State of Florida Department of Transportation
Office of Construction

CRITICAL STRUCTURES CONSTRUCTION ISSUES

SELF STUDY COURSE

January 2014

TABLE OF CONTENTS

► **Certification of Course Completion Form – A copy of this form is the last page of this document**

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. Those that are required to take this course will be notified by e-mail about the Annual Supplement to the course that is posted each January. For those taking the complete course for the first time, review of the Annual Supplement is also required and its review shall be completed prior to signing the Certification of Course Completion form. A certification form is not required for those that have already taken the complete course and are only reviewing the Annual Supplement. Personnel that are newly employed must complete the course not later than 6 months after the start of employment.

Certification of Course Completion Form

After fully completing the entire course (Main Course and Annual Supplement), 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 sent to the District Construction Training Administrator for permanent filing and a copy shall be retained by the student. 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 widely misunderstood or overlooked specifications, procedures and other issues; ■ to present specifications and procedures that were implemented for the first time in recent years; and ■ to introduce new or upcoming specification and procedure changes that will significantly impact Contractor and CEI efforts in the future. The topics covered in this course will be flagged throughout this document with the colored squares above that correspond with their purpose. 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 Engineer, 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 colored text underlined in blue** 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

■ There are seven structures related guidelists as listed below. Review of guidelists, which are lists of the most important contract document requirements that inspectors must verify without fail, is 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 passed out to Contractor personnel at 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 contact 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. View the 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:** Some of this section's provisions have been inconsistently complied with in recent years and need to be reemphasized.

CEIs shall maintain at least a 9 item Shop Drawing Tracking Log 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 in order that they will know which shop drawings require immediate attention.

8.11 ■ **Contractor Initiated Submittals:** This section was implemented over four years ago but many CEI offices are not aware of it and are not complying with the requirement 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 submittals 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 ■ **Pile Lengths:** This section provides guidance related to setting production pile lengths and pile driving criteria to be used during pile driving operations and includes a helpful Flow Chart of the process.

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

10.2.7 ■ **Precast Prestressed Concrete Components, Review and Evaluation:** When preparing a response to a Contractor's proposed disposition of defects, the PA must now 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: 10.3.3 concrete deck thickness and cover checks required of inspectors; 10.3.4 mass concrete monitoring which includes supplemental flow charts; 10.3.5 mandatory crack inspection procedures which includes a flow chart and attachment; 10.3.6 required notification of District Materials Office for pre-work meetings, concrete placements, reduction in sampling frequencies and the occurrence of lumps and balls; and 10.3.7 Observing Concrete Consistency. The following covers important topics related to these CPAM subsections.

10.3.4 ■ **Mass Concrete:** In this subsection, CEIs are reminded that not only are they to oversee the Contractor's monitoring of the temperature differential of mass concrete components but also the maximum core temperature as well which should not exceed 180 degrees.

10.3.4.3 ■ **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 is necessary.

10.3.5 ■ **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 mils (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. The accompanying photos are of sample pocket microscopes.

Once a crack map is completed then Table 1 or 2 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. The tables allow the appropriate repair to be determined by selecting four input parameters and these are 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 10.3.5 with its Attachment 10.3.5-1.

In the accompanying Table 1, from Specification 400-21, the elevation range column is highlighted in green and has three ranges. The Crack Width column in blue has 8 ranges within each elevation range. The red row is Cracking Significance and has 4 levels of cracking severity. Environment Category is the purple row and 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 the accompanying Specification 400-21 table entitled, Key of Abbreviations and Footnotes Table. The calculation requires the determination of the LOT size which is the area of a rectangle that encompasses a group of cracks as seen in the accompanying drawing from CPAM Attachment 10.3.5-1. For example: in the accompanying drawing, the blue rectangles represent the limits of a LOT and encompass groups of red colored cracks. The text of CPAM Section 10.3.5 provides a detailed explanation of how LOT sizes are calculated. LOT areas must be 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 and if a LOT exceeds the maximum area limit, an additional LOT must be used. 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 counteract 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.

Pocket Microscopes
4" to 8" high

SPECIFICATION 400-21

(Note: See Key of Abbreviations and Footnotes on next page**)**

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[5]	NT	PS[5]	PS[5]	PS[5]	PS[5]				
	0.004< x ≤ 0.008	NT	PS[5]	EI[3]	PS[5]	EI[3]	EI[3]	PS[5]					
	0.008< x ≤ 0.012	NT	PS[5]	EI									
	0.012< x ≤ 0.016	PS[5]											
	0.016< x ≤ 0.020			Investigate to Determine Appropriate Repair or Rejection									
	0.020< x ≤ 0.024												
	0.024< x ≤ 0.028									Reject and Replace			
	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[5]	NT	PS[5]	PS[5]	PS[5]	PS[5]	PS[5]	PS[5]		
	0.004< x ≤ 0.008	NT	PS[5]	EI[3]	PS[5]	PS[5]	EI[3]	PS[5]	EI[3]				
	0.008< x ≤ 0.012	NT	PS[5]	EI	EI	EI							
	0.012< x ≤ 0.016	PS[5]	EI	EI	EI								
	0.016< x ≤ 0.020	EI											
	0.020< x ≤ 0.024			Investigate to Determine Appropriate Repair or Rejection							Reject and Replace		
	0.024< x ≤ 0.028												
	x > 0.028												
Elev.: Over Land or More Than 12 ft AMHW	Crack Width	SA	MA	EA	SA	MA	EA	SA	MA	EA	SA	MA	EA
	x ≤ 0.004	NT	NT	NT	NT	PS[5]	PS[5]	PS[5]	PS[5]	PS[5]	PS[5]		
	0.004< x ≤ 0.008	NT	PS[5]	PS[5]	PS[5]	PS[5]	EI[3]	PS[5]	EI[3]	EI[3]	PS[5]		
	0.008< x ≤ 0.012	NT	PS[5]	EI	EI	EI	EI	EI	EI				
	0.012< x ≤ 0.016	PS[5]	EI	EI	EI	EI	EI						
	0.016< x ≤ 0.020	EI	EI	EI	EI								
	0.020< x ≤ 0.024	EI											
	0.024< x ≤ 0.028			Investigate to Determine Appropriate Repair or Rejection							Reject and Replace		
	x > 0.028												

SPECIFICATION 400-21

Key of Abbreviations and Footnotes for Tables 1 and 2		
Type Abbreviation	Abbreviation	Definition
Repair Method	EI	Epoxy Injection [(4a)]
	M	Methacrylate [(4b)]
	NT	No Treatment Required
	PS	Penetrant Sealer [(4b)]
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 is not injectable 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.

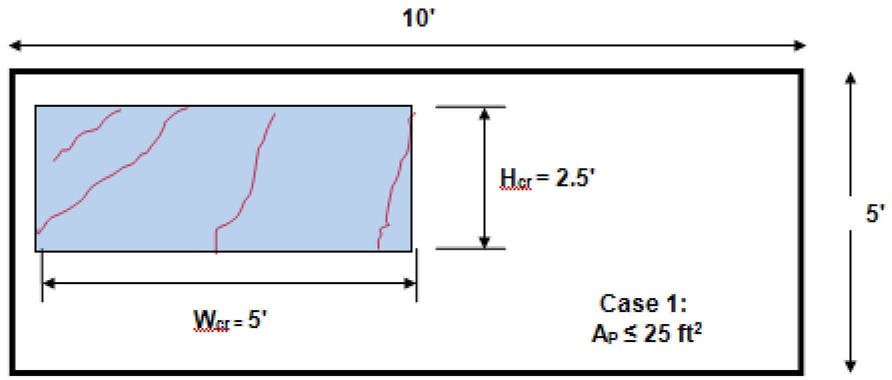
(4) (a) Perform epoxy injection of cracks in accordance with Section 411. (b) Seal cracks with penetrant sealer or methacrylate as per Section 413. Use only methacrylate or penetrant sealer that is compatible, according to manufacturer's recommendations, with previously applied materials such as curing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

(5) 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.

CPAM ATTACHMENT 10.3.5-1

FOOTINGS, COLUMNS, CAPS, ETC.

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

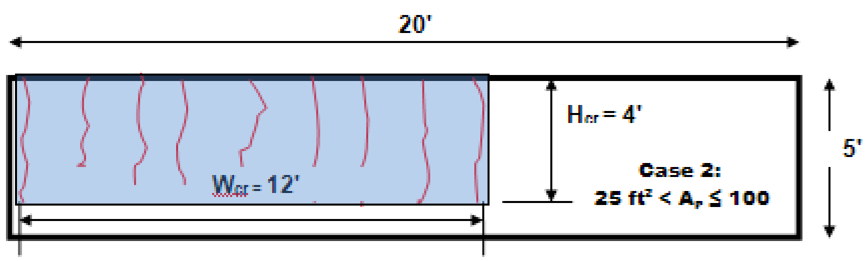


Vertical Face of a Footing, Column or Cap

<u>Lot Size Determination for Case 1: $A_P \leq 25$ ft^2</u>

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

Therefore, $A_L = 25$ ft^2



Vertical Face of a Footing, Column or Cap

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

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

Therefore, $A_L = 48$ ft^2

3 of 4

10.3.5 ■ Crack Inspection Update: The most recent revision of this subsection addresses inspection of components that are hidden from view and reminds CEIs that crack maps and related documents must be entered into the CDMS system in a precise way and without fail as covered in CPAM 10.11.5. Also, this section now addresses whether or not cracks in buried culverts will need repair and makes it clear that a Contractor's Engineer of Record and not a Specialty Engineer must perform the crack evaluation needed for the disposition of **structural cracks**.

10.3.5 ■ Concrete Construction, Crack Inspection: The table below 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.

Rule of Thumb (Rough Estimate) 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 (See Note Below)	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.

10.3.6 ■ This is a new subsection that 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. CEI management of this process has not happened consistently thus the need for this added CPAM requirement. The CEI shall not approve the reduction unless the District Materials Office has reviewed and approved the request.

Additional instructions have been added to ensure that DMO personnel are notified properly of upcoming concrete placements.

New text has been added requiring CEIs to notify the DMO as soon as possible if lumps and balls are observed in delivered concrete. The DMO must be kept aware of the occurrence of lumps and balls because it is their responsibility to review concrete batch plant operations that result in the lumps and balls to determine if any batch plant corrective actions are required such as revision of the batch plant QC Plan.

10.3.7 ■ Observing Concrete Consistency: This new 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 ■ Paint 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 was recently updated and now includes a new topic, 10.4.5.3 Critical Coating Inspection Issues, that makes inspectors aware of coating concerns that are often overlooked, misunderstood or ignored by Contractors during coating operations and are as follows: coating of bolts; surfaces that are visually difficult to inspect and access; caulking gaps and seams; testing for chloride, sulfate and nitrate concentrations; rigging materials quality 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.

The following provision was **deleted** from this section because enforcement of OSHA requirements is not a CEI responsibility:

> *In addition, the Project Administrator must verify, for hazardous coatings removal, that the Contractor supplies and properly uses worker respirators that are in accordance with **29 CFR 1926.62 and 29 CFR 1910.134**.*

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 and includes a Flow Chart of processes.

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. These inspections were not routinely required in the past but are now. Consultant CEI scopes of services shall require this work and budget shall be allocated for it. This section was developed in response to the discovery, by FDOT Bridge Maintenance Inspectors on a number of occasions, of significant underwater defects either during final acceptance inspections or during routine maintenance inspections a year or two after project completion. These types of 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 indentifies specific inspection responsibilities and five supplemental flow charts that also cover various inspection responsibilities. This section has been completely rewritten. What was previously a CPAM Section and separate Guidance document has been combined into a single document. Project Administrator and Inspector duties have been expanded and clarified for all portions of member casting, erection, stressing, grouting and post-grouting. Existing inspection forms have been revised and new forms for Segment Casting and Post-Grouting Inspection have been created. Instructional text that was contained within the main section has been replaced by the following hyperlinks to nationally recognized 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 installation plan for auger cast piles and other important auger cast pile issues.

