State of Florida Department of Transportation
Office of Construction

CRITICAL STRUCTURES CONSTRUCTION ISSUES

SELF STUDY COURSE

July 2020

Contents

INTRODUCTION

Who is Required to Complete this Course and What are the Deadlines for Completion

Completion of this course is mandatory for the following Department and Consultant Construction Engineering and Inspection (CEI) personnel involved in structures related construction: Resident Engineers, Construction Project Managers, Project Overseers, Senior Project Engineers (SPE), Project Administrators (PA), Senior or Lead Inspectors and Inspectors. Contractor employees involved with construction of structures should be encouraged by CEI staff to review the course material. After the complete course is taken the first time, it shall be retaken every three years thereafter. Personnel that are newly employed must complete the course not later than 6 months after the start of employment if they are to work on any FDOT contracts.

Certification of Course Completion Form

After fully completing the entire course, each student must fill out a Certification of Course Completion Form **(see the last page of this document for a copy of the form)** which must be signed by the student. The signed certification form shall be emailed to the District Construction Training Administrator. Submittal of the Certification form is required only once every three years when retaking of the complete course is required.

Individuals to Contact for Further Information

For questions about taking this course and the certification procedures, contact your District Construction Training Administrator. For technical questions about course content, contact the following Office of Construction Engineers: State Construction Structures Engineer or Construction Structures Engineer.

Purpose of the Course

The purpose of this critical issues course is to: heighten awareness of misunderstood specifications, procedures and other issues and to introduce new specification and procedure changes that will significantly impact Contractor and CEI efforts in the future. Course topics were selected by Office of Construction Engineers based on information gathered during annual field reviews of active projects in addition to feedback from Resident Engineers, Senior Project Engineers, Project Administrators and other field personnel related to: changes to contract documents, noncompliance with contact documents, and damaged or defective structural elements. The structures issues presented in this course are arranged by which of five topics they relate to as follows: **I.** Guidelists; **II.** Construction Project Administration Manual (CPAM); **III.** Construction Training and Qualification Manual (CTQM), Other Bridge Training Courses and Manuals, and Experience Requirements for Complex Bridge Projects; **IV.** Specifications; and **V.** Design Standards. **Blue underlined colored text** that appears anywhere in this document is an internet hyperlink. Clicking on the blue text with the cursor will automatically open the internet page containing the information related to the blue text.

I. GUIDELISTS

Guidelists, which are lists of the most important contract document requirements that inspectors must verify, are particularly important since they increase the inspector's awareness of what critical contract document sections apply to the construction operation being inspected. At the end of each guidelist requirement a notation indicates in what section of a publication, such as the Construction Specification, the user can find detailed information about the guidelist item when more information is desired. Guidelists shall be brought to the attention of Contractor personnel at the pre-work/pre-operations meetings and at any other time deemed appropriate by CEI staff in order to help the Contractor be more aware of contract document requirements. The Guidelists identify only the most important contract document requirements to ensure that they are not overlooked during construction by providing a concise tool for doing so; however, they must not be relied upon exclusively during inspections since familiarity with all contract documents is a prime responsibility of the CEI staff and vitally important. The pertinent structures related guidelists are listed below and both QC and QA documents can be viewed here: Latest Guidelists.

8B …… Concrete Materials
9 …….. Structure Foundations
10A..... Bridge Structures - General Concrete
10B …. Bridge Structures - Bearings/Beams/Bolts
10C …. Bridge Structures - Concrete Decks
10D …. Bridge Structures - Post-tensioning
11 …… Mechanically Stabilized Earth (MSE) Walls

II. CONSTRUCTION PROJECT ADMINISTRATION MANUAL (CPAM)

The following CPAM sections contain requirements for CEI personnel covering a wide range of critical construction management responsibilities related to structures. It is very important that CEI personnel involved with structures related construction be thoroughly familiar with these requirements.

8.4 Shop and Erection Drawing Process: CEIs shall maintain a Shop Drawing Tracking Log that includes all information laid out in 8.4.6 at a minimum, and a schedule of planned shop drawing submittals must be provided by the Contractor to the CEI not more than 60 days after the start of work. The schedule of planned shop drawings is very important to EORs and other reviewers in order for them to be able to develop a meaningful manpower estimate for their shop drawing review effort.

At every weekly progress meeting, it is very important for the CEI to ask the Contractor to indicate which shop drawings have the highest review priority – priorities can vary dramatically from week to week - and the CEI shall report this to EOR reviewers making them aware of the shop drawings that require immediate attention.

8.11 Contractor Initiated Submittals: This section requires CEI staff to establish a 17 item tracking log to monitor Contractor initiated submittals. There are three categories of contractor initiated submittals: (1) Requests for Information (RFI), (2) Requests for Correction (RFC), and (3) Requests for Modification (RFM). In the past, all Contractor initiated submittal regardless of their reason were referred to as RFIs which was not adequately descriptive since each category has a different processing procedure. By using separate categories, submittals are easier to track and one can tell which submittals are issues generated by the Contractor to gain a benefit and which submittals have to do with a defect or deficiency that is the responsibility of the Contractor. It is preferred that a separate log be used for each category but a single log is acceptable if it contains a separate data column that identifies its submittal category (RFI, RFC, or RFM). CPAM 8.11 includes a standard procedure for disposition of each submittal category. **You have not completed the review of this course, until you read CPAM 8.11 in its entirety.**

> **8.11.6 Contractor Initiated Submittals, Request for Modification:** A Cost Savings Initiative Proposal (CSIP) is now required to be processed as a Request for Modification (RFM) as covered by CPAM 8.11. A CSIP is a Contractor initiated submittal that if approved, will initiate a change to the contract documents resulting in a reduction of project costs that are shared by the Department and the Contractor. CSIPs are covered by Specification 4-3.9.

10.1 Piles: This section provides guidance related to setting production pile lengths and pile driving criteria to be used during pile driving operations. The back half of this document includes a helpful flow chart of the process and examples of letters to be sent to the Resident Engineer when setting pile lengths and establishing driving criteria.

10.2 Prestressed/Precast Concrete Components: When prestressed/precast concrete components are defective, or are damaged while in the plant where they are produced, this section provides detailed instructions to

CEI personnel on how to proceed with disposition of these defects or damage and includes a Flow Chart of the process.

10.2.6 Precast Prestressed Concrete Components, Review and Evaluation: When preparing a response to a Contractor's proposed disposition of defects, the PA must receive concurrence from either the District Structures Design Engineer or the State Construction Structures Engineer, depending on the bridge category.

10.3 Concrete Construction: This Section has five major subsections that deal with the following topics: 10.3.4 concrete deck thickness and cover checks required of inspectors; 10.3.5 mass concrete monitoring which includes supplemental flow charts; 10.3.6 mandatory crack inspection procedures which includes a flow chart and attachment; 10.3.7 required notification of District Materials Office for pre-work meetings, concrete placements, reduction in sampling frequencies and the occurrence of lumps and balls; and 10.3.8 Observing Concrete Consistency. The following covers important topics related to these CPAM subsections.

10.3.5 Mass Concrete: In this subsection, CEIs are reminded that not only are they to oversee the Contractor's monitoring of the temperature differential between the core and exterior surface (not to exceed 35°F), but also that the maximum core temperature does not exceed 180°F.

10.3.5.3 Implementation of Accepted Mass Concrete Temperature Control Plans: A requirement that mass concrete monitoring records be transmitted to the District Concrete Engineer has been added to this Section. These records shall include all temperature readings that the Contractor is required to take a minimum of every 6 hours during curing. These records shall be transmitted to the District Concrete Engineer as soon as possible after collection. The District Concrete Engineer monitors the readings in order to determine if a Quality Assurance review is needed or if modification to the Mass Concrete Temperature Control Plan (MCCP) is necessary.

10.3.6 Crack Inspection: This subsection includes detailed instructions regarding the disposition of concrete cracks. CEI inspectors are required to map cracks to scale, either on a hand drawn diagram or with CAD, and the map must contain the following information for each crack: width, length, reference points to a fixed object, and depth. Crack widths of 25 mil (1 mil = 0.001 inch) or less are required to be measured with a pocket microscope containing a reticle which is a built in scale that has 1 mil increments. Figure 1 shows examples of pocket microscopes for field measurement.

Pocket Microscopes
4" to 8" high

Figure 1 - Example Crack Measurement Microscopes

Table 1 is intended to be used for guidance when estimating the depth of narrow **nonstructural** cracks. As judged by the Engineer, use of this table may eliminate the need to take concrete cores for determining crack depth.

Table 1 - Rule of Thumb Relating Concrete Crack Width to Depth for Nonstructural Cracks

Average Crack Width (1/1000 inch or mils)	Approximate Crack Depth (inch)
4	1/2 inch
8	1
12	1-1/2
16	2
20	2-1/2

Note: The depth of cracks greater than 20 mils is very variable in comparison to crack width which is why the table stops at 20 mils.

Once a crack map is completed the cracks must be classified as structural, or nonstructural. The Senior Project Engineer, or Project Administrator shall determine if cracks are structural, or nonstructural. If cracks are deemed structural the Project Administrator will inform the DCE and the EOR and then ask the Contractor's EOR to submit an Engineering Analysis Scope for corrective action.

If all cracks are deemed to be nonstructural then the tables in specification 400-21, must be used to determine what action (repair, replacement or no action) will be required to resolve the crack issue for nonstructural cracks. These tables provide a path to the appropriate action by selecting four input parameters as follows: Elevation Range which can be determined from the plans; Environment Category also from the plans; Crack Width Range from the crack map; and Cracking Significance Range which must be computed as explained in CPAM Section 10.3.6 with its Attachment 10.3.6-1.

Shown in Table 2, taken from Specification 400-21, the elevation range column along the left edge has three ranges. The adjacent Crack Width column has 8 ranges within each elevation range. The Cracking Significance and Environment Category encompass the remainder of the table. Within the Cracking Significance are 4 levels of cracking severity, and the Environment Category has 3 environments (SA-slightly aggressive, MA-moderately aggressive and EA-extremely aggressive) for each significance range. By choosing the applicable columns and rows, the appropriate corrective action cell can be determined.

The Cracking Significance range requires a calculation that is explained in footnote (1) of Table 2. The calculation requires the determination of the LOT size which is the area of a rectangle that encompasses a group of cracks. Figure 2 provides an example, which can also be found as CPAM Attachment 10.3.6-1. In Figure 2, the blue rectangles represent the limits of a LOT and encompass groups of red colored cracks. The text of CPAM Section 10.3.6.4 provides a detailed explanation of how LOT sizes are calculated. LOT areas will typically range between 25 ft^2 and 100 ft^2 for footings, columns, caps, etc., and between 100 ft^2 and 400 ft^2 for decks. The Engineer determines the dimensions and sizes of LOTs. Within a LOT, the greater the surface area is of all the cracks added together, the greater is the severity or significance of the cracking. The higher the severity of cracking, the greater is the repair effort and expense required to remediate the cracks. Repair may not be possible if cracking severity is unacceptably high, in which case, the component will have to be removed and replaced.

The subsection also addresses inspection of components that are hidden from view and reminds CEIs that crack maps and related documents must be entered into the EDMS system in a precise way and without fail as covered in CPAM 10.3.6. Also, this section addresses whether or not cracks in buried culverts will need repair.

Table 2 - SPECIFICATION 400-21 Disposition of Cracked Concrete

Table 1 DISPOSITION OF CRACKED CONCRETE OTHER THAN BRIDGE DECKS [see separate Key of Abbreviations and Footnotes for Tables 1 and 2]													
Elev. Range	Crack Width Range (inch) (2) x = crack width	Cracking Significance Range per LOT (1)											
		Isolated Less than 0.005%			Occasional 0.005% to<0.017%			Moderate 0.017% to<0.029%			Severe 0.029% or gtr.		
		Environment Category											
		SA	MA	EA	SA	MA	EA	SA	MA	EA	SA	MA	EA
Elevation: 0 to 6 ft AMHW	x ≤ 0.004	NT	NT	PS (6)	NT	PS (6)	PS (6)	PS (6)	PS (6)				
	0.004< x ≤ 0.008	NT	PS (6)	EI (3)	PS (6)	EI (3)	EI (3)	PS (6)					
	0.008< x ≤ 0.012	NT	PS (6)	EI									
	0.012< x ≤ 0.016	PS (6)	Investigate to Determine Appropriate Repair (4, 5) or Rejection										
	0.016< x ≤ 0.020												
	0.020< x ≤ 0.024									Reject and Replace			
	0.024< x ≤ 0.028												
	x > 0.028												
Elev.: More Than 6 ft to 12 ft AMHW	Crack Width	SA	MA	EA	SA	MA	EA	SA	MA	EA	SA	MA	EA
	x ≤ 0.004	NT	NT	PS (6)	NT	PS (6)	PS (6)	PS (6)	PS (6)	PS (6)	PS (6)		
	0.004< x ≤ 0.008	NT	PS (6)	EI (3)	PS (6)	PS (6)	EI (3)	PS (6)	EI (3)				
	0.008< x ≤ 0.012	NT	PS (6)	EI	EI	EI							
	0.012< x ≤ 0.016	PS (6)	EI	EI	EI								
	0.016< x ≤ 0.020	EI											
	0.020< x ≤ 0.024		Investigate to Determine Appropriate Repair (4, 5) or Rejection								Reject and Replace		
	0.024< x ≤ 0.028												
	x > 0.028												
Elev.: Over Land or	Crack Width	SA	MA	EA	SA	MA	EA	SA	MA	EA	SA	MA	EA
	x ≤ 0.004	NT	NT	NT	NT	PS (6)	PS (6)	PS (6)	PS (6)	PS (6)	PS (6)		
	0.004< x ≤	NT	PS	PS	PS	PS	EI	PS	EI	EI	PS		

	0.008		(6)	(6)	(6)	(6)	(3)	(6)	(3)	(3)	(6)		
	0.008< x ≤ 0.012	NT	PS (6)	EI	EI	EI	EI	EI	EI				
	0.012< x ≤ 0.016	PS (6)	EI	EI	EI	EI	EI						
	0.016< x ≤ 0.020	EI	EI	EI	EI								
	0.020< x ≤ 0.024	EI		Investigate to Determine Appropriate Repair (4, 5) or Rejection									
	0.024< x ≤ 0.028										Reject and Replace		
	x > 0.028												

Key of Abbreviations and Footnotes for Tables 1 and 2		
Type Abbreviation	Abbreviation	Definition
Repair Method	EI	Epoxy Injection
	M	Methacrylate
	NT	No Treatment Required
	PS	Penetrant Sealer
Environment Category	EA	Extremely Aggressive
	MA	Moderately Aggressive
	SA	Slightly Aggressive
Reference Elevation	AMHW	Above Mean High Water

Footnotes

(1) Cracking Significance Range is determined by computing the ratio of Total Cracked Surface Area (TCSA) to Total Surface Area (TSA) per LOT in percent [(TCSA/TSA) x 100] then by identifying the Cracking Significance Range in which that value falls. TCSA is the sum of the surface areas of the individual cracks in the LOT. The surface area of an individual crack is determined by taking width measurements of the crack at 3 representative locations and then computing their average which is then multiplied by the crack length.

(2) Crack Width Range is determined by computing the width of an individual crack as computed in (1) above and then identifying the range in which that individual crack width falls.

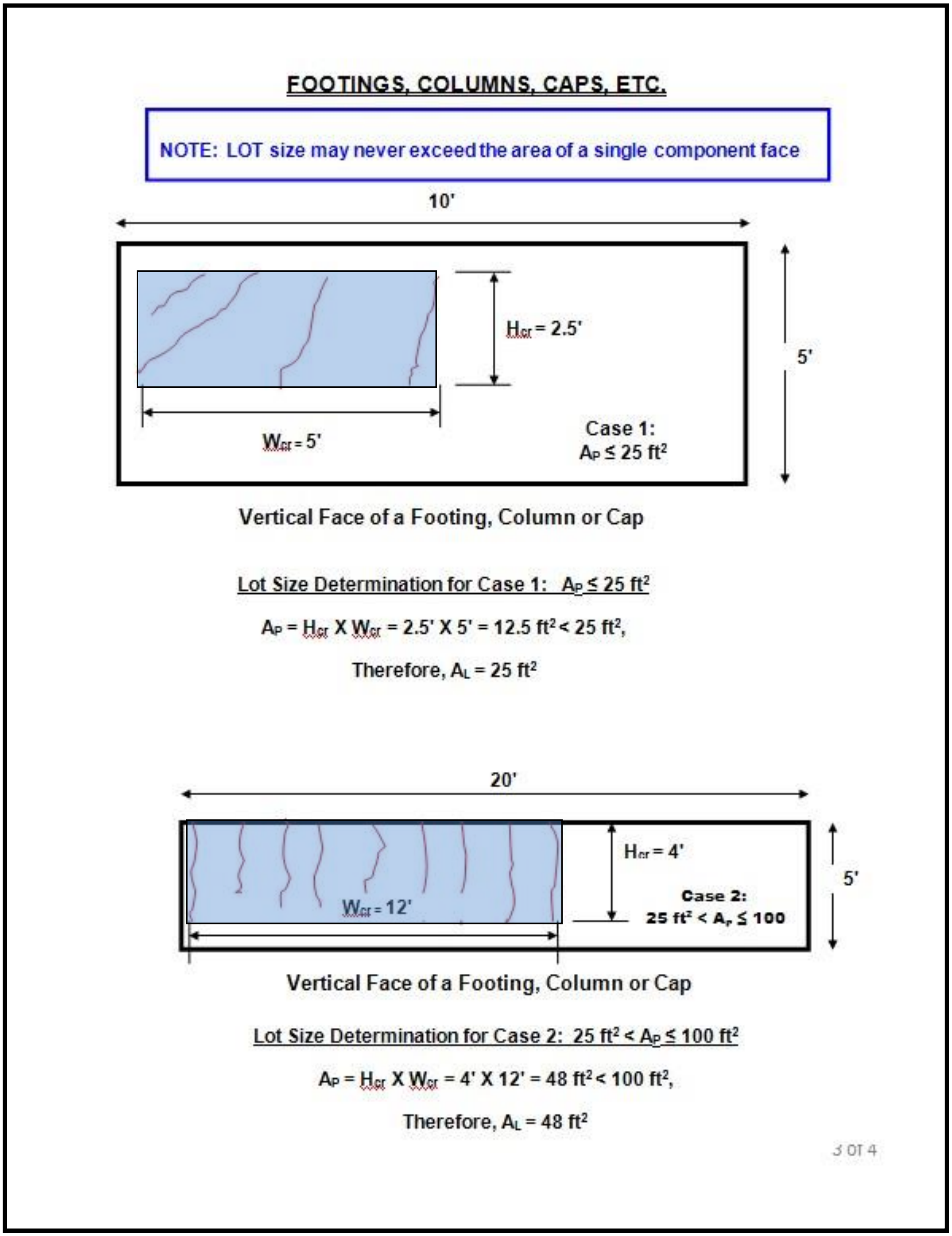
(3) When the Engineer determines that a crack in the 0.004 inch to 0.008 inch width range cannot be injected then for Table 1 use penetrant sealer unless the surface is horizontal, in which case, use methacrylate if the manufacturer's recommendations allow it to be used and if it can be applied effectively as determined by the Engineer.

(4) (a) Perform epoxy injection of cracks in accordance with Section 411. Seal cracks with penetrant sealer or methacrylate as per Section 413. (b) Use only methacrylate or penetrant sealer that is compatible, according to manufacturer's recommendations, with previously applied materials such as curing compound or paint or remove such materials prior to application.

(5) When possible, prior to final acceptance of the project, seal cracks only after it has been determined that no additional growth will occur.

(6) Methacrylate shall be used on horizontal surfaces in lieu of penetrant sealer if the manufacturer's recommendations allow it to be used and if it can be applied effectively as determined by the Engineer.

(7) Unless directed otherwise by the Engineer, repair cracks in bridge decks only after the grinding and grooving required by 400-15.2.5 is fully complete.


FOOTINGS, COLUMNS, CAPS, ETC.

