
- yes
- 3.7 liter; that the samples are representative
- dry
- on the delivery ticket
- it must be clean
- yes

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- check to see that the calibration number on the chart is the same as the one stamped on the distributor
- refer to the gauge on the distributor
- uniform
- rotary tailgate
- A
- Yes
- yes; Project Engineer
- opening or closing spray nozzles
- D
- 15.5°C