10.9 ■ **Structural Steel and Miscellaneous Metal Components:** When steel or metal components are defective or are 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.

> **10.9.5.3** ■ **Structural Steel and Miscellaneous Metal Components, Review and Evaluation:** This Section was revised to now require review of submittals by the Inspection Manager of the fabrication plant inspection service retained by the Department. The Inspection Manager's comments are critical because the consulting firm that provides the service is chosen for their qualifications in the fields of structural steel fabrication and metallurgical science. The Inspection Manager will know if a proposed correction to damage or defects is acceptable or not regarding preapproved fabrication practices or if it sets a precedent and; thereby, requires higher level consideration by the Department. Also, this Section requires all Contractor submittals for correction of steel defects or damage to be referred to as Requests for Correction (RFC) and are to be entitled as such on the cover page instead of their previous title of Non Conformance Report (NCR). However, the Nonconforming Structural Steel and Miscellaneous Metal Component Data Sheet is still required as an attachment to RFC submittals.

A new subsection, 10.9.6 ■ Testing and Record Keeping for Structural Steel, was added to 10.9 in 2012 as follows.

10.9.6.1: 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 new CPAM subsection requires the CEI to observe these tests and procedures in the field and record the results which shall be kept on file in the CEI office.

10.9.6.2: Specification 502**,** Shear Connectors, was recently revised to require all shear connectors to be installed in the field and not in the fabrication plant which requires CEIs to be involved in monitoring the Contractor's bend tests. 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 which shall be kept on file in the CEI office.

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 Management of Construction Documents Required by the District Structures Maintenance Office (DSMO). In the future, topics other than maintenance related, may be added.

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 **"CDMS DOCUMENT PROFILE FIELDS FOR CONSTRUCTION DOCUMENTS REQUIRED BY THE DSMO"** that shows CEI staff where to electronically file construction documents (Construction Document Type, CDMS Group/ Type No., and Mandatory CDMS Document Subject/Description) so that in the future, DSMO staff will be able to find the records they need with minimal effort which has not been the case in the past. Although the "Subject/Description" field of a CDMS 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 **DOCUMENT PROFILE FIELDS FOR CONSTRUCTION DOCUMENTS REQUIRED BY THE DSMO.** 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.

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.

4.5 ■ **Qualifications and Training Courses – Concrete Field Technicians:** 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 ■ **Grouting Technician Training and Qualification Program:** 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 steel. 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.

■ This Section was recently updated and expanded as follows: The previous 8.4 requirement for viewing of the Grouting Video Tutorial, an informal introductory course, has been deleted since formal comprehensive grouting technician training has been in effect for many years and has resulted in the training and certification of hundreds of technicians and engineers.

8.5 ■ **Post-Tensioning Technician Training and Qualification Program:** 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.

8.8 ■ **Bridge Coating Inspector Training:** The lead inspector on a bridge coating project must successfully complete a Bridge Coating Training Course accredited by the Department. 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.

8.9 ■ **Lead Paint Removal:** Senior Project Engineers and Project Administrators on projects requiring the disposal of hazardous waste associated with coatings removal must successfully complete the Society of Protective Coatings (SSPC) Course entitled, C-3 Lead Paint Removal**,** 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.

8.10 ■ **Critical Structures Construction Issues – Self Study Course:** This section makes the Critical Structures Construction Issues – Self Study Course (Main Course and Annual Supplement) a formal requirement for all CEI personnel involved in structures construction and sets forth the requirements of the course and the individuals responsible for course supplements and student tracking.

► **Other Bridge Training Courses and Manuals** ■**:** The following is a listing of structures self study courses, tutorials and CTQP technical training manuals.

Self Study Courses: Structures Inspection Part One and Part Two
Tutorials: Driven Pile, Laptop Pile Driving, Drilled Shaft, Auger Cast Pile CBT, MSE Wall CBT
CTQP Technical Training Manuals: Concrete Field Inspector Specification, Pile Driving Inspector, Drilled Shaft Inspector

► **Experience requirements for CEI staff that are responsible for complex bridge projects** ■**:** CEI personnel working on projects with the following structure types must have the experience and qualifications listed below and that are covered in detail in the Department's Standard Scope of Services, Part 10.2 - Personnel Qualifications: Concrete Post-Tensioned Segmental Box Girder [CPTS], Concrete Post-Tensioned Continuous Beam [CPTCB], Movable Bridges [MB]):

Senior Project Engineer - Registered engineer with 5 years general bridge construction experience.

Project Administrator - Registered engineer with 5 years of general bridge construction experience, 3 years of which, must be in complex bridge projects or non-registered with 8 years of general bridge construction experience, 3 years of which, must be in complex bridge projects.

Senior Inspector - 5 years of general bridge construction experience, 2 years of which, must be in complex bridge projects, plus for CPTS bridges, 2 years of geometry control survey experience if performing casting yard inspection.

Casting Yard Engineer/Manager, CPTS Bridges only - Registered engineer with 1 year of casting yard experience or non-registered with 3 years of casting yard experience.

IV. SPECIFICATIONS [Standard Specifications for Road and Bridge Construction 2014]

1 Definitions and Terms

1-3 ■ Definitions - Contractor's Engineer of Record: In the past, Contractor's 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. As a result, the Department had to expend a great deal of effort on behalf of under qualified engineers by correcting their work or by instructing them about how to properly perform their work. In order to avoid such expenditures of effort in the future and to make certain that 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, the Department strengthened the qualification requirements of engineers that work for Contractors and this went into effect in 2007. A fully qualified Contractor's engineer is now referred to as the "Contractor's Engineer of Record" or "Pre-qualified 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 Pre-qualified Specialty Engineer instead of a Contractor's Engineer of Record then the Pre-qualified Specialty Engineer's work must be checked by another Pre-Qualified Specialty Engineer prior to submittal to the Department. See the list of Pre-Qualified Specialty Engineers.

For design/analysis work that involves a permanent component of a structure, the SPE/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 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, Pre-qualified Specialty Engineer or Specialty Engineer – is permitted to perform.

CLASS OF CONTRACTOR'S ENGINEER VERSUS WORK TYPE

Work Type	Contractor's Engineer of Record	Pre-Qualified Specialty Engineer	Specialty Engineer
Re-design	**Yes**	**No**	**No**
VECP	**Yes**	**No**	**No**
Details of the permanent work not fully detailed in the plans (Example: Pot Bearing Design, non-standard 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 pre-qualified Specialty Engineer**

5 Control of Work

5-1.4.5.4 ■ Temporary Works: This article 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 ■ Beam and Girder Temporary Bracing: The text of this new specification article 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. Develop the required designs following the AASHTO Guide Design Specifications for Bridge Temporary Works and Construction Handbook for Bridge Temporary Works and the Contract Documents. For Construction Affecting Public Safety, submit signed and sealed calculations for stability for all beams and girders.*

The purpose of this new article 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 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 and during construction the CEI staff must verify that the Contractor complies with the approved bracing shop drawings.

5-1.4.5.7 ■ Erection Plan: The text of this specification new article 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 new article 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.

7 Legal Requirements and Responsibility to the Public

7-7.5 ■ Contractor's Equipment on Bridge Structures: This article 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 Department allows only Consultant Bridge Design Firms that are prequalified by the Department in the applicable structures design work category to perform structural analysis for determining load carrying capacity on an existing bridge.

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

105 Contractor Quality Control General Requirements

105-8.8 ■ Supervisory Personnel – Bridge Structures: Some of the bridges the Department builds have highly complex design and construction requirements: see specifications 105-8.8.4, 5 and 6 for these types. 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 105-8.8 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 105-8.8 at all times. Specification 105-8.8.8 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.

105-8.8.7 ■ Post-Tensioning: Post-tensioning and grouting must be performed and supervised by CTQP Qualified Contactor personnel. Post-tensioning must be performed under the direct supervision of a Contractor Level II CTQP Qualified Post-tensioning Technician and the work must be performed by crew members that are at least Level I CTQP Qualified Post-tensioning Technicians. However, qualified post-tensioning and grouting 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 and the work must be performed by crew members that are at least Level I CTQP Qualified Grouting Technicians. To get qualified, prerequisites must be met and once they are met (see the Construction Training and Qualification Manual, Chapter 8.4 and 8.5 for required prerequisites), 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 and grouting technicians on their project meet the PT and grouting qualification requirements.

346 Portland Cement Concrete

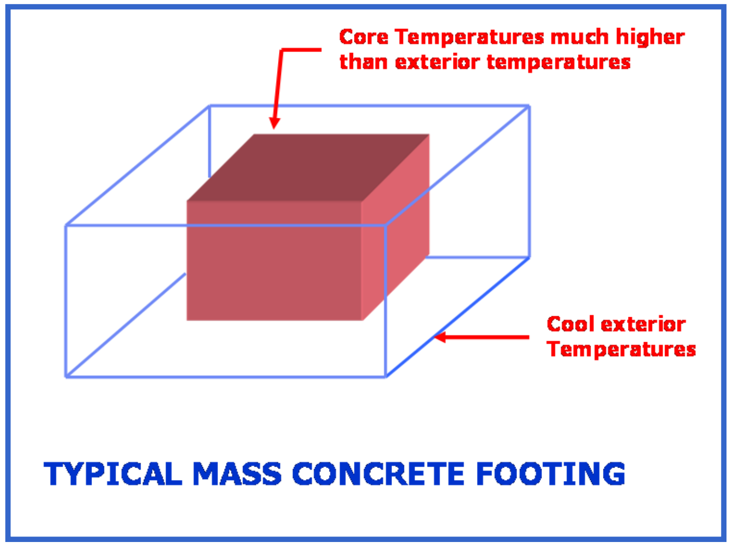
346-3.1 ■ General: This article has been revised – see revised version below - to reduce the processing effort that is required for Contractors to request the substitution of higher class concrete for lower class concrete. Previously, this had to be done on a case by case basis but now it can be done 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 separate classifications of concrete covered by this Section are designated as Class I, Class II, Class III, Class IV, Class V and Class VI. Strength, slump, and air content of each class are specified in Table 2. ***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 Contractor's Quality Control Plan, or for precast concrete, the Precast Concrete Producer's Quality Control 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 2 for the lower class concrete.*

346-3.2 ■ Drilled Shaft Concrete: The slump loss testing provision of this specification has been revised significantly and so CEI staff should review this provision carefully prior to the start of drilled shaft operations.

346-3.3 ■ Mass Concrete: This specification was revised 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 Temperature Control Plan. 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 10.3.4 and corresponding Flow Charts 10.3.4-1, Mass Concrete Temperature Control Plan Approval Process, and 10.3.4-2, CEI Verification Process for Contractor Mass Concrete Monitoring.

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. In the accompanying figure, the hotter core is shown 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 out into the mass of cooler concrete causing the cooler exterior surfaces to stretch, or to be put into 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."

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 differential temperature at least every 6 hours. Recording can be discontinued after the differential peaks and starts to diminish and when the maximum core temperature peaks and starts to diminish. Both conditions must be satisfied before monitoring can be discontinued. 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. A copy of the records must be kept on file in the CEI office and also must be transmitted to the District Materials Engineer for review as soon as available.

Mass Concrete ■: DCE Memo 19-10 revised this specification as follows which will save time and money for Contractors:

The current specification reads as follows: *Do not remove the temperature control mechanisms until the core temperature is within 35 degrees F of the ambient temperature.*

It has been revised as follows: *Do not remove the temperature control mechanisms until the core temperature is within 50 degrees F of the ambient temperature.*

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 was added to this Specification:

For slump target values in excess of 6 inches or 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 square or rectangular openings that are a maximum of 2 1/2 inches in either direction, Remove the lumps or balls from the grate and discard them.

346-6.3 ■ Delivery Certification: The definition of "Transit Time" on the delivery ticket has been changed to 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. So, 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.

