STRUCTURE AND BRIDGE DIVISION

INSTRUCTIONAL AND INFORMATIONAL MEMORANDA

VIRGINIA DEPARTMENT OF TRANSPORATION

VDOT GOVERNANCE DOCUMENT

INSTRUCTIONAL AND INFORMATIONAL MEMORANDA

OWNING DIVISION: Structure and Bridge

DATE OF ISSUANCE: Various

INSTRUCTIONAL AND INFORMATIONAL MEMORANDA

STRUCTURE AND BRIDGE DIVISION

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All Memoranda in a single PDF click here

VIRGINIA DEPARTMENT OF TRANSPORTATION

STRUCTURE AND BRIDGE DIVISION

INSTRUCTIONAL AND INFORMATIONAL MEMORANDUM

GENERAL SUBJECT: Bridge Project/Plan Authorization and Approval Authority	NUMBER: IIM-S&B-19.10
SPECIFIC SUBJECT:	Date: October 24, 2011
	SUPERSEDES: IIM-S&B-19.9
DIVISION ADMINISTRATOR APPROVAL: /original signed/ Kendal R. Walus, P.E. State Structure and Bridge Engineer Approved: October 24, 2011	

Changes are shaded.

EFFECTIVE DATE

This memorandum is effective for bridge projects advertised after July 1, 2011.

PURPOSE

This IIM is to provide guidance on the design and plan authorization authority based on the two tiered project development which is being implemented on July 1, 2011. The two tiers are as follows:

Tier 1 = All projects < $5M (UPC) Construction Cost and that are not Federal Oversight. Non-federal oversight bridge maintenance projects that are limited to the following activities may exceed the $5M level:

- Bridge painting
- Bridge deck patching
- Bridge deck overlays and sealing
- Bridge Joints
- Bridge deck cleaning and washing

For other bridge maintenance projects with a Construction Cost above $5M (UPC), the District Bridge Engineer may request that the project be designated Tier 1 thru the District Project Development Engineer.

Tier 2 = all projects > $5M (UPC) Construction Cost (except as noted above), all projects designated as Design Build at the Scoping Stage, and any project that has Federal Oversight

Tier 1 Bridge Projects (No Central Office Oversight)

- Project will be developed in the District following established VDOT policies, guidelines, procedures and standards to ensure consistency throughout the Commonwealth.

- The Districts will have full approval authority for these projects, with the oversight authority being determined at the project scoping, except that Federal authorizations and funding verifications must be obtained from Central Office Programming Division by the District Planning and Investment Manager (PIM).

- There will be no Central Office involvement in the project approval process except when there are deviations from AASHTO minimum standards, VDOT S&B modifications to AASHTO, VDOT S&B geometrics as shown in the Manual of the Structure and Bridge Division; environmental issues, R/W authorization; and submissions to the Commonwealth Transportation Board. AASHTO Bridge and VDOT S&B deviations shall be resolved by following established S&B design exception or waiver policies.

Tier 2 Bridge Projects (Central Office Oversight)

- Projects shall follow all existing policies, procedures and processes, and shall include Central Office reviews and approvals during the various stages of the project development process.

PROJECT ASSIGNMENT AUTHORIZATION

Tier 1 bridge project assignments will be the responsibility of the District Structure and Bridge Engineer.

Tier 2 bridge project assignments will be the responsibility of the Assistant State Structure and Bridge Engineer responsible for the Design Engineering Program in coordination with the District Structure and Bridge Engineer in which the project resides.

Close coordination of project assignments shall occur between the Central Office and District Bridge Staff to ensure that a defined office is assigned responsibility for each project.

PRELIMINARY PLAN APPROVAL

The S&B Division Central Office/District will perform reviews and provide approval of all Stage I Preliminary Plan submissions developed by in-house staff and consultants. The preliminary plan approval authority is as shown in the following table:

Preliminary Plan – Approval Authority	
Plan Type	**Approval Authority**
Tier 1 Projects	District Structure & Bridge Engineer
Tier 2 Projects	Assistant State Structure & Bridge Engineer (Design Engineering Program Area) and FHWA where required, with input from District Structure and Bridge Engineer
Non-conventional designs and/or Bridge construction costs > $25M (bridge cost only)	State Structure & Bridge Engineer and FHWA where required
Design Build Projects, PPP Projects and Locally Administered Projects	As indicated in the Design-Build Manual, the PPTA Implementation Manual and Guidelines, and the Locally Administered Projects (LAP) Manual

Preliminary plans for new construction and total bridge replacements shall show the layout, substructure type, superstructure typical section, any unusual or distinctive feature(s) and sequence of construction (where required). The format should consist of a bridge plan title sheet and interior bridge plan sheets as needed. Preliminary plans must be accompanied by comparative estimates for the proposed layout as well as for any alternative layouts that were considered.

For new and total replacement bridge projects, a preliminary Stage I report shall be developed. This report shall be posted in iPM after the Stage I plans have been approved.

No final design shall begin until the preliminary plan layout has been approved by the assigned approval authority. If a hydraulic study is required, the preliminary plan layout shall not be approved until the analysis has been received.

Major revisions to the span layout (i.e. a change from a two span to a three span concept) or design (i.e. a change from a fully integral abutment to a conventional abutment) concepts after preliminary plan approval will require a resubmission for authorization to proceed with the new concepts.

PREPARATION OF PLANS

Any new bridge requiring a special design superstructure or substructure, or any repair, alteration, deck/superstructure replacement, or widening performed on an existing bridge which, in any way, affects the structural capacity or integrity of the structure must have design and/or detail plans developed showing the proposed work.

Geometrics shown in the Manual of the Structure and Bridge Division, Volume V – Part 2, Chapter 6, shall be used on all structures unless a design exception/waiver from these standards is authorized in writing by the State Structure and Bridge Engineer.

Minimum bridge widths can be exceeded subject to the approval of the assigned approval authority.

All structure plans are to be prepared in accordance with approved AASHTO Bridge Design Specifications, VDOT Modifications and the Manuals of the Structure and Bridge Division.

Plan numbers are assigned by the Central Office Structure and Bridge Division File Room.

All bridge/drainage ("B" and "D" designation) structure plans (and sketches) shall have a plan number assigned and an “As-Built” plan completed and recorded in accordance with S&B Division policy. This also applies to repair plans involving structural modifications.

<u>Tier 1 Bridge Projects (No Central Office Oversight)</u>

Depending on the type of work being performed, Tier 1 bridge projects may be accomplished by utilizing 8 ½” x 11” detail sheets inserted into the contract assembly or by the use of full size drawings.

Tier 1 Bridge projects utilizing 8 ½” x 11” detail sheets may include, but are not limited to, the following types of structural work:

a) Small drainage structures or other engineered entities with or without road improvements, such as precast concrete box culverts, structural plate arches, 3-sided concrete rigid frames, retaining walls, sinkhole remediations, etc.
b) Bridge rail/parapet repairs
c) Bridge repair/preventative maintenance (Regional/District wide)
d) Bridge painting operations
e) Minor bridge structural repairs, e.g. heat straightening beams/girders
f) Bridge deck overlays and sealing
g) Bridge deck cleaning and washing
h) Bridge concrete Gunite repairs
i) Manufactured superstructure (truss)
j) Bridge scour countermeasures or remedial measures
k) Culvert repairs
l) Bridge debris removal

m) Bridge slope repairs

Tier 1 Bridge projects utilizing full size plans may include, but are not limited to the following types of structural work:

a) Bridge Only Projects with minimal roadway approach work
b) Special design bridges and structures
c) Bridges or structures using standard drawings for superstructure and substructure elements (e.g., Retaining Walls, Steel Beam/Timber Deck (SS-8), C-I-P Slab Spans)

All Tier 2 Bridge projects shall use full size plan sheets.

FHWA REVIEW/APPROVAL:

Projects in the following categories are to be sent to FHWA for review:

- Interstate projects estimated to have a construction cost (exclusive of construction engineering and contingencies) > $1.0 million.

- Interstate Preventive Maintenance Projects estimated to have a construction cost > $5.0 million. The following bridge activities have been defined as "Preventive Maintenance":

  - Seal or replace leaking joints reconstruction of joint areas during joint replacement or elimination of deck joints.
  - Deck Overlays: Thin bonded overlays, rigid overlays and asphalt overlays with waterproof membranes.
  - Spot and zone painting/coating of structural steel to include bearings for prestressed concrete members.
  - Painting/coating of structural steel.
  - Cathodic Protection (CP) Systems for Bridge Decks, substructure elements and superstructure elements other than decks.
  - Electrochemical chloride extraction treatment for deck and substructure elements.
  - Scour countermeasures installation
  - Removing large debris from channels
  - Retrofit of fracture critical members
  - Retrofit of fatigue prone details
  - Concrete deck repairs in conjunction with installation of deck overlays, CP systems, or ECE treatment.
  - Substructure concrete repairs in conjunction with installation of CP systems, ECE treatment, or galvanic anodes.
  - Application of sealants, coatings, and membranes for surface protection of the concrete.
  - Bridge cleaning and/or washing services. (Decks, joints, drains, substructure horizontal elements and superstructure)
  - Place concrete mat along the flow line of steel pipe culverts.

Note: When eligible substructure work and/or painting/coating of ends of girders under joint locations that are leaking, it is required to seal the joints. The District may request a waiver from the State Structure and Bridge Engineer to delay sealing the joints for a period not to exceed one year.

- Projects on the National Highway System (other than Interstate) estimated to have a construction cost (exclusive of construction engineering and contingencies) > $25.0 million.

  See the following link for NHS general information:

  http://www.fhwa.dot.gov/planning/nhs//

  See the following FHWA website that defines NHS Routes in Virginia:

  http://www.fhwa.dot.gov/planning/nhs//maps/va/index.htm

- Projects not meeting the three criteria mentioned above, but have been identified by FHWA as requiring Federal Oversight.

USE OF STANDARD PLANS AND STANDARD DETAILS

Maximum use is to be made of the standards and details in the various Manuals of the Structure and Bridge Division, Volume V-series. These details can easily be modified to fit a particular structure with minimum drafting needed.

FINAL PLAN APPROVAL

The S&B Division/Districts will provide review and recommendation for approval for all final plan submissions developed by both the in-house staff and consultant community in accordance with the table shown on the next page.

Final Plan – Approval Authority	
Plan Type	**Approval Authority**
Tier 1 Projects	District Structure & Bridge Engineer
Tier 2 Projects	Assistant State Structure & Bridge Engineer (Design Engineering Program Area) and FHWA where required, with input from District Structure and Bridge Engineer
Non-conventional designs and/or Bridge construction costs > $25M (bridge cost only)	Assistant State Structure & Bridge Engineer (Design Engineering Program Area) and FHWA where required, with input from District Structure and Bridge Engineer
Design Build Projects, PPP Projects and Locally Administered Projects	As indicated in the Design-Build Manual, the PPTA Implementation Manual and Guidelines, and the Locally Administered Projects (LAP) Manual.

FINAL PLAN SUBMISSION

Completed bridge plan drawings in .dgn and .pdf format shall be archived in accordance with established file documentation policy. Separate plan sets shall be completed for each structure, unless the plan set includes an adjacent twin structure.

At Final Plan Submission, the bridge plans are required to be 100% complete.

After plan submission to the Scheduling and Contract Division, no changes relating to plan quality, constructability and bidability shall to be made without the approval of the Scheduling and Contract Division.

RECOMMEND FOR APPROVAL AUTHORITY

For Tier 1 bridge projects, the District Project Development Engineer recommends “For Approval”, and as such, will append his/her signature and date to the title sheet of completed projects per Manual of the Structure and Bridge Division, Volume V – Part 2.

For Tier 2 bridge projects, the State Structure and Bridge Engineer recommends “For Approval” and as such will append his/her signature and date to the title sheet of completed projects per Manual of the Structure and Bridge Division, Volume V – Part 2.

CC: Chief Engineer
Assistant State Structure and Bridge Engineers
District Structure and Bridge Engineers
Central Office Structure and Bridge Program Managers
FHWA Virginia Bridge Division Engineer
State Location and Design Engineer

VIRGINIA DEPARTMENT OF TRANSPORTATION

STRUCTURE AND BRIDGE DIVISION

INSTRUCTIONAL AND INFORMATIONAL MEMORANDUM

GENERAL SUBJECT: WELDING AND SPLICING OF LOAD CARRYING MEMBERS	NUMBER: IIM-S&B-23.2
SPECIFIC SUBJECT:	Date: DECEMBER 3, 2007
	SUPERSEDES: BR-86-23.1
DIVISION ADMINISTRATOR APPROVAL: Kendal R. Walus, P.E. / Original Signed State Structure and Bridge Engineer Approved December 3, 2007	

Changes are shaded.

CURRENT REVISION

- Converted to electronic format. The subject matter of the IIM did not change.

EFFECTIVE DATE

- This memorandum is effective upon receipt.

POLICY

The welding of steel bridge members or the splicing of steel bridge members shall be performed only when shown on approved repair plans or when approved by the District Structure and Bridge Engineer.

All welding shall be performed by a welder certified for the type of weld and the position of the weld as specified in the latest ANSI/AASHTO/AWS *Bridge Welding Code*.

VIRGINIA DEPARTMENT OF TRANSPORTATION

STRUCTURE AND BRIDGE DIVISION

INSTRUCTIONAL AND INFORMATIONAL MEMORANDUM

GENERAL SUBJECT: Bridge Safety Inspections	NUMBER: IIM-S&B-27.8
SPECIFIC SUBJECT: Inventory and Inspection Requirements for Bridges and Large Culverts	Date: June 30, 2016 SUPERSEDES: IIM-S&B-27.7
DIVISION ADMINISTRATOR APPROVAL:	/original signed/ Kendal R. Walus, P.E. State Structure and Bridge Engineer Approved: June 30, 2016

Changes are shaded

INTRODUCTION:

The attached instructions are intended to complement the National Bridge Inspection Standards (NBIS) found in the Code of Federal Regulations Title 23 Highways – Part 650, Subpart C; *The Manual for Bridge Evaluation* (MBE), published by the American Association of State Highway and Transportation Officials (AASHTO); AASHTO Manual for Element Inspection First Edition, and the AASHTO Movable Bridge Inspection, Evaluation, and Maintenance Manual. For the remainder of this document the Virginia Department of Transportation shall be referred to as VDOT.

A list of Bridge Safety Inspection Documents referenced in this memorandum may be found at the following – http://www.virginiadot.org/business/bridge_safety_inspection.asp.

DEFINITIONS:

For the purposes of this memorandum, unless otherwise noted, the term 'structure' will encompass both bridges and culverts.

Bridge: Any structure not defined as a culvert and which typically has deck, superstructure and substructure components. Some bridge structures may have integral deck and superstructures – i.e. slab/box beams, T-beams, rigid frames, etc. In these cases, the deck and superstructure may be considered separately for condition assessment, however, general condition ratings (GCR's) shall not vary by more than one for the deck and superstructure.

Bridge Record: Cumulative information about an individual bridge or culvert meeting the Federal definition of a bridge as defined in the MBE.

Close-up Inspection: Inspection performed while having a clear unobstructed view of the detail or member in question (typically within 12 feet or one lane) such that it can be determined if defects are present. While binoculars (and other optical enhancements) can be used to supplement a visual inspection, they shall not be used in lieu of methods and requirements defined herein.