NOTE: LOT size may never exceed the area of a single component face

Vertical Face of a Footing, Column or Cap

Lot Size Determination for Case 1: $A_P \leq 25\ ft^2$

$A_P = H_{cr} \times W_{cr} = 2.5' \times 5' = 12.5\ ft^2 < 25\ ft^2$,

Therefore, $A_L = 25\ ft^2$

Vertical Face of a Footing, Column or Cap

Lot Size Determination for Case 2: $25\ ft^2 < A_P \leq 100\ ft^2$

$A_P = H_{cr} \times W_{cr} = 4' \times 12' = 48\ ft^2 < 100\ ft^2$,

Therefore, $A_L = 48\ ft^2$

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Figure 2 - CPAM ATTACHMENT 10.3.6-1

10.3.6.3 Concrete Construction, Documenting Observations of Cracks in Concrete: Previously, this subsection required rigorous concrete crack mapping for all observed cracks and involved the documentation of crack width (multiple measurements), length, depth, and location of termination points on a drawing that was to scale. The crack mapping process requires considerable inspector effort especially if there are numerous cracks. It has been determined that the need for rigorous mapping of hairline cracks (4 mils wide or less) with the corresponding effort is no longer needed, with rare exception, since they are too narrow to require corrective action. Bridge deck hairline cracks are an exception regarding correction, since on very rare occasion, they may require minimal correction with the application of a penetrant sealer. With this in mind, the revised text no longer requires the gathering of as much information for hairline cracks unless, in the Engineer's judgment, it is needed. In the revised version, hairline cracks require only the location of one termination point in lieu of both; no longer requires a crack length or depth measurement; and the crack map no longer needs to be drawn to scale. Even though hairline cracks may not be documented as rigorously, District Structures Maintenance inspectors will still be able to easily locate them during routine periodic maintenance inspections in order to monitor their condition during the service life of the bridge. If cracks widen or lengthen over time, or if new cracks form then Maintenance inspectors will provide any additional crack mapping information that is required.

10.3.7 Notifying the District Materials Office of Concrete Placements, Pre-operations Meetings, Reduced Concrete Sampling Frequencies and the Occurrence of Lumps and Balls: This subsection requires CEIs to process Contactor requests for a reduction in concrete sampling frequency only after receiving approval from the District Materials Office (DMO). Specification 346-9.2.1, allows the Contractor to reduce the concrete QC sampling rate from the standard rate of every 50 cubic yards to a reduced rate of every 100 cubic yards if certain concrete production performance criteria are satisfied.

CEIs are required to notify the DMO as soon as possible if lumps and balls are observed in delivered concrete.

10.3.7.1 Concrete Construction, Concrete Placements: The Project Administrator (PA) must notify the District Concrete Engineer of the anticipated date and time at least 48 hours prior to a planned concrete placement. This information allows the Concrete Engineer to arrange for mandatory Independent Assurance (IA) reviews of concrete technicians performing sampling and testing. The PA must also include in the notification, the Training Identification Numbers (TIN) of all technicians expected to perform during the concrete placement.

10.3.8 Observing Concrete Consistency: This subsection requires CEIs to ensure that the consistency of concrete that arrives at the project site is observed by a qualified technician. This includes all trucks and not just those that are to be acceptance tested. If the technician observes questionable consistency then a slump and/or other test should be performed.

10.4 Coatings and Asbestos Removal, Handling and Disposal: For projects that have paint or asbestos removal this Section covers mandatory Contractor requirements along with mandatory CEI monitoring responsibilities. This Section covers coating concerns including: coating of bolts; surfaces that are visually difficult to inspect and access; caulking gaps and seams; testing for chloride, sulfate and nitrate concentrations; and stripe coating. Inspectors must pay particular attention to these concerns during coating operations and they should be discussed in detail with the Contractor at pre-operations meetings prior to the start of any work.

10.5 Drilled Shafts: This section provides guidance related to approval of drilled shaft installation plans, setting of drilled shaft lengths, and other drilled shaft construction issues. It also includes a sample letter for authorizing production shaft lengths.

10.6 Underwater Bridge Construction Inspection: This Section addresses how, when, where and who will perform underwater inspections while a construction project is underway and prior to final acceptance. Consultant CEI scopes of services shall require this work and budget shall be allocated for it. These Types of underwater defects can be addressed much more effectively and economically during construction then they can at the end of, or after, construction; thus the need for this CPAM section. For bridge projects with underwater bridge components, if the CEI Scope of Services does not include a requirement for underwater bridge construction services then the CEI consultant should request that the Department consider adding this service to the contract.

10.7 Post-tensioned Bridges: The inspection of post-tensioned bridges is covered in this Section and includes text that identifies specific inspection responsibilities, sample casting record, stressing record, and inspection forms, as well as six supplemental flow charts that also cover various inspection responsibilities. Project Administrator and Inspector duties are clarified for all portions of member casting, erection, stressing, duct filler injection and post-filler inspection. Duct filler material can now be one of two types: flexible filler (wax) or grout filler. Sample inspection forms are included for Segment Casting, Epoxy Joint, Stressing, Grouting, Wax Injection, Post Grouting Inspection and Post Wax Injection Inspection. The external reference document for this Section provides hyperlinks to two nationally recognized technical reference documents: FHWA Post-Tensioning Tendon Installation & Grouting Manual and the ASBI Construction Practices Handbook for Concrete Segmental & Cable-Supported Bridges. **If you are, or in the near future will be, involved with Post-Tensioned bridges, you have not completed the review of this course until you have read the latest version CPAM 10.7 in its entirety.**

10.8 Auger Cast Piles: This Section provides guidance related to the approval of the Contractor's Auger Cast Pile (ACP) installation plan, and other important auger cast pile issues such as load testing.

10.9 Structural Steel and Miscellaneous Metal Components: When steel or metal components are found defective or damaged while in the fabrication plant where they are produced, this section provides detailed instructions to CEI personnel about how to proceed with disposition of defects or damage, and includes a Flow Chart of the process.

> **10.9.5.2 Proposal Format and Requirements:** This Section requires all Contractor submittals for correction of steel defects or damage to be described on the cover page and followed by a completed Nonconforming Structural Steel and Miscellaneous Metal Component Data Sheet (Form No. 675-010-10). A list of supporting information such as sketches, documentation, calculations, etc., must be included in the appropriate space on the Data Sheet. Additional sheets may be attached as needed. All the supporting information required for the form must be prepared by, or be under the supervision of, the Contractor's Engineer of Record who shall sign and seal one complete copy of the supporting information.
>
> **10.9.5.3 Review and Evaluation:** This Section requires review of submittals by the Project Administrator with the assistance of the Quality Assurance Inspector of the fabrication plant retained by the Department.
>
> **10.9.6.1 Job Inspection Snug Tight Torque and Rotational Capacity Tests:** Specification 460, Structural Steel, requires Rotational Capacity and Daily Snug Tight Torque tests in addition to adherence to Turn-of-Nut bolt tightening procedures. This CPAM subsection requires the CEI to observe these tests and procedures in the field and record the results.
>
> **10.9.6.2 Shear Connector Bend Tests:** Specification 502**,** Shear Connectors, requires all shear connectors to be installed in the field and not in the fabrication plant. Specification 502-4.8 requires the Contractor to perform shear connector bend tests in the field and the CEI shall observe the bend testing and record the results.

10.10 Bridge Construction Issues that Must Involve Office of Construction Staff: Office of Construction, Bridge Construction Engineers must be involved in decision making related to complex bridge types as covered in this Section.

10.11 General Structures Construction Issues: This fairly new CPAM Section was developed to address structures construction issues that are not covered elsewhere in CPAM Chapter 10. The topics covered in this section relate to structures maintenance issues including: 10.11.3 - Notifying the District Structures Maintenance Engineer of In-Service Dates and Acceptance Inspections; 10.11.4 - Notification and Monitoring of Load Rating

Requirements; and 10.11.5 - Electronic Filing of Bridge Construction Documents. Applied overloads on temporary bridges and return of Department-owned temporary bridging is covered in the back half of this CPAM Section.

In section **10.11.3**, CEI staff is given direction on how and when to contact the District Structures Maintenance Office (DSMO) to arrange for Structures Maintenance inspectors to inspect structures prior to their being put into service and prior to final acceptance. Also, this section covers the process of addressing punch list items, and the collection of data required by the DSMO that CEI staff must collect during construction of the project.

Section **10.11.4**, provides detailed procedures regarding the CEI staff's responsibilities concerning load ratings. The circumstances that govern whether or not the load rating will remain As-Bid or if it will have to become an As-Built load rating at the end of the project, are covered in detail along with the corresponding signed and sealed documents that are required.

Construction documents that are electronically managed and that the DSMO must be able to easily access during the life of the structure are covered in **10.11.5**. A table is provided entitled **"BRIDGE CONSTRUCTION DOCUMENT PROFILE FIELDS"** that shows CEI staff where to electronically file construction documents (Construction Document Type, EDMS Group/ Type No., and Mandatory EDMS Document Subject/Description) so that in the future, DSMO staff will be able to find the records they need with minimal effort. Although the "Subject/Description" field of an EDMS document allows any alpha numeric character to be entered, the only characters that are to be entered as the first characters in the field are those that are required in the table entitled **BRIDGE CONSTRUCTION DOCUMENT PROFILE FIELDS.** Once the Subject/Description that is required by the Table is entered in the first positions of the field, then any other characters may follow at the discretion of the coder. By using the exact characters of the Table, Maintenance personnel can easily search a Subject/Description for a list of documents that have the precise information for which they are looking.

10.11.6 Contractor Applied Overloads on Department Owned Temporary Bridges: Acrow components are designed to carry legal loads and not overloads. The Contractor must not exceed the vehicle loads specified in the Florida Highway Patrol, Commercial Motor Vehicle Manual (CMVM) or weight limits established and posted by the Department. CEI staff shall monitor compliance of the Contractor with the legal loads. The requirements of this CPAM Section apply to temporary bridges owned by the Department and the safe loading of other temporary bridges is the responsibility of the Contractor in compliance with approved shop drawings and applicable provisions of the Contract Documents when included..

10.11.7 Temporary Bridge Activities: This section provides guidance regarding CEI responsibilities associated with temporary bridge acquisition, erection, maintenance and return. CEI staff shall coordinate the Contractor's acquisition of Department owned temporary bridge components with the State Aluminum Structures Shop and a detailed process for performing the coordination is provided in this subsection. Regarding temporary bridge erection verification, this subsection provides detailed guidance as to what verification responsibilities shall be performed by CEI staff for both Department owned components and Contractor supplied components. Contact with the FDOT State Bridge Maintenance and Repair Engineer (SBMRE) of the State Structures Maintenance Office, will be required during verification of Department owned bridge components. Once the temporary bridge is in service, maintenance monitoring procedures for CEI staff are provided in this subsection and CEI staff shall contact the SBMRE for instruction regarding proper monitoring procedures.

The PA shall verify that the Contractor has notified the Department at least 10 days prior to return of any bridge components, that all bridge components are listed on the Detour Bridge Issue and Credit Ticket, and signed by the Contractor. The PA shall adjust payment due to the Contractor for bridge components that are missing or damaged by the Contractor, components that are not properly packed or for components that are not returned within the specified time in accordance with Standard Specification 102-6.2.

10.12 Foundations on Design-Build Projects: This Section provides procedures for observing, reviewing and accepting foundations installed by a Design Build Firm.

III. CONSTRUCTION TRAINING AND QUALIFICATION MANUAL (CTQM), OTHER BRIDGE TRAINING COURSES AND MANUALS, AND EXPERIENCE REQUIREMENTS FOR COMPLEX BRIDGE PROJECTS

The following CTQM sections contain training and qualification requirements for CEI personnel involved with structures projects.

4.4 Qualifications and Training Courses - Concrete Field Technicians and Inspectors: This Section specifies the training courses and experience required to become a Construction Training and Qualification Program (CTQP) Qualified Level I or II Concrete Field Technician or Inspector. A Level I qualification is required for CEI personnel that sample and test concrete and Level II is required for the CEI lead inspector on all structures projects.

8.4 Structural Qualifications and Courses:

8.4.1 Grouting Technician Requirements: Grouting technicians must have the training and qualifications specified in this Section in order to inspect bridge projects that require the grouting of post-tensioning tendons. By meeting the training and qualification requirements, a technician is eligible to become a CTQP qualified grouting technician Level I or II. In order to be eligible for qualification, technicians must submit proof of successful completion of a Department accredited grouting training course to the CTQP Administrator for consideration. The CEI inspector in charge of inspection (lead or senior inspector) of grouting work must be at least a Level I technician.

8.4.2 Post-Tensioning Technician Requirements: Post-tensioning technicians must have the training and qualifications specified in this Section in order to inspect bridge projects that require the post-tensioning of steel tendons and strands. By meeting the training and qualification requirements, a technician is eligible to become a CTQP qualified post-tensioning technician Level I or II. In order to be eligible for qualification, technicians must submit proof of successful completion of a Department accredited post-tensioning training course to the CTQP Administrator for consideration. The CEI inspector in charge of inspection (lead or senior inspector) of post-tensioning work must be at least a Level I technician.

8.4.3 Bridge Coating Inspector Requirements: The lead inspector on a bridge coating project must successfully complete the Society for Protective Coatings (SSPC) course entitled "Bridge Coating Inspector Program" which is designated as SSPC course "BCI". Proof of successful completion must be presented to the appropriate Department Official prior to the start of coating inspection. This requirement does not require a CTQP qualification.

8.4.4 Lead Paint Removal Requirements: Senior Project Engineers and Project Administrators on projects requiring the disposal of hazardous waste associated with coatings removal must successfully complete the Society for Protective Coatings (SSPC) course entitled "Lead Paint Removal (C3)" ", prior to the start of removal work. This training is also strongly recommended for Construction Project Managers of projects requiring hazardous coatings removal. This requirement does not require a CTQP qualification.

IV. SPECIFICATIONS

1 Definitions and Terms

1-3 Definitions - Contractor's Engineer of Record: In the past, Contractors have occasionally used the services of under-qualified Engineers to perform design or analysis of permanent elements of structures for the purpose of proposing a corrective action for damaged or defective components or for a redesign that benefitted the Contractor. Consequently, only fully qualified engineers are permitted to design or analyze permanent structures that are expected to be used by the public for at least 75 years. A fully qualified Contractor's engineer is referred to as the "Contractor's Engineer of Record" or "Department-approved Specialty Engineer" as defined in Specification 1-3. This means that the Contractor's Engineer, whether the employee of an engineering consulting firm or a self-employed engineer, must be pre-qualified with the Department in accordance with the Rules of the Department, Chapter 14-75, or in other words, must meet the same qualifications as do engineers of record that are employed by the Department to perform original designs of permanent structures. If the Contractor elects to use a Department-approved Specialty Engineer instead of a Contractor's Engineer of Record then the Department-approved Specialty Engineer's work must be checked by another Department-approved Specialty Engineer prior to submittal to the Department. See the list of Department-Approved Specialty Engineers.

For design/analysis work that involves a permanent component of a structure, the Senior Project Engineer (SPE), or Project Administrator (PA) must make certain that any engineer performing work for the Contractor is pre-qualified by the Department in the appropriate Type of Work category for bridge design as described in Florida Administrative Code Rule 14-75.003. The work categories are as follows: 4.1.1: Miscellaneous Structures; 4.1.2: Minor Bridge Design; 4.2.1: Major Bridge Design-Concrete; 4.2.2: Major Bridge Design – Steel; 4.2.3: Major Bridge Design – Segmental; 4.3.1: Complex Bridge Design – Concrete; 4.3.2: Complex Bridge Design – Steel; 4.4: Movable Span Bridge Design. The SPE/PA shall not accept, for review by the Department, submittals from a Contractor's engineer who does not meet the pre-qualification requirements of Chapter 14-75 and the conditions of Specification 1-3.

Design/analysis engineering services may also be performed by a Specialty Engineer (see specification 1-3 for a definition) who is not required to be prequalified by the Department but who must be a registered engineer in Florida and who must have the education and experience to competently perform the work. In general, Specialty Engineers are permitted to work on temporary structures or systems that are used by the Contractor to build the permanent structure such as falsework, forms, scaffolding, etc. They may also be permitted to work on permanent structural elements that are minor or nonstructural or for special items of the permanent works not fully detailed in the plans. The accompanying table shows what work type each class of engineer - Contractor's Engineer of Record, Department-approved Specialty Engineer or Specialty Engineer – is permitted to perform.

CLASS OF CONTRACTOR'S ENGINEER VERSUS WORK TYPE

Work Type	Contractor's Engineer of Record	Department Approved Specialty Engineer	Specialty Engineer
Re-design	Yes	No	No
Cost Savings Initiative Proposal	Yes	No	No
Details of the permanent work not fully detailed in the plans (Example: Pot Bearing Design, nonstandard expansion joints, MSE walls, other specialty items)	Yes	Yes	Yes
Design and details of the permanent work declared to be minor or non-structural including minor repairs	Yes	Yes	Yes
Design and details of the permanent work declared to be major or structural including major repairs	Yes	Yes *	No
Design and drawings of temporary works such as falsework, formwork, etc.	Yes	Yes	Yes

*** The work must also be checked by another Department Approved Specialty Engineer**

5 Control of Work

5-1.4 Shop Drawings:

5-1.4.5.4 Temporary Works: This Subarticle requires the Contractor to submit shop drawings for temporary works that affect public safety. Construction affecting public safety pertains to construction operations conducted over or adjacent to active roadways, pedestrian ways, railroads, navigable waterways, etc., which might cause injury or death if a construction related mishap were to take place: see Specification 5-1.4.1 for a detailed definition. This section was recently revised to require bracing system shop drawings to be submitted for EOR approval. Bracing systems were added because of problems with beam stability during erection operations. By requiring the Contractor to submit drawings and calculations related to the stabilization of beams by bracing during erection, the Department can reduce the possibility that beams or their components will fall onto vehicles, pedestrians, trains, boats, etc. At the preconstruction conference, the SPE/PA must remind the Contractor that these drawings are required and during construction the CEI staff must verify that the Contractor complies with the approved shop drawings.

5-1.4.5.6 Formwork and Scaffolding: This Subarticle requires formwork, scaffolding and other temporary works affecting public safety to be developed and designed in accordance with the AASHTO Guide Design Specifications for Bridge Temporary Works, and the AASHTO Construction Handbook for Bridge

Temporary Works, and Chapter 11 of the Structures Design Guidelines (SDG) using wind loads specified in the SDG. CEI staff shall verify that the Contractor is aware of this requirement and the Contractor states that the temporary works are in compliance with the AASHTO Specifications and Handbook as well as the SDG.

5-1.4.5.7 Beam and Girder Temporary Bracing: The text of this Subarticle is as follows:

The Contractor is solely responsible for ensuring stability of beams and girders during all handling, storage, shipping and erection. Adequately brace beams and girders to resist wind, weight of forms and other temporary loads, especially those eccentric to the vertical axis of the products, considering actual beam geometry and support conditions during all stages of erection and deck construction. At a minimum, provide temporary bracing at each end of each beam or girder. Develop the required bracing designs in accordance with the AASHTO LRFD Bridge Design Specifications (LRFD) and Chapter 11 of the SDG using wind loads specified in the SDG. For information not included in the SDG or LRFD, refer to the AASHTO Guide Design Specifications for Bridge Temporary Works and the AASHTO Construction Handbook for Bridge Temporary Works.

For Construction Affecting Public Safety, when temporary bracing requirements are shown in the Plans, submit plans and calculations signed and sealed by a Specialty Engineer for the design of temporary bracing members and connections based on the forces shown in the Plans. In addition, submit a written certification that construction loads do not exceed the assumed loads shown in the Plans.

For Construction Affecting Public Safety, when temporary bracing requirements are not shown in the Plans or an alternate temporary bracing system is proposed, submit plans and calculations signed and sealed by a Specialty Engineer including the stability analysis and design of temporary bracing members and connections.

The purpose of this Subarticle is to make the Contractor aware that stabilizing beams is a critical issue that requires serious attention and which is solely the Contractor's to address. In recent years there have been instances of beam stability problems as follows: improperly braced beams have collapsed onto the roadway beneath them prior to deck form placement; fascia beams have rotated during placement of deck concrete due to inadequate overhang brackets and/or bracing between the fascia beam and the adjacent beam as well as inadequate blocking at bearings; undersized bracing elements between beams have failed during a high wind event; etc. At the preconstruction conference, the SPE/PA must remind the Contractor that these drawings are required and should emphasize the importance of properly designed bracing systems. Also, the Contractor must be reminded that the bracing systems must be designed following the AASHTO LRFD Bridge Design Specifications (LRFD), AASHTO Guide Design Specifications for Bridge Temporary Works and the Construction Handbook for Bridge Temporary Works. Finally, the SPE/PA should review the contract documents for any references to beam and girder temporary bracing, such as notes in the plans provided by the EOR, and bring these to the attention of the Contractor. During construction, the CEI staff must verify that the Contractor complies with the approved bracing shop drawings.

5-1.4.5.8 Erection Plan: The text of this specification Subarticle is as follows:

Submit, for the Engineer's review, an Erection Plan that meets the specific requirements of Sections 450, 452 and 460 and this section. Refer to Index 600 for construction activities not permitted over traffic.

The purpose of this Subarticle is to make the Contractor aware that an erection plan may be part of the shop drawing process, and as such, must comply with all the shop drawing requirements of Specification Section 5. The SPE/PA should review the contract documents for any references to erection procedures or requirements, such as notes in the plans provided by the EOR, and bring these to the attention of the Contractor.