346-6.4 and 12 ■: This 346 section underwent a number of important changes that went into effect on July 1, 2010. Articles 6.4 and 12 are particularly important for Contractors and CEI staff to know about. In 6.4, the Department has removed the target range requirement for concrete slump and now only requires the Contractor to be within the tolerance range: plus or minus 1.5" from the "Target Value" which is usually 3". What is also new and which 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 Article12, the Department now 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 revised articles follow:

> ***346-6.4 Plastic Property Tolerances:*** *Do not place concrete with a slump more than plus or minus 1.5 inches from the target slump value specified in Table 2.*
>
> *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 so that it will fall within specified tolerances. 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.*
>
> ***346-12 Pay Reduction for Plastic Properties:*** *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 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.*

346-7.2 ■ Transit Mixing: This specification was revised (7/2009) to make it clear that the addition of water or admixtures is not permitted if the number of mixing revolutions will exceed 160. 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.

346-7.6 ■ 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 in the too dry range 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 will only stay in the tolerance range for a short time after adding water because the aggregates will draw moisture out of the cement in order to re-saturate. If enough water is absorbed, the concrete may return to the too dry range 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.

- 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, approximately where in 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 an approximate 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 to verify the water content. 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 Contractor’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. 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: This provision has been changed as follows (new text in Italics):

~~Do not proceed with the placement operation until QC tests confirm that the delivered concrete complies with the plastic properties specified.~~ *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.* ~~When a truck designated for QC testing arrives at the site of discharge, subsequent trucks may not discharge until QC testing results are known.~~ Reject non-complying loads at the jobsite. Ensure that corrections are made on subsequent loads. *Immediately cease concrete discharge of the subsequent truck if the QC truck has failing tests and perform a slump test of that truck. Immediately cease discharge and reject the remainder of the subsequent truck if its slump test fails and reject the remaining concrete of loads that fail plastic properties tests as soon as the test results are known. Perform slump tests on all trucks that arrive at the site prior to the first corrected truck. When more than one truck is discharging into a pump simultaneously, discharge all trucks completely prior to discharging a truck designated for QC testing into the pump and discharge a sufficient quantity of concrete from the end of the pump hose to obtain a representative sample of concrete from only the QC truck.*

346-12 ■ Pay Reduction for Plastic Properties: This provision has been changed as follows and now covers pay reduction for concrete placed in precast plants:

~~If concrete is placed even when the result of plastic properties testing requires its rejection, the payment for concrete represented by the plastic property tests will be reduced by twice the invoice price per cubic yard for all concrete in the load that is placed. If the Engineer authorizes placement of the concrete, there will be no pay reduction.~~
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 is placed, payment for the concrete will be reduced. The pay reduction for cast-in-place concrete will be twice the 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.

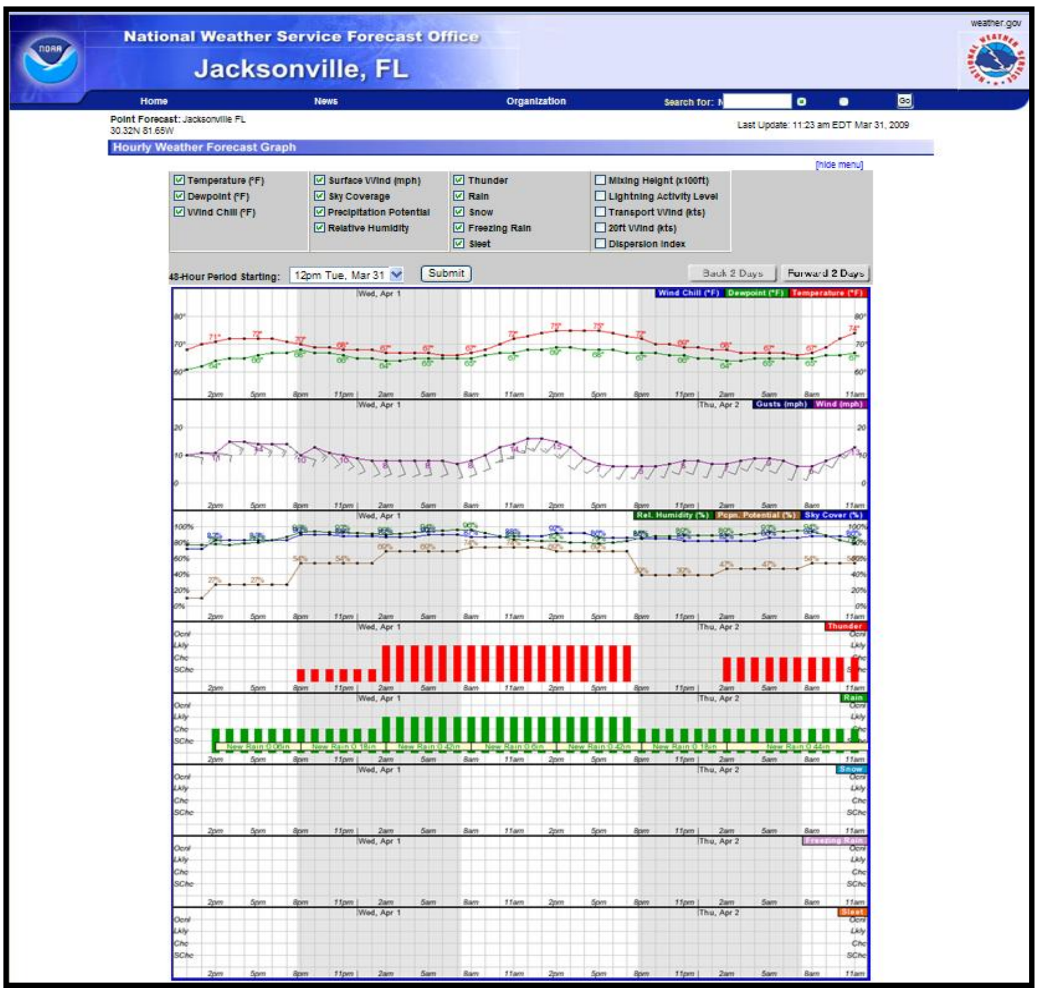
If the Engineer authorizes placement of the concrete, even though plastic properties require rejection, there will be no pay reduction based on plastic properties failures; however, any other pay reductions will apply.

400 Concrete Structures

400-7.1.3 ■ 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.*

This text was added because experience has shown that 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 not controlled, 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 internet address is as follows: http://www.nws.noaa.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 Graph” which will automatically display weather forecast data including wind velocity 48 hours in advance of the input time. An example Hourly Weather Graph can be seen in the accompanying sample computer display.



400-10.3 ■ **Bearing Pads:** This provision – see below - has been revised 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. <u>CEI staff shall thoroughly inspect all elastomeric bearing pads for excess deformation and general condition prior to final acceptance and if possible well before, in order that the Contractor has ample time to perform corrections before final acceptance.</u>

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.

400-15.2.6.4 ■ **Application of Class 5 Applied Finish Coating:** The application rate (50 square feet plus or minus 10 square feet per gallon) for Class 5 applied finish coating has not always been complied with in the last few years. 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. Written records must be kept 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. 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 Paul Vinik in the State Materials Office to find out how best to determine the required coating thickness and how to measure it.

400-16.1 ■ **General – Moisture Evaporation Monitoring and Control:** This specification was revised to emphasize 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. This is what the revised specification says: *Until curing has begun, retain concrete surface moisture at all times by maintaining a surface moisture evaporation rate less than 0.1 lb/ft^2/hr. 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 lb/ft^2/hr or greater, employ measures to prevent moisture loss such as application of evaporation retarder, application of supplemental moisture by fogging or by 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: see accompanying photo. These devices are carried by Kestrel Weather Meters and may be supplied by others 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.

In lieu of the nomograph, an easy to use and accurate internet based evaporation rate calculator can be used and the website address is: http://construction.asu.edu/cim/cimasu1/curing/curingfirstpage.htm.

Evaporation rates increased 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. The following table contains examples of typical weather conditions at different times of the year in Florida with their corresponding evaporation rates.

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/ft^2/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 from the table above, a cool windy winter day produces the highest evaporation rate which far exceeds the 0.1 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 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 that produce concrete for the project only and so are less stressed, 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 consequent repair costs, can be a very negative consequence.

400-16.2 and 16.4 ■ Methods – Curing Bridge Decks with Membrane Curing Compound: 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; 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 damp 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 ■ Traffic Barriers, Railings, Parapets and End Post – Curing Concrete: 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.

400-19 ■ Cleaning and Coating Concrete Surfaces of Existing Structures: This provision – see below - has been expanded to more clearly explain 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 400-14.2.6 or as otherwise specified in the Plans.

400-21 ■ Disposition of Cracked Concrete: This specification was dramatically changed in 2007 to take into account additional factors that influence how best to repair a crack. New factors include the elevation of the crack with regard to mean high water, the addition of more crack width ranges and the measurement of cracking severity.

The elevation is important because the closer the crack gets to salt water the more likely are the steel rebars to corrode prematurely, and conversely, the rebars in a crack far above salt water will not be effected significantly. The previous version of the specification did not take this into account. The number of crack width ranges was increased from 3 to 8 because 3 ranges did not account for the effect of width on susceptibility to deterioration accurately enough. A measure of crack severity, referred to in the specification as "Cracking Significance," was added because the previous version treated the significance of one crack in a component the same as hundreds of cracks which was obviously not adequate since the impact of many cracks on long term durability will be much more significant then will one crack.

This specification was revised (7/2009) to make it clearer in general but there were also specific changes as well. The article had always applied to cast-in-place concrete components but it now applies to precast components as well 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, as shown in the specification table, for all the cracks in that LOT. Cracks are now required to be repaired, as shown in the specification table, 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.

415 Reinforcing Steel

415-5.10.1 ■ Supports (Reinforcing Steel): This article has been revised in a number of areas. It now makes it clear that slab bolsters used to support the bottom mat of bridge deck rebars can have continuous rails that are in direct contact with stay-in-place forms. The only exception is for stay-in-place forms below 12' above mean high water elevation in an extremely aggressive environment, in which case, continuous steel rails are not permitted. It will also allow plastic coated steel bolster rails to be in contact with removable forms such as with deck overhangs, if the environment is slightly aggressive. Continuous plastic high chairs may also be used in slightly aggressive as well as steel high chairs with plastic coated leg tips. Coated steel bolster rails may not be used on removable forms if the environment is moderately or extremely aggressive but continuous plastic high chairs or continuous steel high chairs with coated leg tips are allowed in moderately aggressive environments. Only plastic high chairs are permitted to be used in an extremely aggressive environment on removable forms.

Specific strength requirements for rebar supports have been deleted and instead the specification now requires them to function without deformation or relaxation under load. Finally, water absorption requirements for nonmetallic supports and spacers have been revised.

416 Installing Adhesive-Bonded Anchors and Dowels for Structural Applications

416-6.1 ■ Field Testing: 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 (pull out test) 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 decided that 10% was an unnecessarily high sampling rate so it was changed and is now 4%. If the pullout tests consistently pass then the rate may be reduced to 2% and even to 1%; however, any test failure requires a return to the 4% rate.

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 Design Standard Index No. 470, Traffic-Railing (Thrie-Beam Retrofit), and for Dowel bars in Design Standard Index No. 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 470 or 480. For example: a pulling force of 15,000 lbs. is required by index 470 for a 7/8” diameter anchor bolt.

This article was recently revised to require testing of anchors at least once per day which was not the case prior to the revision. <u>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.</u>

450 Precast Prestressed Concrete Construction

450-12 ■ Non-complying Prestressed Products: A number of subarticles have been significantly revised most of which define the type or location of defects that require corrections that are addressed in the specifications and; therefore, do not require an engineering evaluation by a Specialty Engineer. CEI’s must be aware of these changes in order to verify that Contractor’s and Producer’s are fully complying with these revised specifications. **<u>You have not completed the review of this course until you have read the latest version of the following specifications in their entirety: 450-12.2.2, 450-12.5, 450-12.5.3.2, 450-12.5.3.4, and 450-12.5.3.5.</u>**

450-14.2 ■ Submittal of Repair Proposal: This Subarticle has been significantly revised and CEI’s must be aware of the changes in order to verify that Contractor’s and Producer’s are fully complying with this specification. **<u>You have not completed the review of this course until you have read the latest version of 450-14.2 in its entirety.</u>**

450-16.2 ■ Storage - Measuring Camber and Sweep: This specification requires the Contractor to measure and record beam camber once per month while beams are in storage at the plant and to keep the records on file for review of 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.