Complex Bridges: This category of structures includes movable, cable-stayed, segmental concrete, and other bridges with unusual characteristics. These types of structures will require specialized inspection procedures or specialized personnel/inspector training and experience. A specialized inspection procedure, additional personnel/inspector training and experience required to inspect complex bridges will be developed prior to the scheduled inspection taking place. The complex bridges shall receive routine and in-depth inspections according to those procedures. These bridges shall be identified in the inventory.

Culvert: Any structure that has an integral floor system that supports the sidewalls and provides a lined channel. A culvert has no distinction between substructure and superstructure and typically has no deck. Multiple box or pipe culverts will be considered a single structure where the clear distance between openings is less than half of the smaller contiguous opening. Otherwise, each opening shall be considered a separate structure.

Element Inspection: An inspection in accordance with the AASHTO Manual for Bridge Element Inspection and VDOT Supplement that includes defining the total quantity of National Bridge Elements (NBEs), Bridge Management Elements (BMEs) and Agency Developed Elements (ADEs) present and assessing the quantity to be included in the condition states for each element present.

Entities: Localities (municipalities), other agencies, toll authorities and other non- VDOT organizations that own and maintain NBIS structures.

Fatigue and Fatigue Prone Details: The definition of fatigue is the tendency of a member to fail at a stress level below its yield stress when subject to cyclical loading. Fatigue prone details are details meeting the AASHTO fatigue detail categories of C through E' on bridges meeting at least one of the following two criteria: either carries a route that has 500 or more trucks per day or carries an interstate route.

Note that the classification of fatigue prone details by category does not apply to all details and some details may be considered fatigue prone due to other conditions and forces. These conditions will typically cause localized stress concentrations. See appendix for a list of typical fatigue prone details. Engineering judgment is required to recognize and assess structure specific fatigue prone conditions.

Fracture Critical Bridges: Bridges that contain fracture critical members and carry vehicular traffic.

Fracture Critical Member (FCM): Metal member or element that is subjected to tension forces and whose failure would "likely" cause a portion of or the entire bridge to collapse.

Hands-on Inspection: An inspection performed within an arm's length of the detail or member being inspected. This is intended to mean the inspector is close enough to touch the member or detail should magnification, testing, measurement or other quantification methods be needed.

In-depth inspection: A routine inspection in combination with inspections of one or more members above or below the water level utilizing advanced techniques in addition to visual techniques to identify deficiencies not readily detectable using routine inspection procedures. This type of inspection will be required for complex bridges or structures identified by VDOT, with pre-defined inspection techniques, for a special assessment of one or more components or the entire structure. Additionally, this type of inspection is commonly associated with determinations of structural integrity of compromised members.

Initial Inspection: First inspection of a structure when it becomes part of the highway system and an active record in the inventory.

Interim Inspection: Special inspection to assess or monitor structural damage, a structural deficiency, or any other feature of a structure that needs to be inspected on a specific frequency. Interim inspections are typically performed more frequently than the regular inspection. Only those features requiring the interim inspection need to be inspected. A cursory inspection shall be performed of other components, members and elements (with an emphasis on those in fair or poor condition) while inspectors are on site.

Large Culvert: A culvert that either meets the definition of a Non-NBI structure in this IIM or a culvert that meets the definition of a structure as defined in Federal item 112 (Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges) in the NBIS.

NBI: Abbreviation for "National Bridge Inventory." In the context of this memorandum when a structure is referred to as an NBI structure it meets the federal definition of a bridge as defined in the NBIS.

Non-destructive Testing (NDT): A diverse group of analysis techniques to evaluate the properties of a material, component or system without causing damage.

Non-NBI: A structure to be included in the VDOT Structure Inventory that does not meet the NBI definition above. Structures in this category include, but are not limited to, culverts and bridges less than 20 feet between undercopings of abutments or between springlines of arches and structures which do not carry highway traffic (i.e. railroad structures, pedestrian structures, footbridges, etc.). A culvert in this category can be a single barrel or have a number of barrels where the clear distance between openings is less than half of the smaller contiguous opening and the total hydraulic opening is equal to or greater than 36 square feet.

Nonscheduled/Damage Inspection: Inspection to assess structural damage resulting from environmental factors or human actions or to inspect changed conditions of elements due to construction or maintenance activities when the NBI schedule will not be adjusted accordingly.

Past Due Inspection: Inspection that did not take place in or before the month it was due.

Regular/Routine Inspection: Inspection which meets the requirements of a routine inspection as defined in the NBIS and MBE. In this memorandum, the terms regular and routine are used interchangeably.

Underwater Inspection: Inspection performed by trained and qualified divers to assess the condition of submerged structure elements that otherwise cannot be inspected through the normal wading inspection as part of the NBI scheduled underwater inspection or to supplement regular or nonscheduled inspections.

Unobstructed View: View of a component or an element that is not visibly obstructed by another object or member, dirt, debris, vegetation, corrosion, etc. This is also applicable to lighting conditions that may cause shadows across components or elements to be inspected.

ROLES AND RESPONSIBILITIES:

Structure and Bridge – Central Office

The Central Office Structure and Bridge Division shall have overall responsibility for the statewide compliance with the inventory and inspection policy standards and procedures of all NBI and VDOT maintained Non-NBI structures.

Structure and Bridge – District

Each District Structure and Bridge Section shall maintain an organization that will inspect, or cause to be inspected, all structures defined in this memorandum as NBI or VDOT maintained Non-NBI structures. District Structure and Bridge Sections shall have overall responsibility for compliance with the NBIS and VDOT requirements of all structures within their respective district, including other entities.

District Structure and Bridge Engineer (DSBE) or designee, typically District Structure and Bridge Safety Inspection Engineer (DSBSIE), shall follow the procedures outlined in Table 1 on the following page for notifying entities of their inspection responsibilities within their respective District.

Railroad Structures – District/Consultant

To obtain railroad right of entry agreements, coordination shall be made with the Virginia Department of Transportation, Right of Way and Utilities Division, Rail Section. Advanced coordination should be initiated typically three to six months prior to the inspection due date. Inspectors shall have railroad safety training that would satisfy the respective Railroad (RR) where required. Inspection of the bridge shall be performed after obtaining the Right of Entry Agreement (ROE) and scheduling flagging services with the respective RR.

Clearance measurements (horizontal and vertical) are required to be taken at each inspection.

Table 1 – Procedures for Notifying Entities for Inspections Due			
	Reason for Notification	**When to Notify**	**Distribution**
1.	Inspection Schedule	6 months in advance of inspections due	NOTIFY • Official directly responsible for the inspection program in the entity
2.	Follow Up for Inspections Due in Previous Month	Monthly – for inspections 1 day or more past the month due	NOTIFY • Official directly responsible for the inspection program in the entity to determine the status inspections due in the previous month (has it been inspected, when will it be inspected if it has not been inspected) COPY • Central Office Structure and Bridge Safety Inspection Program Manager • Official in the highest authority in the entity being notified.
3.	Follow Up for Past Due Inspections	Monthly – for inspections 31 days or more past the month due	NOTIFY • Official directly responsible for the inspection program in the entity COPY • VDOT's Local Assistance Division and the local liaison in the District • Central Office Structure and Bridge Safety Inspection Program Manager • Official in the highest authority in the entity being notified.
4.	Subsequent Follow Up for Past Due Inspections	Monthly – for inspections 61 days or more past the month due	NOTIFY • VDOT's Local Assistance Division and the local liaison in the District COPY • Central Office Structure and Bridge Safety Inspection Program Manager • Assistant State Structure and Bridge Engineer for Bridge Safety Inspection • Official in the highest authority in the entity being notified. • Official directly responsible for the inspection program in the entity

Notification procedures for load ratings and inventory discrepancies shall be similar to Table When these submissions are not in accordance with the time limits set forth in the NBIS or this memorandum, the District Structure and Bridge Engineer shall notify the entity in accordance with Step 3, 'Follow Up for Past Due Inspections', outlined above and, if necessary, follow up with Step 4, 'Subsequent Follow Up for Past Due Inspections'.

Entities

Each entity shall maintain an organization that will inspect, or cause to be inspected, all structures defined in this memorandum as NBI that are owned or maintained by the entity. Each entity shall have overall responsibility for compliance with the NBIS and applicable VDOT requirements of all NBI structures within their respective jurisdiction.

The NBIS requires VDOT to maintain the structure inventory system of all public roads maintained by public entities that are within Virginia's boundaries. In order to maintain this information each entity must submit all NBIS required information, to include structural inventory and appraisal data, inspection reports following VDOT format, and load ratings following VDOT Summary Format to VDOT in accordance with the policies and procedures set forth in the NBIS and this memorandum. Additionally, for all NBI structures on the National Highway System (NHS), entities shall conduct element inspections and submit all element data to VDOT for entry into the Department's Bridge Management System (BrM). Upon request, copies of the Inspection Summary Report and structure inventory sheets will be provided to the entity when the inspection schedule is transmitted.

Although the NBIS does not require Non-NBI structures to be inspected, entities are strongly encouraged to inspect their Non-NBI structures at a level and frequency equal to those set forth in this memorandum.

FREQUENCY OF INSPECTIONS:

All NBI structures and VDOT maintained Non-NBI structures shall receive inspections at the frequency indicated in Table 2, on the following page. The District/Entity shall use engineering judgment to inspect the structure more frequently as conditions warrant.

Every effort shall be made to inspect each structure in the month the inspection is due. If a structure becomes past due, immediate action shall be taken to inspect the structure and the reason for the inspection being past due documented. As soon as it is known that an inspection is expected not to be performed within the month due, the reasons for the late inspection must be submitted to the Central Office for notification of the FHWA to be considered for an inspection waiver.

Inspections not performed within the month due shall be reported, by the responsible team leaders for VDOT or by the official directly responsible for the inspection within entities, immediately to the District Structure and Bridge Safety Inspection Engineer (DSBSIE) to assure that appropriate documentation, including the structure information, reason for the late inspection and the inspection schedule is gathered and submitted to the Central Office Structure and Bridge Division. A copy of the reason for the late inspection shall also be included in the inspection folder.

When construction and/or maintenance activities cause a change to the NBI general condition rating(s), vertical clearance or posted restrictions, the structure must be re-inspected and the changes are required to be made within 30 days after construction has been completed or within 30 days of becoming aware of a possible change. Generally, maintenance work which is considered preventative or restorative (i.e. deck patching, deck overlays, painting, repairing expansion joints, crack repairs…etc.) can be documented by conducting a nonscheduled inspection that will not change the NBI next inspection date.

Table 2 – Frequency of Inspections		
FREQUENCY	**NBI**	**NON-NBI**
12 months	Redundant pin and hanger assemblies with evidence of problems such as frozen hanger bars or other questionable conditions	Redundant pin and hanger assemblies with evidence of problems such as frozen hanger bars or other questionable conditions
	Non-redundant pin and hanger assemblies	Non-redundant pin and hanger assemblies
	Structures that have a restricted weight limit (2)	Structures that have a restricted weight limit (2)
	Structures having a general condition rating of '4' or less on one or more of the following: Deck; Superstructure; Substructure; Culvert (1)	Structures having a general condition rating of '4' or less on one or more of the following: Deck; Superstructure; Substructure; Culvert (1)
	Fracture Critical Bridges (1)	Fracture Critical Bridges (1)
24 months	Redundant pin and hanger assemblies except as noted above	Redundant pin and hanger assemblies except as noted above
	Bridges and culverts except as noted above	Bridges, except as noted above (3), and Culverts with a general condition rating of '5'
48 months	Not applicable	Culverts, except as noted above
60 months	Underwater inspections of bridges and culverts	Underwater inspections of bridges and culverts
See footnote (4)	Complex bridges	Not applicable

(1) Only the bridge component(s) (deck, superstructure and/or substructure) which has the general condition rating of '4' or less, and the fracture critical members and connections need to be inspected at the interim inspection frequency of 12 months. However, if the culvert component or 2 or more bridge components for a given structure have a general condition rating of '4' or less, the regular inspection frequency for the entire structure shall be 12 months. Fracture Critical Cross Girder Box Beams that can be entered and inspected from the interior may be inspected every 12 months alternating between interior and exterior inspections to comprise an overall frequency not to exceed 24 months (as approved by the DSBE or designee). These members are also sometimes referred to as straddle bents, integral caps or integral straddle bents.

(2) Restricted weight limits include both Field Posted and 45T structures (as defined in IIM-S&B-86). Field Posted structures for legal loads and 45T structures with general condition ratings of '6' or above are not required to be on a 12 month inspection frequency as approved by the DSBE or designee. The inspection frequency for 45T structures which are concrete and where the reinforcing details are unknown may be changed to 24 months if the structure shows no signs of structural distress. Only the component(s) which causes the weight restriction needs to be inspected at the interim inspection frequency of 12 months.

(3) The inspection frequency for footbridges, except swing spans, may be changed to 48 months if all components have general condition rating of '6' or above.

(4) Complex bridges shall receive an in-depth inspection at the level and frequency detailed in the complex bridge list/procedure. Movable bridges and their inspections are described in detail in the AASHTO "Movable Bridge Inspection, Evaluation and Maintenance Manual".

Clearances

Vertical and lateral clearance restrictions for roadways on and under each NBI structure and each VDOT maintained Non-NBI structure shall be checked during each regular inspection of the structure.

Non-NBI structures owned and maintained by non-VDOT entities which create vertical and lateral clearance restrictions to a roadway maintained by VDOT shall have their vertical and lateral clearances checked at intervals not to exceed 24 months. These structures will typically be under records in the Bridge Management System (BrM).

Closed Structures

Closed structures, not undergoing construction or maintenance activities, will need to be visited by the appropriate VDOT personnel or local entity at intervals not to exceed 24 months to assure the barricades and signage are still functioning as intended and the structure does not pose a risk to the public. Approach photographs (with date stamp included) showing barricades should be taken and included in the bridge file. These inspections shall be documented in the bridge record and should note which VDOT entity performed the inspection. Documentation can be a memo to the bridge file or notes in the Bridge Management System (BrM). Photos should be placed in the bridge file.

LEVEL OF INSPECTIONS AND SPECIAL CATEGORY INSPECTIONS:

All NBI structures and VDOT maintained Non-NBI structures shall receive inspections at the same level as defined by the NBIS requirements, MBE, and this document. Element Inspections are required for all VDOT maintained NBI and Non-NBI structures except temporary structures, pedestrian and foot bridges, pier or dock structures and under records. Routine inspection techniques shall be sufficient to quantify the condition and remaining section of structural components. Routine inspections are primarily visual and tactile (i.e. probing, measuring, sounding, etc.) in nature; however, these inspections may include cleaning sheet corrosion in key locations that influence load carrying capacity, dye penetrant testing and/or magnetic particle testing to verify cracking in steel members, removing concrete delamination at isolated locations over traffic and/or removing debris as needed to access the element, etc.

For each routine inspection and special category inspection noted below, the report shall document the results of the inspection using notes, sketches and/or photographs. At each subsequent inspection, an on-site comparison with the previously reported conditions is to be made and documented. As a result of these routine and special category inspections, any critical findings and urgent repairs shall be brought to the attention of the District Structure and Bridge Engineer or designee or the local Entity in an expeditious manner within a timeframe not to exceed 24 hours. If warranted, a critical recommendation shall be issued. Emergency findings shall be reported immediately by the Team Leader while on-site. Contact will normally be initiated by telephone and followed up the same day with email documentation of the findings, including photographs. Once contacted, the District Structure & Bridge Engineer or designee will work with the Team Leader to quantify and assess the situation to determine if it warrants an emergency response or can be addressed through the critical recommendation process.