5-1.5 Certifications:

5-1.5.2 Falsework and Shoring Requiring Shop Drawings: This Subarticle allows any Specialty Engineer that is qualified and not just the designer of the falsework to personally inspect it once erected. It also allows a designee appointed by the Specialty Engineer to inspect the work. However, the Specialty Engineer and not a designee must sign and seal the letter of certification. Also, where so directed in the shop drawings, all welds must be performed by welders qualified under AWS D1.5 for the type of weld being performed. CEI staff shall review the shop drawings to determine if qualified welders are required and if so, their credentials shall be verified prior to commencement of any welding.

5-1.5.3 Temporary Formwork: The inspection responsibilities of the Specialty Engineer for temporary formwork are the same as 5-1.5.2.

5-1.5.4 Erection: The inspection responsibilities of the Specialty Engineer for erection are the same as 5-1.5.2. Unless otherwise specified in the Plans, erection plans are not required for simple span precast prestressed concrete girder bridges with spans of 170 feet or less. For structures without temporary supports but with temporary girder bracing systems, performance of inspections of the bracing until all the diaphragms and cross frames are in place are required as a minimum, on a weekly basis. For structures with temporary supports, daily inspections are required until the temporary supports are no longer needed as indicated in the erection plans. CEI staff shall verify that the required inspections are taking place.

7 Legal Requirements and Responsibility to the Public

7-7.2 Overloaded Equipment: This Subarticle makes it clear that Department owned temporary bridges may not be loaded with vehicles that exceed legal weight limits of Florida as covered in the Florida Highway Patrol, Commercial Motor Vehicle Manual (Trucking Manual), or lower weight limits legally established and posted for any section of road or bridge by the Department or local authorities.

7-7.5 Contractor's Equipment on Bridge Structures: This Subarticle has been revised - see excerpt of revised version below - to make it clear that the analysis for determining whether or not Contractor equipment can be carried safely by an existing bridge during construction must be performed by a Contractor's Engineer of Record and not a Specialty Engineer.

The Contractor's Engineer of Record shall analyze the effect of imposed loads on bridge structures, within the limits of a construction contract, resulting from the following operations:

1. Overloaded Equipment as defined in 7-7.2:
   a. Operating on or crossing over completed bridge structures.
   b. Operating on or crossing over partially completed bridge structures.

2. Equipment within legal load limits:
   a. Operating on or crossing over partially completed bridge structures.

3. Construction cranes:
   a. Operating on completed bridge structures.
   b. Operating on partially completed bridge structures.

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

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

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

Submit to the Department for approval the design calculations, layout drawings, and erection drawings showing how the equipment is to be used so that the bridge structure will not be overstressed. The Contractor's

Engineer of Record shall sign and seal the drawings and the cover sheet of the calculations for the Department's Record Set.

105 Contractor Quality Control General Requirements

105-8.10 Supervisory Personnel – Post-Tensioned and Movable Bridge Structures: Some of the bridges the Department builds have highly complex design and construction requirements. In the past, Contractors have occasionally staffed these type projects with under qualified and inexperienced engineers, superintendents and foremen which resulted in major problems. In order to prevent these problems, the Department implemented specification 105-8.10 (previously 105-8.7) to ensure that only qualified Contractor supervisors are permitted to work on these complex projects. The SPE/PA is responsible for verifying that Contractor supervisors fully comply with the requirements of 105-8.10 at all times. Specification 105-8.10.8 sets forth actions that the SPE/PA must take if the Contractor fails to comply with the qualification requirements at any time while the project is under way. These actions can have significant negative consequences for the Contractor if not in compliance.

105-8.10.7 Post-Tensioning (PT) and Filler Injection Personnel Qualifications: Post-tensioning must be performed under the direct supervision of a Contractor Level II CTQP Qualified Post-tensioning Technician. For the superstructures of bridges having concrete post-tensioned box or I girder construction, the Contractor must provide at least two CTQP Qualified PT Technicians, Level I or II, on the work crew. However, qualified post-tensioning technicians are not required for the work crew of simple components such as pier caps or flat slabs.

Grouting must be performed under the direct supervision of a Level II CTQP Qualified Grouting Technician. For the superstructures of bridges having concrete post-tensioned box or I girder construction, the Contractor must provide at least two CTQP Qualified Grouting Technicians, Level I or II, on the work crew. However, qualified grouting technicians are not required for the work crew of simple components such as pier caps or flat slabs.

Flexible filler injection operations must be performed under the direct supervision of a Filler Injection Foreman who has American Segmental Bridge Institute (ASBI) certification in the flexible filler process. The Contractor must provide at least two CTQP Qualified Grouting Technicians with ASBI certification in the flexible filler process, one of whom must be a Level II CTQP Qualified Grouting Technician. Both technicians must be present at the site of the flexible filler injection work during the entire duration of the operation. The Contractor must provide a Filler Injection Quality Control (QC) Inspector who has ASBI certification in the flexible filler process. The Filler Injection QC Inspector must be present at the site of the flexible filler injection work during the entire duration of the operation. Both the Foreman and the QC Inspector must be Level II CTQP Qualified Grouting Technicians.

To get qualified, prerequisites must be met and once they are met (see the Construction Training and Qualification Manual, Chapter 8), the applicant has to apply to the CTQP Administrator to be officially qualified. Even if a technician satisfies all the mandatory prerequisites to become qualified, they will not be considered qualified until they apply to and are officially issued a qualification certificate by the CTQP Administrator. The SPE/PA is responsible for verifying that all CEI and Contractor post-tensioning, grouting and flexible filler injection technicians on their project meet the PT and grouting qualification requirements.

108 Monitor Existing Structures

The title of the Specification was changed from "Protection of Existing Structures" to "Monitor Existing Structures" to reflect the work that is required.

108-2.3 Groundwater Monitoring: The specification requires the Contractor to install a piezometer at the right of way line and near any existing structure that may be affected by dewatering operations, or as directed by the Engineer. The Contractor is required to monitor the piezometer and record the groundwater elevation level each day that dewatering activities are performed and for one week after activities have ceased, or on a schedule approved by the Engineer. Notify the Engineer of any groundwater lowering near the structure of 12 inches or more.

346 Portland Cement Concrete

346-3 Classification, Strength, Slump and Air Content:

346-3.1 General: This Subarticle reduces the processing effort that is required for Contractors to request the substitution of higher class concrete for lower class concrete. Previously, this had to be done on a case by case basis but now it can be done for general cases through the approved QC Plan. This applies to cast-in-place concrete used by Contractors directly or for precast concrete produced in offsite plants through the Producer's QC Plan.

The classifications of concrete covered by this Section are designated as Class I, Class I Pavement, Class II, Class II Bridge Deck, Class III, Class III Seal, Class IV, Class IV Drilled Shaft, Class V, Class V Special, Class VI and Class VII. Strength and slump are specified in Table 3*. The air content for all classes of concrete is less than or equal to 6.0%.*

Substitution of a higher class concrete in lieu of a lower class concrete may be allowed when the substituted concrete mixes are included as part of the QC Plan, or for precast concrete, the Precast Concrete Producer's QC Plan. The substituted higher class concrete must meet or exceed the requirements of the lower class concrete and both classes must contain the same types of mix ingredients. When the compressive strength acceptance data is less than the minimum compressive strength of the higher design mix, notify the Engineer. Acceptance is based on the requirements in Table 3 *for the lower class concrete.*

Table 3 - Classes of Structural Concrete

TABLE 3 Structural Concrete Class, Compressive Strength, and Slump		
Class of Concrete	28-day Specified Minimum Compressive Strength (f_c') (psi)	Target Slump Value (inches) (c)
I (a)	3,000	3 (b)
I (Pavement)	3,000	2
II (a)	3,400	3 (b)
II (Bridge Deck)	4,500	3 (b)
III (d)	5,000	3 (b)
III (Seal)	3,000	8
IV	5,500	3 (b)
IV (Drilled Shaft)	4,000	8.5
V (Special)	6,000	3 (b)
V	6,500	3 (b)
VI	8,500	3 (b)
VII	10,000	3 (b)

(a) For precast three-sided culverts, box culverts, endwalls, inlets, manholes and junction boxes, the target slump value and air content will not apply. The maximum allowable slump is 6 inches, except as noted in (b). The Contractor is permitted to use concrete meeting the requirements of ASTM C478 4,000 psi in lieu of Class I or Class II concrete for precast endwalls, inlets, manholes and junction boxes.
(b) The Engineer may allow a maximum target slump of 7 inches when a Type F, G, I or II admixture is used. When flowing concrete is used, the target slump is 9 inches.
(c) For a reduction in the target slump for slip-form operations, submit a revision to the mix design to the Engineer. The target slump for slip-form mix is 1.50 inches.
(d) When precast three-sided culverts, box culverts, endwalls, inlets, manholes or junction boxes require a Class III concrete, the minimum cementitious materials content is 470 pounds per cubic yard. Do not apply the air content range and the maximum target slump shall be 6 inches, except as allowed in (b).

346-3.2 Drilled Shaft Concrete: The CEI staff should review the slump loss testing provision carefully prior to the start of drilled shaft operations. If the elapsed during placement exceeds the slump loss test data, a Specialty Engineer must submit an Engineering Analysis Scope, per 6-4, to determine if the shaft is structurally sound and free from voids.

346-3.3 Mass Concrete: This specification was implemented so that it would be clear about the involvement of the Specialty Engineer in charge of developing and overseeing the implementation of the Mass Concrete Control Plan (MCCP). The specification requires the Specialty Engineer to be directly involved at the project site in certain phases of the implementation, and if needed, for adjustment or revision of the plan. Therefore, the SPE/PA must confirm that the Specialty Engineer is on site when required by the specification and is consulted appropriately by the Contractor when adjustments or revisions are required. This is important, since on occasion; Contractors have not implemented the plan as intended by the Specialty Engineer because the Specialty Engineer or his employee never visited the project in person for verification. The improper implementation of plans has resulted in the formation of concrete cracks. Guidance about CEI responsibilities related to mass concrete approval and monitoring processes is provided in CPAM Section 10.3.5 and corresponding Flow Charts 10-3-5-1, Mass Concrete Temperature Control Plan Approval Process, and 10-3-5-2, CEI Verification Process for Contractor Mass Concrete Temperature Monitoring.

This specification has been revised to reduce the mass concrete monitoring effort required by Contractors under certain circumstances. The new provision is as follows:

If the first element of a group of elements with the same dimensions is placed in accordance with the approved MCCP, without exceeding either the maximum temperature or maximum temperature differential of the concrete, reduced monitoring of the remaining elements may be allowed with written approval from the Engineer. Request approval from the Engineer at least 14 calendar days prior to the anticipated date of reduced monitoring. If approved, temperature monitoring is required only for the initial element of a group of concrete elements meeting all of the following requirements:

1. All elements have the same dimensions.

2. All elements have the same concrete mix design.

3. All elements have the same insulation R value and active cooling measures (if used).

4. Ambient temperatures during concrete placement for all elements are within minus 10°F of the ambient temperature during placement of the initial element.

5. Use the same temperature control measures used for the initial monitored element and keep in place for at least the same length of time as for the initial element. The Contractor and Engineer each have the option to have the temperature monitored to ensure the core temperature is within 50°F of ambient prior to termination of temperature control measures.

Install temperature measuring and recording devices for all mass concrete elements. Position the temperature sensors 2.00± 0.25 inches inside the concrete surface for surface temperature measurements and at the expected location of the maximum temperature for core temperature measurements. Place the ambient temperature sensor in a location that protects it from direct exposure to rain, sun, or sources of radiated heat, such as concrete or asphalt pavement surfaces. Temperatures shall be continuously recorded starting at the end of concrete placement and continuing until the core has cooled to within 50°F of the ambient temperature. Resume monitoring of the temperatures for all elements if directed by the Engineer.

In addition to the above, at the Contractor's option, instrumentation and temperature measuring may be omitted, provided the below requirements are met. Note: An MCCP is still required to be submitted even when instrumentation and temperature measuring are omitted:

Temperature monitoring may be omitted at the Contractor's option, for any mass concrete substructure element meeting all of the following requirements:

1. The minimum cross-sectional dimension of the element is six feet or less.

2. Insulation R value of at least 2.5 provided for at least 72 hours following the completion of concrete placement.

3. The environmental classification of the concrete element is Slightly Aggressive or Moderately Aggressive.

4. The concrete mix design meets the mass concrete proportioning requirements of 346-2.3.

5. The total cementitious content of the concrete mix design is less than or equal to 750 lb/yd^3.

6. Temperature of the concrete is 95°F or less at placement.

Note that the Department will make no compensation for additional costs or loss of time due to additional analyses, tests, or other impacts on production caused by the use of reduced monitoring or the Contractor's option.

Another result of recent changes is that mass concrete control provisions are not required for drilled shafts supporting sign, signal, lighting or intelligent transportation (ITS) structures that meet the following requirements:

1. The diameter is six feet or less.
2. The total cementitious materials content of the concrete mix design is less than or equal to 750 lb/yd^3.

If the Contractor elects to use this complex new provision, the CEI staff shall have thorough discussions about proper implementation with the Contactor's staff well in advance of this work. Diligent monitoring of Contractor compliance with this new provision will also be required by CEI staff.

Understanding why mass concrete is likely to crack during curing if temperatures are not controlled and how temperatures can be controlled

When concrete for a mass (short for massive) concrete component is placed and the curing process begins, the concrete at the core of the component heats up as a result of a chemical reaction of the cement called hydration. Figure 3 shows the hotter core as the red cube at the center of a typical footing. The blue lines represent the cooler exterior surfaces of the footing. When the concrete heats up, it expands and this process of expansion continues until the core begins cooling. Cooling of the core usually begins two or three days after concrete placement. As the core heats up, it expands and thus pushes against the cooler concrete causing the cooler exterior surfaces to stretch, and experience tension. If the core expands beyond a certain point, the tension strength of the concrete will be exceeded and it will crack. These type cracks are referred to as "Thermal Cracks."

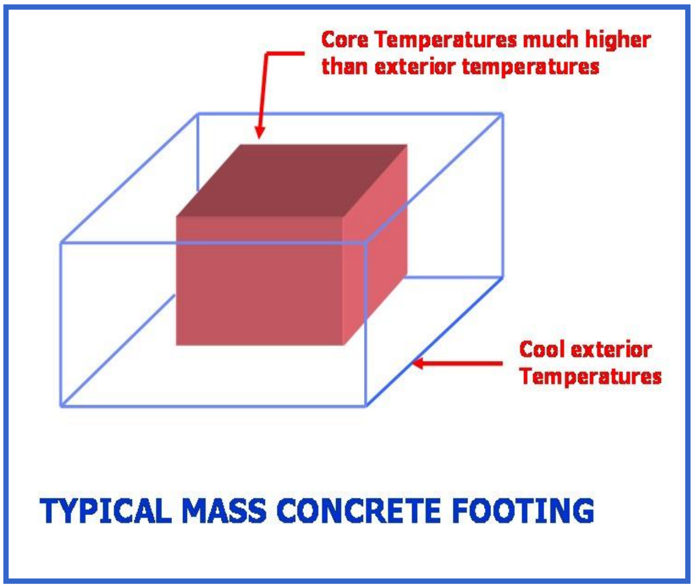

Figure 3 - Mass Concrete Temperature Differential

In order to prevent thermal cracks, the Contractor must hire a Specialty Engineer who is an expert in this field of technology and who develops a Mass Concrete Temperature Control Plan which must be approved by the Department. In the Plan, the Specialty Engineer tells the Contractor how to keep the core temperature from exceeding external surface temperatures by more than 35°F. The temperature difference between the core and the external temperature is referred to as the differential temperature and if it does not exceed 35°F, cracking is very unlikely to occur. The Contractor's measures for controlling the core and surface temperatures may include all or some of the following as well as others: use of cooled water for mixing the concrete which results in a lower initial core temperature; use of insulation to cover the exterior surfaces of the component to keep them from getting colder at night and during cooler weather; use of external heaters to keep external surfaces from rapid cooling during very cold weather; and use of piping that is installed through the core to allow circulation of cool water that reduces heat buildup.

The Contractor monitors the temperature differential during the early stages of the curing process by installing electronic temperature sensors called thermal couples in the core and on the surface of the concrete and that are attached to the rebar cage prior to concrete placement. The thermal couples are attached to an electronic reading device that is located outside of the component and which records the temperature measurements at least once per hour beginning at the completion of concrete placement and continued until the core temperature is within 50°F of the ambient temperature. Temperature readings shall be monitored at least every six hours and the Specialty Engineer must be available for immediate consultation during the monitoring period. The SPE/PA must verify that the monitoring process, with appropriate adjustments as needed, is being done properly and that the required monitoring records are accurate, complete, and submitted on time. Records must be kept by the CEI and transmitted to the District Materials Engineer for review as soon as available.

346-5 Sampling and Testing Methods: The requirement to take a composite concrete sample has been eliminated so instead of filling the wheel barrow up by taking concrete from the discharge stream at two different times, the entire sample can now be supplied all at one time.

346-6.2 Concrete Design Mix: The following text is included in this Subarticle:

For slump target values in excess of 6 inches, including flowing and self-consolidating concrete, utilize a grate over the conveyance equipment to capture any lumps or balls that may be present in the mix. The grate must cover the entire opening of the conveyance equipment and have an opening that is a maximum of 2 1/2 inches in any one direction. Remove the lumps or balls from the grate and discard them.

346-6.3 Delivery Certification: This Subarticle requires an electronic delivery ticket is furnished with each batch of concrete before placement and that the ticket shall be printed. The batcher responsible for production of the batch must sign the delivery ticket certifying the concrete was produced in accordance with the Contract Documents, and the Contractor must sign the delivery ticket certifying that the design mix maximum specified W/C ratio was not exceeded due to jobsite adjustments.

346-6.4 Plastic Property Tolerances: In Subarticle 6.4, the Department requires the Contractor to reject concrete that is not within the specified slump tolerance range of plus or minus 1.5" from the "Target Slump Value" shown in Table 3. What should improve the Contractor's ability to provide beneficial concrete fluidity, is that water is permitted to be added as long as the initial slump is anywhere within the tolerance range and as long as the resultant water addition does not cause the slump to exceed the upper limit of the tolerance range or exceed the maximum W/C ratio. In Article **346-12 Pay Reduction for Plastic Properties**, the Department requires a pay reduction if the Contractor places concrete that has failed a plastic properties test. The pay reduction applies to the entire quantity of concrete – usually 10 cubic yards - in the truck from which the failing concrete was discharged. The pay reduction shall be computed by using twice the invoice price of the concrete which is the price that the Contractor paid the concrete supplier for the concrete. The CEI staff shall substantiate the invoice price by obtaining a copy of the Contractor's invoice which shall be retained in the project records. The following is an excerpt from Subarticle 346-6.4.

Reject concrete with slump or air content that does not fall within the specified tolerances and immediately notify the concrete production facility that an adjustment of the concrete mixture is required. If a load does not fall within the tolerances, test each subsequent load and the first adjusted load. If failing concrete is not rejected or adjustments are not implemented, the Engineer may reject the concrete and terminate further production until the corrections are implemented.

Do not allow concrete to remain in a transporting vehicle to reduce slump. Water may be added only upon arrival of the concrete to the jobsite and not thereafter.

346-7.2 Transit Truck Mixing: This specification requires a completely uniform mixed concrere and sets the range for mixing between 70 and 100 revolutions at the mixing speed designated by the truck manufacturer. If water is added at the jobsite, the quantity must be recorded and 30 additional drum revolutions are required prior to discharge of the concrete. No more than two mix adjustments are allowed.

For each concrete truck used on a specific placement, a quality control (QC) technician should verify that the revolution counter is functioning properly at least once per day. The QC technician must observe the counter directly regardless of where in the vehicle it is located. CEI staff should occasionally perform a quality assurance inspection of counters by direct observation.

346-7.2.1 Transit Time: The definition of "Transit Time" on the delivery ticket is defined as the time of complete discharge from the concrete truck. So instead of this time being when all concrete in the load is in its final position in the forms as before, it is now the time when all concrete has been discharged from the truck. However, the Engineer must approve any placement of concrete in its final position in the forms that exceeds the Transit Time by greater than 15 minutes as covered in **346-7.2.2 Placement Time** and Table 4. In other words, if the Contractor expects to take more than 15 minutes to transport the concrete from the back of the truck to the point of final placement, the Engineer (District Materials Engineer) must approve a time extension.

Table 4 - Allowable Transit Time

Maximum Allowable Transit Time	
Non-Agitator Trucks	Agitator Trucks
45 minutes	60 minutes
75 minutes*	90 minutes*
*When a water-reducing and retarding admixture (Type D, Type G, or Type II) is used.	

346-7.6 Adding Water to Concrete at the Placement Site: Concrete Field Technicians that are responsible for ensuring that concrete consistency is acceptable are often unsure about when water may be added at the project site and when it may not be added.