455 Structures Foundations

455-1.1 Protection of Existing Structures: This specification has undergone significant revision that CEIs will need to be familiar with completely. **<u>You have not completed the review of this Supplement, until you have read the latest version of 455-1.1 in its entirety.</u>**

455-5.11 Methods to Determine Pile Capacity: This specification has been revised to address the use of Embedded Data Collectors (EDC) as follows:

455-5.11.1 General: Dynamic load test*s using Embedded Data Collector (EDC) equipment and the UF Method of analysis, or an externally mounted instrument system and signal matching analyses* will be used to determine pile capacity for all structures or projects unless ~~shown~~ otherwise *shown* ~~i~~on the *Plans*~~Contract Documents~~. 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. ~~When considered necessary by the Engineer, adjust the blow count criteria to match the resistance determined from static load tests.~~ *Notify the Engineer two work days prior to placement of piles within the template and at least one work 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.*

455-5.11.7 Structures without Test Piles: CEIs must be aware of the following **<u>new</u>** specification:

For projects without test piles, the Engineer will dynamically test the first pile(s) in each bent or pier at locations shown ion the plans to determine the blow count criteria for the remaining piles. When locations are not shown ion the plans, allow for dynamic load tests at 5% of the piles at each bent or pier. 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. When using externally mounted instruments, allow the Engineer one work day after driving the dynamic load tested piles for the Engineer to complete the signal matching analyses and determine the driving criteria for the subsequent piles in the bent or pier.

455-5.14.2 Production Pile Length: This specification has been subdivided into two parts and revised as follows:

455-5.14.2.1 Structures With Test Piles: When *test pile lengths are* shown in the plans, the *production pile* lengths are based on information available during design and are approximate only. The Engineer will determine final pile lengths in the field which may vary significantly from the lengths or quantities shown in the plans.
455-5.14.2.2 Structures Without Test Piles: Authorized lengths are provided as Production Pile Order Lengths in the Pile Data Table in the Structure Plans. Use these lengths for furnishing the permanent piling for the structure.

455-5.14.4 Elevation: This specification has been revised as follows:

Ensure that the final elevation of the pile head is no more than 1 1/2 inches above, or more than 4 inches below, the elevation shown in the plans*, and in no case shall the pile be embedded less than 8 inches into the cap or footing*. ~~Do not embed the pile less than 6 inches below the elevation shown in the plans unless a minimum penetration requirement is shown.~~

455-7.2 Manufacture: This specification has been revised as follows:

Fabricate piles in accordance with Section 450. *When ~~Embedded Data Collectors~~EDCs will be used for dynamic load testing, supply and install in square prestressed bridge foundation piles in accordance with Design Standards Index No 20602. Ensure the EDCs are installed by personnel approved by the manufacturer.*

455-12.2 Prestressed Concrete Piling: This change is being made to delete the text in 455-12.2 relating to partial payments for piling because Subarticle 9-5.5.2 addresses partial payment amounts for all materials; therefore, partial payments for piling will no longer be at the 70% rate and instead will be according to 9-5.5.2 or an 85% rate.

455-15.1.3 ■ General Methods & Equipment: This specification has been revised as follows:

Provide drilling tools with a diameter not less than 1 inch smaller than the shaft diameter required in the plans.

For drilled shafts installed to support mast arms, cantilever signs, overhead truss signs, high mast light poles or other miscellaneous structures, fill the excavation with premixed mineral slurry meeting the requirements of 455-15.8.1 or polymer slurry meeting the requirements of 455-15.8.2 before the drill advances to the bottom of the temporary casing. Do not attempt to excavate the shaft excavation using plain water or natural slurry.

455-16.4 ■ Cross-Hole Sonic Logging (CSL) Tubes: This specification has been revised as follows:

Access tubes must be NPS 1 1/2 Schedule 40 black iron or steel (not galvanized) pipe *from the top of the cage to the tip of the shaft*. *Access tubes may be either NPS 1 1/2 Schedule 40 black iron or steel (not galvanized) or Schedule 80 PVC pipe above the top of the cage.*

455-17.6.2 ■ Access for Thermal Integrity Testing: CEIs must be aware of the following **new** specification:

455-17.6.2 Access for Thermal Integrity Testing: Provide safe and secure access and assistance to the Engineer, when requested, for the purpose of evaluating drilled shaft integrity via internal temperature measurements using the Thermal Integrity Test method as described herein. The Thermal Integrity Test method is based on measuring the heat generation of hydrating cement. The analysis of measured temperature profiles requires knowledge of the concrete mix used and soil profile for the purposes of determining heat generation and soil insulation parameters. For typical drilled shaft concrete mixes, thermal testing should be performed between one and two days after shaft concreting.

Provide access to the Engineer for testing the shafts within 4 hours of the peak temperature generation, which is expected to occur between 24 and 48 hrs after shaft concrete placement. Provide access to the Engineer for testing all drilled shafts in bridge bents or piers considered non-redundant in the plans. Based on the observations during drilled shaft construction, the Engineer may test one or all drilled shafts in bridge bents or piers considered redundant in the plans. For drilled shaft foundations supporting miscellaneous structures, only drilled shafts selected by the Engineer will be tested.

455-17.6.2.1 Evaluation of Thermal Integrity Testing: The Engineer will evaluate the observations during drilled shaft construction and the Thermal Integrity Test results within three working days of testing the shaft. If the shaft is selected for CSL testing, the evaluation will not be given to the Contractor before all CSL testing and analysis is complete and reported to the Engineer.

455-17.6.2.2 Coring and/or Repair of Drilled Shafts: If the Engineer determines a drilled shaft is unacceptable based on the Thermal Integrity Testing, core the shaft to allow further evaluation and repair, or replace the shaft in accordance with 455-17.6.1.5.

If repairs are performed, test in accordance with 455-17.6.1.5 and when requested, assist the Engineer in retesting the shaft(s) in accordance with 455-17.6.2.

455-29 ■ Excavations: CEIs must be aware of the following **new** specification:

If the excavation must be carried deeper than shown in the plans to obtain a satisfactory foundation, the Engineer will revise the plans in accordance with the following:

a. When the change in bottom elevation of the footing is 12 inches or less, the Engineer will keep the top of the footing at the elevation shown in the original plans and will increase the thickness to obtain a satisfactory foundation.

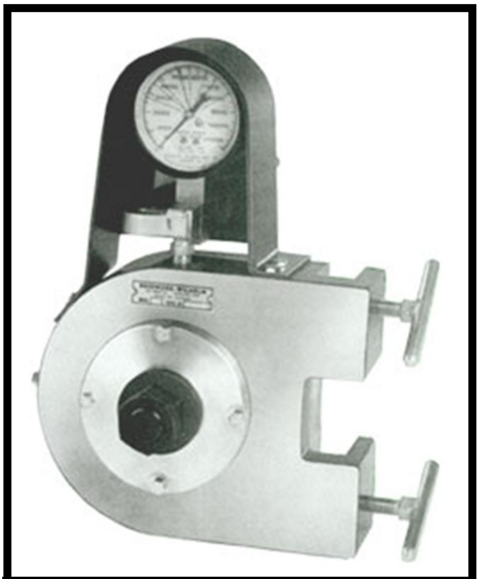
b. When the change in elevation of the bottom of footing exceeds 12 inches, the Engineer will revise the plans and lower the footing, thereby increasing the height of stem, to obtain a satisfactory foundation. Generally, the Engineer will also increase the thickness and width of footing over that shown in the original plans.

455-36.3 ■ Excavation: This specification has been revised as follows:

If the elevation of a footing as shown in the plans is changed to a higher or lower elevation, the Engineer will not consider such change as a material change to the original Contract Documents, a waiver of any condition of the Contract, or an invalidation of any of the provisions of the Contract.

460 Structural Steel and Miscellaneous Metals

460-5.2.1 ■ Rotational Capacity (RC) Test – Bolts: 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 accompanying photo) 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.



Skidmore Tension Analyzer

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 is 15% above the minimum required by the specification; (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.

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.

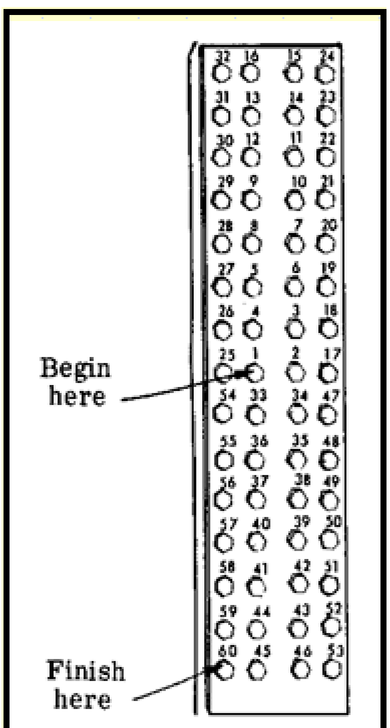
460-5.4.8 ■ Turn-of-Nut Tightening – Daily Snug Tight Torque Test for Bolts: Each day that bolts are being installed in a permanent structure, a test must be performed to determine what bolt torque will be needed to snug the connection. The connection is snugged or is "Snug Tight" when the surfaces of the connection plates, referred to as the faying surfaces, are in full contact with each other which requires the bolts to be tightened to a tension of between 10% and 20% of the minimum final tension. 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, or an additional 5%, times 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 a minimum of 1.15 times or an additional 15% of the minimum required tension, which for a 7/8" bolt, is 44.85 kips or 45 kips rounded. Specification 460-5.4.6.1 does not say this, but the required final tension in the bolt should not exceed the Rotational Capacity limit since bolts are not tested beyond, which means that there is no guarantee that bolts can be acceptably tightened beyond the additional 15% limit. Therefore, bolts should be tightened to between 5% and 15% above the minimum required tension or for a 7/8" bolt, between 41 and 45 kips. There are plans to make the specification clear about this but in the interim, CEIs should make it clear to the Contactor that application of the daily snug-tight-torque must result in a minimum required final tension, after the turn-of-nut is applied, that does not exceed the 15% limit but is equal to or greater than the 5% limit.

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.



Sequence of Bolting

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.

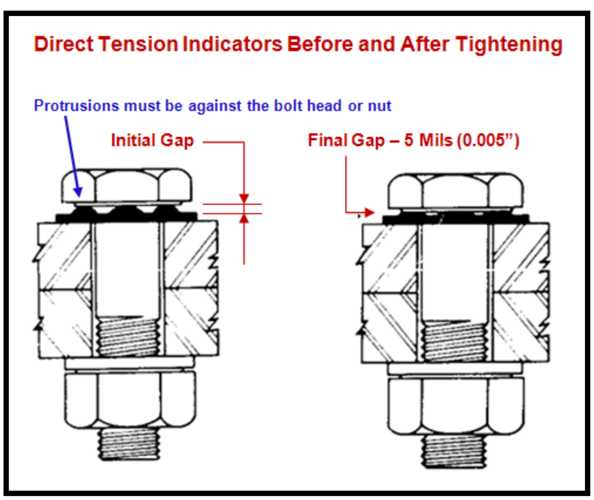
Once the daily snug tight torque is determined then installation of bolts in the connection can begin. The inspector must witness this process and the order in which the bolts must be tightened, referred to as the sequence of bolting (see accompanying drawing) must be followed for snugging and for final Turn-of-Nut tightening. As can be seen in the drawing, 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.

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). The accompanying photo 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.