Pin (or pinned) Connections

During each scheduled inspection of the pin and hanger assembly, each pin assembly shall receive a hands-on inspection and each pin shall receive ultrasonic testing. Where practical, ultrasonic testing of each pin shall be performed from both ends of the pin. A statement about the condition of each pin or groups of pins shall be entered in the inspection report regardless of condition. Separate ultrasonic testing documentation shall be kept in the bridge file and may be included in the inspection report as optional supporting documentation.

Other types of pin connections that will require ultrasonic testing may exist on structures including details such as truss pins, girder pin connections, superstructure to substructure pin connections, etc. The District Structure and Bridge Engineer, or their designee, shall determine the need for this additional level and frequency of testing for these pin connections.

Fatigue Prone Details

Fatigue prone details shall receive a hands-on inspection of fatigue prone categories D, E, and E' details during each inspection. Category C or C' details shall receive a close-up inspection during each inspection. Additionally, other areas that may cause stress concentrations (i.e. out of plane distortion, traffic impacts, copings, field welds, flame cut surfaces, etc.) shall be evaluated and classified as fatigue prone (as applicable) and receive a hands-on or close-up inspection as determined by the District Structure and Bridge Engineer or designee. Bridge records are to include sketches showing category type and location of fatigue prone details and any specific areas that are to be inspected. Inspection reports shall note the fatigue prone details and locations and a statement regarding the method of access used during the inspection. A statement about the condition of each fatigue prone detail or group of details shall be entered in the inspection report regardless of their condition.

Fracture Critical Members

Fracture critical members and their connections (including gusset plates) are to receive a hands-on inspection during each inspection as required. The fracture critical member (FCM) inspection uses visual methods that may be supplemented by NDT for verification and quantification of visual indications. A very detailed visual hands-on inspection is the primary method of detecting cracks. This may require that critical areas be specially cleaned prior to the inspection and additional lighting and magnification be used. NDT methods may be required for verification and documentation of visual indications and shall be used at the discretion of the Team Leader. Note that it is not acceptable documentation to report a possible crack or to report a visual indication without conclusive determination and quantification of the field condition. Bridge records are to include sketches showing the type and location of fracture critical members or details and any specific areas that are to be inspected. Inspection reports shall note the fracture critical members or details and locations and a statement regarding the method of access used during the inspection. A statement about the condition of each fracture critical member or detail or group of details shall be entered in the inspection report regardless of their condition.

Similar to crack verification in steel members, if an inspection finds areas on fracture critical members or their connections (including gusset plates) where corrosion is evident and section loss cannot be quantified or determined by visual and tactile methods, an appropriate non-destructive evaluation technology shall be used to assess the condition and quantify the remaining thickness.

Complex Bridges

Complex bridges are to receive an in-depth inspection in accordance with the complex bridge list/procedure. Bridge records are to include appropriate documentation for any specific details that are to receive in-depth inspection including method of access for the specific location(s).

INSPECTION AND INVENTORY REQUIREMENTS

Determining Structure Numbers (State)

This section may be used as a guide to create new Virginia Structure Numbers. When a structure record is created, the Virginia structure number is typically given to a structure based upon which highway system the bridge is located. The following series can be used to create the Virginia Structure Number: For city/county line structures, a 9 should be placed in the second digit of the above series (except for the 100-999 and the 1800 series).

SERIES	EXPLANATION
100-999	Structures in PE or construction phases, structure number was required for billing purposes, no traffic on structure and not replacing an existing structure
1000 – 1999	Primary system (excludes the 1800 series)
1800 – 1899	VDOT maintained in a municipality
2000 – 2999	Interstate system
5000 – 5999	Pedestrian bridges that cross a roadway
6000 – 6999	Secondary system
8000 – 8999	Municipality maintained
9000 – 9999	Footbridges that do not cross a roadway

Note there will be exceptions to this guidance and not all Districts will have historically followed the table above. However, for statewide consistency, it is recommended.

New 4-digit Virginia Structure Numbers are assigned by the District Structure & Bridge Engineer or designee. The Virginia Structure Number shall be unique to the county and should be validated to assure no duplication in the inventory for structures open to traffic.

Virginia Structure Numbers for new bridges on a new alignment shall be unique within the county. For replacement structures on the same or similar alignment the existing Virginia Structure Number can be reused. If a replacement structure has the same 4-digit Virginia Structure Number within the same county, but is not yet open to traffic as coded in the inventory (i.e. ‘G’), then this is valid and is not considered a duplication.

Three digit temporary structure numbers for new structures not yet open to traffic are optional at the District’s discretion.

New Structure Numbers (Federal)

The Central Office is responsible for assigning new Federal Structure Numbers and will require the following minimum information from the Districts as part of that process: District, County, route number of roadway carried, feature intersected, maintenance responsibility, and plan number (if known at time of request).

New Federal Structure Numbers are required for new structures on new alignments and total replacement structures on existing alignments. This includes replacement culverts that meet the definition of Large Culvert. Typically for replacement structures, if portions of the old structure remain in the new work (can be superstructure and/or substructure elements), the structure is not considered new but rather reconstructed and a new Federal Structure Number is not required.

Inspections

Prior to opening to traffic, all new and rehabilitated structures, including the constructed portion(s) of each phase of construction where applicable, will be inspected. These inspections can coincide with the final or punch-list inspection coordinated with the Construction Division. The Area Construction Engineer or designee shall contact the District Structure and Bridge Engineer or designee to request the inspections.

Construction work resulting in a rehabilitated structure (i.e. deck / superstructure replacement, widening, etc.) should be documented by conducting a regular inspection that will change the NBI next inspection date.

Each inspection shall include a review of all structure inventory items and element data. Discrepancies shall be corrected. Inventory data sheets are available for taking hard copies into the field for verification.

Apart from the exception noted below, an inspection team will be composed of no fewer than two people when performing inspections of any structure. The team is to be comprised of a Team Leader (or Senior Inspector) and a Team Member and in some cases due to varying conditions additional Team Members could be warranted. Given the nature of the work, two people on-site enable the members to monitor each other's safety and call for assistance if something were to happen to the other Team Member. In certain circumstances and with the approval of the District Structure & Bridge Safety Inspection Engineer, Team Leaders (or Senior Inspectors) may perform inspections as needed without assistance from a Team Member. Assistance from other sections' personnel is encouraged for safety and physical activities during the inspection if a Team Member is not available. In these instances, all VDOT health and safety regulations and work zone protection standards of practice shall be observed and safety of the Team Leader or traveling public shall not be compromised. Although it is not anticipated that this will be a common occurrence, it may be warranted on a case by case basis.

An inventory 'on' record and an 'under' record (if necessary) shall be created for all structures that require an inspection in accordance with this document, the NBIS, and the FHWA Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges.

Additionally, an inventory 'under' record shall be created by VDOT for Non-NBI structures owned and maintained by Non-VDOT entities which create vertical and lateral clearance restrictions to a roadway maintained by VDOT (including pedestrian and foot bridges). The term 'inspection' in these records will refer to, at a minimum, the clearance checks performed and a review of the required inventory data.

Quality control (QC) and quality assurance (QA) procedures, including qualifications of inspection personnel, shall be in accordance with the current IIM-S&B-78, Subject: Bridge Safety Inspection QC/QA Program.

Report Requirements

Bridge safety inspection reports shall include the following:

- Actual inspection date(s) shall be recorded.
- For inspections that overlap in months, the NBI inspection date should be documented as the first or last date.
- Unless otherwise approved by the DSBSIE, new photographs shall be required during each inspection. Old photos can be included for comparison or to show a better picture of a condition (i.e. such as the substructure when the water level was much lower during a past inspection).
- All photographs shall include the date stamp.
- Ambient weather conditions shall be recorded (i.e. clear and sunny 78 degrees).
- Access equipment and type of Maintenance of Traffic (MOT) shall be noted in the inspection report.
- Special testing equipment used during the inspection shall be noted.
- Special considerations for contacts, access, right of entries and/or other restrictions shall be noted.
- List other persons present during the inspection such as MOT crew, RR Flagger, QA Reviewer, Special Access operator….etc.

All inspections of VDOT maintained structures shall be documented using VDOT's most current electronic safety inspection report form (SB540). Entities are strongly encouraged to use VDOT's most current electronic safety inspection report form for Entities (SB541). Entities may use a different safety inspection report form; however, the contents must, at a minimum, meet FHWA and VDOT guidelines. Reports submitted by Entities shall include both printed and electronic copies.

For general condition ratings of '7' or less, detailed comments supporting these ratings must be included in the report. In addition to detailed comments, photos, sketches and tables may also be needed for deficiency clarification. Current photographs shall be included in the report of all items which warrant a general condition rating of '4' or less.

Any item which shows a change in condition since the previous inspection will be marked to indicate a change since the previous inspection. The method of marking these changes will be clearly noted in the 'Miscellaneous' section of the report. When interim and nonscheduled inspections are performed, the reason for this type of inspection shall be documented in the 'Miscellaneous' section of the report.

Vertical clearances will be documented on a sketch. This sketch will show the minimum vertical clearance for each lane and include the minimum vertical clearance for a ten-foot width of pavement where the clearance is greatest (Federal Item 10). For paved roadways, measurements will be limited to travel lanes and improved shoulders between edges of pavement and only be taken between lateral restrictions (i.e. guardrail, barriers, etc.).

Repair recommendations are to be listed in priority order with the highest priorities listed first. Cost estimates for these repair recommendations are not required.

For bridges having a non-integral wearing surface, the average thickness and nature of the overlay material shall be recorded in the 'Wearing Surface' section of the inspection report. If the wearing surface thickness is not able to be field verified or cannot be taken from bridge plans, a reasonable estimate based on the judgment of the inspector may be used until more accurate measurements can be obtained. If a non-integral wearing surface is not present, the nature of the integral wearing surface shall be recorded under the 'Deck' section of the report and 'None' or 'N/A' shall be recorded in the 'Wearing Surface' section.

The 'Object Marker' section of the inspection report shall note the presence and condition of object markers and other safety features at structures.

The 'Field Posting' section of the inspection report shall note the presence, details of the restriction and condition of any signs indicating weight restrictions, vertical restrictions, or horizontal restrictions. This includes, but is not limited to signs indicating vertical restrictions, narrow bridge, one lane bridge and load postings.

The results of the latest underwater inspection shall be considered when assigning the substructure general condition ratings, and the inspection reports shall contain a statement indicating that these results were considered. The latest underwater inspection report may optionally be attached to the inspection report. If the underwater inspection findings adversely influence the substructure rating or provide additional pertinent information not accessible to the Team Leader, a brief summary of these findings shall be included in the 'Substructure' section of the report.

Structure inventory and appraisal sheets may optionally be included in the inspection report. These inventory sheets shall be reviewed during the inspection and submitted along with the inspection report. A statement should be in the inspection report that the inventory was checked or reviewed. The statement should also include any changes that were made to the inventory.

Additional report requirements may be found in the 'Scour and Stream Channel Documentation' and 'Load Rating Analysis' sections.

Updating Inventory Data

The inventory information for all structures shall be updated in accordance with the NBIS.

The inspection report and all inventory data for new, rehabilitated and repaired structures shall be entered into the inventory database within 90 days of opening the structure to traffic for VDOT and within 180 days for Entities.

For changes in load rating due to initial or changed conditions the capacity rating shall be in accordance with the current IIM-S&B-86, Subject: Load Rating and Posting Structures (Bridges and Culverts).

Structures that have been closed to traffic shall have the closure indicated in the inventory upon notification that the closure has taken place.

Structures that have temporary conditions including vertical or horizontal clearances, temporary shoring or temporary structures shall be indicated in the inventory.

INSPECTION FORMS AND DISTRIBUTION:

In addition to the repair recommendations on the bridge safety inspection report for VDOT structures, the District Structure and Bridge Section shall utilize a standard method for notifying other responsible managers of preventive and ordinary maintenance needs. To assist in facilitating this notification, the Structure Preventive Maintenance Form (SB504) may be used. For information purposes a copy of this form has been included in the 'Attachments' section of this document.

Copies of all inspection reports are to be placed on the State Structure and Bridge Safety Inspection Team Site within 90 days after the inspection is performed. For VDOT maintained structures, the District Structure and Bridge Section shall send monthly notifications to the responsible Maintenance Manager of completed inspection reports placed on the team site. Each entity should have a similar process, as noted above, to ensure that each structure's maintenance needs are considered and addressed as appropriate.

District Structure and Bridge Sections and Entities shall maintain a bridge record of each structure within their jurisdiction in accordance with the NBIS, including, but not limited to, the official signed structure inspection reports, damage reports, strengthening, repairs, load rating analysis and capacity data, scour analysis, scour critical plans of action, critical recommendations and related correspondence until the structure is demolished. Once a structure is demolished, the inspection records may be disposed of in accordance with the current records retention policy of each respective organization.

All bridge safety inspection reports are designated Critical Infrastructure Information (CII). This designation identifies information that is not appropriate for public release. Printed copies of the inspection reports shall be protected at all times. Each person who works with protected documents is personally responsible for taking proper precautions to ensure unauthorized persons do not gain access to the reports. Anyone requesting copies of bridge safety inspection reports should be referred to the District Structure and Bridge Section. District Structure and Bridge Engineers/Entities may release inspection reports of structures within their respective jurisdiction to individuals or parties that have a legitimate business need-to-know in accordance with the latest CII guidelines. Such cases require those non-VDOT individuals or parties to submit a completed and signed 'Multi-Purpose Non-Disclosure Agreement' form to the appropriate District Structure and Bridge Engineer. For information purposes, a copy of this agreement has been included in the 'Attachments' section of this document and the electronic file is available upon request.

CRITICAL RECOMMENDATIONS:

Critical recommendation forms shall be used to notify the responsible manager of conditions identified as posing a threat to public safety. Critical recommendations can be an emergency condition posing an immediate safety risk or hazard to the structure's integrity and/or traveling public or an imminent condition that could, if left unresolved, result in localized failure of the structure or present a safety issue to the traveling public. Critical recommendations that are considered emergency conditions should be addressed immediately or not to exceed 30 days and those that are imminent conditions should be addressed not to exceed 90 days from date of discovery. Others which will require processing through a formal project shall have a monitoring process in place until work is complete and the critical should be closed out.

Conditions requiring the issuance of a critical recommendation form include, but are not limited to:

1. Critical repairs to fracture critical members.
2. Correction of critical scour and/or hydraulic induced problems.
3. General condition rating lowered to a '3' or less for deck, superstructure, substructure or culvert.
4. Immediate work to prevent substantial reduction in a structure's load capacity.

The critical recommendation form will identify the problem and provide an action to be taken, including a cost estimate and a time frame for the action to be completed. Possible actions may include, but should not be limited to, immediate repair, posting the structure, closing the structure, inspecting the structure more frequently, performing a structural analysis and/or removing traffic from the affected members.

Upon completion of the follow-up inspection, a copy of the critical recommendation form shall be included in the bridge record.

The District Structure and Bridge Safety Inspection Engineer will be responsible for assuring that a critical recommendation form is created and updated on the Critical Recommendation Team Site for all stages of the process.

VDOT

Upon learning of the need for a critical recommendation to be issued, the District Structure and Bridge Engineer or their designee shall notify the District Bridge Maintenance Manager or the responsible manager in the most expeditious manner available. The Critical Recommendation Form (SB500) will be prepared and transmitted to the responsible manager using the Critical Recommendation Team Site and in accordance with the guidelines therein. For information purposes a copy of this form has been included in the 'Attachments' section of this document.