- Water must not be added to concrete with a slump outside the Tolerance Range (too dry or too wet) but must be rejected and not placed. Concrete that is too dry is likely to be critically deficient because concrete this dry often indicates that the aggregates in the concrete are not fully saturated with water. When this happens, even if water is added on site to bring the mix into the tolerance range, the problem cannot be reliably corrected by simply adding water because aggregates can take up to 24 hours to fully saturate. This means that the mix may only stay in the tolerance range for a short time after adding water because the aggregates will draw moisture out of the paste. If enough water is absorbed, the concrete will again be too dry which would result in seriously deficient concrete that has already been placed. To make matters worse, it is highly likely that this deficient condition will not be revealed unless it results in a performance of durability problem at a much later date.
    - Note: The water level in the water storage tank on the truck should be checked upon the truck's arrival. Water missing from the water storage tank must be included as part of the jobsite water added.

- Concrete acceptance samples are required to come from the middle of the truck drum which will be cubic yards 4 through 7 for a 10 cubic yard drum. This means that a minimum of 3 cubic yards are placed in the component before plastic properties testing is started. If the tests require rejection of the concrete then the CEI inspector should record, in the daily diary, extents within the component the rejected concrete is located. This is very important, because if the cylinder breaks of the rejected concrete show low strength then the component they represent will have to be cored and the cores will have to be broken to verify whether or not the in place concrete also has low strength. Locating where coring is to be done is much more difficult if the location of the rejected concrete is not recorded during the placement operation.

Technicians are often unsure about when to perform a slump test other than for acceptance. The slump should be tested on the following occasions:

- A Concrete Field Technician (CEI or Contractor) must observe the consistency of the concrete for each truck arriving at the project site, even when not scheduled for acceptance testing, as discharge begins. The technician should look for signs of excessive dryness or wetness and if in the technician's judgment, one of these conditions exists then discharge should be stopped and a slump test should be performed. The result of the slump test will dictate an action: no water can be added, water can be added, or the load must be rejected. These observations of every truck are very important because as many as 18 loads (180 yd^3 when the QC sampling rate is every 100 yd^3) of concrete could be delivered between acceptance samples that are tested for plastic properties (slump, air, temperature). Therefore, if a responsible technician is not observing each load as it arrives then as many as 18 loads could be placed but be out of tolerance. This would happen without the Department knowing that potentially failing concrete was placed which could have significant consequences if the structure is compromised as a result.

- When a concrete truck arrives at the site and if the first slump test is in tolerance but too dry for the Contactor's purposes then water may be added after which a slump must be performed to verify that the adjusted slump is still in the tolerance range. After the water is added and before the slump test is performed, the truck drum must be rotated at least 30 revolutions at mixing speed.

- When a concrete truck arrives at the site and if the first slump test is in the too dry or too wet range (out of tolerance) the truck must be rejected and the plant must be notified of this and that an adjustment must be made to the mix that will result in concrete within tolerance. All unadjusted trucks that arrive at the site after the rejected truck must be slump tested since it is likely that they have out of tolerance concrete as well. Finally, when the first adjusted truck arrives at the site, it must be slump tested in order to verify that the adjustment was effective.

346-7.7 Sample Location: All concrete samples (initial and acceptance) must be taken at the point of discharge of the bucket unless the bucket can be fully discharged within 20 minutes in which case the sample may be taken from the end of the trough of the mixer truck. For all other transport methods (pump, conveyor, etc.) initial and acceptance samples must be taken from the discharge end of the transport device unless a correlation test is performed by the Contractor establishing how much the slump changes when a pump or conveyor is used. Department approval must be obtained to sample at the discharge of the mixer only. Approval may be obtained after submitting a sampling correlation procedure to the Engineer prior to placement of the concrete. For example, a sample is taken from the back of the truck and another sample of the same load is taken from the end of the pump hose. The slump of both samples is determined and the end of pump sample has ½" less slump than the back of the truck sample. If this same difference is repeated on a number of samples over a period of time then a consistent pattern or correlation of ½" inch loss due to pumping can be established. Thereafter, samples may be taken from the back of the truck as long as the recorded slump value is adjusted down by ½". However, if conditions change (average ambient air temperature changes by 15 degrees, pumping distance changes significantly, type of pump truck changes) then a new correlation test must be performed. Correlations may also be established when buckets are used to allow the concrete to be sampled at the back of the truck instead of at the point of discharge of the bucket.

346-8 Plastic Concrete Sampling and Testing: When there are multiple trucks that arrive to the discharge site, trucks other than that designated as QC may commence discharging before acceptance of plastic properties testing. In the event of failed QC testing all other trucks must immediately halt discharging and have plastic property tests performed:

When a truck designated for QC testing arrives at the discharge site, a subsequent truck may also discharge once a representative sample has been collected from the QC truck and while awaiting the results of QC testing. Reject non-complying loads at the jobsite. Ensure that corrections are made on subsequent loads. Immediately cease concrete discharge of all trucks if the QC truck has a failing test. Perform plastic properties tests on all trucks prior to the first corrected truck and the corrected truck. When more than one truck is discharging into a pump simultaneously, only the truck designated for QC testing may discharge into the pump to obtain a representative sample of concrete from the QC truck only.

346-12 Pay Reduction for Plastic Properties: This provision covers pay reduction for concrete placed in precast plants:

A rejected load in accordance with 346-6.4 is defined as the entire quantity of concrete contained within a single ready mix truck or other single delivery vehicle regardless of what percentage of the load was placed. If concrete fails a plastic properties test and is thereby a rejected load but its placement continues after completion of a plastic properties test having a failing result, payment for the concrete will be reduced.

The pay reduction for cast-in-place concrete will be twice the certified invoice price per cubic yard of the quantity of concrete in the rejected load.

The pay reduction for placing a rejected load of concrete into a precast product will be applied to that percentage of the precast product that is composed of the concrete in the rejected load. The percentage will be converted to a reduction factor which is a numerical value greater than zero but not greater than one. The precast product payment reduction will be twice the Contractor's billed price from the Producer for the precast product multiplied by the reduction factor.

If the Engineer authorizes placement of the concrete, even though plastic properties require rejection, there will be no pay reduction based on plastic properties failures; however, any other pay reductions will apply.

400 Concrete Structures

400-7.1 Weather Restrictions:

400-7.1.1 Concreting in Cold Weather: The temperature requirement for concreting in cold weather has changed as follows:Do not place concrete when the air temperature at placement is below ~~45ºF~~ *40ºF*.

400-7.1.3 Wind Velocity Restrictions: This Article states: *Do not place concrete for bridge decks if the forecast of average wind velocity at any time during the planned hours of concrete placement exceeds 15 mph. Obtain weather forecasts from the National Weather Service "Hourly Weather Graph" for the city closest to the project site.*

When the wind velocity exceeds 15 mph, rapid drying of concrete surfaces or excessive evaporation of surface moisture in the concrete cannot be controlled effectively using common practices. If uncontrolled, excessive drying is likely to cause cracking that is referred to as "plastic shrinkage cracking" since cracks form prior to initial set of the concrete while the concrete is still plastic.

This specification requires Contractors to consult the National Weather Service (NWS), Hourly Weather Graph, for wind velocity forecasts prior to a planned placement in order to determine if wind velocity will be a postponing factor. CEI staff should also check the NWS website in order to verify that the Contractor has satisfied the specification requirement properly. The NWS home page can be accessed at the following link: http://www.weather.gov**.** On the NWS home page, input the name of the city closest to the project site in the window at the top left of the screen and press ENTER. A new page will be displayed and at the bottom, select "Hourly Weather Forecast" which will automatically display weather forecast data including wind velocity 48 hours in advance of the input time. An example Hourly Weather Forecast can is shown in Figure 4.

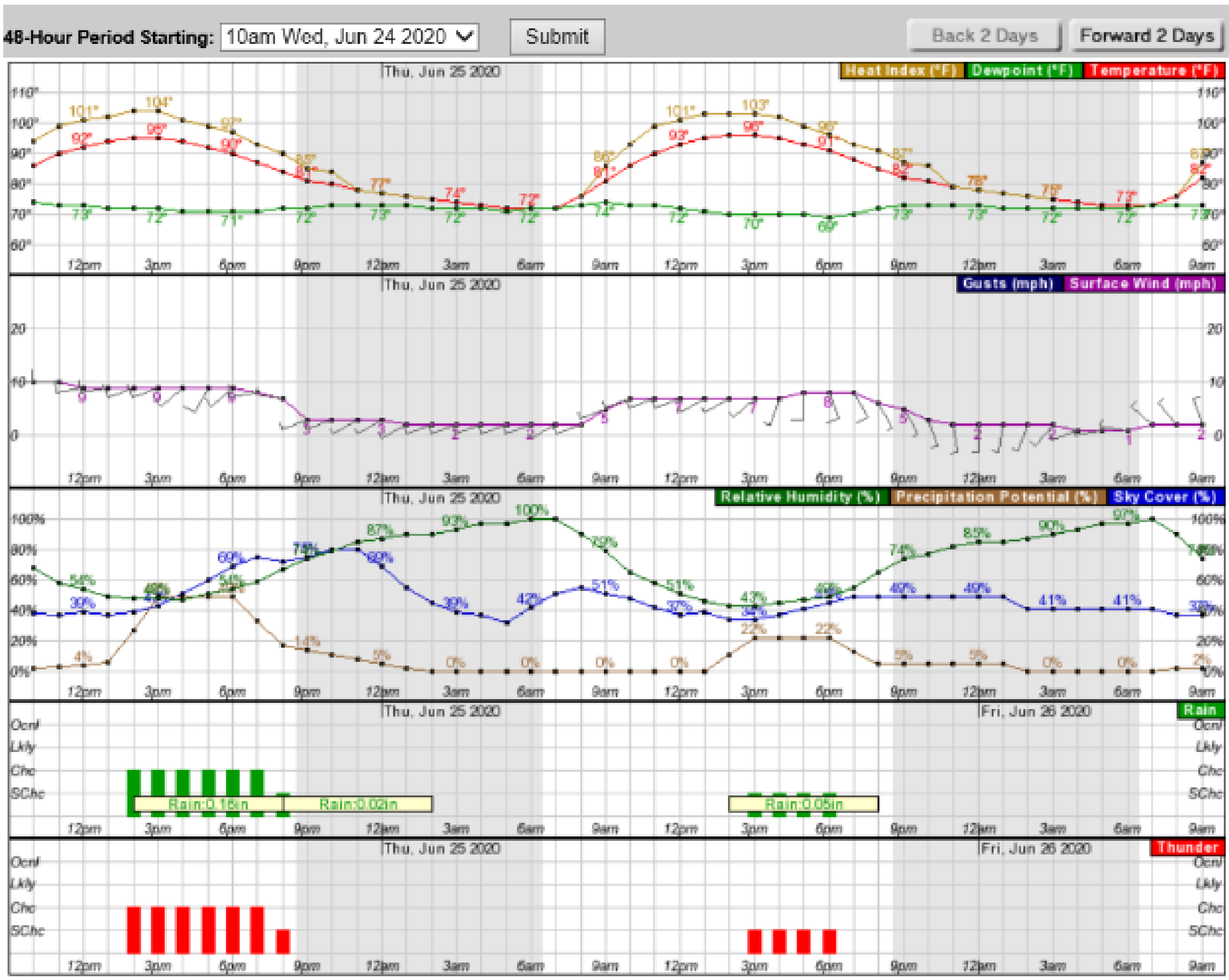

Figure 4 - Example Hourly Forecast

400-7.10 Requirements for Successive Layers: The maximum layer thickness is limited to 20”, and to avoid cold joints ample vibration of the concrete must be provided per 400-7.11.

400-11.3 Bearing Pads: This provision was implemented to ensure that elastomeric bearing pads are not overextended or damaged prior to final acceptance. Since the Contractor has no practical way of avoiding an occasional overextension, the effort for performing a correction if needed will be considered as extra work with corresponding reimbursement. CEI staff shall thoroughly inspect all elastomeric bearing pads for excess deformation and general condition prior to final acceptance, and if possible, well before, to provide the Contractor has ample time to perform corrections before final acceptance.

The Engineer will evaluate the degree of deformation and condition of bearing pads in the completed bridge on or before the final inspection required by Specification 5-10 or when requested by the Contractor. As directed by the Engineer, correct horizontal bearing pad deformations that at the time of inspection exceed 50% of the bearing pad thickness or that the Engineer predicts will exceed 50% of the bearing pad thickness during future high or low temperature periods. Payment for this correction effort will be considered extra work in accordance with 4-3.

400-15.1 General Surface Finish (Required for All Surfaces): The use of Class 5 finish on projects is less common than in previous years, due to changes in the specification. Consequently, 400-15.1 contains language regarding patching materials more closely matching the color of the base concrete since the natural concrete color is the final finish for most structures (walls and bridges). The specification requires patching mortar that is either a blend of the mix ingredients of the base concrete or a custom blend of white cement and gray cement that closely matches the color of the base concrete. Additionally, the surface texture of patched areas must match the base concrete. The intent of the specification here is for the final concrete surface finish, without rubbing and after patching of flaws is complete, to have a color and texture that will be uniform and patched areas made unnoticeable.

400-15.2 Surface Finishes:

400-15.2.4 Class 3 Surface Finish: Class 3 finishes require the use of a form liner. Form liners are almost always used to produce a surface finish having a pattern or texture that has a pleasing appearance.

400-15.2.6.4 Application of Class 5 Applied Finish Coating: The duration of the service life for Class 5 finish is governed by the quantity of coating that is applied: the less coating applied the shorter is the service life assuming that proper application procedures are followed. CEI staff must verify compliance with the spread rate on all projects with coatings. Records must be made showing the number of gallons that were used to coat a given square footage of surface as well as the resultant spread rate in square feet/gallon. Per the Specification the finished coating shall be applied at a rate of 50 ft^2/gal plus or minus 10 ft^2/gal. The Contractor may produce these records but their accuracy must be verified by the CEI staff. If, for any reason, the CEI staff considers the number of gallons used to be in question or if CEI staff is unable to witness the coating being taken from source containers during application then the coating thickness can be measured to confirm that it is in compliance; however, the thickness may not exceed 1/8" because a coat that is too thick is much more likely to peel or flake. If the coating thickness needs to be measured, contact the State Materials Office to find out how best to determine the required coating thickness and how to measure it.

400-16.1 Curing Concrete - General: This specification emphasizes the importance of controlling moisture evaporation from concrete surfaces prior to application of curing compound and what measures should be implemented to prevent excessive evaporation.

Until curing has begun, retain concrete surface moisture at all times by maintaining a surface moisture evaporation rate less than 0.1 pound per square foot per hour. Periodically, at the site of concrete placement prior to and during the operation, measure the ambient air temperature, relative humidity and wind velocity with industrial grade weather monitoring instruments to determine the on-site evaporation rate. If the evaporation is, or is likely to become 0.1 pound per square foot per hour or greater, employ measures to prevent moisture loss such as application of evaporation retarder, application of supplemental moisture by fogging or reduction of the concrete temperature during batching. Compute the evaporation rate by using the nomograph in the ACI manual of Concrete Practice Part 2, Section 308R, Guide to Curing Concrete, or by using an evaporation rate calculator approved by the Engineer.

Devices that measure ambient air temperature, humidity and wind velocity are available as separate devices or in one device. There is also a device that will display evaporation rate directly an example of one is shown in Figure 5. These devices are carried by Kestrel Weather Meters® and may be available from other suppliers as well. Evaporation rate input parameters (concrete temperature, ambient air temperature, humidity, and wind velocity) can be measured separately with less sophisticated devices and then used as input with the ACI nomograph to determine the evaporation rate.

Figure 5 - Weather Meter for Evaporation Rate

Evaporation rate increases dramatically as wind velocity increases and humidity decreases so careful monitoring is particularly important during times of the year when humidity is low and wind velocity is high such as Spring and Fall. Of course, very hot weather will always produce increased evaporation, because the hotter the concrete gets the higher is the rate of moisture loss regardless of wind velocity or humidity, so careful monitoring during very hot weather is always critical. Table 5 contains examples of typical weather conditions at different times of the year in Florida with their corresponding evaporation rates.

Table 5 - Weather Conditions & Evaporation Rates for Florida

Sample Weather Data for Various Florida Seasons with Corresponding Evaporation Rates					
Typical Florida Season	**Ambient Air Temperature (°F)**	**Relative Humidity (%)**	**Concrete Temperature (°F)**	**Wind Velocity (mph)**	**Evaporation Rate (lbs/ft²/hr)**
Windy Winter Day	65	25	80	15	0.34
Summer Day	90	65	95	10	0.19
Summer Night	72	90	85	5	0.08

As can be seen in Table 5, a cool windy winter day produces the highest evaporation rate which far exceeds the 0.1 lbs/ft^2/hr limit. This means that the Contractor will have to employ measures to control the evaporation rate such as the application of evaporation retarder: an inexpensive fluid that is sprayed onto the surface which holds in moisture. The summer night condition is below the 0.1 lbs/ft^2/hr limit, so no measures are required. The CEI staff should make Contractors aware of the fact that evaporation rates are low at night. Other advantages of night placements include: reduced traffic congestion that can delay concrete delivery, concrete plants are likely to be producing concrete for their project only therefore production will be less stressed and more timely, and easier working conditions for workers. CEI staff should verify that the Contractor is measuring evaporation rates accurately by performing independent weather data gathering and evaporation rate determinations using weather monitoring instruments of their own. The specification does not directly penalize the Contractor for failing to control the evaporation rate; however, deliberate violation of this specification must be reflected in the Contactor's Past Performance Report (CPPR) and the cracks that may result from a violation, with ensuing repair costs, can be a very negative consequence.

400-16.2 & 400-16.4 Curing Concrete - Methods & Bridge Decks and Approach Slabs: The proper application of curing compound may be the most important curing requirement performed, so it is critical that it be done correctly. Curing compound must be applied at a spread rate of not less than 1 gallon per 150 square feet and within 120 minutes of initial concrete placement. At this coverage rate, the deck surface should look completely white after application of the compound and should not have any areas that appear to be uncoated or where coating thickness is obviously deficient. Curing compound must also be applied to deck areas that will be beneath barrier walls. Prior to concrete placement, the Contractor is required to tell the Engineer how the number of gallons of curing compound will be measured. For example, a graduated rod that reads gallons will be lowered into a 55 gallon drum of curing compound and will directly measure remaining gallons. The Contractor is also required to report to the Engineer how many gallons, at the required spread rate, it will take to meet the specification requirements prior to application, and finally, the Contractor is required to report to the Engineer the actual gallons used after completing application.

Compound should be applied to a deck while the surface is still damp, after pooled water has evaporated; however, compound will be effective even if diluted somewhat because the deck is still a little wet. Waiting until there is no doubt that the surface is at the damp state, instead of wet, may result in a surface that has dried beyond the damp condition. It is better for the compound to be diluted a little but still be effective then to apply the compound to a deck that is too dry. However, compound should not be applied to a deck with areas of standing water.

400-16.6 Curing Concrete - Concrete Barriers, Traffic Railings, Parapets and End Posts: Slip formed barrier walls require the use of self-supporting concrete which has minimal moisture content. Because of the low moisture content, exposed barrier wall surfaces dry rapidly which can cause cracking. In order to prevent excessive drying, the specification requires the application of curing compound within 30 minutes of concrete extrusion or loss of water sheen whichever comes first. The application rate must be 1 gal/150 square feet and the Contractor must report his method for measuring the gallons of compound used as well as how much was used after application. To maximize the effectiveness of the curing compound, it must not be removed prior to seven days after application. CEI staff should verify that the Contractor complies with the curing compound spread rates and duration of coverage.

Contractors may also apply Type I-D clear curing compound onto traffic barriers, railings, parapets and end posts that will not have a Class 5 finish. This eliminates the need to remove the compound since it is not visible as is the Type II pigmented compound. The clear compound will be required to contain a fugitive dye which shows color for a minimum duration – at least 4 hours – before it fades and is no longer visible. The dye allows inspectors to verify that the compound is applied uniformly.

400-19 Cleaning and Coating Concrete Surfaces of Existing Structures: This provision explains how concrete surfaces of existing structures are to be cleaned and coated.

For the purposes of this Article, an existing structure is one that was in service prior to the start of the project to which this specification applies. For existing structures, clean concrete surfaces that are designated in the Contract Documents as receiving Class 5 Applied Finish Coating by pressure washing prior to the application of coating. Use pressure washing equipment producing a minimum working pressure of 2,500 psi when measured at or near the nozzle. Do not damage or gouge uncoated concrete surfaces or previously coated concrete surfaces during cleaning operations. Remove all previously applied coating that is no longer adhering to the concrete or that is peeling, flaking or delaminating. Ensure that after the pressure wash cleaning and the removal of non-adherent coating, that the cleaned surfaces are free of efflorescence, grime, mold, mildew, oil or any other contaminants that might prevent proper adhesion of the new coating. After cleaning has been successfully completed, apply Class 5 Applied Finish Coating in accordance with 400-15.2.6 or as otherwise specified in the Plans.

400-21 Disposition of Cracked Concrete: This specification takes into account additional factors that influence how best to repair a crack. The elevation is important because the closer a cracks is to, or propogates toward salt water, the more likely the steel reinforcement is to corrode prematurely.