460-5.4.9 ■ Direct-Tension-Indicator (DTI) Tightening - Bolts: 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 the accompanying photo. The DTI is placed between the bolt head and the plate with the protrusions against the bottom of the bolt head as seen in the accompanying photo. 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.

Sample Direct Tension Indicators



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 in the accompanying photo. 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.
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. Many Contractors are unaware of DTIs since they are relatively new to Florida so the SPE/PA should discuss their use with the Contractor at the preconstruction conference since use of DTIs could save time and effort for the Contractor and CEI.

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 contact 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 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.

460-7.2 ■ Weathering Steel: The Department now requires all structural steel superstructures to be fabricated with weathering steel which does not require painting and 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. Also shown below for information, are Structural Detailing Manual Drawings 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 though a Supplemental Agreement.

460-7.2.2 Steel Preparations: 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: 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: 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 16.12-1 Weathering Steel I-Girder Details (1 of 2)

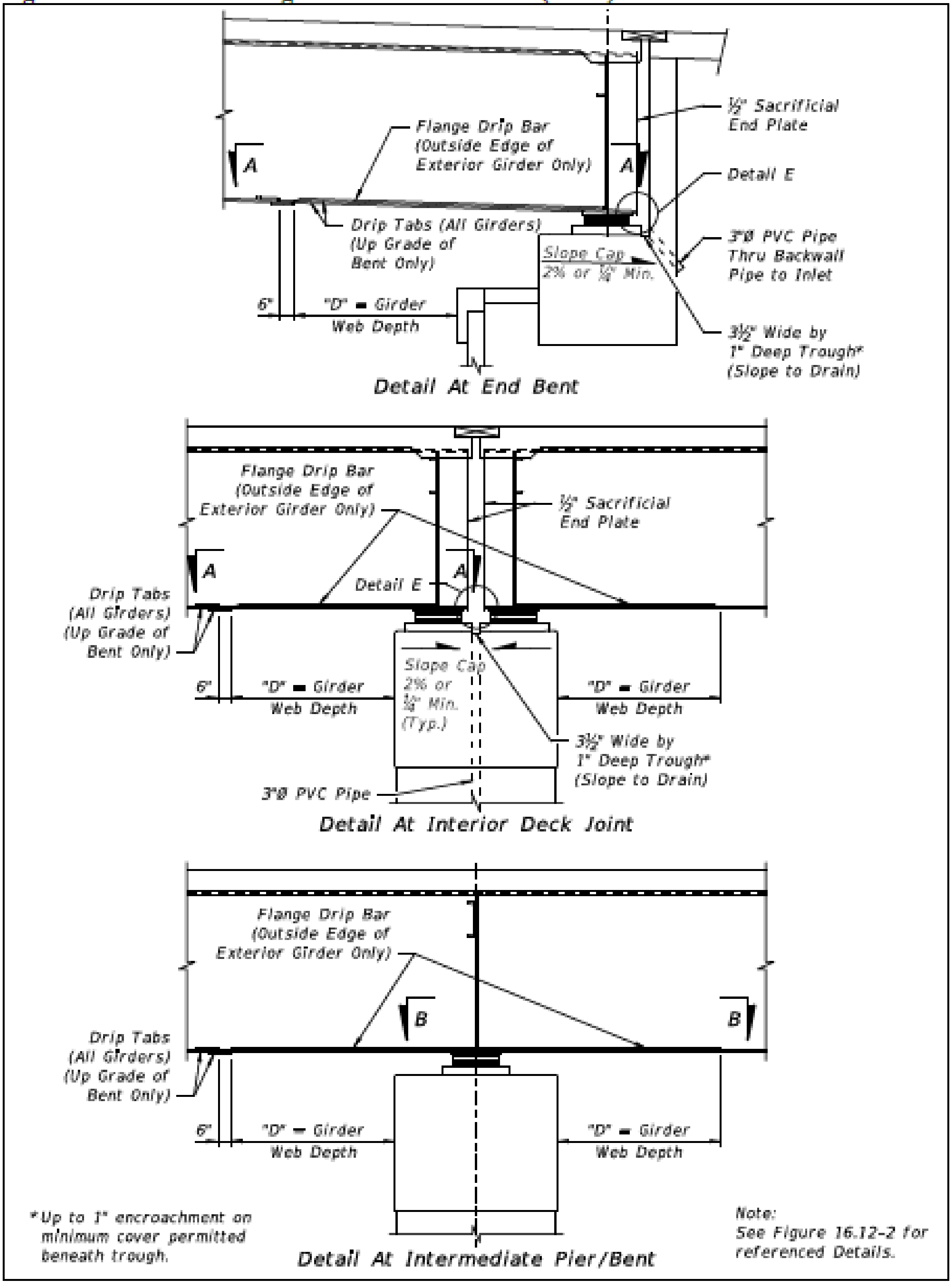


Figure 16.12-2 Weathering Steel I-Girder Details (2 of 2)

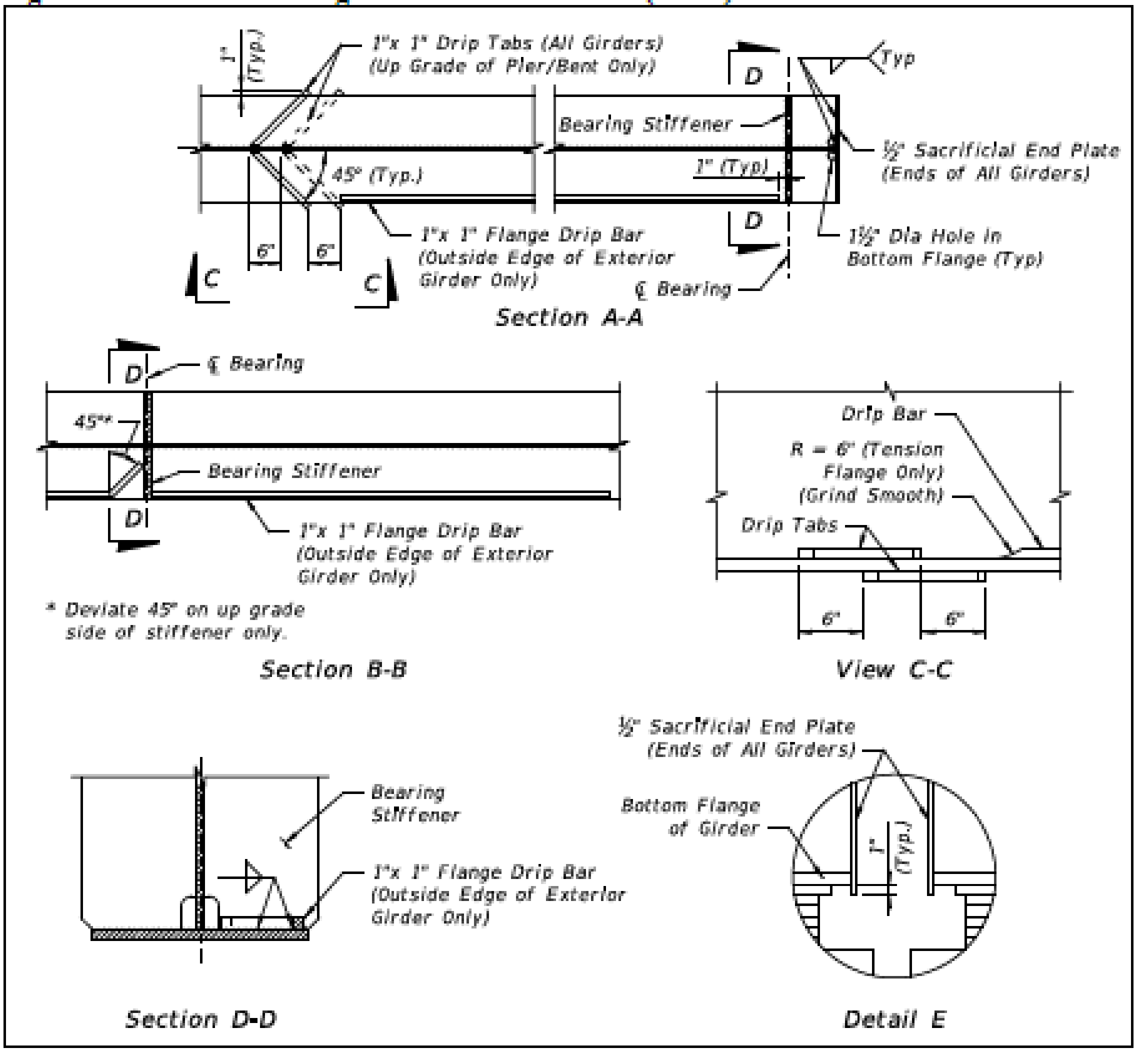
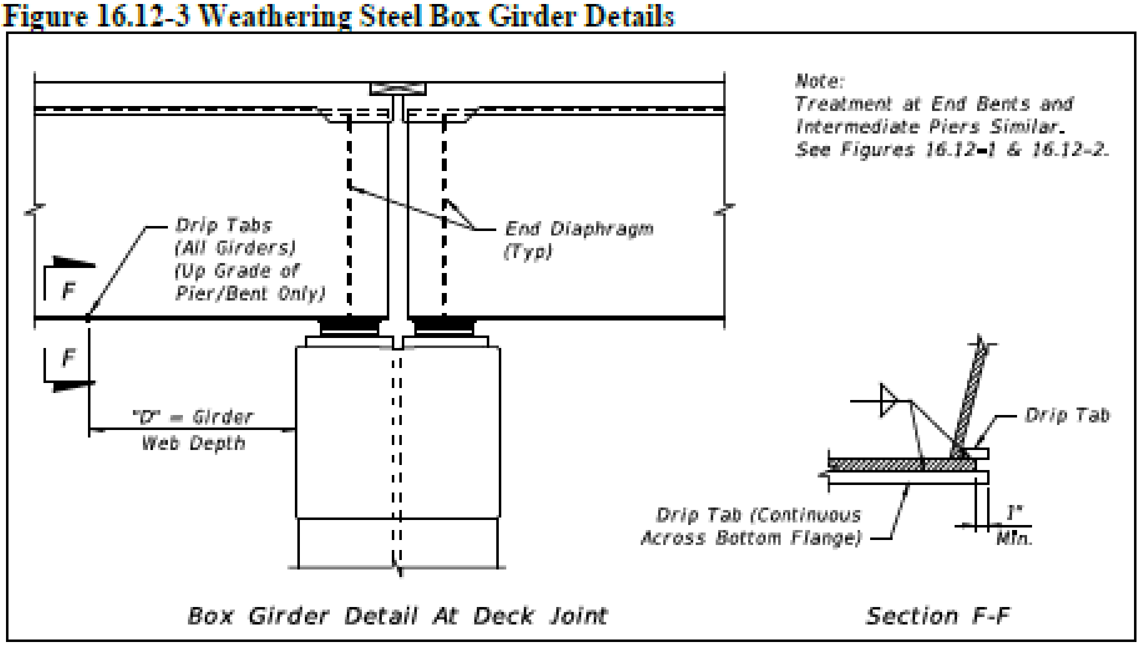
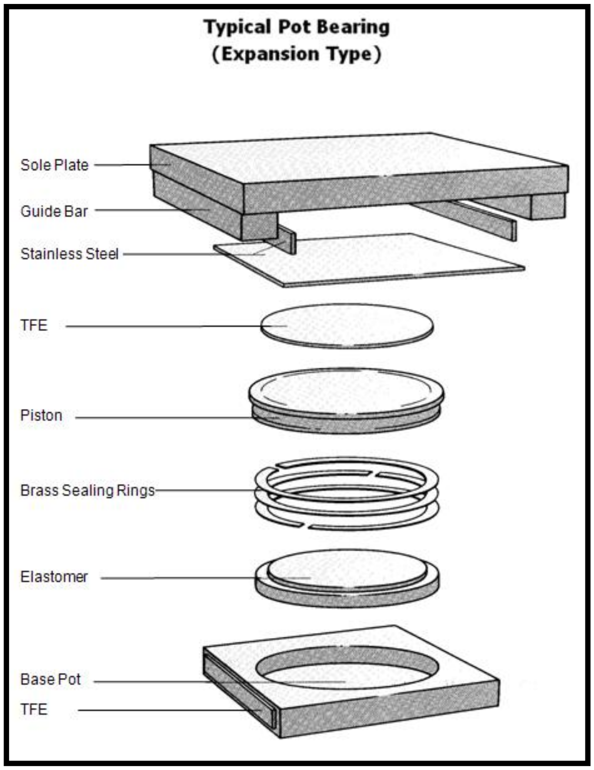


Figure 16.12-3 Weathering Steel Box Girder Details



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 the accompanying drawing. 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.