The subsequent corrective action by the responsible manager and follow-up inspection by the District Structure and Bridge Section shall be documented in the electronic critical recommendation form on the Critical Recommendation Team Site. The follow-up inspection shall be completed within 10 working days upon notification that the corrective action is completed.

Entities

Entities shall use a process similar to that of VDOT for addressing critical findings in accordance with the requirements of the NBIS. A Non-VDOT Critical Recommendation Form (SB501) may be used to notify the responsible manager and document the critical finding. For information purposes a copy of this form has been included in the 'Attachments' section of this document and the electronic template is available upon request.

A copy of the initial notice and a copy of the form noting that the follow-up inspection has been completed shall be promptly provided to the District Structure and Bridge Engineer.

District Structure and Bridge Engineers or their designee shall monitor inspection reports from Entities to identify conditions that may warrant the issuance of a critical recommendation form. If a condition is identified as requiring a critical recommendation form, the District Structure and Bridge Engineer or their designee shall:

1. Contact the responsible official for the Entity and inquire about the status of the remedial work on the structure.
2. Emphasize to the responsible official the importance of prompt corrective action.
3. If the Entity's actions are unacceptable, written notification shall be made detailing VDOT's concerns. The District Administrator or appointed representative should sign the written notice. Copies of all correspondence shall be sent to the State Structure and Bridge Engineer and the Central Office Bridge Safety Inspection Program Manager.

The Central Office Structure and Bridge Division will provide assistance as requested by the District after the District has exhausted the remedial actions above.

SCOUR AND STREAM CHANNEL DOCUMENTATION:

The vulnerability of a bridge to scour (Federal Item 113) shall be initially determined through analysis by a hydraulic/geotechnical/structural engineer and/or the design engineer of record.

The lead inspector shall review Federal Item 113 as a part of each inspection to determine if field conditions warrant a change. All changes to Federal Item 113 will be coordinated with the District Structure and Bridge Engineer or designee and/or the District Hydraulics Section prior to making changes to the inventory database.

All scour critical bridges shall be monitored in accordance with their respective plan of action (POA) as applicable. During the inspection of a scour critical bridge, the POA for the structure will be reviewed and updated as necessary. For information purposes a copy of this form has been included in the 'Attachments' section of this document and the electronic template is available upon request.

Channel Cross Section at Fascias

For every structure that crosses a waterway, a channel cross section shall be made along the upstream or downstream fascia of the structure using readings as described in the following paragraph. Channel cross sections along both fascias shall be provided when warranted by field conditions such as channel alignment issues and streambed degradation. Channel cross sections are to be recorded during the initial inspection of each structure. At each regular

inspection, current readings are to be taken and compared to the previously recorded cross sections(s) to determine if significant changes have occurred. At a minimum, the latest, initial and previously recorded streambed cross section elevations shall all be recorded on the same sketch for comparison purposes. If the cross section has not changed, a comment that the cross section was checked is to be added to the inspection report and the channel cross section sketch indicating the date(s) that it was checked.

Readings are vertical measurements taken from a fixed reference line to the streambed or floodplain, and are used to develop a channel cross section between the two substructure abutments. Readings shall be taken along the fascia(s) starting at the substructure unit before the floodplain and ending at the substructure unit beyond the end of the floodplain at intervals sufficient to show a cross section elevation that is representative of the streambed and floodplain. If readings were previously taken, new readings shall be taken at the same intervals from the same reference line. Additional readings shall be taken at locations where obvious changes in the streambed or floodplain are evident to provide an updated elevation. Readings shall be recorded in a fashion similar to that shown on the Sample Channel Cross Section sketch in the 'Attachments' section of this document.

For structures that require an underwater inspection, the lead inspector shall evaluate the existing stream channel and scour conditions during each inspection to the extent that this can be accomplished without diving. If no changes can be observed from the latest underwater inspection report, this will be noted, along with the date of the referenced underwater inspection. If significant changes are detected, normal documentation will be used to the extent possible and the District Structure and Bridge Engineer or designee shall be notified by the lead inspector in the most expeditious manner of the need for an underwater inspection.

Cross section elevation readings and sketches produced during underwater inspections shall be referenced to a common point with readings taken from the above water inspections to establish continuity between the two inspections in referencing the same channel bed elevations.

Channel Profile at Substructure Units

Channel profiles around the perimeter of the substructure units are required whenever the inspection of the substructure unit reveals scour and/or undermining that affects or may affect the structural integrity of the substructure unit. The channel profile at a substructure unit must be documented relative to fixed points on the substructure, such as the top of footing, beam seats, top of pier caps, and readings shall be taken along the face of the substructure unit at intervals necessary to properly indicate the severity of the scour and/or undermining. For undermining, these readings shall quantify the height, length and depth back under the substructure unit.

Stream Alignment Sketch

Stream alignment sketches are used to show the stream alignment relative to the bridge opening and quantify the extent and severity of any existing channel migration, scour, erosion and/or sedimentation. Stream alignment sketches shall be shown in a plan view.

Stream alignment sketches shall be included in the inspection reports for bridges where erosion problems are identified that may affect the structural integrity of one or more substructure units. Additionally, stream alignment sketches shall be used to document any deficiencies in the stream channel that cannot be adequately shown in a photograph.

LOAD RATING ANALYSIS:

Load Ratings shall be performed in accordance with the current IIM-S&B-86, Subject: Load Rating and Posting Structures (Bridges and Culverts). Structural analyses are to be part of each structure's bridge record and will have a completed 'Load Rating Summary Form for Structures' attached to each regular inspection report.

The deterioration levels and rating assumptions are to be reviewed as part of each scheduled inspection. A statement shall be placed in the structural analysis section of the inspection report stating that the rating has been reviewed with respect to the current condition.

When a superstructure GCR changes to a 4 or less, a new load rating is required. Other changes to the GCR for deck, superstructure and substructure shall be reviewed to determine if a new load rating is warranted. Any condition that may affect safe load carrying capacity shall be evaluated to determine if a new load rating analysis is warranted.

STRUCTURE RESTRICTION AND POSTING:

Reduction of weight limits on any structure shall be in accordance with the Code of Virginia - Title 46.2, Chapter 10 and current IIM-S&B-86.

Restricted weight limit signs when required, shall be erected in accordance with the latest version of the Virginia Supplement to the Manual of Uniform Traffic Control Devices (MUTCD), Part 2 – Signs, Section 2B.59.

Overhead structures or parts of structures having an actual vertical clearance less than or equal to 14'-5" shall be signed in accordance with the latest version of the Virginia Supplement to the MUTCD, Part 2 – Signs, Section 2C.27.

Should the inspection find that restrictive signs are not in compliance with the Virginia Supplement to the MUTCD, Part 2 – Signs, a form similar to the attached Bridge Signage Form (SB503) shall be used to alert the local Residency for secondary routes and the Regional Traffic Operations Centers for primary routes. This notification shall be made in an expeditious manner upon completion of the field inspection. New or replacement signs shall be erected as soon as fabrication permits and generally within 30 days of the notification. If the completed Bridge Signage Form is not returned to Structure & Bridge Division within 30 days, then the District Structure and Bridge Engineer or designee/Entity shall follow-up on the status of the signage. For information purposes a copy of this form has been included in the 'Attachments' section of this document.

CC: Chief Engineer
Division Administrators under the Deputy Chief Engineer
Local Assistance Division Director
District Administrators
District Maintenance Engineers
District Construction Engineers
Assistant State Structure and Bridge Engineers
District Structure and Bridge Engineers
District Bridge Safety Inspection Engineers
District Bridge Maintenance Managers
Residency Administrators
Regional Traffic Operations Centers
Federal Highway Administration

ATTACHMENTS

Structure Preventative Maintenance Form – Form SB504

Critical Infrastructure Information/Sensitive Security Information (CII/SSI) – Multi-Purpose Non-Disclosure Agreement

Critical Recommendation Form – Form SB500

Non-VDOT Critical Recommendation Form – Form SB501

Sample Channel Cross Section

Bridge Signage Form – Form SB503

Scour Critical Plan of Action Template

Typical Fatigue Prone Details

VDOT Virginia Department of Transportation

Structure and Bridge

INTRA-DEPARTMENTAL MEMORANDUM

Structure Preventive Maintenance Form

City/County: _____
Route: _____ **Over:** _____
Structure No.: _____

Inspected By: _____
Inspection Date: _____

To: _____ **From:** _____ **Date:** _____

District Bridge Maintenance Manager **District Structure & Bridge Engineer**

Inspection by the District Bridge Safety Inspection Team has revealed that the reference bridge requires preventive maintenance. These items, with cost estimates are as follows:

		Approximate Cost	Date Work Performed	Performed By
Seal Expansion Joints	☐			
Clean Deck	☐			
Clean Abutment Seats	☐			
Clean Pier Seats	☐			
Clean Bearings	☐			
Clean Truss Panel Points	☐			
Clear Debris from Scuppers	☐			
Clean Other (Identify) _____	☐			
*** Clear Debris (Identify)** _____	☐			
Other (Identify) _____	☐			

* May include removing silt from boxes/culverts/pipes, or removing debris between steel beams or at piers

The above deficiencies were corrected on the dates indicated above.

Signature: _____
District Bridge Maintenance Manager

Once the deficiency is corrected, please forward the original of this form to the District Structure & Bridge Engineer and copy the District Structure & Bridge Safety Inspection Engineer.

Form SB504

Critical Infrastructure Information/Sensitive Security Information (CII/SSI)
Multi-Purpose Non-Disclosure Agreement

Retain a copy of both the front and back sides of this form for future reference

VDOT requires CII/SSI be protected and not disclosed to unauthorized persons.

PART A: To Be Completed By Individual VDOT or Company Employee

I agree with the following as a condition of being granted access to CII/SSI:

CII/SSI, which is valuable and sensitive, is protected by law and by strict VDOT policies. The intent of these laws and policies is to assure that CII/SSI will remain confidential - that is, it will be used only as necessary to accomplish VDOT's mission. Disclosure of CII/SSI in any manner that permits interception by unauthorized persons could compromise safety and security and is prohibited. CII/SSI may be released only to persons with a need-to-know.

I might have access to this information in various formats including but not limited to documents and drawings, physical structures, and computer based systems. I have no right or ownership interest in any VDOT CII/SSI. VDOT may at any time revoke my authorization allowing access to CII/SSI.

Willful violation of this agreement may subject me to discipline which might include, but is not limited to, removal from current VDOT projects; exclusion from further VDOT related work; and legal liability. My obligations with respect to the confidentiality and security of all CII/SSI disclosed to me shall survive the termination of any agreement or relationship with VDOT. My execution of this agreement shall not nullify or affect in any manner any other agreement, non-disclosure or otherwise, which I have executed or may execute with VDOT or the Commonwealth of Virginia.

I am obligated to protect this information from unauthorized disclosure in accordance with the terms of this agreement. I will only use CII/SSI that I obtain to perform my legitimate VDOT related duties. I will conduct myself in a strict conformance to applicable laws and VDOT policies governing CII/SSI. I will safeguard the confidentiality of all CII/SSI at all times. I will be responsible for my misuse or my wrongful disclosure of CII/SSI.

Each provision of this agreement is severable. If any administrative or judicial tribunal should find any provision of this agreement to be unenforceable, all other provisions shall remain in full force and effect.

I make this agreement in good faith, without mental reservation or purpose of evasion.

Printed Name	Date
VDOT District/Division OR Company Name	Phone Number
Company Address	
Signature	Signature of Authorized Agent (Not required for VDOT employees)

PART B: To Be Completed By Company Agent

Only: In addition to the provisions above, I certify:

All employees of this company involved with this VDOT project, regardless of location, who will have access to CII/SSI, myself included, will complete Part A of the Critical Infrastructure Information/Sensitive Security Information Multi-Purpose Non-Disclosure Agreement. The Agreement will be signed by me and accepted by VDOT prior to being granted access to CII/SSI. We will only access CII/SSI for which we have a need-to-know.

We will safeguard the confidentiality of all CII/SSI at all times. We will conduct ourselves in strict conformance to applicable laws and VDOT policies governing CII/SSI. Obligations with respect to the confidentiality and security of all CII/SSI disclosed to us shall survive the termination of any agreement or relationship with VDOT.

Authorized Company Agent:

Signature of Authorized Agent	Date
Printed Name	Title
Company Name	Phone Number
Company Address	
VDOT Contract Name and Number	

This form is valid for the identified project for a period of two years, while employed by the same company.

Critical Infrastructure Information/Sensitive Security Information (CII/SSI)
Multi-Purpose Non-Disclosure Agreement
Back Page

Retain a copy of both the front and back sides of this form for future reference.

Handling CII/SSI

You are responsible for safeguarding Critical Infrastructure Information/Sensitive Security Information (CII/SSI) in your custody or under your control.

The extent of protection afforded CII/SSI shall be sufficient to reasonably foreclose the possibility of its loss or compromise.

The terms of this clause (*Handling CII/SSI*), including this paragraph, must be included in any dissemination of any document, in whole or in part, that contains CII/SSI.

Protection - CII/SSI shall be protected at all times, either by appropriate storage or having it under the personal observation and control of a person authorized to receive it. Each person who works with protected CII/SSI is personally responsible for taking proper precautions to ensure that unauthorized persons do not gain access to it.

Use and Storage - During working hours, reasonable steps shall be taken to minimize the risks of access to CII/SSI by unauthorized personnel. After working hours, CII/SSI shall be secured in a secure container, such as a locked desk, file cabinet or facility where contract security is provided.

Reproduction - Documents or material containing CII/SSI may be reproduced to the minimum extent necessary consistent with the need to carry out official duties provided that the reproduced material is marked and protected in the same manner as the original material.

Disposal - Material containing CII/SSI shall be disposed of by any method that prevents unauthorized retrieval (e.g. shredding, burning, returning to original source, etc.).

Transmission - CII/SSI shall be transmitted only by VDOT courier, US first class, express, certified or registered mail, or through secure electronic means.

VIRGINIA DEPARTMENT OF TRANSPORTATION
STRUCTURE AND BRIDGE DIVISION

Critical Recommendation Form

for, Repair and/or Strengthening

Route: _____ NBIS (Y/N) _____
Over: _____
County: _____
Str. No.: _____
Located: _____ Mi. To: _____
_____ Mi. From: _____
Inspected By: _____ Inspection Date: _____

WHEN A CRITICAL CONDITION IS DISCOVERED SEND FORM:

To: _____ From: _____ Date: _____
District Bridge Maintenance Manager
District Structure & Bridge Safety Inspection Engineer

cc: District Structure and Bridge Engineer
District Maintenance Engineer
State Structure and Bridge Engineer
District Environmental Engineer

AFTER THE CRITICAL CONDITION IS REPAIRED SEND FORM:

To: _____ From: _____ Date: _____
District Structure & Bridge Safety Inspection Engineer
District Bridge Maintenance Manager

cc: District Structure and Bridge Engineer
State Structure & Bridge Engineer

Federal Structure ID No:0000000000 _____

CRITICAL CONDITION REQUIRING IMMEDIATE ATTENTION (≤ 30 days) or (≤ 90 days)

- [ ] Immediate performance of work on fracture critical member(s) is needed.
- [ ] Immediate correction of scour and/or hydraulic induced problem is needed.
- [ ] Condition rating of 3 or less for deck, superstructure, substructure and/or culvert.
- [ ] Immediate work to prevent substantial reduction in safe load capacity and/or for the safety of the traveling public.