The Article applies to both cast-in-place concrete components and precast components with the exception of those covered by Specification 449, Precast Concrete Drainage Products. It applies to precast components only after the component has been installed since precast components are produced in a plant and the specifications that govern plant operations contain provisions for dealing with cracks if they happen while still in the plant. Nonstructural cracks are now defined as having a depth of not greater than ½" unless the Engineer determines that a crack is nonstructural even if greater than ½" deep. Cracks with depths greater than ½" or that are partially or completely submerged during their service life, are considered to be structural unless they are in a slightly aggressive environment. The repair of nonstructural cracks was previously based on computing the average width of all cracks in a LOT and then using that crack width to determine one type of repair for all the cracks in that LOT. Cracks are now required to be repaired, as shown in Table 2, according to their individual width. The reason for this change is because in any LOT, cracks may vary in width from very narrow to very wide. When cracks are very narrow they rarely need any correction and when cracks are very wide they usually need extensive correction; however, by applying the average crack width, as before the specification was revised, narrow cracks may have required unnecessary repairs and wide cracks might not have been repaired adequately.

400-21.3 Classification of Cracks: All cracks in concrete decks on beams are classified as nonstructural unless the Engineer decides that they are structural. This means that with rare exception, correction of cracks in decks will be determined by following the tables within 400-21, which will not require the Contractor to submit a repair proposal by a professional engineer, so resolution time and expense will be reduced. Nearly all deck crack repairs whether structural or nonstructural require either penetrant sealer, methylcrylate, or epoxy injection; therefore, since all these are covered well by the tables within 400-21, no other action is needed. This provision applies only to concrete decks on beams and not to other components such as beams, caps, columns and footings.

415 Reinforcing for Concrete

415-5.1 Placing and Fastening - General: The significance of this provision is that a concrete cover tolerance is required.

Unless otherwise specified in the Contract Documents, the tolerance for bar spacing is plus or minus 1 inch from the plan position and the tolerance for concrete cover is minus 1/4 inch or plus 1/2 inch from the plan dimensions.

415-5.13 Bar Supports: The requirements for bar supports on stay-in-place and removable forms are as follows:

When using bar supports on corrugated metal stay-in-place forms, use supports specifically designed for the form being used.

For structural elements located in extremely aggressive environments, do not use metal bar supports in contact with removable forms or floor surfaces to support reinforcing bars.

415-5.13.2 Metal Bar Supports: *For metal bar supports in contact with removable forms, provide supports constructed with molded plastic legs or plastic protected metal legs or bolster rails. Do not allow any portion of the bar support other than the molded plastic leg or plastic protected portion of the metal leg or bolster rail to be closer than 1/2 inch from the removable form surface for concrete to be cast.*

Specific strength requirements for bar supports are described in **415-5.13.1**, and the specification requires them to function without permanent deformation or breakage and with deflection less than 5% of the support height under load. No more than 5% of the reinforcing bar supports shall exhibit unsatisfactory performance, breakage, or permanent deformation during bar tying and/or concrete placement operations. If a bar support does not achieve this level of performance, the average spacing between bar supports shall be reduced by 15%, or remove that product from use on the job.

416 Installation of Post-Installed Anchor Systems and Dowels for Structural Applications in Concrete Elements

416-6.1 Field Testing of Post-Installed Anchor Systems and Dowels - General: Dowels that are used to connect a new bridge barrier wall to an existing bridge curb are examples of adhesive-bonded anchors. These types of anchors are installed by drilling a hole, filling it with an approved adhesive and then inserting the anchor dowel into the hole which squeezes out the excess adhesive. These type anchors are designed to develop high levels of pull out resistance as required during a vehicle impact which makes it critical that they not fail. In order to ensure that the likelihood of failure is very low, the installed anchor dowels are randomly tested (restrained static tension tests per ASTM E-488) by attaching them to a jack that applies the minimum specified pull out force they must be able to resist. In the past, the number dowels that were required to be pull out tested were a minimum of 10% per LOT; however, it was determined that 10% was an unnecessarily high sampling rate so it was changed and is now 4 randomly selected anchors within a LOT and a LOT can contain a maximum of 100 anchors, or dowels. If the pullout tests consistently pass then the testing rate may be reduced to 2% and even to 1%. In the case of a failed test, two additional field tests must be performed and testing for the next LOT will require a return to the rate of 4 per LOT.

This Subarticle requires testing of anchors at least once per day which was not the case prior to the revision. It is also very important that a qualified inspector observe the testing of dowels and record the results, or obtain a copy the Contractor's test record for the project file. The installation of dowels shall be observed by a qualified inspector.

416-6.1.1 Adhesive-Bonded Anchors: Field testing of anchors that are not quantified in the Contract Documents will be paid for by the Department as shown below in underlined italics.

Field test installed anchors and dowels for applications connecting traffic railings to bridge decks, approach slabs and concrete pavement using Type HSHV adhesives. The Engineer may also require field testing of installed anchors and dowels for other applications. Any field testing of installed anchors which is required by the Engineer and not quantified in the Contract Documents shall be paid for by the Department unless a failure occurs during the field testing.

The specification requires the pulling force to be 85% of the specified bond strength of the adhesive but not more than 90% of the yield strength of the dowel. However, in the case of proof loading of base plate anchor bolts in Standard Plans 460-470, Traffic-Railing (Thrie-Beam Retrofit), and for Dowel bars in Standard Plans 521-480, Traffic Railing (Vertical Face Retrofit), the pulling force shall be as specified in the Traffic Railing Notes under Adhesive-Bonded Anchors and Dowels of index 460-470, or 521-480. For example: a pulling force of 15,000 lbs. is required by index 460-470 for a 7/8" diameter anchor bolt.

450 Precast Prestressed Concrete Construction

450-2.3 Quality Control Program - Tolerances: This specification requires the Contractor to measure and record beam camber once per month while beams are in storage at the plant and to maintain records for review by the Engineer: measurements are actually done by the beam Producer. As mentioned in this course under Miscellaneous Specification Related Issues, Topic A, Excessively Thick Beam Buildups, the Contractor should review these records before pier/bent cap pedestal construction begins so that elevation adjustments can be made if camber measurements are significantly different then are the estimates shown in the plans. By doing this, the Contractor will be able to avoid excessively thick beam buildups, the consequences of which are covered in aforementioned Topic A. CEI staff should remind the Contractor that the measurement information is available and is vital for avoiding excessively thick buildups.

450-10.5 Concrete Operations - Finishing:

450-10.5.2 Beams: For external surfaces except for the top surface, a General Surface Finish must be applied in accordance with **400-15.1**, unless otherwise specified. A roughened surface that provides mechanical bond with the deck is required for the top surface of beams.

450-10.5.4 Slabs and Double-T Beams: Top surfaces are to have an applied Class 4 floor finish when they are to be the riding surface, unless otherwise shown. A General Surface Finish is required for all other external surfaces, unless otherwise specified.

450-12 Non-complying Prestressed Products: When a precast prestressed concrete product does not comply with the requirements of Section 450 or is damaged, CEI's must verify that Contractor's and Producer's are fully complying with all requirements for evaluating and disposing of deficiencies. **You have not completed the review of this course until you have read the latest version of 450-12 in its entirety.**

450-13 Repair Methods and Materials: CEI's must verify that Contractor's and Producer's are fully complying with this specification. **You have not completed the review of this course until you have read the latest version of 450-13 in its entirety.**

455 Structures Foundations

455-1.1 Monitor Existing Structures: This specification requires existing structures to be monitored in accordance with Section 108. CEIs will need to be familiar with this section completely. **You have not completed the review of this Supplement, until you have read the latest version of Section 108 in its entirety**.

455-5.12 Methods to Determine Pile Capacity: This specification addresses the use of externally mounted instrument system and signal matching analyses or internal gauges as follows:

455-5.12.1 General: CEIs must be aware of the following provision:

Dynamic load tests using an externally mounted instrument system and signal matching analyses or internal gauges will determine pile capacity for all structures or projects unless otherwise shown in the Plans. When necessary, the Engineer may require static load tests to confirm pile capacities. When the Contract Documents do not include items for static load tests, the Engineer will consider all required static load testing Unforeseeable Work. Notify the Engineer two working days prior to placement of piles within the template and at least one working day prior to driving piles. Do not drive piles without the presence of the Engineer.

If the internally mounted system fails to communicate properly with the receiving system, allow the Engineer sufficient time to mobilize back-up equipment for performing dynamic load testing.

455-5.12.7 Structures without Test Piles: CEIs must be aware of the following provision:

For structures without 100% dynamic testing or test piles, the Engineer will dynamically test the first pile(s) in each bent or pier at locations shown in the plans to determine the blow count criteria for the remaining piles. When locations are not shown in the plans, allow for dynamic load tests at 5% of the piles at each bent or pier (rounded up to the next whole number). If the Engineer requires additional dynamic load tests for comparison purposes, the Contractor will be paid as for an additional dynamic load test as authorized by the Engineer in accordance with 455-11.5.

Allow the Engineer one working day after driving the dynamic load tested piles to complete the signal matching analyses and determine the driving criteria for the subsequent piles in the bent or pier.

455-7.2 Prestressed Concrete Piling - Manufacture: This specification reads as follows:

Fabricate piles in accordance with Section 450. When internal gauges will be used for dynamic load testing, supply and install in square prestressed concrete piles in accordance with Standard Plans, Index 455-003. Ensure the internal gauges are installed by personnel approved by the manufacturer.

455-16.4 Nondestructive Integrity Testing Access Tubes: This specification describes material requirements for TITDS and CSL tubes:

Access tubes from the top of the reinforcing cage to the tip of the shaft shall be NPS 1-1/2 Schedule 40 black iron or black steel (not galvanized) pipe. Access tubes above the top of the reinforcing cage may be the same black iron or black steel pipe or Schedule 40 PVC pipe.

455-17.6.1 Thermal Integrity Testing for Drilled Shafts (TITDS): TITDS testing is required on all bridge shafts in bridge bents or on piers considered as nonredundant in the Plans. TITDS testing must be performed between the minimum and maximum times shown in Table 6 after the batching time of the first truck load placed in the drilled shaft.

Table 6 - Timeframe for TITDS

Shaft Diameter (inches)	Minimum time (hours)	Maximum time (hours)
36-48	24	54
49-60	24	72
61-72	24	72
73-84	24	90
85-120	24	108

455-17.6.2 Cross Sonic Logging (CSL) and Tomography: When requested CSL testing in accordance with ASTM D6760 will be performed for the purpose of evaluating drilled shaft integrity via first pulse arrival time (FAT) versus depth and pulse energy versus depth.

460 Structural Steel and Miscellaneous Metals

460-5.2 Bolted Connections - Testing:

460-5.2.1 Rotational Capacity (RC) Tests: A Rotational Capacity test must be performed at the project site on two bolt assemblies (bolt, nut and washer) of each LOT. The purpose of the test is to make sure that the bolt assembly, not only has the minimum tension strength required by the specification, but that it also has a certain amount of reserve tension strength that provides a factor of safety. Without reserve strength, bolts would fail too often because the tightening process is not precise enough to avoid over tightening of bolts well beyond the required minimum strength. The reserve strength significantly reduces the number of failed bolts that have to be removed and replaced during assembly of connections. The RC test requires the bolt assembly to be placed in a Skidmore Tension Analyzer (see Figure 6) and then tightened according to the procedure specified in Florida Method (FM) 5-581 (long bolts) or FM 5-582 (short bolts). The Skidmore directly measures the tension in the bolt as it is tightened and displays the tension force in kips on a dial gage attached to the load measuring device.

Figure 6 - Skidmore Tension Analyzer

For long bolts, the bolt assembly must pass the following three performance measures that are determined by the RC test before the LOT can be accepted: (1) bolt tension strength must be developed that meet, or exceed the values shown in Table 7 (Section 3.7, FM 5-581); (2) the torque, applied by a calibrated torque wrench and measured in foot-pounds, required to develop the minimum tension must not exceed the limit that is calculated by the formula: 0.25 X Bolt Diameter X Tension Force; and (3) after the test, the nut must be able to be removed from the bolt with minimal effort.

Table 7 – Required Tested Tension in FM 5-581

Bolt Dia. (in.)	1/2	5/8	3/4	7/8	1	1 1/8	1 1/4	1 3/8	1 1/2
ASTM A 325 Bolt – Tension (kips)	14	22	32	45	59	64	82	98	118

The Contractor's technician must perform the RC test which must be witnessed by a CEI inspector who shall verify that the test is performed in full compliance with the applicable Florida Method. The inspector must be experienced and knowledgeable about the test method and required documentation. The Contractor must record the test data (tension value, torque value, required tension, maximum required torque, etc.) and the inspector must verify the accuracy of the data and retain a copy for the CEI project records. The SPE/PA must review the test procedure with the Contractor prior to the first test and the Contractor's data collection form must be reviewed for adequacy and completeness prior to use.

460-5.4 Assembly of Bolted Connections:

460-5.4.8 Turn-of-Nut Tightening: Each day that bolts are being installed in a permanent structure, a test must be performed to determine what bolt torque will be needed to snug the connection. The connection is snugged or is "Snug Tight" when the surfaces of the connection plates, referred to as the faying surfaces, are in firm contact, meaning the plies of the faying surface are solidly seated, but not necessarily in continuous contact. If the connection has been snugged properly then when the bolt is turned a further measured amount, that is called out in the specification, the resulting tension in the bolt will be at least the minimum required by the specification for a fully tightened bolt. The procedure used for turning the nut after snugging is referred to as the "Turn-of-Nut" method which is explained in detail in **Section 649-5** of this document.

A "Daily Snug Tight Torque Test" (Specification 460-5.4.8) is required to be performed on 5 bolt assemblies each day for each LOT and the average of 3 tests – the highest and lowest of the 5 are not used – becomes the "Daily Snug Tight Torque". The test must be performed by the Contractor's technician and must be witnessed by the CEI inspector and requires the use of a Skidmore Tension Analyzer. The correct snug tight torque for that day is determined by tightening the nut using a spud wrench or an impact wrench to a trial tension as measured by the Skidmore after which the nut receives further tightened using the Turn-of-Nut method. If the Skidmore shows a tension after the Turn-of Nut that is at or slightly above 1.05 times the minimum final tension then the trial snug tight tension is acceptable. If the minimum final tension is not produced by the turned nut then a new higher trial snug tight tension must be applied and the procedure repeated until an acceptable minimum final tension is produced by the trial snug tight tension. Once the correct snug tight tension is established then the remaining bolts must be tested using the same snug tight wrench settings or turning force used for the trial bolt. The test data for all 5 bolts must be recorded on the Contractor's form and the average of the middle 3 results will be the snug tight torque that must be used all that day.

460-5.4.8.1 Snug Tight Condition: This specification requires bolts to be tightened to 1.05 times, or an additional 5% above, the minimum required tension specified in **460-5.4.6**. For example, the minimum required tension is 39 kips for a 7/8" diameter bolt. The added 5% results in a minimum required final tension for a 7/8" bolt of 40.95 kip or 41 kips rounded to the nearest kip. Specification **460-5.2.1** requires each LOT of bolts to be Rotational Capacity tested to the values shown in Table 7 (Section 3.7, FM 5-581), which for a 7/8" bolt, is 45 kips. As a practical maximum, the final tension for 7/8” bolts in production assemblies should not exceed the minimum required test tension, which is 45 kip for a 7/8” bolt.

The daily snug tight torque test must be performed each day because the snug tight torque can vary significantly from day to day due to a number of factors that influence the degree of contact friction between the nut and bolt surfaces. These factors are as follows: temperature of the nut and bolt, relative humidity, smoothness and cleanliness of the contact surfaces, and degree of lubrication. A high level of bolt cleanliness and lubrication must be maintained by properly protecting the bolt assembles from the elements at all times while they are in storage.

The Contractor must record the test data (tension values, torque values, required tension, average torque, etc.) and the inspector must verify its accuracy and retain a copy for CEI project records. The SPE/PA must review the daily snug tight test procedure with the Contractor prior to the first test and the Contractor’s data collection form must be reviewed for adequacy and completeness prior to use.

Once the daily snug tight torque is determined then installation of bolts in the connection can begin. The inspector must witness this process and the order in which the bolts must be tightened, referred to as the sequence of bolting (see Figure 7) must be followed for snugging and for final Turn-of-Nut tightening. As can be seen in Figure 7, the bolts at the center of the connection are tightened first followed by the bolts that are farther and farther out. Following this sequence is very important because if the connection plates are warped, this sequence will usually remove the warps as the sequence progresses. If the sequence is not followed then the warps will not be removed which is likely to result in loosening of the initially tightened bolts as the sequence progresses.

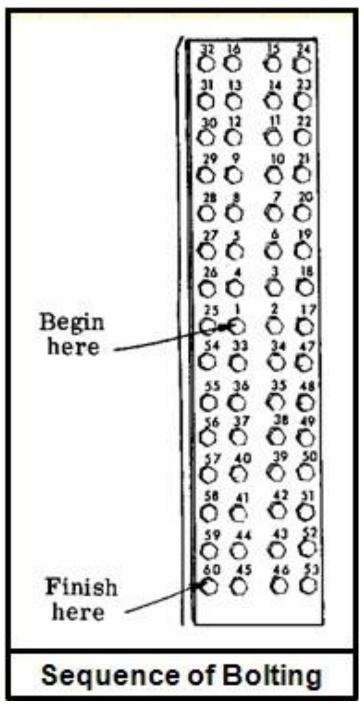

Figure 7 – Example Bolting Sequence

Once the Contractor is satisfied that all bolts in the connection are snug tight and that all faying surfaces are in contact then the CEI inspector must personally verify that the bolts have the correct daily snug tight torque by checking the torque of 3 bolts or 10% of the bolts whichever is larger (**Specification 460-5.4.11**). Figure 8 shows an inspector performing a torque verification test on a box girder connection with hundreds of bolts. If a sample bolt fails the test then all bolts in the connection must be torque tested and the Turn-of-Nut must not be applied until all bolts have the required snug tight torque value.

The CEI inspector must record the results of verification testing and this information must be kept on file in the project records.

Figure 8 – CEIs Performing Verification Tests for Snug Tightness

460-5.4.9 Direct-Tension-Indicator (DTI) Tightening: Another method for ensuring that bolts are tightened to the minimum tension required by the specification, other then Turn-of-Nut, is to use a Direct Tension Indicator (DTI). A DTI looks like an ordinary washer except that its surface has a number of protrusions as seen in Figure 9. The DTI is placed between the bolt head and the plate with the protrusions against the bottom of the bolt head as seen in Figure 10. Prior to tightening the nut, there is an initial gap between the bottom of the bolt head and the top of the DTI because of the protrusions. As the nut is tightened, the protrusions are crushed which reduces the initial gap and when it is not more than 5 mils, as determined by a feeler gage, then the minimum bolt tension has been achieved. The gap may be less than 5 mils but should never be zero since this may be an indication of over tightening.

Figure 9 - DTI Examples

DTI's are very accurate and can be more economical for achieving the minimum tension then is the Turn-of-Nut method because they require far less bolt installation labor since match marking and daily snug tight tests are unnecessary. A type of DTI referred to as a "Squirter" DTI has orange gel in the voids behind the protrusions as seen at the far right of Figure 9. When the 5 mil gap is achieved, the gel squirts out the sides of the DTI which eliminates the need for a feeler gage during the tightening process. If DTI's are used, the CEI inspector must verify each gap with a feeler gage, even when squirter DTIs are used, and the procedure for doing this is covered by **Specification 460-5.4.9.2**. In addition to the RC test required by **Specification 460-5.2.1**, an additional test is required for DTIs to verify that DTI LOTs are accurate and this is covered by **Specification 460-5.2.2**.

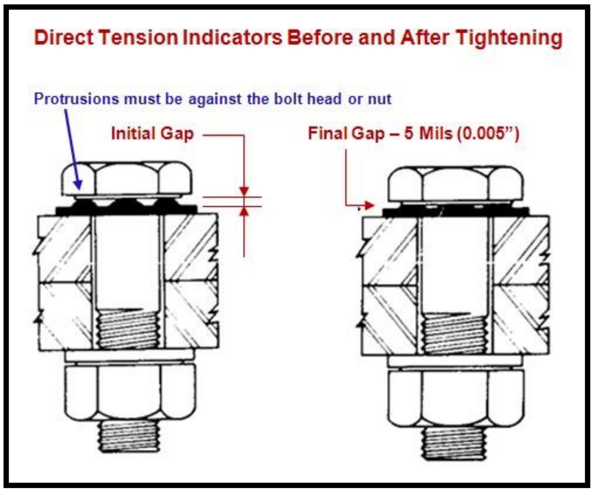

Figure 10 – Bolt Correctly Tightened Using a DTI

The Contractor and CEI inspector must keep appropriate records of DTI tests and of the tightening operation and these records must be kept on file. The SPE/PA must review the test procedures and tightening procedures with the Contractor prior to the first test and tightening operation and the Contractor's data collection form must be reviewed for adequacy and completeness prior to use.