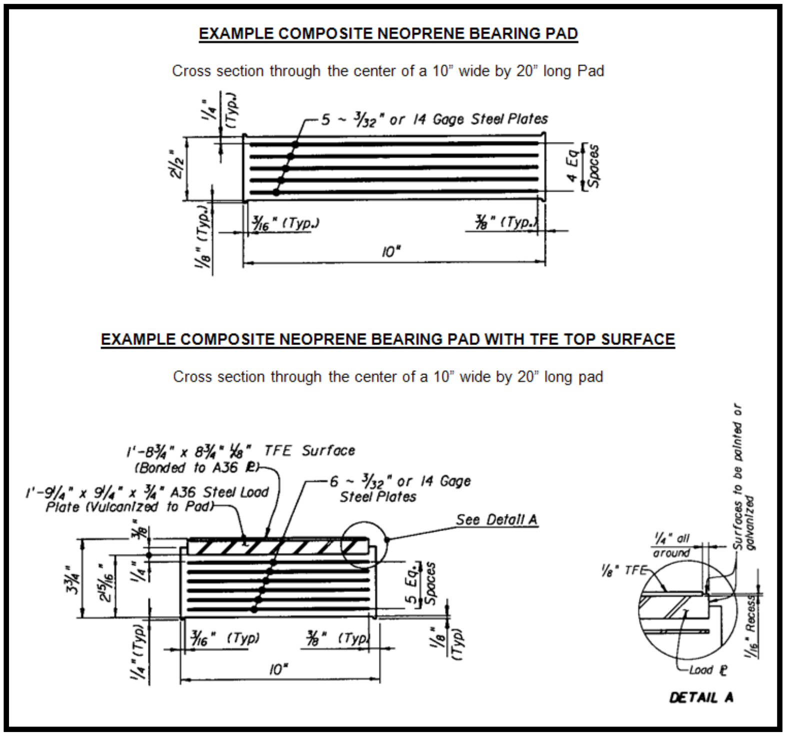


Misalignment errors can be prevented if the Contractor requests the as-fabricated bearing center geometry of the beam from the fabricator while the beam is still in the fabrication plant and compares it to the centerline of bearing geometry in the field prior to delivery of the beams to the project site. 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. **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 70^0F 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 70^0F 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^{0}F change in temperature. If the beam is 200’ long it will change 2/8” and so on. So for example, a 250’ long beam that is 55^{0}F (15^{0}F cooler than the 70^{0}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 (the beam is hotter than 70^{0}F) of the bearing is required than 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^{0}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 it the accompanying drawing) must be adjusted after the beam is placed because they accommodate expansion and contraction by deforming so unless the temperature is nearly 70^{0}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^{0}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.

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

461-5 ■ Construction (Multirotational Bearings): 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 been seriously lacking from time to time 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.

502 Shear Connectors

502-1 ■ Description: The 2010 Standard Specifications allow Contractors to install shear connectors on steel beams in the field or in the shop. However, in September of 2009, OSHA changed their position on the practice of shop installation of shear connectors and it is now prohibited due to tripping hazard concerns during the placement of deck forms. 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. The specification has been revised as follows and is required on all projects:

> ***502-1 Description:*** *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.*

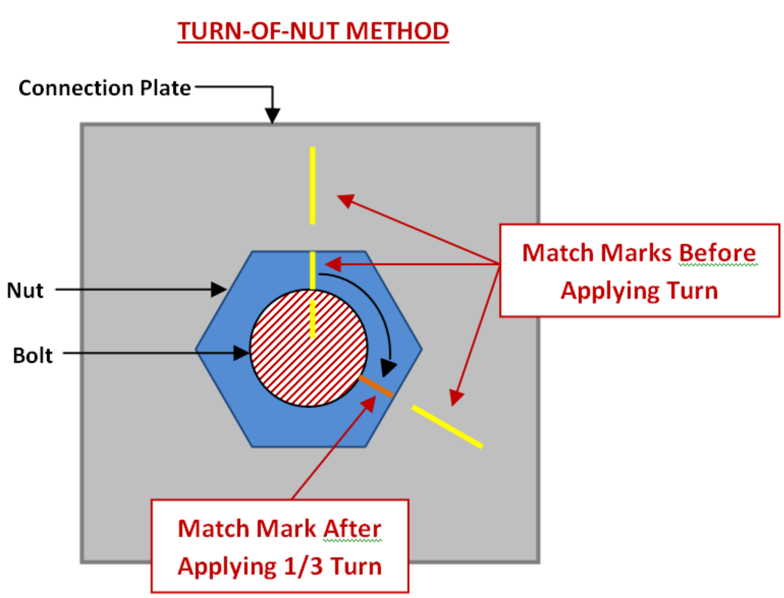
560 Coating Structural Steel

560-9.7 ■ Stripe Coating: Recent experience has shown that the Specification 560-9.7 requirement to stripe coat welds, corners, crevices, sharp edges, bolts, nuts, rivets, and rough or pitted surfaces which is required and not optional, has not been consistently performed by Contractors. Application of stripe coating is particularly important for bolts and nuts which are very difficult to protect properly without stripe coating. The SPE/PA shall inform the Contractor of this requirement at the first pre-work meeting that addresses painting operations.

560-11.2 ■ Application of Coating (Coating Structural Steel): This article has been revised so that sheet pile interlocks are no longer required to be coated. Interlocks are far less critical with regard to corrosion damage than other areas of sheet piles since they are much thicker and so the cost benefit of coating them is not justified especially since significant sections of interlock coating are scraped off during the installation process.

649 Steel Strain Poles, Steel Mast Arms and Monotube Assemblies

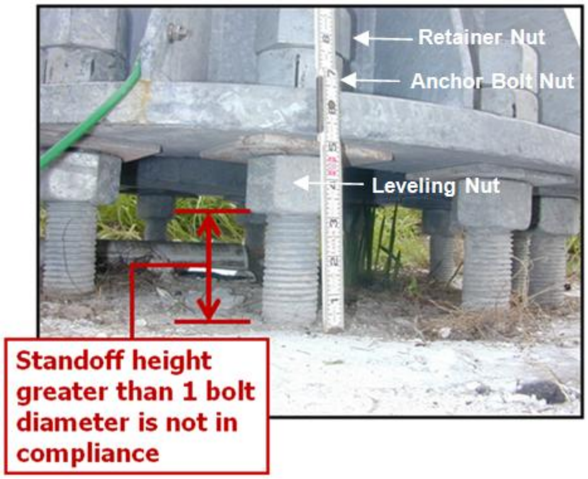
649-5 ■ Installation – Bolting: Nuts of anchor bolts and non-anchor bolts are required to receive an initial stage of tightening referred to as “Snug Tight Condition” or just “Snug Tight.” Snug tight is achieved when an ironworker using an ordinary spud wrench turns the nut with full effort or as tight as possible without excessive force.



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 and then to a final stage. However, after both stages of tightening the faying surfaces (surfaces of the connecting plates that are required to be in contact) must be in full contact or the connection is not acceptable. 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 specification Table 460-7. 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.

Match marking - see the accompanying drawing for a match marking example - 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.

Tightening is acceptable when the turn is applied to all nuts of the connection and all faying surfaces are in full contact. Minor isolated gaps between the faying surfaces may be permitted with approval of the Engineer. The order in which nuts should be turned for both stages of tightening should keep clamping forces balanced as much as possible. This means that adjacent nuts should never be tightened one after the other because this produces unbalanced clamping forces which can lead to unacceptable gaps in the plates after all nuts have been tightened.



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: see the accompanying photo. Step one in the base plate connection process is leveling and consists of incrementally adjusting the leveling nuts until all are in direct contact with the bottom of the base plate and the base plate is level in two directions that are perpendicular to each other. Step two requires the anchor bolts to be tightening to a snug tight condition against the top of the base plate. For step three, the leveling nuts must be tightened to a snug tight condition. The anchor bolts receive match marked Turn-of-Nut tightening in step four and the required amount of turn is specified in Table A of specification 649-5. The retainer nut is tightened in step 5 to a snug tight condition. During each stage of nut tightening (leveling, anchor bolt, retainer) use a tightening sequence that, as nearly as possible, produces a balanced distribution of clamping forces on the base plate as tightening progresses.

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

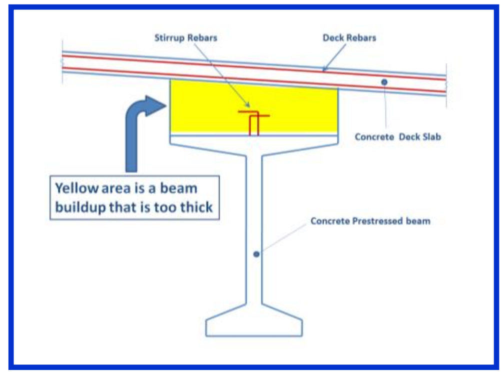
649-6 ■ Screen Installation: The specification was revised to require the use of screens to cover the gap between the bottom of the base plate and the concrete foundation as seen in the accompanying photo. The use of grout for this purpose is no longer permitted by the specification due to widespread durability problems. However, under certain circumstances a District may wish to specify grout which will require a note in the plans that requires grout and prohibits screens.

700 Highway Signing

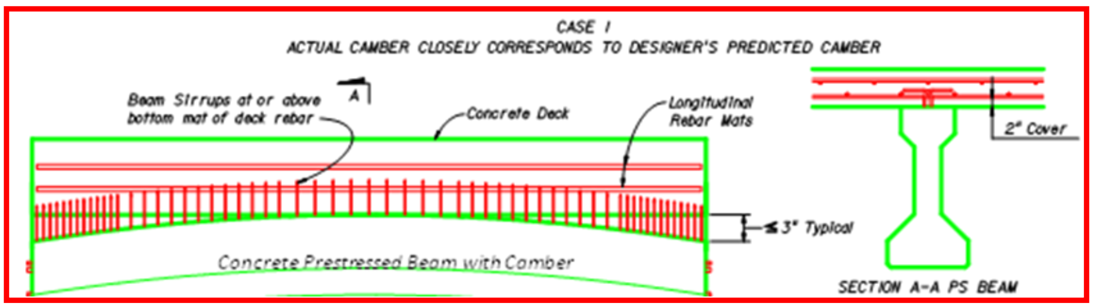
700-2.5.3 ■ Installation: Bolting procedures for highway signs are as specified in 649-5 for anchor bolts and for alternate slices of span sign structures. For all other bolts, nuts are tightened to a snug tight condition with all faying surfaces in contact for the initial stage. For the final stage, nuts are tightened to a level of torque (see Specification Table 700-1 for required minimum torque), as measured by a calibrated torque wrench, instead of using the turn-of-nut method. Screen material over gaps is also required for covering the base plate gap as specified in 649-6.

Miscellaneous Specification Related Issues

A. ■ Preventing Excessively Thick Beam Buildups: The accompanying drawing 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 the accompanying drawing. 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.



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 the accompanying drawing. 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.