Action required (include date work must be completed): _____

ESTIMATED COST - $ _____

BELOW TO BE FILLED OUT BY RESIDENCY ADMINISTRATOR and/or DISTRICT BRIDGE MAINTENANCE MANAGER WHEN WORK HAS BEEN COMPLETED

Action taken (include date work was completed): _____

Signature _____
District Bridge Maintenance Manager

Follow-up Inspection after work is complete by: _____
Bridge Safety Inspector Date

Form SB500

Municipality/Agency: _____

Non-VDOT Critical Recommendation Form

for, Repair and/or Strengthening

Route: _____ NBIS (Y/N) _____
Over: _____
Str. No.: _____
Located: _____ Mi. To: _____
_____ Mi. From: _____
Inspected By: _____ Inspection Date: _____

WHEN A CRITICAL CONDITION IS DISCOVERED SEND FORM:

To: From: _____ Date: _____
(Insert Title of Responsible Manager)

District Structure and Bridge Safety Inspection Engineer

cc: District Structure & Bridge Engineer
State Structure & Bridge Engineer

AFTER THE CRITICAL CONDITION IS REPAIRED SEND FORM:

To: _____ From: _____ Date: _____
District Structure and Bridge Safety Inspection Engineer

(Insert Title of Responsible Manager)

cc: District Structure and Bridge Engineer
State Structure & Bridge Engineer

Federal Structure ID No:0000000000 _____

CRITICAL CONDITION REQUIRING IMMEDIATE ATTENTION (≤ 30 days) or (≤ 90 days)

- [ ] Immediate performance of work on fracture critical member(s) is needed.
- [ ] Immediate correction of scour and/or hydraulic induced problem is needed.
- [ ] Condition rating of 3 or less for deck, superstructure, substructure and/or culvert.
- [ ] Immediate work to prevent substantial reduction in safe load capacity and/or for the safety of the traveling public.

Action required (include date work must be completed): _____

ESTIMATED COST - $ _____

BELOW TO BE FILLED OUT BY MUNICIPALITY/AGENCY WHEN WORK HAS BEEN COMPLETED

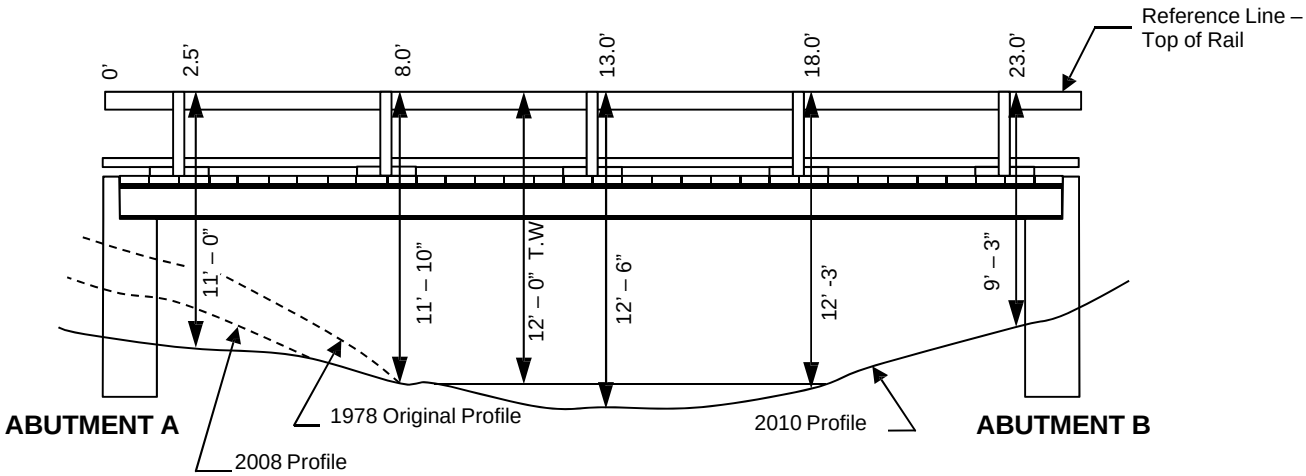
Action taken (include date work was completed): _____

Signature _____
(Insert Title of Responsible Manager)

Follow-up Inspection after work is complete by: _____
Bridge Safety Inspector Date

Form SB501

SAMPLE CHANNEL CROSS SECTION



ELEVATION VIEW
Upstream Fascia
Looking Downstream

YEAR	STATION 2.5'	STATION 8.0'	STATION 13.0'	STATION 18.0'	STATION 23.0'
1978 Original	6' – 6"	11' – 10"	12' – 6"	12' – 3"	9' – 3"
2008 Readings	8' – 6"	11' – 10"	12' – 6"	12' – 3"	9' – 3"
2010 Readings	11' – 0"	11' – 10"	12' – 6"	12' – 3"	9' – 3"

Legend: T.W. = Top of water

VDOT Virginia Department of Transportation

Structure and Bridge

INTRA-DEPARTMENTAL MEMORANDUM

Bridge Signage Form

City/County: _____
Route: _____ **Over:** _____
Structure No.: _____

To: _____ **From:** _____ **Date:** _____
(Insert Title of Responsible Manager) District Structure & Bridge Engineer

SIGNAGE AFFECTED

☐ Weight Restriction ☐ Vertical Clearance Restriction ☐ Object Markers ☐ Other

Inspection and/or analysis by the District Structure and Bridge Section revealed that the signage for the above referenced bridge is: (check all that apply)

☐ Required and not in place.
☐ No longer required and needs to be removed.
☐ Missing or damaged and needs to be replaced.
☐ Incorrect and needs to be lowered.
☐ Incorrect and needs to be raised.
☐ Obscured
☐ Advance warning signs are not placed in accordance with Section 46.2-1130 of the Code of Virginia
☐ Comments: _____

_____

_____

SIGNING FOR WEIGHT RESTRICTION OF STRUCTURE shall adhere to the latest version of the Virginia Supplement to the Manual of Uniform Traffic Control Devices (MUTCD), Part 2 – Signs, Section 2B.59 and shall indicate a maximum capacity of:

_____ tons on a R12-1 sign or

_____ tons (single unit) and _____tons (semi-trailer) on a R12-V1 sign

SIGNING FOR VERTICAL CLEARANCE OF STRUCTURE shall adhere to the latest version of the Virginia Supplement to the (MUTCD), Part 2 – Signs, Section 2C.27 and shall indicate a maximum clearance of:

_____ feet _____inches

The above signage deficiency was corrected on the following date: _____

Signature: _____
(Insert Title of Responsible Manager)

Once the deficiency is corrected, please forward the original of this form to the District Structure & Bridge Engineer and copy the District Structure & Bridge Safety Inspection Engineer.

Form SB503

Scour Critical Plan of Action

Structure ID	
Federal Aid System of Highways	
FIPS County	
District	
County/City	
Carrying	
Over	
Virginia Structure Number	
Year Built	
Size of Existing Bridge	
Foundation Type	
Scheduled for Replacement	
Detour Length	
Average Daily Traffic	
Source of Scour Critical Rating	
Scour Rating (Item 113)	
Planned Actions	
Other actions	
Prepared by	
Signature	
Date	

TYPICAL FATIGUE PRONE DETAILS

Close visual inspection of fatigue prone details is required. Concentrate on following areas:

- **Distortion in small gaps.**
- **Weld tips (terminations).**
- **Intersecting welds.**
- **Reduction in x-sections.**
- **Skewed bridges.**
- **Wrapped around welds.**

Typical details to inspect for localized fatigue cracking:

1. Lateral connection plates with intersecting welds, weld tips, & gaps or backing bars and tack welds.
2. Transverse connection plates. (Need to be positively connected to both flanges.)
3. Longitudinal stiffener butt welds, fillet welds, and cope holes.
4. Floorbeam to girder connection. (Coped beam flanges or blocked beam flanges.)
5. Rolled beam diaphragm connection. (Also, with coped flanges.)
6. Coverplate end welds and butt welds.
7. Termination of longitudinal coverplate welds. (Not end welded.)
8. Web plate penetration including box pier caps.
9. Web and flange splices. (Particularly field welded - quality may be suspect. Built-up welds)
10. Web cope holes
11. Stringer to floorbeam connections (out-of-plane bending)
    - Stringer framing into Girder webs - Category E or E'
    - Stringer framing into Girder flange - Category E or E'
12. Lateral connection to girders and floorbeams.
13. Backing bar splices. (Backing bars should be continuous. Ideally should be removed, but not practical.
14. Repaired holes with partial or complete plug welds.
15. Tack welds. Near ends of plates. Near end of backing bars. (AWS requires that tack welds be properly removed or incorporated into permanent weld. Identify as potential locations for fatigue cracks.
16. Gouges and arc strikes.
17. Intermittent fillet welds. (Category E for web to flange or CP to flange.)
18. Pin & hanger assemblies.
19. Insert plates in haunched girders.
20. Riveted members (girders & trusses) with tack welds or subject to prying action.
21. Corrosion induced defects.
22. Construction & traffic damaged areas.
23. Field welding of curved girder cross frame members (Category E equivalent) (Check quality of field welds, terminations of welds, undercutting or notch effects)
24. Field welding of attachments to tension areas of webs or flanges after the bridge was built.

VIRGINIA DEPARTMENT OF TRANSPORTATION

STRUCTURE AND BRIDGE DIVISION

INSTRUCTIONAL AND INFORMATIONAL MEMORANDUM

GENERAL SUBJECT: Restricted Structure Atlas	NUMBER: IIM-S&B-35.5
SPECIFIC SUBJECT:	Date: June 8, 2010
	SUPERSEDES: IIM-S&B-35.4
DIVISION ADMINISTRATOR APPROVAL: /original signed/ Kendal R. Walus, P.E. State Structure and Bridge Engineer Approved: June 8, 2010	

Changes are shaded.

Increasingly, industry is producing and transporting goods and equipment that exceeds the standard load, height and width restrictions. To aid industry, protect infrastructure, and enable routing, the Restricted Structures Atlas was developed, and is updated in January and July of each year. These maps show the locations of vertical, horizontal clearance, and weight limit restrictions on Interstate, Primary and Urban Extension highways.

The following restricted clearances shall be shown on the maps:

Vertical: Structures with vertical clearance less than 20 feet (Rounded down to the nearest inch)

Horizontal: Horizontal restrictions on or under structures less than 18 feet wide

Additionally, restricted capacities for the following vehicle types shall be depicted on the maps:

Gross weight for single unit truck (Type 3): 27 Tons or less

and

Gross weight for vehicle combination (Type 3S2): 40 Tons or less

and

Gross weight for permit vehicles: 45 Tons

In May and again in November of each year, the Central Office Structure and Bridge Division (COS&B) will provide the District Structure and Bridge Sections two copies of the latest maps within their District to review these maps for accuracy and provide updates. Updates reflecting changes in vertical and horizontal clearances or weight restrictions are to be provided to the COS&B no later than the last week of May and November, respectively.

The updates will be reviewed and compiled by the COS&B, and forwarded to the Office of Communications and Public Affairs, who will update the maps, print copies, and make distribution within and outside the Department.

When changes occur after an updated map is issued, IMMEDIATE actions shall be taken by the District Structure and Bridge Engineer or their designee as follows:

Upon learning of a change or an addition to the Restricted Structures Atlas, the District Structure and Bridge Engineer or their appointee shall notify the following person at the Virginia Department of Motor Vehicles by phone: Wayne Davis (804) 497-7121 directly or (804) 497-7135 for the Hauling Permits office. Immediately following the phone notification send an email to:

Wayne Davis
Wayne.Davis@dmv.virginia.gov
and
Fitzhugh Jackson
Fitzhugh.Jackson@dmv.virginia.gov

All personnel who have the authority to issue hauling permits within your District (this may include personnel in the Residencies).

and copied to:

C. M. 'Ceil' Asbury
Ceil.Asbury@dmv.virginia.gov
and
Michael Baxter
Michael.Baxter@dmv.virginia.gov
and
Keith A. Clary (Structure & Bridge, Central Office)
Keith.Clary@vdot.virginia.gov
and
Office of Public Affairs
Vdotmapfiles@vdot.virginia.gov
and
Central Office Hauling Permits
haulingpermits@vdot.virginia.gov

The email shall include the following:

District:
County:
Route:
Feature Intersected:
Virginia Structure Number:
Page number(s) of Restricted Structures Atlas where restriction is shown:

and

Clearance on the Restricted Structures Atlas should be changed from _____ to _____.

or

Capacity on the Restricted Structures Atlas should be changed from _____ to _____.

Attachment: Appendix A

CC:
Chief Engineer
Chief of Systems Operations
Chief of Communications and Public Affairs
Director of Virginia Transportation Research Council
Division Administrator, Location & Design Division
Division Administrator, Maintenance Division
Division Administrator, Traffic Engineering Division
Division Administrator, Operations and Security Division
District Administrators
District Maintenance Engineers
District Structure and Bridge Engineers
Residency Administrators
Federal Highway Administration, Bridge Division

APPENDIX A

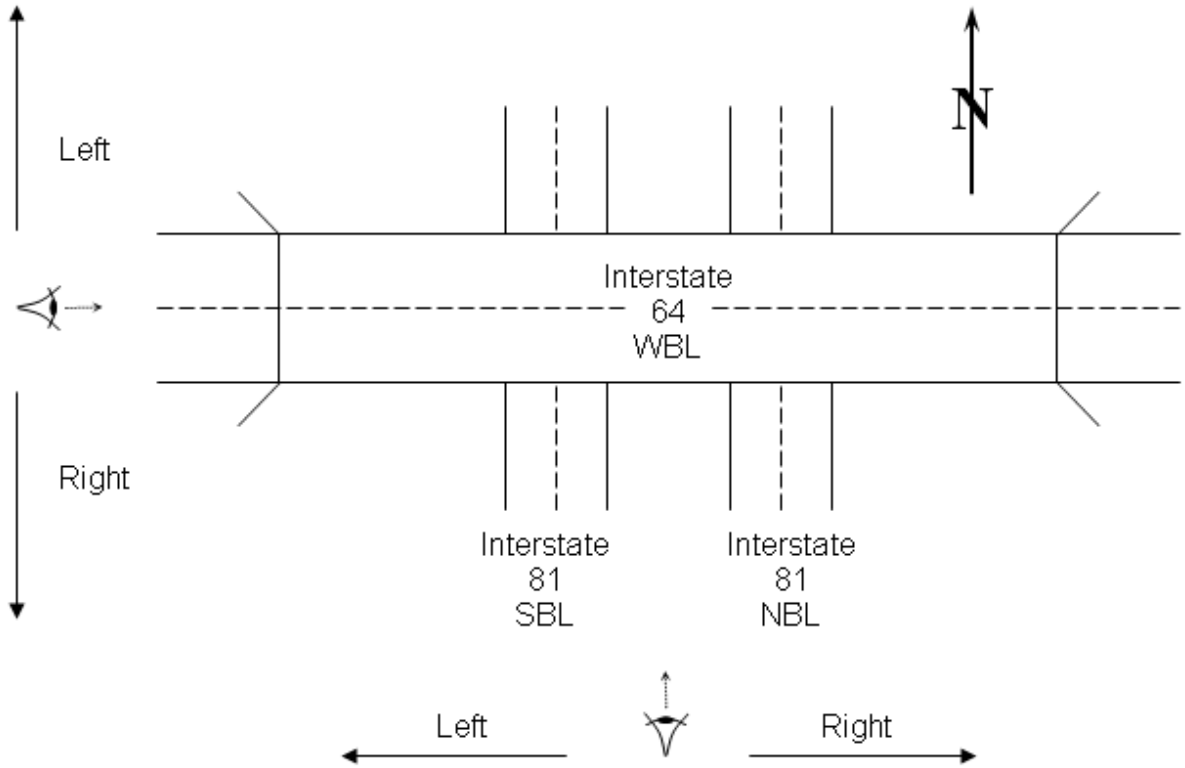
How to record a vertical clearance:

According to the definition of terms in the manual 'Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges':

> Inventory Route – The route for which the applicable inventory data is to be recorded. The inventory route may be on the structure or under the structure. Generally, inventories along a route are made from west to east and south to north.