460-7.1 Pre-erection Requirements:

460-7.1.3 Erection Plan: This Article requires the Contractor to submit an erection plan that addresses 9 categories of information related to erecting steel components of the project. The submittals must comply with **Specification 5-1.4** and are required for all steel erection operations whether they affect public safety or not. It is the responsibility of the SPE/PA to review these plans for completeness and conformity to contract documents and not for approval; however, if the SPE/PA has issues then these should to be addressed by the Contractor before the work begins. The erection plan must be signed and sealed by a Specialty Engineer and must have calculations when warranted. If public safety is affected then shop drawings must be submitted to the EOR for review and a pre-erection meeting must be held by the Contractor two weeks prior to work at which the Specialty Engineer and SPE/PA must be present.

Erection shop drawings will no longer be required to show all underground utilities and the decision regarding what underground utilities are shown will be the responsibility the Specialty Engineer that prepares the shop drawings.

460-7.2 Special Requirements for Uncoated Weathering Steel: The Department prefers all structural steel superstructures to be fabricated with weathering steel unless prohibited by site conditions (proximity to coast and vertical and horizontal clearances to a body of water). Weathering steel does not require painting, which will reduce maintenance costs significantly over the life of the bridge. Some exceptions will be permitted but they must be approved by the Chief Engineer which will require rigorous justification by the District. The specification has been revised as shown below and generally has to do with protecting concrete surfaces from corrosion staining. Figure 11, Figure 12, and Figure 13are drawings take from the FDOT Structural Detailing Manual that show designers how to prevent drainage water from causing rust stains on concrete elements. CEIs should verify that these details have been provided and that they are effective. If they are not effective, the EOR shall provide revised details and these shall be implemented through a Supplemental Agreement.

460-7.2.2 Steel Preparations: CEIs must be aware of the following provision:

Prior to erection, perform the following as appropriate:

*Blast clean the exposed fascia of the exterior girders (both I and box) to meet SSPC-SP10 criteria; blast clean the remaining exposed surfaces of steel trapezoidal girders, not required to be prepared otherwise, to meet SSPC-SP6 criteria; for steel I-girders, if a non-uniform mill scale finish has developed, as determined by the Engineer, blast clean all remaining exposed surfaces, not required to be prepared otherwise, to an SSPC-SP6 criteria; coat the inside of box members including, but not limited to, all bracing members, cross frames and diaphragms in accordance with **Section 560**. Coat the exterior face of box girder end diaphragms and all interior surfaces of box girders extending beyond the end diaphragm with an inorganic zinc coating system in accordance with **Section 560**.*

460-7.2.3 Concrete Substructure Preparations:

460-7.2.3.1 Substructure Areas Not Receiving Class 5 Finish: CEIs must be aware of the following provision:

*Prior to erection of the girders, cover all exposed substructure concrete surfaces to protect them against staining from the weathering steel components. Leave the covering in place until after placement of the concrete deck. As directed by the Engineer, clean all visible stains on concrete in areas not receiving a Class 5 Finish by sandblasting and follow-on cleaning using a stain remover or commercial cleaner after completion of the structure in accordance with **Section 400**.*

460-7.2.3.2 Substructure Areas Receiving a Class 5 Finish: CEIs must be aware of the following provision:

If the Class 5 Finish is to be applied prior to the placement of the concrete deck, cover all finish concrete surfaces after application and curing of the Class 5 Finish to protect them from staining from the weathering steel components. Leave the covering in place until after placement of the concrete deck. Upon removal of the covering, reapply the Class 5 Finish to cover any stains which may be present.

If the Class 5 Finish is to be applied after placement of the concrete deck, no substructure covering will be required.

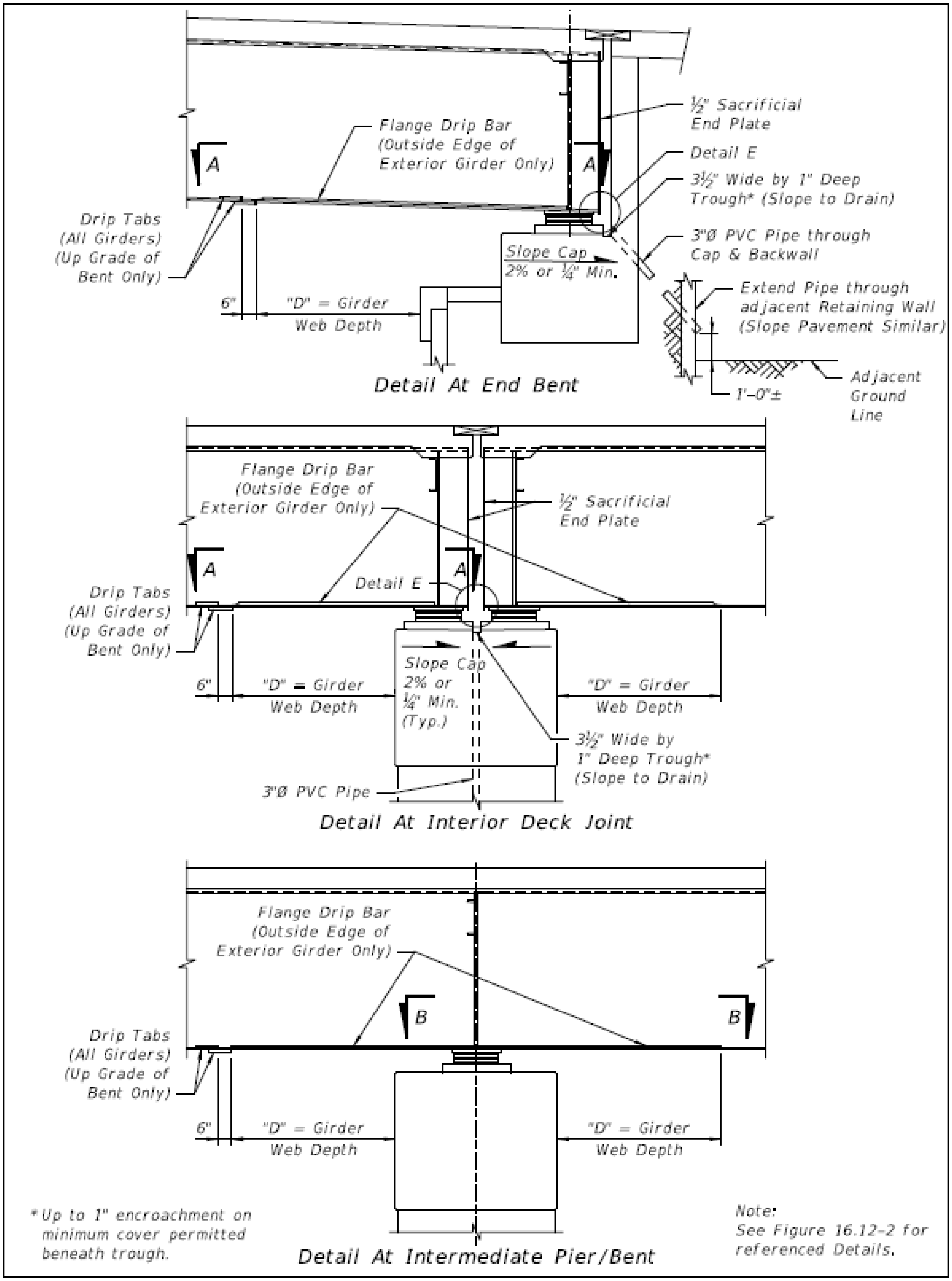

Figure 11 – Weathering Steel I-Girder Details (1 of 2)

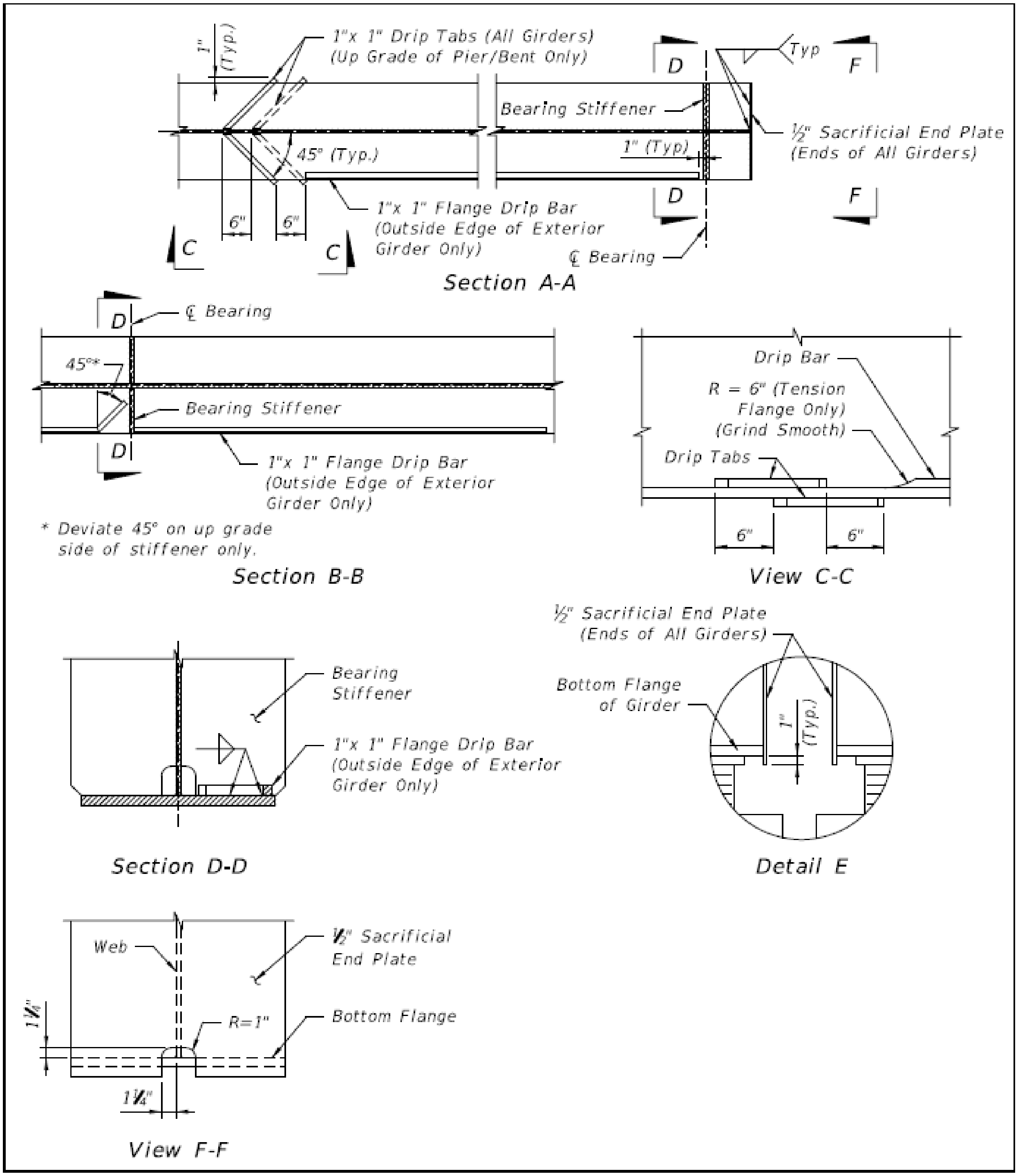

Figure 12 - Weathering Steel I-Girder Details (2 of 2)

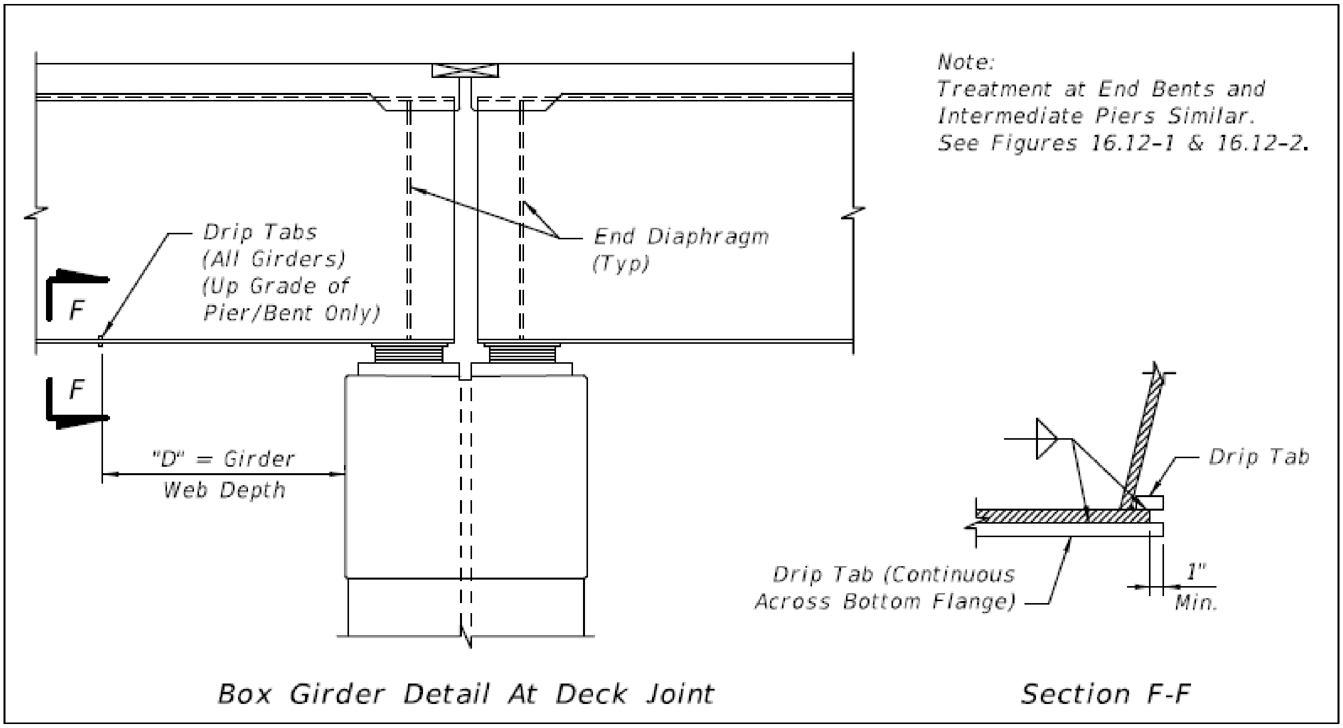

Figure 13 - Weathering Steel Box Girder Details

460-7.5 Preparation of Bearing Areas and Setting of Bearings: Bearings must be positioned as precisely as possible since misaligned bearings can cause a number of serious durability problems. This is particularly true for a steel pot bearing, a typical example of which is shown in Figure 14. The specification sets tight centerline of bearing tolerances of 1/16" transversely and 1/4" longitudinally. These tolerances are not easy to achieve so the Contractor's staff must pay careful attention to the bearing centers of the fabricated beams in relation to the centerline of the bearing on top of pier/bent caps. For example, if the dimension between bearing centers of a steel beam is 100' but the dimension between the centerline of the bearings it will be supported by on top of the concrete cap is 100'-1" (1" longer than the beam) then the centerline of bearings can be adjusted as much as 1/4" (maximum allowed tolerance) to accommodate the shorter beam length. However, even with the adjustment (maximum 1/2" total), the bearings will still be extended by at least a 1/4" each immediately after the beam is placed instead of being in the non-extended position anticipated in the design. This means that during cold weather when the beam contracts, it may shorten well beyond what the bearing is designed to handle since it already had a 1/4" of movement to start with instead of being in a non-extended position.

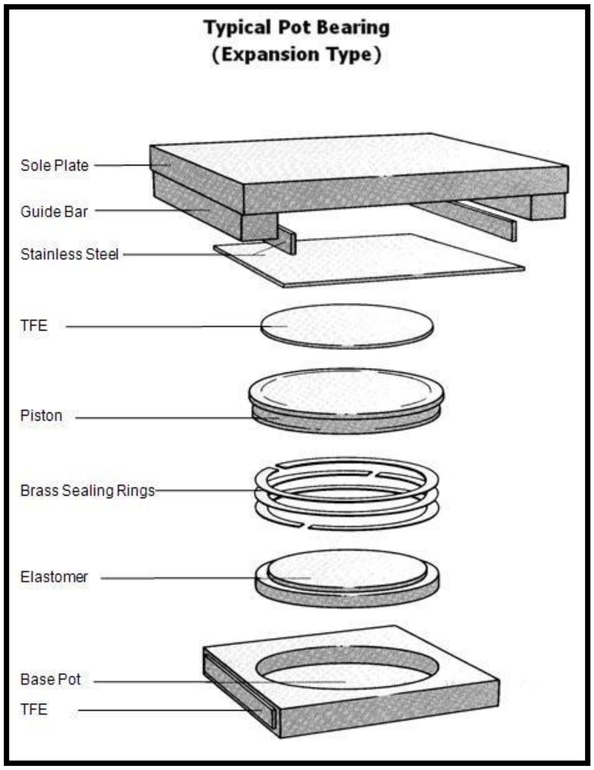

Figure 14 – Steel Pot Bearing

Misalignment errors can be prevented if the Contractor requests the as-fabricated bearing center geometry of the beam from the fabricator while the beam is still in the fabrication plant and compares it to the centerline of bearing geometry in the field prior to delivery of the beams to the project site. If the comparison shows tolerance problems then the bearings can be adjusted prior to erection which will eliminate the need to correct misaligned beams by jacking when beams are erected before tolerance problems are discovered. For extreme situations, bearing adjustments may not be adequate by themselves and the beams or caps may have to be modified prior to erection. Correction of misalignments by jacking of already erected beams is a very undesirable practice and must not be done unless approved by the Engineer and only as a last resort. The SPE/PA must make sure that the Contractor is clear about requiring the Engineer's approval for jacking since improper jacking can damage the substructure and/or superstructure severely which may not be obvious until performance or durability is compromised at a much later date. EOR recommendations may also be required depending on the degree of misalignment which may cause the Engineer to prohibit jacking entirely in favor of using cranes to reposition beams.

Setting of anchor bolts that connect a bearing to the pier or bent cap must also be done precisely. The most common method used to allow the setting of anchor bolts is by forming a cylindrical void (blockout) in the cap during concrete placement. Later, the anchor bolt is positioned in the void and then grouted in once its proper position is established. This method works well if the blockout is securely fastened to the rebar cage and cannot move during concrete placement. When significant misalignment of a blockout occurs, a new void may have to be provided by core drilling. **Drilling must not begin without the Engineer's approval which may also require a recommendation from the EOR.** If drilling is done improperly then critical pier/bent cap rebars may be damaged or completely severed which may not be discovered until performance or durability is compromised at a much later date. If severing of rebar during coring operations occurs or is unavoidable in order to relocate the blockout, the EOR must reanalyze the capacity of the cap discounting the contribution of that particular bar(s). **Well in advance of the first anchor bolt placement, the SPE/PA must make sure that the Contractor is fully aware that drilling of anchor bolt holes is not permitted unless approved by the Engineer.**

Another very important concern related to the proper setting of bearings is the temperature of the beam when it is lowered onto the bearings. Designers assume that the beam temperature will be 70°F when the beams and bearings are dimensioned for the plans because data has shown it to be the average annual temperature of the beam. Knowing the average temperature is important because it allows the designer to minimize the amount of movement the bearing must accommodate which reduces the cost of the bearing. Of course beams are rarely 70°F when placed so the Contractor has to take this into account by compensating for the temperature variation. Steel beams expand and contract significantly as their temperature varies and the following rule of thumb approximates the magnitude of expansion or contraction: a 100' long beam will change length (lengthen or shorten) by 1/8" for every 15°F change in temperature. If the beam is 200' long it will change 2/8" and so on. For example, a 250' long beam that is 55°F (15°F cooler than the 70°F design temperature) will shorten by 2.5 eighths of an inch or 5/16". If the same beam is 30^{0}F cooler it will shorten 5/8". The length change issue is important and if not taken into account, the bearing may be positioned out of tolerance. For example: if the beam temperature indicates that a 5/8" expansion adjustment of the bearing is required due to the beam being hotter than 70°F, then as one end of the beam is lowered onto its steel bearing, the bearing centerline should be positioned 5/8" toward the opposite end of the beam. If the adjustment is done properly then when the beam cools to 70°F it will shorten to a length that positions it so the beam center and bearing centerline coincide. If the adjustment is not made then when the beam gets very cold in the winter it may cause the bearing to exceed its movement limit which may result in bearing and/or beam damage.