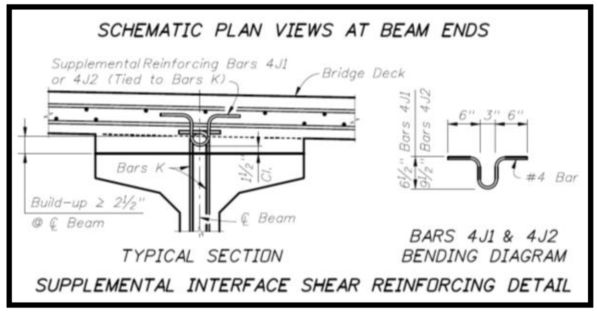


Stirrup engagement is also important because it keeps the beam and deck connected in case of lateral impact. If the stirrups do not extend into the slab but remain in the buildup then the beam can fall away from the deck if a high lateral impact is applied by a vehicle. The accompanying photograph shows what can happen if a beam does not have adequate attachment to the deck. With adequate attachment, the beam usually suffers only localized damage in the immediate vicinity of the impact but does not disconnect from the slab in large segments.

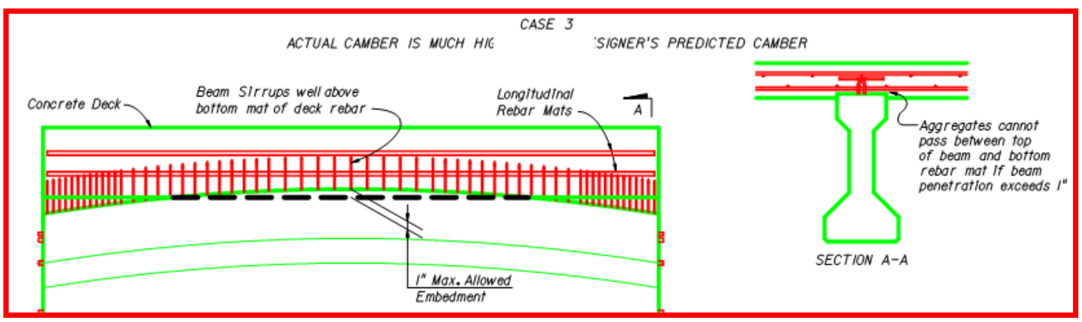
Preventing Excessively Thick Buildups: The Designer estimates the camber value and includes it in the plans so that the Contractor can set grades for the beam pedestals relative to the deck elevations. The designer's camber estimate is based on a beam age of 120 days. Age is a factor in the estimate 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 450-16.2 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.

When Excessively Thick Buildups are Unavoidable: A Contractor worker or a CEI inspector must monitor stirrup extension during deck forming and rebar placement by observing the distance between the top of beam and top of the deck form, which is the planned slab bottom. If this distance is not at least 1.5 inches less than the vertical length of the stirrup then the buildup is too thick and some corrective action is required prior to concrete placement. If the buildup is too thick by a small amount then with the EOR's approval, the horizontal legs of the stirrups can be bent up at a 45 degree angle if the resulting additional extension into the deck will be adequate as determined by the EOR. When the buildup is too thick to be corrected by bending the stirrup legs then additional reinforcing bars that will extend the stirrups, as shown in the accompanying drawing, will be required and must be approved by the EOR. The stirrup extensions (at least 2 sizes can be fabricated) are tied to the existing stirrup tops which results in a correctly positioned stirrup extension in relation to the bottom mat of deck rebars.



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 as can be seen in the accompanying drawing. This practice is usually acceptable if approved by the EOR but is never permitted if the beam is required to be inserted more than 1". The reason for the 1" limit is because a space between the bottom mat of rebars and the top of the beam that is less than 1" will not allow large aggregates in the concrete to enter the space resulting in deficient concrete. If the 1" 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.

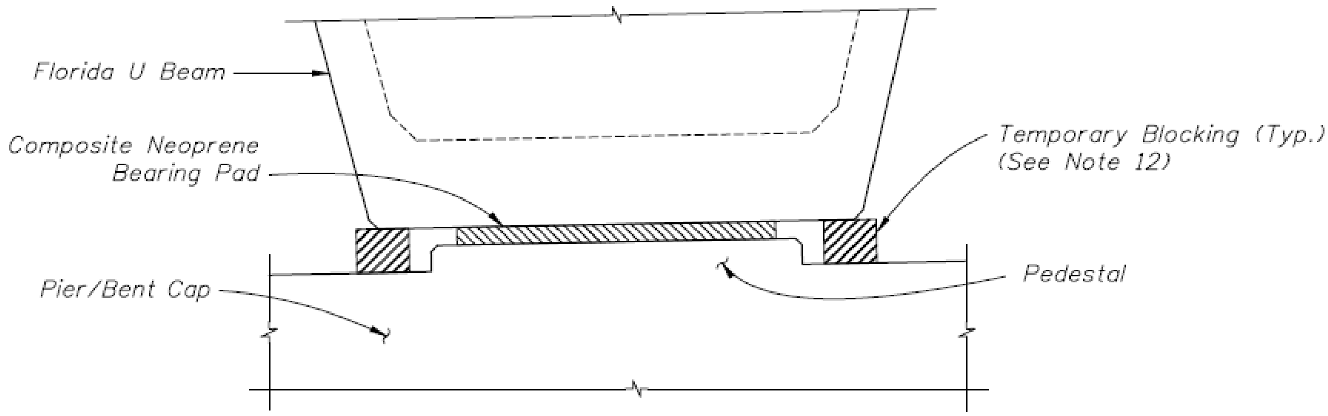
D. ■ Deck Concrete Placement Direction: Concrete for constructing a bridge deck that is continuous over multiple spans is routinely placed in stages and this requires plastic concrete for the latest stage to be in direct contact with the hardened face of a previously completed stage. This is referred 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 it is placed 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. Since the concrete is no longer plastic or fluid, the beam rotation puts tension stresses into the initially set concrete that exceed its capacity which causes cracks. When 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: see the accompanying photo of 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.

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 accompanying blocking detail and note). 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.

Standard Index 20210, U-Beam Notes (Note 12) and Blocking Detail:



TEMPORARY BLOCKING OF BEAM ENDS

Note 12: Prior to deck placement, based on the deck forming system and deck placement sequence, evaluate and provide, if necessary, temporary bracing between the U Beams. Also, 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 that occur during placement of the deck. Leave temporary blocking and bracing in place for a minimum of four days after the deck placement.

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. The table below is intended to provide a user friendly format for determining the temporary works submittals needed for a given circumstance; however, it is not intended to be a substitute for the applicable specification which must be complied with fully. Each Submittal or Action includes the number of the specification to which it applies.

Required Contractor Submittals or Actions Required for Bridge Temporary Works

Contractor Submittal or Action Required for Temporary Works	Temporary Works Category											
	PS Concrete Beam Bracing		Falsework/ Shoring		Beam/Girder Erection Plans		Special Erection Equipment		Scaffolding		Formwork	
	PSN[4]	PS[4]	PSN	PS	PSN	PS	PSN	PS	PSN	PS	PSN	PS
Submittal to the Engineer for review if not steel or post-tensioned beams/girders [5-1.4.5.7 and 5-1.5.4][3]					X	X						
Submittal to the Engineer for review and prepared by the SE[2] for steel and post-tensioned beams/girders [5-1.4.5.7 and 5-1.5.4]					X	X						
At a minimum, girders must be braced at each end of each span [5-1.4.5.6]	X	X										
Submittal to the EOR[1] of design calculations for bracing members and connections prepared by the SE [5-1.4.5.6]		X										
Submittal to the EOR of a certification by the SE that loads do not exceed the assumed loads shown in the plans for prestressed concrete beams that have bracing plan requirements in the plans [5-1.4.5.6]		X										
Submittal to the EOR of beam stability calculations prepared by the SE when temporary bracing requirements are not shown in plans or are revised by the Contractor [5-1.4.5.6]		X										
Submittal to the EOR of shop drawings with applicable design calculations prepared by the SE [5-1.4.5.4]				X			X	X		X		X
Certification to the Engineer by the SE that fabrication and operation are in accordance with approved drawings and calculations [5-1.5.1]							X	X				
Certification to the Engineer by the SE that construction is in accordance with approved drawings and calculations or plans [5-1.5.2, 5-1.5.3 and 5-1.5.4]			X	X		X						X
Inspection by Contractor of erected structural systems each day while they are in a temporary condition and report inspections to the Engineer in writing [5-1.5.4]						X						

1 – EOR: Engineer of Record, 2 – SE: Specialty Engineer, 3 – Specification references in parenthesis

4 – PSN: Public Safety is Not Affected, PS: Public Safety is Affected

V. DESIGN STANDARDS

Index Number ■ 6110, Wall Coping with Traffic Railing/Junction Slab:

The Department recently met with members of the construction industry that manufacture and erect Mechanically Stabilized Earth (MSE) walls to listen to their concerns regarding the current design standards which result in the top panels of the wall having to be cast to a custom height most of the time. This increases fabrication costs as well as adding additional costs associated with the tracking for correct installation on the project site. As a result of the meeting with industry, the Department has made revisions to Standard Index 6110 to address their concerns and these revisions went into effect with July 2012 lettings.

Index Numbers ■ 11871, Single Post Median Barrier Mounted Sign Support:

As a follow-up to Roadway Design Bulletin 12-05 and Structures Design Bulletin 12-03, titled "Median Traffic Railing Mounted Signs", the Department has developed new Design Standard Index 11871 for single post median barrier mounted signs supports. The new Standard Index addresses installing permanent and temporary sign support on both permanent and temporary barriers and traffic railings.

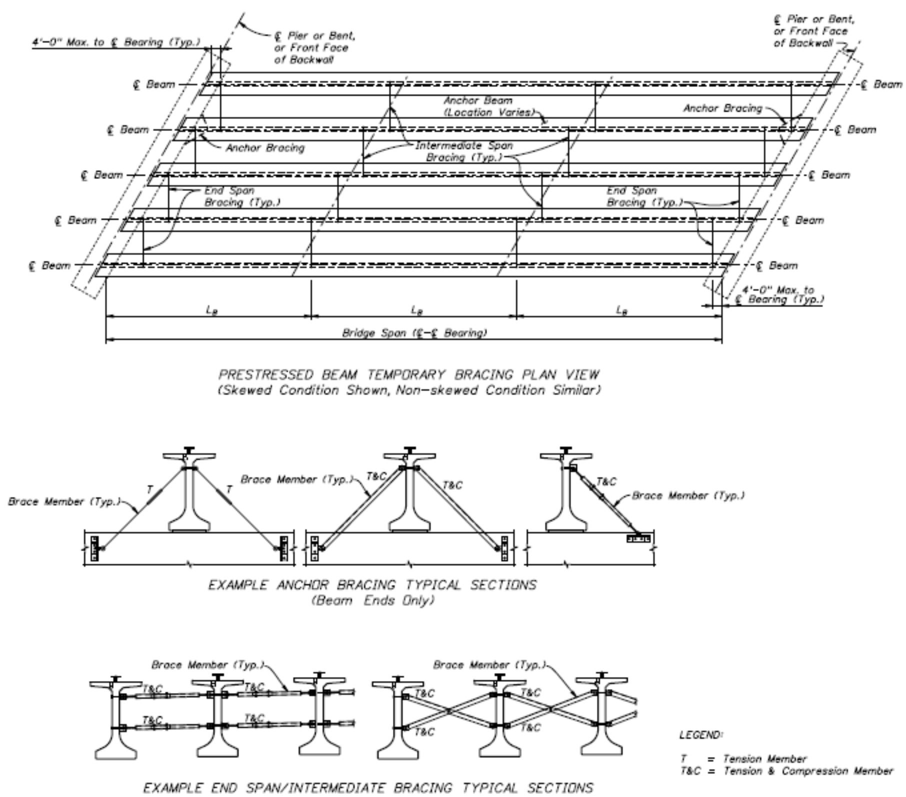
Index Number ■: 20005, Prestressed Beam Temporary Bracing

Starting in July of 2011, and possibly before for selected projects, bridge plans will include Standard Index No. 20005, prestressed Beam Temporary Bracing (see copy of the 1 sheet index below), which will show generic standard bracing requirements and details for prestressed concrete beam superstructures for use prior to diaphragm and deck completion. There will also be another new sheet in the plans which will be project specific and entitled "Prestressed Beam Temporary Bracing Data Tables (BDT)", which will include the following tables (see the sample sheet with instructions below): Wind Load Variables, Assumed Construction Loads, and Temporary Bracing Variables. The data in the BDT sheet is provided by the EOR to aid the Contactor's Specialty Engineer in designing the project specific bracing system required by revised Specification 5-1.4.5.6, Beam and Girder Temporary Bracing.