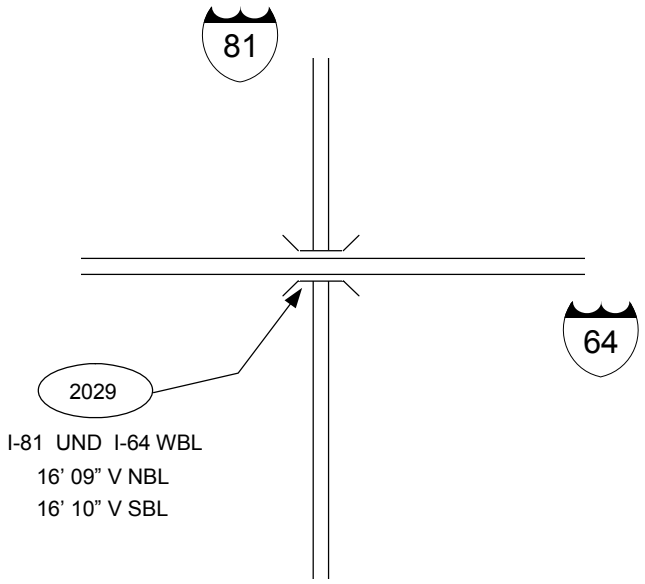
West to east and south to north are generally the directions of increasing mileposts, therefore, unless stated otherwise in the description of an item in the coding guide left and right shall be determined by looking in the direction of the increasing mileposts on the route.

Consider the sketch below. Look east to determine left and right for items pertaining to Interstate 64 (mileposts increase as you travel east) and look north for items pertaining to Interstate 81 (mileposts increase as you travel north).



When the information is recorded on the maps, all information shall adhere to the standards noted below:

- Restrictions for an undivided route carrying traffic in both directions shall show the minimum restricted clearance.
- Restrictions for a divided route carrying northbound and southbound traffic shall show the northbound restriction first and be labeled ‘NBL’. The southbound restriction shall be shown last and labeled ‘SBL’.
- Restrictions for a divided route carrying eastbound and westbound traffic shall show the eastbound restriction first and be labeled ‘EBL’. The westbound restriction shall be shown last and labeled ‘WBL’.
- Information about a restriction shall be shown in the following order: structure number, location and restriction.
- The location of the structure shall be noted showing the route for which the restriction exists followed by any other pertinent route information.



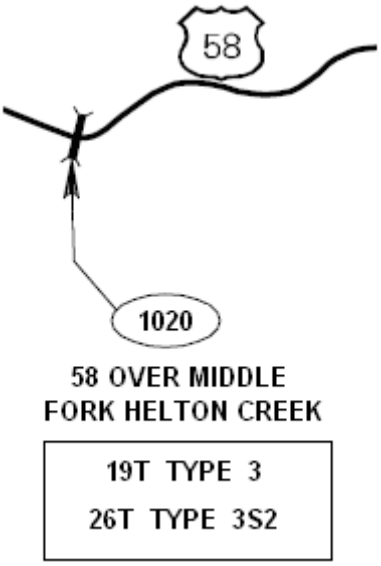
In the above example, only a restriction for I-81 under I-64 WBL is shown. If eastbound and westbound I-64 are separate structures, restrictions will be recorded for each structure.

For the sake of space and uniformity all references to 'under' on the Restricted Structures Atlas will be abbreviated 'UND' and all references to 'Rte.' or 'Route' or 'Rt.', etc. on the Restricted Structures Atlas will be not be shown. All interstate routes will be preceded by 'I-' to eliminate confusion with other routes with the same number, i.e. Secondary Route 664 versus Interstate Route 664.

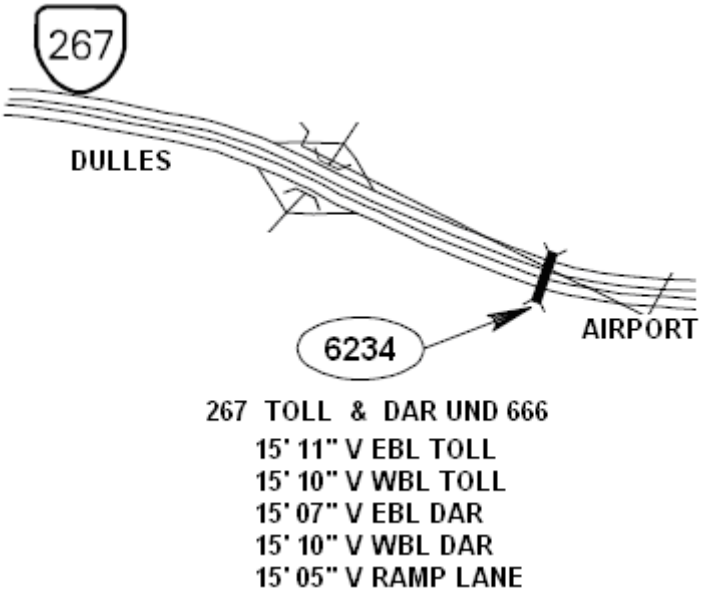
The vertical clearances reported on the Restricted Structures Atlas shall be the vertical clearances that are reported in the official inventory system and the vertical clearances reported in official inventory system shall be the vertical clearances measured in the field (rounded down to the nearest inch).

Example: Rte. 58 over Middle Fork Helton Creek; VA Structure number 1020 has the following weight restrictions for single unit trucks and vehicle combinations.

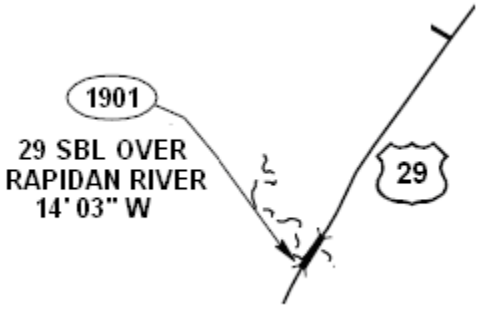
Posted capacity for a single unit truck (Type 3): 19 Tons
Posted capacity for a vehicle combination (Type 3S2): 26 Tons



Example: Reporting vertical clearances under Rte. 666 for Rte. 267 and Dulles Airport Road; VA Structure number 6234.

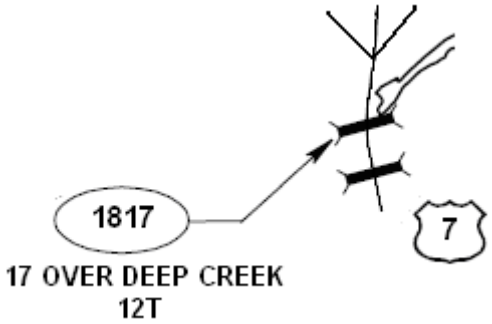


Example: Reporting horizontal restriction for Rte. 29 SBL over Rapidan River; VA Structure number 1901.

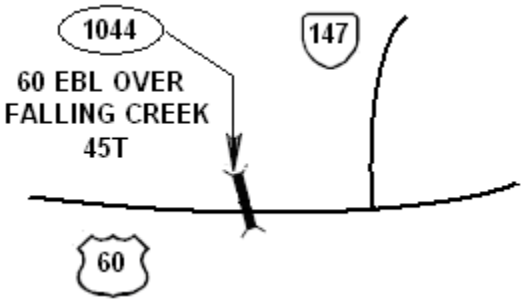


Example: Rte. 17 over Deep Creek; VA Structure number 1817 has a weight restriction for single unit trucks.

Posted capacity for the single unit truck (Type 3): 12 Tons



Example: Rte 60 EBL over Falling Creek; VA Structure number 1044 has a weight restriction of 45 Tons gross weight for permit vehicles.



Procedure to track changes on the Restricted Structure Atlas and communication between the District Structure and Bridge Offices with COS&B:

- Notify Central Office via email immediately when a change occurs.
- Changes shall be notated on the COS&B office copy of the Restricted Structure Atlas.
- During the first week of May and November of each year, COS&B shall request two copies of the Restricted Structures Atlas from the Office of Communications and Public Affairs with changes that have been recorded since the last issue date marked in **RED** on the maps.
- Changes on the maps received from the Office of Communications and Public Affairs shall be reconciled with changes recorded on the COS&B copy of the maps.
- COS&B shall then send each district two copies of their respective maps with the changes annotated in **RED**.
- Districts shall then review the maps, verify all changes, and annotate any additional changes. All changes to the maps by the Districts shall be made in **GREEN**. One copy of the final marked-up maps shall be returned to the COS&B.
- Any new changes or corrections marked in **GREEN** on the returned maps will be reviewed and added to the COS&B office copy.
- The FINAL combined annotated copies of the revised Restricted Structure Atlas shall then be sent the Office of Communications and Public Affairs for transcription.
- After the Office of Communications and Public Affairs corrects each District's maps, the maps shall be returned to COS&B to Copy Check.
- Upon COS&B verification and reconciliation, maps are then printed and distributed by the Office of Communications and Public Affairs.
- Once every three years, COS&B will perform a quality control/quality assurance review of the District maps against the inventory system.

VIRGINIA DEPARTMENT OF TRANSPORTATION

STRUCTURE AND BRIDGE DIVISION

INSTRUCTIONAL AND INFORMATIONAL MEMORANDUM

GENERAL SUBJECT: SOUND BARRIER WALL ATTACHMENTS	NUMBER: IIM-S&B-40.2
SPECIFIC SUBJECT:	Date: DECEMBER 3, 2007
	SUPERSEDES: BR-86-40.1
DIVISION ADMINISTRATOR APPROVAL: Kendal R. Walus, P.E. / Original Signed State Structure and Bridge Engineer Approved December 3, 2007	

Changes are shaded.

CURRENT REVISION

- Converted to electronic format. The subject matter of the IIM did not change.

EFFECTIVE DATE

- This memorandum is effective upon receipt.

POLICY

Provisions for sound barrier wall attachment to bridges are to be made when requested by the Environmental Division or when shown on the road plans.

The bridge is to be designed to carry the gravity loads of the sound barrier panels, the weight of the support posts, and the weights specified in the AASHTO group loadings listed in the latest edition of the AASHTO *Guide Specifications for Structural Design of Sound Barriers*. The design of the sound wall panels, posts and anchors shall be based on the guide specifications. Typically, this will require a wind loading of twenty to forty pounds per square foot applied to the sound barrier wall and used for the design of the sound panels, posts and anchors. The wind force used for the sound barrier wall varies with the height

above geographical or manmade obstructions that can disrupt straight line wind. As a general rule, select the wind pressure using the height from the center of the exposed sound barrier wall to the ground beneath the bridge. The bridge superstructure and substructure shall be designed to carry the wind loads specified in the AASHTO *Standard Specifications for Highway Bridges*. This load is typically on the order of fifty pounds per square foot applied to the area of exposed superstructure, including the area of exposed sound barrier wall.

The contract pay item for sound barrier wall normally includes the design and detailing of structure mounted and ground mounted walls. However, the bridge plans are to detail the anchorages for the sound wall posts. A note must be placed on the plans indicating the wind pressure and the weight of the sound wall used for the design of the anchorages. The plans and calculations submitted by the contractor shall be reviewed for conformity to the plans, specifications, supplemental specifications, and special provisions included in the contract. A generic special provision for sound barrier walls is attached.

Attachment

CC: Chief Engineer
Chief of Systems Operations
Director of Virginia Transportation Research Council
Division Administrators under the Chief Engineer
District Administrators
Resident Engineers
Federal Highway Administration

ATTACHMENT

----- GENERIC SPECIAL PROVISION ----

VIRGINIA DEPARTMENT OF TRANSPORTATION
SPECIAL PROVISION FOR
SOUND BARRIER WALLS

I. DESCRIPTION - Sound barrier walls shall conform to the plans, Section 519 of the Specifications and the provisions herein. Ground mounted sound barrier walls shall be precast concrete with a sound absorptive finish. All structure-mounted walls shall be metal or other approved lightweight material with sound absorptive panels. The panels on structure-mounted metal barriers shall be oriented vertically or horizontally as the case may be to match the aesthetic features of the ground-mounted walls. In either case, panel orientation shall be such that panels are free draining to prevent moisture buildup and possible corrosion. Proposed structure-mounted sound barrier walls shall aesthetically match ground-mounted barriers as to color.

II. DESIGN PARAMETERS - Sound barrier walls shall be designed in accordance with the current AASHTO *Guide Specifications For Structural Design of Sound Barriers* except as otherwise noted herein. All references in the *Guide Specifications* to "an industry recognized design specification" shall not apply without the prior authorization of the Engineer.

A 70 mph up through 90 mph wind load, as deemed appropriate for a given project area, exposure category B-2 design, shall be used for designing all ground mounted sound barrier walls. All structure-mounted sound barrier walls shall also be designed to a 70 mph up thru 90 mph wind load as deemed appropriate for a given project area, exposure category C, with panels weighing roughly 7.5 pounds per square foot, and posts placed 8 feet((parapet groove spacing)) on center for bridges and 12 feet for cast-in-place concrete retaining wall..

All sound absorptive precast concrete panels and footings shall be constructed in accordance with Sections 404 and/or 405 of the Specifications, except that patching of panels will not be allowed without the approval of the Engineer. Where patching is permitted by the Engineer it shall be performed in accordance with the panel manufacturer's recommendations. Absorptive sound barrier walls shall be designed so that the absorptive portion of the panels on the highway side shall have a minimum noise reduction coefficient of 0.70.

Sound barrier walls shall be designed to be free flowing hydraulically so as not to trap surface water. Weep holes shall be provided in panels, where necessary, to facilitate proper drainage. A graded ditch or similarly functional drainage shall be provided in front and behind of the barrier wall to control and dispose of roadway and slope drainage. The ground mounted sound barrier posts and bottom precast concrete wall panels shall be designed in consideration of the additional load created by the ditch slope where it rests against the wall. Drainage design shall not create sound leaks.

III. PANEL REQUIREMENTS - Where sound absorptive panels have a structural concrete or other approved material core, the sound absorptive finish shall be permanently bonded or attached to the core material and have the same service life as the core material. The absorptive finish of precast concrete barriers shall meet the requirements of ASTM C666, Procedure B, for 300 cycles.

Finish on the roadway side of the precast concrete absorptive barrier shall be vertically fluted. Finish on the landowner's side of precast sound barrier walls shall be fuzzy raked. No absorptive finish is required on that portion of the base panels below ground and 6 inches above the ground line. Base panels shall be a minimum height of 2 feet and shall be embedded in the ground a minimum of 6 inches to prevent sound leaks. Panels having deficiencies such as cracking, crazing, scaling, efflorescence, segregation, mottling of the color coating or stains on the finish shall be rejected.