The bearing adjustments mentioned above apply to steel pot and other type bearings that have sliding plates to accommodate movement and are adjusted by using slotted holes in plates or by grouting the anchor bolts after they are positioned at the adjusted location within their blockouts. Elastomeric bearings/pads (typical examples are shown Figure 15) must be adjusted after the beam is placed because they accommodate expansion and contraction by deforming, so unless the temperature is nearly 70°F when the beam is placed, they may deform significantly until relieved. Bearings are relieved when the load is removed and they can return to an un-deformed shape. If they are not relieved then they may be subjected to excessive deformation which can cause shearing and cracking of the pad material and eventual failure. The pad is relieved by raising the beam off the pad a very small amount, usually with flat jacks, when the temperature is around 70°F. Most of the time the misalignment is minor and the pad only needs to be relieved but sometimes the pad will need to be repositioned as well. If the pad has very small deformations in its unrelieved state then it may not need to be relieved; however, the EOR must be consulted for the final determination as to whether or not relief is needed.

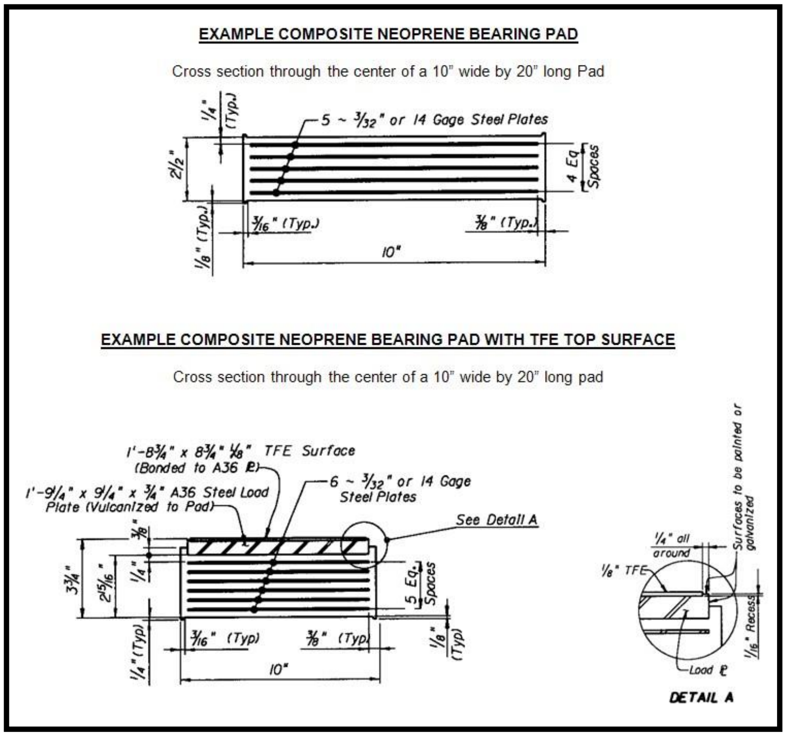

Figure 15 – Elastomeric Bearing Pads

It is critical that the SPE/PA discuss these bearing issues with the Contractor well in advance of the start of any bearing placement or beam erection operation.

461 Multirotational Bearings

461-7 Installation: According to CEI's and Department Bridge Maintenance Engineers, the qualifications and experience of the Manufacturer's Representative that is required by this specification has at times been seriously lacking with significant consequences. More specific experience and knowledge requirements have recently been added to this specification for the Manufacturer's Representative as well as the requirement for a written certification of the Representative's qualifications to be submitted to the Engineer.

462 Post-Tensioning

Recurring issues and complications associated with the use of grout as a corrosion preventing filler material have illustrated the need for development of alternative techniques and materials for corrosion protection of tendons. One such promising technique is the use of a corrosion inhibiting flexible filler material that is pumped into the duct after the tendon is stressed. A benefit of flexible filler is replaceability of tendons during the service life of a structure, besides providing a robust corrosion protection. Flexible filler materials have been used successfully for this purpose for selected tendons in post-tensioned European bridges for over 20 years.

A. Flexible filler will be required for all tendons except those listed in paragraphs B and C below.

B. Grout will continue to be used for the following internal strand tendons with predominantly flat geometries:
- Top slab cantilever longitudinal tendons in segmental box girders
- Top slab transverse tendons in segmental box girders
- Tendons that are draped 2'-0" or less in post-tensioned slab type superstructures

C. Either grout or flexible filler material may be used in the design of the following tendons:
- Straight strand or parallel wire tendons in U-beams and girders
- Bar tendons (predominately vertical or horizontal)

Design criteria and details for unbonded post-tensioning tendons have been revised and added in the Structures Manual and Standard Plans to facilitate access for inspection, maintenance and replacement of critical tendons, and to minimize disruption to Florida's transportation system in the event of a repair. to the old Design Standards Indexes 21801, 21802 and 21803 associated with replaceable tendons have been updated and released as Standard Plans, Indexes 462-001, 462-002 and 462-003. An update to the Instructions for Design Standards Index 21800 Series has also been released as a 462-000 Series Standard Plans Instruction (SPI) document.

Specification changes were required for the implementation of flexible filler in post-tensioning applications. These changes were based on collaboration between FDOT Structures Design Office, Construction Office, Materials Office, Maintenance Office, industry partners (flexible filler vendors, post-tensioning component vendors) and industry organizations (ASBI, PTI, PCI). The following Sections were revised:

Section 105 Expanded to include flexible filler personnel training requirement.
Section 452 Modified to use the word filler instead of grout for post-tensioning applications.
Section 462 Expanded for flexible filler in post-tensioning applications.
Section 938 Expanded to include flexible filler material requirements.
Section 960 Expanded to include requirements for flexible filler applications.

462-7.4 Filler Injection Operations:

462-7.4.1.4 Grouting Operations - Equipment: Vacuum grouting equipment and experienced operators must be on site to meet the timeframe requirements of 462-8.3.2.1. The vacuum grouting operation must be complete within 4 days after grouting..

462-7.4.1.4.3 Grouting Operations - Vacuum Grouting: Contractors may use a variety of approved grout injection volume measuring devices, flow meters are not the only option. Alternative mixing methods for small volumes of grout (5.5 gallons, or less) are permitted instead of using a colloidal mixing method with the grout Manufacturer's approval.

462-7.4.1.5 Grouting: This provision allows certain grout tests to be performed in a warehouse instead of in the field.

In the presence of the Engineer, perform a test to confirm accuracy of grouting equipment volume-measuring components each day of use before performing any grouting operations. Testing in a warehouse or similar condition is acceptable. Use either water or grout for testing using standard testing devices with volumes of 0.5 gallon and 6.5 gallon and an accuracy of equal to or less than four ounces. Perform one test with each device. Results must verify accuracy of grouting equipment void volume-measuring component within 5% of test device volume and must verify accuracy of grouting equipment grout volume component within 10% of test device volume for the 0.5 gallon test device. When testing the 6.5 gallon device, ensure an accuracy of 3% (test device volume) and 6% (grout volume).

462-7.4.2 Flexible Filler Operations: Vacuum assistance is required for the injection of flexible filler for all tendons except for tendons with vertical or predominately vertical profiles as shown in Standard Plans, Index 462-001. Vacuum assistance is optional for tendons with vertical or predominately vertical profiles.

502 Shear Connectors

502-1 Description: Contractors must install shear connectors on steel beams in the field. CEI Staff shall discuss this issue with the Contractor prior to the start of beam fabrication in order to make certain that the shear connectors are not mistakenly installed in the fabrication plant:

Furnish and install welded shear connectors on steel beams and girders at locations shown in the Contract Documents. Field weld shear connectors located on the top flange only after the deck forms are in place. Installation of shear connectors in the fabrication plant is not permitted.

521 Concrete Barriers, Traffic Railing Barriers and Parapets

521-4.2 Stationary Form Construction: A General Surface Finish is required on all precast and cast-in-place barriers, traffic railing barrier and parapets.

560 Coating New Structural Steel

In **560-2.4**, use of fully automated conductivity meters are permitted for soluble salts testing. For nonmetallic abrasives, compliance with the conductivity and cleanliness requirements of SSPC-AB1 is required by **560-2.5**. Soluble salt detection and removal requirements have been expanded in **560-7.5**, and clarified with addition of a table listing allowable surface contaminants. Stripe coating requirements have been clarified and expanded in **560-9.6**. In **560-9.8**, coating thickness requirements have been clarified.

560-9.6 Stripe Coating: Application of stripe coating to welds, corners, crevices, sharp edges, bolts, nuts, rivets and rough or pitted surfaces is required and is particularly important for bolts and nuts which are very difficult to protect properly without stripe coating. The SPE/PA shall discuss with the Contractor this requirement at the first pre-work meeting that addresses coating operations.

560-9.7 Sealing Using Caulk: The need to caulk gaps within steel box girders of less than 3 mils in width is not required. This provision requires the caulking of the perimeter of faying surfaces, cracks and crevices, joints open less than 1/2 inch, and skip-welded joints using caulk. Some CEI staff have interpreted “perimeter of faying surfaces” as applying to the contact surface of a bolt head or nut against a plate. The bolt head or nut to plate interface is not considered to be a faying surface by this specification, and therefore, shall not be caulked. By definition, there must be no gap between bolt head or nut and the plate if proper tightening has taken place; therefore, if there is a gap between the bolt head or nut and the plate then the fastener assembly should be removed and retightened. If, on rare occasion, a gap cannot be avoided then proper painting procedures including required stripe coating of bolts will effectively seal gaps without the need to apply caulk.

649 Galvanized Steel Poles, Mast Arms and Monotube Assemblies

649-5 Installation: Nuts of anchor bolts and non-anchor bolts are required to receive an initial stage of tightening referred to as “Snug Tight Condition” or just “Snug Tight.” Snug tight is defined as the maximum nut rotation resulting from the full effort of a person using an ordinary spud wrench.

For a non-anchor bolt connection such as the connection plates between a mast arm and its supporting pole, nuts must be tightened to the initial stage of snug tight. The connections must be visually inspected to verify firm contact has been achieved between faying surfaces (surfaces of the connecting plates that are required to be in contact) beneath bolts. CEI staff should make sure the Contractor re-snugs bolts where faying surfaces are not in firm contact.Final tightening is applied with what is referred to as the "Turn-of-Nut" method which requires the bolt head to be kept from turning while the nut is rotated relative to the plate an amount prescribed in Table 8, which can also be found in **Specificaiton 460**. For example, if a bolt is less than or equal to four diameters long then the nut must be turned relative to the plate, 1/3 of a turn or 120 degrees.

Table 8 - Nut Rotation from the Snug-Tight Condition

Bolt Length Measured from Underside of Head to End of Bolt	Both Faces Normal to Bolt Axis	One Face Normal to Bolt Axis and Other Face Sloped Not More than 20:1. Bevel Washer not Used.	Both Faces Sloped Not More than 20:1 from Normal to Bolt Axis. Bevel Washers not Used.
Up to and Including Four (4) Diameters	1/3 turn	1/2 turn	2/3 turn
Over Four (4) Diameters but not Exceeding Eight (8) Diameters	1/2 turn	2/3 turn	5/6 turn
Over Eight (8) Diameters but Not Exceeding Twelve (12) Diameters	2/3 turn	5/6 turn	1 turn

Notes:
1. Nut rotation is relative to the bolt, regardless of the element being turned.
2. Tolerance for bolts installed by 1/2 turn or less is ± 30 degrees. For bolts installed by 2/3 turn or more, the tolerance is ± 45 degrees.
3. Nut rotations given are only applicable to connections in which all material within the grip of the bolt is steel.
4. For bolt lengths exceeding 12 diameters, establish the required rotation by performing actual tests in a suitable tension device simulating the actual conditions. Submit procedures to the Engineer for review.

Final tightening is acceptable when the following Specification language has been performed:

Maintain as close to uniform contact pressure as possible on the faying surfaces during snugging and turn-of-nut process by utilizing suitable erection methods and a bolt tightening pattern that balances the clamping force of each bolt, as closely as possible, with the equal clamping force of a companion bolt.

Match marking - see Figure 16 for an example of match marking - must take place prior to turning the nut by marking the plate then by marking the nut to coincide with the plate mark and then by marking the plate again at the position where rotation must stop: for example, 1/3 of a turn. The nut is then turned until the nut mark coincides with the second mark on the plate. If there is any question about whether or not the bolt head can be kept from turning then it is good practice to also mark the bolt to coincide with the initial plate mark so it will be obvious if the bolt turns during nut rotation.

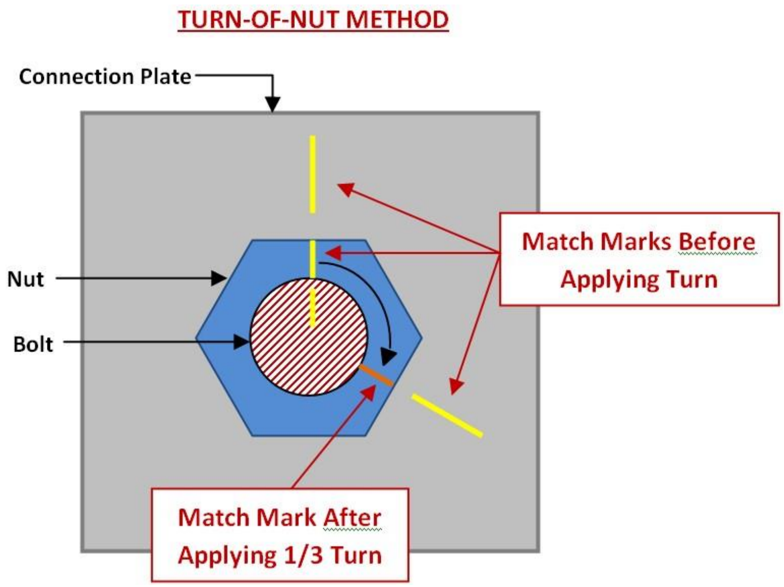

Figure 16 - Match Marking

Tightening of anchor bolts that connect the pole base plate to the concrete foundation must be done in the sequence shown in the specifications and the leveling nut standoff height (distance from bottom of leveling nut to concrete foundation) must not be more than one bolt diameter. Figure 17 shows an example of leveling nuts that have been installed that are not in compliance with the Specifications. The steps in the base plate connection process start with cleaning and lubricating the exposed threads of the anchor bolts as well as the threads and bearing surfaces of the leveling nuts. This is followed by turning the leveling nuts onto the anchor bolts and aligning the nuts to the same elevation that is equal to, or less than one bolt diameter from the top of the foundation. With the leveling nuts in place a structural washer gets added atop each leveling nut, followed by the base plate, another structural washer and then a nut (anchor nut) run down to make contact. Referencing Note 3 on Sheet 3 of Standard Plans Index 649-031, the anchor nut can be a half-height nut. The anchor nuts are then tightened to the snug-tight condition working the nuts by a star pattern sequence. Next the leveling nuts are also tightened to a snug-tight condition, again working by a start pattern sequence. Each anchor bolt will get a third “retainer” nut which will be run down to make contact with the anchor nut after the anchor nut and leveling nuts have tightened to the snug-tight condition. Next the retainer nuts will be tightened to the snug-tight condition, but the anchor nuts must be held in place, so they do not rotate. Before final tightening of the retainer nuts, mark the reference position of each snug-tight nut on one flat with a corresponding reference mark on the anchor nut and base plate on each bolt. Then while preventing the anchor nut from rotating, incrementally turn the retainer nuts using a star pattern until achieving the required nut rotation specified in Table 9, which can also be found in Specification 649-5. During each stage of nut tightening (anchor nut, leveling nut, retainer nut) the star pattern tightening sequence is intended to produce a balanced distribution of clamping forces on the base plate as tightening progresses.

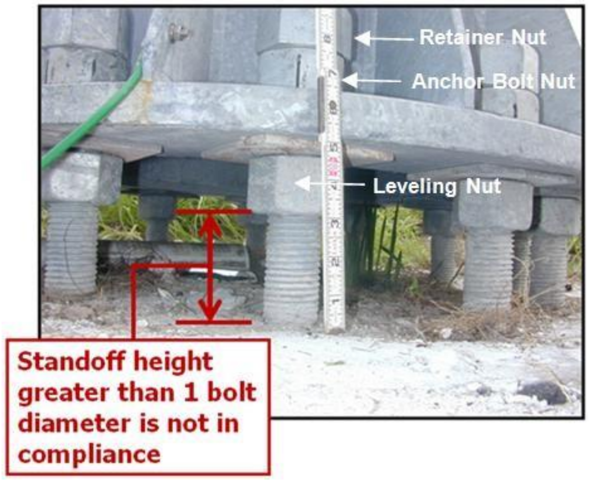

Figure 17 - Out of Tolerance Standoff Height

CEI staff should make every effort to witness all nut tightening operations, particularly turn-of-nut and match marking operations. The installation procedures should also be discussed in detail with the Contractor at the pre-operations meeting before any installations takes place.

Table 9 – Required Anchor Nut Rotation

Anchor Bolt Diameter (inches)	Nut Rotation from Snug-Tight Condition
≤ 1-1/2	1/3 turn
> 1-1/2	1/6 turn

649-6 Screen Installation: For steel strain poles and steel monotube assembles a standard grade plain weave galvanized steel wire screen with ½" x ½" mesh shall be install along the perimeter of the base plate to prevent vermin and debris from entering the gap. This verical screen shall sit flush on the concrete foundation and is not to extend above the top surface of the base plate.

649-7 Structural Grout Pads: Research has shown that base plate anchor bolts for mast arm support structures (vertical poles) are not structurally adequate to resist maximum stress conditions without the additional strengthening of a structural grout pad that fills the gap between the pole base plate and the top of the concrete foundation element. Unlike the grout pad used in past years that were used to simply fill the gap beneath the base plate; the new pads have a critical structural function. Because of this, attention must be paid to testing the grout prior to placement and making sure the Specifications and Standard Plans Index, 649-031 are followed. Prior to installation of the first grout pad, CEI staff shall conduct a review of the specification with the Contractor. Figure 18 shows a properly installed grout pad.

Figure 18 - Structural Grout Pad for Mast Arm

700 Highway Signing

700-2.2.3 Static – Overhead Signs - Installation: As with mast arm poles, cantilever sign structure poles will require a structural grout pad beneath the base plate. This specification references **649-7** for the specific provisions dealing with proper installation of the pad. Prior to installation of the first grout pad, CEI staff shall review this specification and [Standard Plans Index, 700-040](#) with the Contractor.

Miscellaneous Specification Related Issues

A. Preventing Excessively Thick Beam Buildups: Figure shows the cross section of a concrete prestressed beam supporting a concrete deck. Notice that the yellow colored layer of concrete between the top of the beam and the bottom of the deck slab, referred to as the beam buildup, is too thick. This is because the red colored stirrup rebars at the top of the beam, do not extend into the deck slab but instead terminate in the Buildup. Buildups are needed because prestressed beams come from the production plant in the shape of a very shallow arch which is also called a cambered shape as can be seen in Figure 20. The vertical distance from a string line pulled tight between the top of beam ends, to the top of the beam at mid span is called the camber; and depending on the beam length it can vary from almost zero to five inches for typical situations.