Use of the BDT data is optional but if the Contractor chooses to use the BDT sheet data and if construction affecting public safety is involved then the Contractor must submit to the Engineer signed and sealed bracing system calculations by a Specialty Engineer in addition to a certification statement that construction loads do not exceed the assumed loads shown in the plans and BDT sheet. If the Contractor chooses not to use the BDT sheet data or if the plans do not include a BDT sheet then for construction affecting public safety, the Contractor must submit to the Engineer a Specialty Engineer's signed and sealed calculations for stability for all beams and girders and the design calculations for bracing members and connections.

Index 20005, explains that the anchor beam is a beam which has anchor bracing at its support locations. It is to be set first, and its location may vary. All subsequent beams are to be braced against the Anchor Beam sequentially. The Anchor brace may be located at an exterior girder provided that all required bolt clear distances are met and overhang bracing is not impacted. Anchor bracing may be inclined, as shown in the plan view, or may be installed vertically. The temporary bracing at the ends of the beams shall be installed prior to crane release if indicated in the "TABLE OF TEMPORARY BRACING VARIABLES". Beams shall not be left un-braced during non-work hours. Bracing at the ends of the beams shall remain in place until the diaphragm concrete reaches 2,500 psi. The temporary intermediate bracing, if required, shall remain in place until bridge deck concrete reaches 2,500 psi

The SPE/PA shall discuss these requirements with the Contractor well in advance of the first beam erection operation of the project and the SPE/PA shall monitor the Contractor's compliance with the approved bracing system and shall confirm that the order and sequence of assembly specified in the Standard Index 20005 is followed as well as construction related notes in the BDT sheet.



NOTES:

1. The 'PRESTRESSED BEAM TEMPORARY BRACING PLAN' is to be used in conjunction with the 'TABLE OF TEMPORARY BRACING VARIABLES' in the Structures Plans. The brace locations and quantities shown in the plan view are schematic only, and the actual brace locations and quantities should be determined from the 'TABLE OF TEMPORARY BRACING VARIABLES' in the Structures Plans.

2. The bracing members shown in the sections are schematic only, and are meant to show geometry in which bracing should be placed. The bracing members and connections shall be designed and detailed by the Contractor. Any of the geometric configurations shown in the bracing sections are acceptable. The bracing may be attached through the web or to the flanges of the beam, as necessary. The bracing shall be positively and securely connected to each beam, and shall not be designed to exert any vertical force on the outer edge of the top flange. All bolt holes in beams are to be preformed and filled after use. All bracing is to be placed perpendicular to beams.

3. The anchor beam is a beam which has anchor bracing at its support locations. It is to be set first, and its location may vary. All subsequent beams are to be braced against the Anchor Beam sequentially. The Anchor brace may be located at an exterior girder provided that all required bolt clear distances are met and overhang bracing is not impacted. Anchor bracing may be inclined, as shown in the plan view, or may be installed vertically.

4. Overhang bracing requirements are neither specified here nor in the 'TABLE OF TEMPORARY BRACING VARIABLES.' It is the Contractor's responsibility to design overhang bracing which does not cause excessive deflection or rotation of the exterior girder, or cause the girder stresses to exceed stress limits per the FDOT Structures Manual.

5. The Contractor shall submit documentation required by the Specifications for Road and Bridge Construction, Section 5 for 'Beam and Girder Temporary Bracing.' If the Contractor elects to use the bracing requirements shown in the 'TABLE OF TEMPORARY BRACING VARIABLES,' the documentation shall include signed and sealed certification that the construction loads do not exceed those shown in the 'TABLE OF ASSUMED CONSTRUCTION LOADS' and signed and sealed design of bracing members and connections. If the Contractor elects to use a bracing scheme different from those shown in the 'TABLE OF TEMPORARY BRACING VARIABLES,' the documentation shall include signed and sealed calculation of the bracing requirements and design of bracing members and connections.

REVISIONS						
DATE	BY	DESCRIPTION	DATE	BY	DESCRIPTION
01/01/10	SJN	New Design Standard			

2010 Interim Design Standard

PRESTRESSED BEAM TEMPORARY BRACING

Interim Date: 01/01/10 | Sheet No. 1 of 1 | Index No. 20005

INSTRUCTIONAL NOTES TO DESIGNERS

GENERAL INSTRUCTIONS:

The Standard Drawings for prestressed beam bracing (Index No. 20005) depict notes and details that are schematic for use in the development of beam bracing shop drawings. These drawings and notes are included in the contract documents by reference to the Index No. in the plans. Companion MicroStation CADD cell 20005, which includes the 'TABLE OF TEMPORARY BRACING VARIABLES,' the 'TABLE OF WIND LOAD VARIABLES,' the 'TABLE OF ASSUMED CONSTRUCTION LOADS,' and the 'BEAM TEMPORARY BRACING NOTES'. The tables are to be completed and included in the plans with the note.

The FDOT Beam Stability MathCAD program may be used to determine the variables to be input into the 'TABLE OF TEMPORARY BRACING VARIABLES,' the 'TABLE OF WIND LOAD VARIABLES,' and the 'TABLE OF ASSUMED CONSTRUCTION LOADS.'

The forces that are entered into the columns for beam end and intermediate horizontal bracing forces in the 'TABLE OF TEMPORARY BRACING VARIABLES,' shall be the horizontal reaction forces at each brace point. Forces should not be resolved into a diagonal component, regardless of any inclination of the actual bracing. These forces are to be used by the Contractor to design bracing members and connections.

The assumed weight for the finishing machine is left to the discretion of the EOR, but suggested total weights for the finishing machine are 10 kips for bridge widths less than 45 feet and 20 kips otherwise.

If intermediate span braces are not required, enter "N/A" in the horizontal and overturning force columns for each span for which intermediate span braces are not required.

EXAMPLE PROBLEM

The following example shows the data required for completion of the Data Table for the Prestressed Beam Temporary Bracing Index No. 20005. This case shows a Florida-I 78 Beam (Index No. 20078).

The example assumes a three equal span bridge designed for the following conditions:

Girder Span: 182'-0"
Girder Spacing: 6'-0"
Number of Girder Lines: 7
Deck Thickness: 8½"
Deck Overhang: 3'-0"
Skew Angle: 45°
Bridge Height: 60'-0"
Construction Inactive Wind Load: 44.0 psf (150 mph reduced by 0.6 to 90 mph)
Construction Active Wind Load (20 MPH): 2.2 psf (girder only), 1.1 psf (bridge with forms in place)

Based on beam stability calculations, (1) intermediate brace point would be sufficient, but the bracing force would be very large. Therefore, the bracing requirements will be calculated based on (2) intermediate brace points.

The maximum unbraced length is: 182'-0"/3 = 60'-8"

TABLE OF WIND LOAD VARIABLES	Table Date 1-01-10
WIND SPEED, BASIC (MPH)	150
WIND SPEED, CONSTRUCTION INACTIVE (MPH)	90
WIND SPEED, CONSTRUCTION ACTIVE (MPH)	20
VELOCITY PRESSURE EXPOSURE COEFFICIENT	1.137
GUST EFFECT FACTOR	0.85

TABLE OF ASSUMED CONSTRUCTION LOADS (UNFACTORED)	Table Date 1-01-10
BUILD-UP (PLF)	50
FORM WEIGHT (PSF)	20
FINISHING MACHINE TOTAL WEIGHT (KIP)	20
FINISHING MACHINE WHEEL LOCATION BEYOND EDGE OF DECK OVERHANG (IN.)	2½
DECK WEIGHT (PSF)	113.3
LIVE LOAD (PSF)	20
LIVE LOAD AT EXTREME DECK EDGE (PLF)	75

TABLE OF TEMPORARY BRACING VARIABLES						Table Date 1-01-10	
SPAN NO.	L_b, MAXIMUM UNBRACED LENGTH (FT)	HORIZONTAL FORCE AT EACH BEAM END AND ANCHOR BRACE (KIP)	HORIZONTAL FORCE AT EACH INTERMEDIATE SPAN BRACE (KIP)	OVERTURNING FORCE AT EACH BEAM END AND ANCHOR BRACE (KIPxFT)	OVERTURNING FORCE AT EACH INTERMEDIATE SPAN BRACE (KIPxFT)	BRACE ENDS PRIOR TO CRANE RELEASE?	TOTAL NUMBER OF BRACES
1	60.67	8.69	23.90	27.31	63.75	NO	24
2	60.67	8.69	23.90	27.31	63.75	NO	24
3	60.67	8.69	23.90	27.31	63.75	NO	24

BEAM TEMPORARY BRACING NOTES:

Based on investigation of the beam stability, temporary bracing as shown in the 'TABLE OF TEMPORARY BRACING VARIABLES' and Design Standard Index No. 20005 is required. The Table and following information is provided to aid the Contractor in design of beam temporary bracing:

1. Design the bracing members and connections to transfer both compressive and tensile forces equal to the horizontal forces given in the 'TABLE OF TEMPORARY BRACING VARIABLES'. Also design bracing members and connections to be capable of resisting the overturning forces given in the Table, non-simultaneously with horizontal forces. Assume that horizontal bracing forces are applied perpendicular to the beam web at mid-height of the beam, and assume that overturning bracing forces are applied at the centerline of the beam at the top of the top flange.
2. The horizontal brace forces have been determined by application of the Construction Inactive Wind Load as listed in the 'TABLE OF WIND LOAD VARIABLES'. The overturning brace forces have been determined by application of the Construction Active Wind Load as listed in the 'TABLE OF WIND LOAD VARIABLES' plus the assumed construction loads shown in the 'TABLE OF ASSUMED CONSTRUCTION LOADS'. It is the Contractor's responsibility to re-calculate the bracing requirements if the actual construction loads exceed the assumed loads shown, or if the finishing machine wheel location from the edge of the deck overhang exceeds the value listed.
3. The temporary bracing at the ends of the beams shall be installed prior to crane release if indicated in the 'TABLE OF TEMPORARY BRACING VARIABLES'. Beams shall not be left un-braced during non-work hours. Bracing at the ends of the beams shall remain in place until the diaphragm concrete reaches 2500 psi. The temporary intermediate bracing, if required, shall remain in place until bridge deck concrete reaches 2500 psi.
4. The exposure period (defined as the time period for which temporary load cases of the superstructure exist) is assumed to be less than one year. Horizontal bracing forces, as specified in the 'TABLE OF TEMPORARY BRACING VARIABLES', are not valid if the exposure period is more than one year; for this case the Contractor shall re-calculate bracing requirements.
5. Horizontal and overturning forces are factored per the Strength III limit state for construction.

Design Instructions & Information For FDOT Design Standards

PRESTRESSED BEAM TEMPORARY BRACING INSTRUCTIONS

Last Revision 01/01/10 | Sheet No. 1 of 1 | Index No.(s) 20005

Index Numbers ■ 20511 & 20512, Bearing Plates (Type 1 & 2) – Prestressed Florida-I Beams: These new Standard Indexes, 20511 and 20512, were implemented in the last year and cover details of bearing plates for Florida I Beams (FIB).

State of Florida Department of Transportation
Office of Construction

CERTIFICATION OF COURSE COMPLETION

ATTENTION:* *This form is only required for completion of the Main Course. Completion of the annual Supplement to the Main Course does not require a certification of completion statement so <u>do not</u> submit this form for completing the Supplement.

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

____

E-mail address