Maximum length of ground-mounted panels shall be 24 feet. Steps created at the top of wall panels when traversing a grade shall be as uniform in height as possible. Once installed, the edges of stacked panels shall be neat, and sides that mate together shall be straight and true. Irregularities at panel edges that appear broken, ragged or chipped to the extent that a gap appears once they are stacked will be cause for rejection. When panels are stacked, horizontal joints shall typically be 4 feet c-c maximum, and aligned to create continuous horizontal lines; however, foundations and/or ground contact panels may be adjusted within the limits established herein to provide for the continuous horizontal alignment of joints. Horizontal joints formed where panels mate together and false or dummy joints (if present) must match in appearance and alignment.

Where sound barrier panels do not occupy the full width between the flanges of the sound barrier posts, panel attachment details shall be furnished with the working drawings. Such details shall also include material descriptions. Post flanges and panels shall overlap at least 1-1/2 inches after installation. Spacer blocks\wedges will not be permitted. The face of the panel on the roadway side of the barrier shall fit tightly against the post flange for the full height of the panel after installation.

Color of sound barrier walls shall be Federal Standard 595B-30313 or comparable. Proposed precast concrete ground mounted sound barrier walls shall be colored on the roadway side of the barrier only. Color of metal barrier shall match as closely as possible that of ground mounted barrier. If the structure mounted metal sound barrier walls have sound absorptive perforated metal panels, the panels shall be painted a matte powder coat finish with a colorant from the Department’s approved listing. The Contractor shall contact the Project Engineer at the appropriate district office, to verify wall color prior to fabrication.

The Contractor shall erect a sample section of the ground mounted wall at the job site prior to receiving final written approval to proceed with panel fabrication from the District office. The sample section shall be three bays of panels with posts to show how panels shall be secured to posts with attachment hardware. Sample panels must show the attachment area formed in the panel. Further, sample panels shall show color and finishes of both sides of the wall.

IV. POST REQUIREMENTS - If steel posts are used they shall be fabricated from steel conforming to the requirements of ASTM A36. All steel and miscellaneous hardware used above the foundation shall be galvanized after fabrication. Structure mounted walls shall have steel posts. Anchor bolts for structure-mounted walls shall be integrally cast into parapets. Adhesive or epoxy anchors will not be permitted as a method of post attachment for structure mounted walls. The details of the connection of the structure mounted wall panels to the steel posts shall be as shown in the plans for bridges and retaining walls. Connections between the panel and the posts and the sound barrier wall and the bridge shall account for the movement of the bridge as well as the expansion and contraction of the panels. Post spacing, size and attachment details shall be incorporated into the working drawings.

The Contractor is advised that slip forming of bridge parapets where structure mounted sound walls is to be attached will not be allowed by the Department due to the use of embedded anchors for post attachment. Bridges with sound barrier walls attached to the parapets have been designed assuming a mass of weight of 7.5 pounds per square foot of sound barrier wall.

The maximum deflection of supporting posts for sound barrier walls shall be limited to the pertinent span length divided by 240. The unbraced length used for bending design of steel posts shall be taken as the actual length of the cantilever unless both flanges are sufficiently braced to allow a reduction of the unbraced length of section. (This paragraph is intended as a clarification of the design specifications. It is not intended to imply additional requirements other than those already specified in the AASHTO specifications)

Anchor bolts for general use in attaching sound barrier posts shall conform to Section 226 except as provided herein. Anchor bolts shall conform to AASHTO 314, Grade 36 or 55. Where high strength anchor bolt material is used, the design shall be limited to a maximum yield strength of 55 ksi and a maximum ultimate tensile strength of 75 ksi. Hydraulic cement grout conforming to Section 218 shall be placed between the base plate and the top of the foundation to retard corrosion of the anchor bolts but shall not be considered a factor for strength purposes. Ground mounted anchor bolts shall be covered with hot asphalt after installation.

V. FOUNDATION REQUIREMENTS - Existing ground line elevations shall be established and verified by the Contractor prior to submitting working drawings. The Contractor shall remove and dispose of all above ground obstruction such as trees and other clearing and grubbing items unless otherwise directed by the Engineer. Excavation of tree roots, existing limited access fence and other clearing and grubbing items such as those identified in Section 301 required for the placement of walls shall be included in the square foot price bid of the sound barrier walls.

The Contractor is advised that the Department has not performed subsurface investigation to locate existing utilities on this project. Therefore, it shall be the Contractor's responsibility to perform this work so as to avoid utility conflicts with the construction associated with the proposed sound barrier wall. The Contractor shall adjust foundations to avoid conflicts with pipes or utilities. Wall panel lengths may be shortened or lengthened so that foundation locations may be adjusted to avoid conflicts and clear existing pipes, utilities and other underground obstructions. When a conflict cannot be avoided using this method, the Contractor must submit his alternative design

for the Department's written approval. The Contractor shall modify the design of wall foundations where foundations may conflict with the limits of proposed or existing rights-of-way or where foundation designs may leave a portion of the foundation exposed above the finished ground line. Such conflicts and proposed modifications shall be reviewed with the Engineer prior to installation. Where sound barrier walls are self-supporting, they shall be designed to prevent pipe or utility damage caused by excessive bearing loads when placed over pipes, utilities or other underground obstructions.

Foundation designs may require pilings, caissons, or special design as indicated by subsurface investigations (Soil reports and boring logs) taken at appropriate intervals to establish soil capacity. Copies of the geological data are available in the office of the District Materials Engineer in which the project is located. In no case will the foundation for the wall be located on top of the duct banks for any of the TMS Center's equipment. Soil friction angle and strength of soils shall be used when designing foundations. Foundations shall be designed in accordance with *Section 4 Foundations,* of the AASHTO *Specifications for Highway Bridges*.

The Brom's method may be used for the design of laterally loaded caissons. For Group II and Group IV where wind is a contributing load, a minimum safety factor of 2.25 shall be used if soil parameters are based on the results of standard penetration tests. When parameters are based on the results of subsurface exploration and laboratory testing programs as detailed in Section 4.3 of Section 4 Foundations, or are set by the Department, a safety factor of 1.9 may be used. The soil at the surface to a depth equal to the diameter of the caisson shall not be considered effective when calculating the required embedment of the caisson. The minimum area of longitudinal reinforcement for caisson type foundations shall be greater than 1 percent of the gross area of the foundation section.

For walls on spread footings, a bearing capacity analysis shall be submitted as part of the calculations and the safety factor against bearing failure shall be taken as 2.25 for Group II and Group IV where wind is a contributing load. The ground surface slope shall be taken into account when determining bearing capacity of the soil. Embedment of footings shall be in accordance with AASHTO specifications.

For walls on piles, design shall be in accordance with Section 4, Foundations. The factor of safety shall be on the level of construction control as required in section 4.4.6.2. The required factors of safety may be modified by the allowable overstress permitted in the wind load condition.

Foundation design will be considered incidental and all costs associated with foundation design shall be included in the price bid per square foot of sound barrier wall.

VI. WORKING DRAWINGS AND REVIEW

Working drawings for sound barrier walls shall conform to the requirements of Section 105.02 except as noted herein. Working drawings shall contain all specific details and dimensions necessary for the complete review, construction and inspection of the work. The working drawings for sound barrier walls shall also reflect coordination with the working drawings for retaining walls where applicable. Working drawings shall be

certified by a Professional Engineer holding a valid license to practice engineering in the Commonwealth of Virginia.

Working drawings shall be formally submitted as described in Section 105.02 of these Provisions. In order to expedite the review of the working drawings, three advance copies shall be sent to the individual listed below. Advance copies shall contain all hand calculations verifying the adequacy of the design. Hand calculations shall also indicate the design methodology and validate the results of the worksheets. VDOT Central Office contact:

Virginia Department of Transportation
Location and Design Division
Engineering Services
1401 E. Broad Street
Richmond, Virginia 23219

Payment will be made under: Any changes to the working drawings by the Contractor after the initial submittal shall be clearly identified. Changes shall be identified on the working drawings and denoted in narrative form (i.e. cover letter) and dated after making all requested changes. This format shall be followed until all requested changes are completed to the satisfaction of the Engineer.

VII. MEASUREMENT AND PAYMENT

Precast Sound Barrier Wall will be measured and paid for in accordance with Section 519 of the Specifications except that the precast sound barrier shall be measured at the contract unit price per square foot of surface area from existing ground line or finished grade line to the sound attenuation line shown in the proposal. The 6 inch minimum embedment in the ground of all base panels of ground-mounted precast sound barrier walls will be considered incidental and will not be measured for separate payment.

Sound barrier walls will be measured at the contract unit price per square foot of surface area from the top of the bridge parapet or retaining structure to the sound attenuation line shown in the proposal.

The price bid shall also include furnishing, installation, providing modifications to avoid utility, right-of-way, foundation exposure, and other structures whose foundations or designs may conflict. The cost of foundation designs and supplemental geotechnical investigation and foundations shall be considered incidental and will not be measured for separate payment but shall be included in the price bid per square foot of sound barrier wall.

Pay Item	**Pay Unit**
Precast Concrete Sound Barrier Wall, Absorptive	Square Foot
Sound Barrier Wall	Square Foot

519 - SOUNDWALL COLOR COATING

I. DESCRIPTION - This work shall consist of furnishing and applying a soundwall color coating in accordance with this provision. The color and location shall be as specified on the plans or as directed by the Engineer.

II. MATERIALS - The soundwall color coating shall not diminish the noise absorption coefficient specified for the soundwall upon which it is applied when tested in accordance with ASTM C423. The coating shall be a semiopague toner containing methyl methacrylate-ethyl acrylate copolymer resins with toning pigments suspended in solution at all times by a chemical suspension agent and solvent. Color toning pigments shall consist of laminar silicates, titanium dioxide and inorganic oxides. There shall be no settling or color variation. The use of vegetable or marine oils, paraffin materials, stearates or organic pigments in the coating formulation will not be permitted.

Physical properties of the coating shall be as follows:

Mass per gallon	8.3 pounds (min.)
Solids by mass	30 percent (min.)
Solids by volume	21 percent (min.)
Drying time	30 minutes (max.) at 70°F and 50 percent humidity

Coating material shall not oxidize and shall show no appreciable change in color after 1000 hours when tested in accordance with ASTM D822; shall have excellent resistance to acids, alkalies, gasoline and mineral spirits when tested in accordance with ASTM D543; shall allow moisture vapor from the concrete interior to pass through when tested in accordance with ASTM E398 or D1653; and shall reduce the absorption rate of exterior moisture into the pores of the concrete surface when tested in accordance with Federal Specification TT-C-555 B.

The soundwall color coating shall be from the approved list of absorptive concrete soundwall color coatings.

III. APPLICATION - Surface preparation, application rate and application procedures shall be as specified by the coating manufacturer, using airless spray equipment, having a minimum capacity of 1,000 psi and 1/2 gallons per minute. Coating shall not be applied when the air temperature is below 50°F, to damp surfaces or when the air is misty or unsatisfactory for this work as determined by the Engineer.

IV. QUALITY CONTROL PANEL - Prior to beginning coating operations the Contractor shall provide and erect on the project site a representative sample of the color coated soundwall containing at least 30 square feet, for approval of uniformity and appearance of the color coating. This approved sample shall remain on the project site and will be used by the Engineer as a basis for comparison and acceptance of the Contractor's finished coating.

V. METHOD OF MEASUREMENT - Unless otherwise specified, soundwall color coating will not be measured for separate payment but shall be included in the price bid for sound barrier wall.

When specified as a contract item, soundwall color coating will be measured in square feet of surface coated.

VI. BASIS OF PAYMENT - When specified as a contract bid item soundwall color coating will be paid for at the contract unit price per square foot, which price shall be full compensation for furnishing and applying the soundwall color coating, surface preparation and for all materials, labor, tools, equipment and incidentals necessary to complete the work.

Pay Item	**Pay Unit**
Soundwall Color Coating	Square Foot

VIRGINIA DEPARTMENT OF TRANSPORTATION

STRUCTURE AND BRIDGE DIVISION

INSTRUCTIONAL AND INFORMATIONAL MEMORANDUM

GENERAL SUBJECT: HIGHWAY AND PROJECT IDENTIFIERS	NUMBER: IIM-S&B-49.2
SPECIFIC SUBJECT:	Date: DECEMBER 3, 2007
	SUPERSEDES: BR-86-49.1
DIVISION ADMINISTRATOR APPROVAL: Kendal R. Walus, P.E. / Original Signed State Structure and Bridge Engineer Approved December 3, 2007	

Changes are shaded.

CURRENT REVISION

- Revised to reference IIM-LD-151.4..

EFFECTIVE DATE

- This memorandum is effective upon receipt.

POLICY

All bridge plans for “bridge only” contracts will have a five (5) digit number shown on the title sheet in accordance with the requirements of the Location and Design Division Instructional & Informational Memorandum IIM-LD-151.4. All other bridge plans included in contracts with approach work will be covered by the number shown by the road designer on the road plans.

Digits 1, 2 and 4 are shown in the Road Inventory Mileage Records, T&S 5-1. A copy of these records for Interstate, Primary, Arterial, and Urban Systems is available in the Bridge Division File Room. Each District Bridge Section has a set of these records for all systems.

The number is to be shown on all “bridge only” contract plans to be advertised.

VIRGINIA DEPARTMENT OF TRANSPORTATION

STRUCTURE AND BRIDGE DIVISION

INSTRUCTIONAL AND INFORMATIONAL MEMORANDUM

SUBJECT: **Metric Conversion** **Structure Design Guidelines**	**NUMBER:** **S&B-95-65.2**
DIRECTED TO: **All Structural Designers**	**DATE:** **October 16, 1995**
SIGNATURE: **MALCOLM T. KERLEY, P.E.**	**SUPERCEDES:** **S&B-95-65.1**

The following guidelines shall apply to all METRIC plans prepared by or for the Structure and Bridge Division.

- All plans shall be in metric units only. **Dual units shall not be used.**
- As a general rule, use millimeters (mm) for all plan dimensions (**xxxx or xxx,xxx**). Use meters (m) for elevations(**xxx.xxx**). The 100 meter method of stationing will be used (**xxx+xx.xxx**).
- Place the following notes in the General Note, "All dimensions are in millimeters." "All elevations are shown in meters."
- All abbreviations shall be lower case except for liter (L) and those derived from proper names such as Newton (N).
- Many bridge components will require a soft metric conversion. Soft metric means no physical change in manufacturing is required (conversion to the nearest one (1) millimeter). Hard metric means the product requires physical change (conversion to a convenient and practical measurement). Reinforcing steel is one example of a soft metric conversion.

The attached sheets outline various values and dimensions that shall be used in the development of METRIC structural plans.