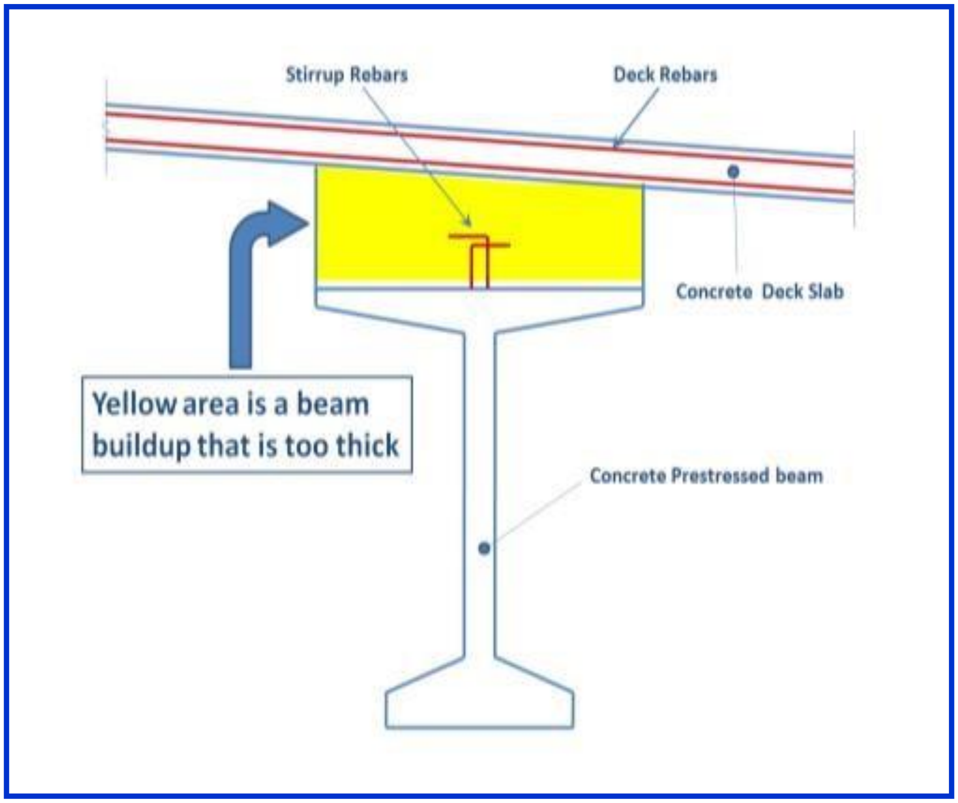

Figure 19 - Thick Beam Buildup

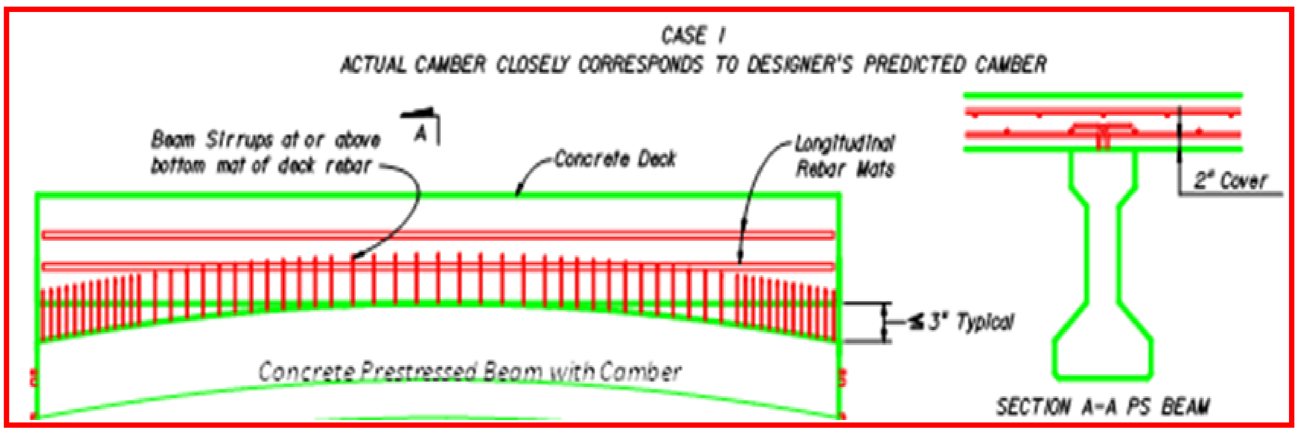

Figure 20 - Beam Camber, Stirrups and Deck

Most of the time the profile grade of the deck is relatively flat compared to the degree of camber; therefore, at the beam mid span, the top of the beam touches or almost touches the bottom of the deck slab but at the beam ends it does not as can be seen in Figure 20. There are stirrups along the entire length of the beam, and under ideal conditions all stirrups will extend into the slab to at least the bottom mat of deck rebars; however, many times the stirrups at the ends of the beam do not extend to the bottom mat but are still in the slab. Stirrups should always fully engage the deck which is very important structurally because the designer expects the beam and the slab to resist stresses together as a single unit which is referred to as composite action. The stirrups ensure that composite action takes place and the superstructure will not be as strong if composite action is not fully developed.

Preventing Excessively Thick Buildups: The Designer estimates the camber value and includes it in the plans so that the Contractor can set grades for the beam pedestals relative to the deck elevations. The designer's camber estimate is based on a beam age of 120 days. Age is a factor in the estimate because the camber increases with time or "grows" and generally is negligible after one year. However, many factors that continually change such as air temperature and humidity influence the rate of camber growth which makes it difficult to accurately predict. Beams rarely are erected at exactly 120 days and even if they are, the variability of camber growth reduces the likelihood that it will agree exactly with the value in the plans. From time to time because of the variability, beams are placed that have much less camber than the Contractor anticipated based on camber values in the plans. However, by this time, beam pedestals have almost always been constructed and so the beams are placed on pedestals that are too low for the actual amount of camber in the beams so excessively thick buildups result.

Specification 450-2.3 requires camber to be measured once per month while beams are in storage at the prestressed plant and a record of the measurements must be kept on file for review of the Engineer and/or Contractor. If the Contractor reviews these measurements periodically, prior to pedestal construction, then the pedestal elevations can be adjusted to take into account the actual camber instead of the estimated camber shown in the plans. This will dramatically reduce the possibility of excessively thick buildups and at the pre-operations meeting, prior to construction of the first beam pedestals, the CEI staff should remind the Contractor that camber measurements are on file at the prestressed plant.

B. Excessive Camber: When the actual camber is much larger than the camber shown in the plans, the beam will have to be inserted into the deck which results in a deck thickness above the beam that is less then shown in the plans. This practice is usually acceptable if approved by the EOR but it is never permitted if the beam is required to be inserted more than one inch. The reason for the one inch limit is because a space between the bottom mat of rebars and the top of the beam that is less than one inch will not allow large aggregates in the concrete to enter the space resulting in deficient concrete. If the one inch limit is exceeded then the deck grade must be raised, as approved by the EOR, in order to provide acceptable clearance.

C. Inspection of Prefabricated Products: It is the responsibility of the CEI inspector to carefully examine prefabricated products for defects when they arrive at the project site from the plant at which they were produced. This is particularly important for prestressed concrete products (beams, slabs, piles, etc.) since the Department no longer does a comprehensive inspection of these products nor do these products receive a Department approval stamp prior to shipping. This means that the CEI inspector is the only Department representative that has the opportunity to perform a thorough inspection of these products before they are incorporated into the project. Inspection at the site for steel products is also critical; however, the Department employs a materials testing firm at the steel fabrication plant and their inspectors perform a thorough inspection prior to shipping of the product from the plant. Regardless of the level of inspection in the plant, these products can be damaged while they are being transported from the plant to the site which makes thorough inspection of all these products critical when they arrive at the project site.

D. Deck Concrete Placement Direction: Concrete for constructing a bridge deck that is continuous over multiple spans is routinely placed in stages and this requires plastic concrete for the latest stage to be in direct contact with the hardened face of a previously completed stage. This is referred to as a cold joint. When this situation exists, placement of the plastic concrete should start at the end of the span opposite the cold joint, thus the last of the concrete will be placed at the cold joint face. If this procedure is not followed then transverse cracks are likely to form in the newly placed concrete within a short distance of the cold joint.

The reason for this is that when the deck concrete is added to the beam it causes the beam to deflect which in turn causes the beam end top to rotate away from the adjacent span along with the newly placed deck concrete if the concrete is placed in contact with the cold joint at the start. For long beam spans, the concrete initially placed often approaches or has its initial set by the time the last concrete is placed. Because the concrete initially placed is no longer plastic or fluid, beam rotation can put tension stresses into this concrete that exceed its capacity which causes cracks. If instead the last of the concrete is placed at the cold joint, all the beam rotation has taken place while the deck concrete is still fluid, so tension stresses cannot develop in the deck concrete at the cold joint: thus preventing cracks.

E. Fascia Beam Rotation Issues: The section of a concrete bridge deck that cantilevers or overhangs beyond exterior or fascia beams is constructed by using horizontal form panels that are supported by brackets, referred to as overhang brackets.: Figure 19 shows overhang brackets attached to a Florida U Beam. The horizontal element of the bracket is stabilized by a strut that bears on the beam web or bottom flange. The force transmitted into the bottom section of the beam by the strut produces torsional forces in the beam that may result in excessive rotation of the beam about its longitudinal axis if not counteracted. If the beam itself is not stiff enough to counteract the rotational forces then a temporary bracing system must be used. If the beam rotation is not well controlled then a number of serious deck slab and/or beam defects can occur that will have to be corrected: often at significant expense.

Figure 19 - Form Overhang Brackets

The SPE/PA shall discuss the fascia beam rotation concern with the Contractor well in advance of the Contractor's planning for the selection of a deck forming system so that the Contractor will be aware of its importance, if not already. Except when the EOR details a fascia beam bracing system in the plans, which is very rare, it is the Contractor's responsibility to provide an effective fascia beam bracing system. This is a routine task for Contractors on most projects; however, when deck overhangs are unusually wide, which can develop much higher than normal torsional forces in fascia beams, the Contractor may need to hire a specialty engineer to design a special fascia beam bracing system that will effectively counteract the higher torsional forces. This concern is particularly important for Florida U-Beam superstructures because they have no end diaphragms that restrain the fascia beams from rotating, so the beam ends must be restrained by blocking the bottom slab at the bearings and/or by bracing the top flanges in a manner that will minimize rotation (see Figure 20). Long span steel girders can also be more susceptible to the high rotational forces generated by wide overhangs since their inherent flexibility means reduced torsional strength so proper fascia beam bracing is critical.

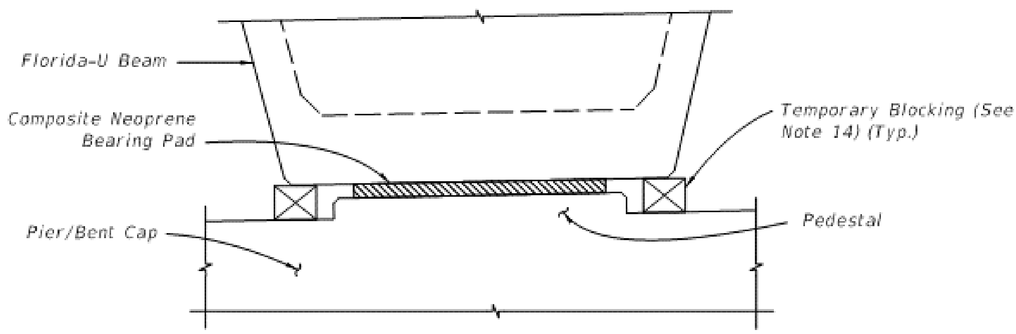

Figure 20 - Temporary Blocking of U-Beam Ends

<u>Standard Plans Index 450-210, Florida-U Beam Typical Details & Notes (Note 14) and Blocking Detail:</u>

Note 14: Prior to deck placement, provide temporary blocking under each web at both ends of every beam. Ensure the temporary blocking is adequate to resist movements and rotations during deck placement. Leave temporary blocking and bracing in place for a minimum of four days after the deck is placed.
Note 15: Based on the deck forming system and deck placement sequence, evaluate and provide any required temporary bracing between the U Beams.

F. Required Contractor Submittals or Actions Required for Bridge Temporary Works: In recent years the Department has increased the number and type of temporary works submittals and actions required of Contractors and this has caused some misunderstandings and oversights by both Contractors and CEI personnel related to what is required. Make sure you read the latest version of **Specification 5-1.4** and **5-1.5** in its entirety.

G. Placement of EPS Foam for Bridges with Skewed Caps & Squared Beam End Details:

The detail provided in Section 15.8 of the FDOT Structures Detailing Manual requires Expanded Polystyrene (EPS) foam to be bonded to the top of the Florida I Beam (FIB) in three locations in the case of bridges with continuous decks (see Figure 21). The first location is a 4" wide sheet below the tooled or saw cut deck joint that starts at a top flange edge of one of two beams in-line at a pier, and ends at the opposite top flange edge of the other beam, and is the thickness of the concrete build up between the beam tops and the deck bottom. The two other locations are ½" thick triangular shaped sheets (shown as crosshatched in the plan view of Figure 21) that are bonded to the top of the FIB.

The purpose of the EPS foam is to prevent the formation of cracks in the deck that could be caused by rotation of beam ends. When the end of the beam's top flange rotates during loading, the EPS easily compresses without significant resistance - eventually a void is formed above the beam end as the EPS is worn away - which prevents the beam end from scraping the bottom of the deck and producing high tension stresses that can cause cracking.

The CEI staff shall discuss proper placement of EPS foam with the Contractor at the pre-work meeting prior to any deck placements that require EPS and during the meeting a copies of the Figures in 15.8 of the Structures Detailing Manual shall be used to clearly illustrate how this is to be done. In addition to the Figures in 15.8, project specific details in the plans that are pertinent to beam end details shall also be fully discussed with the Contractor.

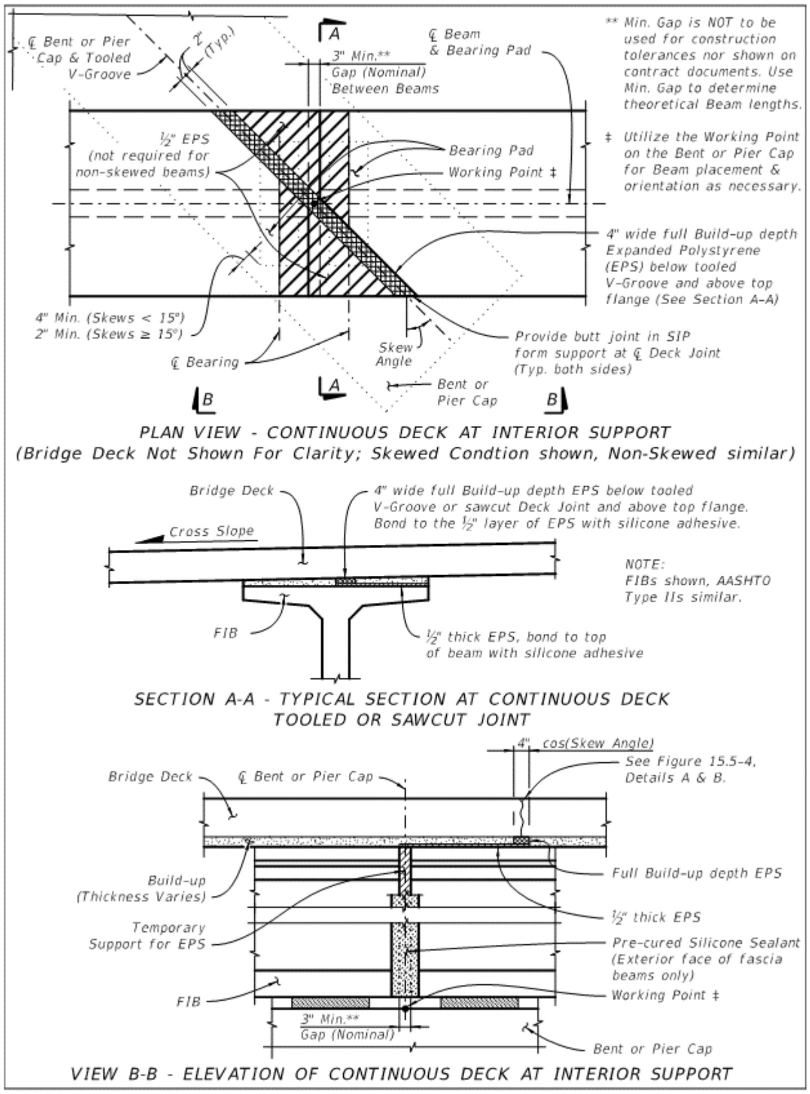

Figure 21 - Squared Beam End Details, Cont. Deck at Int. Support

H. Buy America Requirements: The Code of Federal Regulations, 23 CFR 635.410 requires that domestic steel or iron materials be used on projects which utilize Federal funding in any phase of the project. As of July 12, 2016, all items containing foreign steel which are permanently incorporated into the completed work must now be tracked in accordance with **Specification Section 6-5.2**. This includes: all steel members, cabinets, covers, shelves, clamps, fittings. Sleeves, washers, bolts, nuts, screws, tie wire, spacers, chairs, lifting hooks, faucets, light bulbs, door hinges, etc.

V. STANDARD PLANS

Standard Plans Index 521-426 and 521-427 Single-Slope (Traffic Railing):

The 36" Single-Slope Traffic Railing is the basic default traffic railing for use on FDOT bridges and retaining walls. Standard Plans 521-427 (36" Single-Slope Traffic Railing) and 521-426 (36" Single-Slope Median Traffic Railing) as shown in Figure 22 replaced the use of the 32” F Shape and Median 32” F Shape from the old Design Standards (Indexes 427 & 426). These requirements are effective on projects let after July 1, 2018. The new Standard Plans Indexes 521-426 (36" Single-Slope Median Traffic Railing), 521-427 (36" Single-Slope Traffic Railing) and 521-428 (42" Single-Slope Traffic Railing) are available for earlier implementation on all other design-bid-build projects at the discretion of the District.

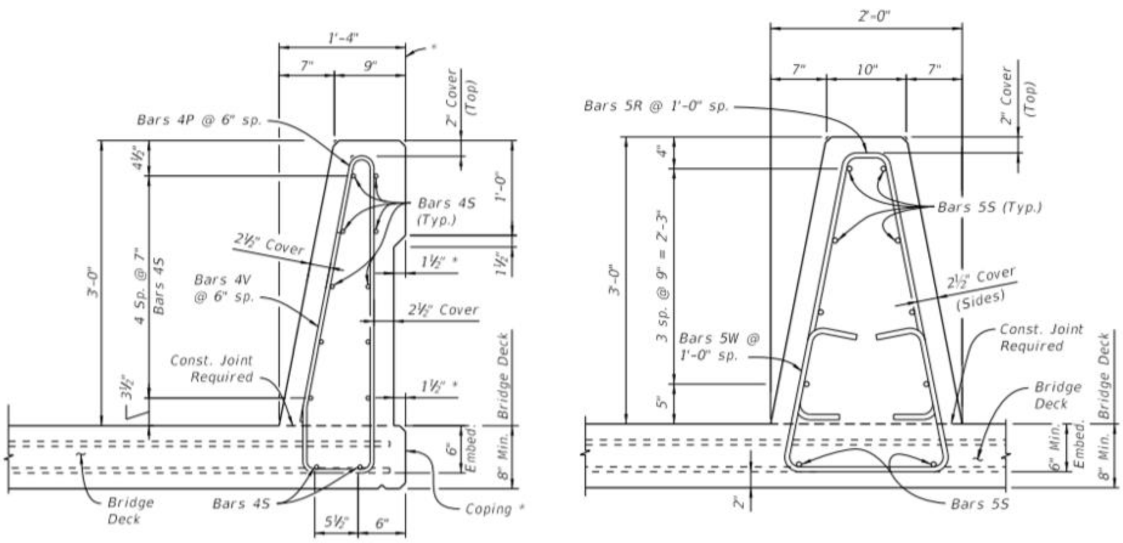

Figure 22 - Single Slope Traffic Railings

Specification 521-4.3 has been revised changing the slip forming cover tolerance from 1¼" to ¾" and was included in the July 2017 Workbook. If Standard Plans Indexes 521-426, 521-427 or 521-428 are used on projects let before the July 2017 Workbook was implemented, a Modified Special Provision shall be provided for **Specification 521-4.3** that specifies a ¾" slip forming cover tolerance.

Index Number 20005 (Prestressed I-Beam Temporary Bracing):

Index 20005 (Prestressed I-Beam Temporary Bracing) was removed from the old Design Standards prior to the Department transitioning to Standard Plans. The removal of that Design Standard was made to clarify prestressed concrete I-beam plan requirements for the Engineer of Record regarding beam stability and Contractor requirements regarding temporary bracing design. As required by **Section 5** of the Specifications, the Contractor is to provide shop drawings and calculations for the temporary bracing design. The temporary beam bracing shall be designed in accordance with the FDOT Structures Manual, the Specifications and the information contained in the Contract Documents.

Standard Plans Index 450-120 (AASHTO Type II Beam):

Type II AASHTO beams had been replaced in the Standards by the Florida I Beam (FIB) but they were reintroduced in the 2014 Standards. Contractors requested that Type II AASHTO beams be permitted again because they can be placed with much lighter lifting equipment; therefore, they are more economical than FIBs for certain minor bridge projects while providing comparable performance and durability.

Standard Plans Index 450-511 and 450-512 (Bearing Plates Type I and II):

AASHTO Type II Beam details have been included in these Indexes because of the restoration of Design Standard Index 20120, now Standard Plans Index 450-120.

Standard Plans Index 455-002 (Square Prestessed Concrete Pile Splices):

A cast-in-place (CIP) concrete pile build-up detail was added to this index. The build-up can be used when the distance from the pile cut off elevation to the top of an overdriven pile does not exceed 5.0'.

Standard Plans Index 102-200 (Temporary Detour Bridge General Notes and Details):

A Thrie-Beam Panel detail was added to the traffic side of the truss panel to provide better protection for motorists and truss components than does the minimal rub rail on the deck.

State of Florida Department of Transportation
Office of Construction

CERTIFICATION OF COURSE COMPLETION

Critical Structures Construction Issues – Self Study Course

NOTE: *The original of this certification must be transmitted to the District Construction Training Administrator within 7 days of execution and a copy must be retained by the student. A false statement made in connection with this certification is sufficient cause for disciplinary action by the Department.*

I, (print student's name here) ____, certify that I have, to the best of my ability, read and understand the information presented in the above named course which I completed on (enter date of course completion here) __________________. I also acknowledge that I must complete the above named course again within 3 years of the date of completion on this certification.

Signature and e-mail address of the above named student and date signed:

________________________________, _____________

Signature Date

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E-mail address