STRUCTURE DESIGN GENERAL PRACTICE FOR METRIC CONVERSION

Deck

width	hard
thickness	hard
concrete strength	hard
reinforcement	soft
parapet	soft
sidewalk, median	hard
elevations	hard
drains	soft
metal rails	soft

Structural Steel

plate thickness	hard
rolled shapes	soft
bending stresses	hard
fatigue stresses	hard
camber & dimen.	hard
shear conn. size	soft
weld size	soft

Expansion Joints

All types	soft

Bearings

anchor bolts	soft
elastomeric	soft
steel	soft

Piles

precast prestr.	soft
steel H	soft
timber	soft
spacing	hard
concrete strength	hard
reinforcement	soft

Prestressed Concrete

shapes	soft
strand spacing	hard
strands	soft
concrete strength	hard
reinforcement	soft

Bents & End Bents

dimensions	hard and soft
concrete strength	hard
reinforcement	soft

Culverts

tables/charts	soft
details	soft

concrete strength	hard		
reinforcement	soft		
Geometric Clearance (per Roadway)			
horizontal	hard		
vertical	hard	4450 mm	(14.60 ft)
		5050 mm	(16.56 ft)
Geometric Clearance (per Railroad)			
		7000 mm	(23.00 ft)

STRUCTURE DESIGN METRIC PRACTICE

LOADING:		Metric	(English)
Truck		MS18	(HS20)
Front Axle		35 kN	(8 kips)
Rear Axle		145 kN	(32 kips)
Axle Spacing	minimum	4.3 m	(14 ft.)
	Maximum	9.0 m	(30 ft.)
Wheel Spacing		1.8 m	(6 ft.)
Alternate Truck			
Axle		110 kN	(24 kips)
Axle Spacing		1.2 m	(4 ft.)
Lane Loading			
Distributed Load over 3 meters		9.3 kN/m	(0.64 k/ft)
Concentrated Load		80 kN	(18 kips)
		115 kN	(26 kips)

Dead Loads	Metric	(English)
Fut. Wearing Surface	0.7 kN/m^2	(15 psf)
Constr. Tolerance	1.0 kN/m^2	(20 psf)

Unit Weights		
Reinforced concrete	23.6 kN/m^3	(150 pcf)
Soil	18.9 kN/m^3	(120 pcf)
Steel	77.2 kN/m^3	(490 pcf)

Lateral Soil Pressure

Equiv. fluid weight	2.4 kN/m^3	(15 pcf)
	4.8 kN/m^3	(30 pcf)
	9.6 kN/m^3	(60 pcf)

DECK

Shoulder width	600 mm	(2 ft)
	1200 mm	(4 ft)
	1800 mm	(6 ft)
	2400 mm	(8 ft)
	3000 mm	(10 ft)
	3600 mm	(12 ft)
Lane width	2700 mm	(9 ft)
	3000 mm	(10 ft)
	3300 mm	(11 ft)
	3600 mm	(12 ft)
Thickness	190 mm	(7.50 in)
	200 mm	(8.00 in)
	210 mm	(8.25 in)
	220 mm	(8.75 in)
	230 mm	(9.00 in)
Cover	25 mm	(1.00 in)
	30 mm	(1.25 in)
	40 mm	(1.50 in)
	50 mm	(2.00 in)
	65 mm	(2.50 in)
	75 mm	(3.00 in)

Elevations Meter (to the 0.001).

Slopes	2%	(1/4 in/ft)
	4%	(1/2 in/ft)
	6%	(3/4 in/ft)
	8%	(1 in/ft)

MATERIAL STRENGTH

Structural Steel M-270

Grade	Tensile Strength (MPa)	Min Yield strength (MPa)	(Min. yield strength,ksi)
36	400-550	250	(36)
50	450	345	(50)
50W	485	345	(50)

Reinforcing bars ASTM A615M	Metric	(English)
Yield strength	420 MPa	(60 ksi)

Bar sizes (See Attach. I for additional details)

Bar Designation	Cross Sectional Area (sq. mm)

10	70.97
13	129.03
16	200.00
19	283.87
22	387.10
25	509.68
29	645.16
33	819.35
36	1006.45

Bar lengths — Give length of bars to the nearest 10 mm

Concrete f'c	20 MPa	(3000 psi)
Substructure Min.	25 MPa	(3500 psi)
Superstructure Min.	30 MPa	(4000 psi)
	35 MPa	(5000 psi)
	40 MPa	(6000 psi)

Prestressing Strand ASTM A416/416M

Grade	Nominal Dia. in.	Nominal Dia. mm	Nominal Area in.	Nominal Area mm^2	Minimum Tensile ksi	Minimum Tensile MPa
250	0.375	9.53	0.080	51.61	250	1725
250	0.500	12.54	0.144	92.90	250	1725
250	0.600	15.24	0.216	139.35	250	1725

Prestressing Strand ASTM A416/416M

Grade	Nominal Dia. in.	Nominal Dia. mm	Nominal Area in.	Nominal Area mm	Minimum Tensile ksi	Minimum Tensile MPa
270	0.375	9.53	0.085	54.84	270	1860
270	0.500	12.54	0.153	98.71	270	1860
270	0.600	15.24	0.216	139.35	270	1860

STRUCTURAL SHAPES

Precast concrete — All dimensions of the precast sections such as prestressed girders and cored slabs should be converted to the nearest millimeter.

Steel Rolled Shapes — Specify mm by kg/m as per AISC tables. (See Attach. IV)

Mill Plates — Specify mm as per USS tables. (See Attach. III)

	Metric	(English)
Anchor Bolts (A307)	20 mm	(3/4 In dia.)
A307 is not available in metric. Use A307 (Specify in English) or A325M	22 mm	(7/8 In dia.)
	25 mm	(1 In dia.)
	38 mm	(1 1/2 In dia.)

	50 mm	(2 In dia.)
High Strength Bolts (A325M)	M16	0.63 in
	M20	0.79 in
	M22	0.87 in
	M24	0.94 in
	M27	1.06 in
	M30	1.18 in
	M36	1.42 in

Shear Studs — All dimensions to be converted to the nearest millimeter.

PILES

Length — To nearest 500 mm.

Precast Concrete — Soft conversion of all current pile dimensions

H-Pile — Specify mm by kg/m as per AISC tables. (See Attach. II)

Pile Capacity	Metric	(English)
Steel H-Piles	400 kN	(45 Ton)
Precast/Prestressed Piles	400 kN	(45 Ton)

Pile Spacing

minimum	3.0 times nominal size	
maximum	3000 mm	(10 ft)

SPREAD FOOTINGS

Qmax.	143.5 kPa	(3000 psf)

TEMPERATURE EFFECTS

Coefficient of thermal expansion

Steel & Concrete	0.0000117/ C	(0.0000065/ F)
Temperature Range	-18 to 49 C	(0 to 120 F)
	- 7 to 38 C	(20 to 100 F)

EXPANSION DEVICES — Soft conversion of all dimensions to the nearest millimeter.

BEARINGS

Elastomeric & fixed — Soft conversion of all dimensions to the nearest mm.

QUANTITIES

ITEM	Round to:	Pay Item
Structure Excavation	1.0 m^3	m^3
Steel Sheet Piling(+Temporary Sheet Piling)	1.0 m^2	m^2
Class X concrete	0.1 m^3	m^3
Bridge Deck Grooving	1.0 m^2	m^2
Reinforcing bars	5 kg	kg
Structural steel	50 kg	L.S.
Prestressed Concrete Girders	1.0 m	Ea.
Prestressed Concrete Piles	1.0 m	m
Steel Piles	1.0 m	m
Timber Piles	1.0 m	m
Concrete Parapet (Median Barrier)	1.0 m	m
Slope Protection	1.0 m^2	m^2
Dumped Riprap	Metric ton	
or	m^2	m^2
Elastomeric Expansion Dam	1.0 m	m
Preformed Elastomeric Sealer	1.0 m	m
Tooth Joint	1.0 m	m

NOTE: The pay items shown above may not agree with the ones specified by the Construction Division. Should a conflict exist, those required by Construction shall be used.

REINFORCING BARS

METRIC				ENGLISH			
No.	Wt. kg/m	Dia. mm	Area mm^2	No.	Wt. lb/f	Dia. in	Area in^2
10	.560	9.53	70.97	3	.376	.375	0.11
13	.994	12.70	129.03	4	.668	.500	0.20
16	1.552	15.88	200.00	5	1.043	.625	0.31
19	2.235	19.05	283.87	6	1.502	.750	0.44
22	3.042	22.23	387.10	7	2.044	.875	0.60
25	3.973	25.40	509.68	8	2.670	1.000	0.79
29	5.060	28.65	645.16	9	3.400	1.128	1.00
33	6.404	32.26	819.35	10	4.303	1.270	1.27
36	7.907	35.81	1006.45	11	5.313	1.410	1.56
43	11.384	43.00	1451.61	14	7.650	1.693	2.25

VIRGINIA DEPARTMENT OF TRANSPORTATION

LOCATION AND DESIGN DIVISION

INSTRUCTIONAL AND INFORMATIONAL MEMORANDUM

GENERAL SUBJECT: Design Exceptions / Waivers	NUMBER: IIM-LD-227.10 IIM-S&B-70.8
SPECIFIC SUBJECT: Design Exception Request Form LD-440 Design Waiver Request Form LD-448 Design Waiver Request Form LD-452	DATE: November 7, 2016 SUPERSEDES: IIM-LD-227.9 IIM-S&B-70.7
LOCATION AND DESIGN DIVISION APPROVAL: B. A. Thrasher, P.E. State Location and Design Engineer Approved November 7, 2016	STRUCTURE AND BRIDGE DIVISION APPROVAL: Kendal R. Walus, P.E. State Structure and Bridge Engineer Approved September 30, 2016

Changes are shaded.

CURRENT REVISIONS

- This memorandum was revised to reduce the number of Federal Highway Administration (FHWA) recognized Controlling Criteria for Design Exceptions from thirteen (13) to ten (10).

- This memorandum was revised to delete the specific items requiring a Design Waiver previously listed under “DESIGN WAIVER POLICY FOR HYDRAULIC DESIGN”. This revision clarifies that the District Hydraulics Engineer shall request waivers where hydraulic design criteria fall short of the VDOT minimum standards.

- This memorandum was revised to update AASHTO bridge specification references, clarify bridge source references in regards to design exceptions and waivers, add and update references to specific parts of VDOT’s Manual of the Structure and Bridge Division and indicate where VDOT design waivers are not required for bridges.

- A reference to the FHWA Stewardship and Oversight Agreement was added.

- A Design Exception is not required for Horizontal Curve Radius, Maximum Grade or Stopping Sight Distance when approaching the stop control at an intersection. Stop-control is defined as having one or more "STOP" signs.

- A Design Exception is not required for geometric elements of the ramp proper as shown in the Road Design Manual, Appendix C: superelevation rate, lane width, horizontal curve radius, maximum grade, etc. Should these elements not meet VDOT minimums, then a design waiver is required.

- A reference to the Land Development Waiver approval process has been provided.

- A link to the VDOT-FHWA Agreement for Safety and Operational Projects not Requiring Formal Design Exceptions and Design Waivers has been included.

EFFECTIVE DATE

- This memorandum is effective upon receipt.

DESIGN EXCEPTION REQUEST RECOMMENDATIONS

- All design exceptions should have an adequate justification and project description regardless of the funding source.

- An estimate of the cost to attain full standards should always be discussed to determine safety benefits for the dollars invested.

- The mitigation measures that would minimize the effects of the deviation should be considered.

- An accident analysis should always be performed to determine what affects the design exception would have on safety.

- Future improvements that would mitigate the effects of the design exception should be addressed.

- In order to streamline and simplify design exception requests, Form LD-440 was developed for <u>all</u> design exception requests.

FEDERAL REQUIREMENTS

- Under Title 23, United States Code (USC) 109, the Secretary of Transportation approves design and construction standards for the National Highway System (NHS) including Interstates. The 23 CFR 625 designates those standards, specifications, policies, guides, and references that are acceptable to the Federal Highway Administration (FHWA) for use on the NHS.

- Title 23 CFR 625 provides that exceptions may be given on a project basis to designs which do not conform to the minimum criteria as set forth in the standards, policies, and standard specifications, which for National Highway System (NHS) Projects, the full list of standards can be found in 23 CFR 625.4, which includes the AASHTO "Green Book."

- On October 7, 2015, the FHWA published a notice in the Federal Register soliciting comments on proposed changes to the 1985 policy that established thirteen (13) controlling criteria for design. Based on the comments received in response to FHWA's proposal, combined with FHWA's own experience and the findings of National Cooperative Highway Research Program (NCHRP) Report 783 "Evaluation of the 13 Controlling Criteria for Geometric Design" (2014), FHWA has updated its 1985 policy regarding controlling criteria for design, applicable to projects on the NHS, thus reducing the number of controlling criteria from thirteen (13) to ten (10), and applying only two (2) of these criteria to low speed roadways. The FHWA also issued guidance clarifying when design exceptions are needed and the level of support documentation that is required. Please see the May 5, 2016 FHWA Memorandum at the following location: http://www.fhwa.dot.gov/design/standards/160505.pdf

- The Federal Register was also updated to reflect the controlling criteria changes: https://www.federalregister.gov/articles/2016/05/05/2016-10299/revision-of-thirteen-controlling-criteria-for-design-and-documentation-of-design-exceptions

- The FHWA's participation in plan reviews is vital throughout the design process and may be required on Projects of Divisional Interest (PODI) and Projects of Corporate Interest (POCI).

FHWA'S CONTROLLING CRITERIA

- Although all deviations from accepted standards and policies need to be justified and documented, the FHWA has established ten (10) controlling criteria for high speed design. All ten (10) controlling criteria apply to high-speed (design speed ≥50 mph) roadways on the NHS, as defined by FHWA mapping: http://www.fhwa.dot.gov/planning/national_highway_system/nhs_maps/virginia/index.cfm

  The FHWA requires a Design Exception whenever the following controlling criteria are not met.

  - Design speed
  - Lane width
  - Shoulder width
  - Design Loading Structural Capacity
  - Horizontal Curve Radius
  - Maximum Grade
  - Stopping Sight Distance
  - Cross slope
  - Superelevation Rate
  - Vertical Clearance

- On low-speed roadways (i.e., non-freeways with design speed <50 mph) on the NHS, only the following two controlling criteria apply:

  - Design Loading Structural Capacity
  - Design Speed

- The FHWA Virginia Division Office has established access control along the Interstate as the 11th controlling criterion. A design exception must be prepared for FHWA review and approval for any break in access control within:

  - Rural areas: 300 feet of a ramp terminal (as defined by the Green Book)
  - Urban areas: 100 feet of a ramp terminal (as defined by the Green Book)

  Please reference AASHTO's most recent VDOT adopted version of *A Policy on Design Standards – Interstate System*

  - Existing access points are not subject to the Access Control for Interstate Interchanges Agreement between FHWA and VDOT.

VDOT DESIGN EXCEPTION POLICY (APPLICABLE TO ROADWAYS)

- The geometric design standards approved for use are contained in AASHTO's Policy on Geometric Design of Highways and Streets. This publication, commonly referred to as the "Green Book" is published by the American Association of State Highway and Transportation Officials (AASHTO). In addition, AASHTO's Policy on Design Standards—Interstate System is applicable to the Interstate System. For the Interstate System, the current editions of AASHTO's A Policy on Geometric Design of Highways and Streets and the LRFD Bridge Design Specifications shall be used as design **standards** where they do not conflict with AASHTO's Policy on Design Standards—Interstate System.

- In light of the FHWA's policy change, VDOT is reestablishing its policy that a Design Exception shall be required whenever any of the ten (10) controlling criteria are not met regardless of design speed, functional class or whether the roadway is NHS or non-NHS; or when Minimum Acceleration and Deceleration Lane Lengths for Grade Separations and Interchanges are not met on the NHS System (Interstates, Freeways and Arterials). See AASHTO Green Book, Chapter 10.

- The State Location and Design Engineer approves **all** design exceptions regardless of who designs the project (VDOT or LAP), funding type (State, Federal or Local) and ownership/maintenance responsibility (VDOT/Locality). For bridge-related design exceptions (e.g. bridge shoulder width), approval by the State Structure and Bridge Engineer is also required, except as noted below for bicycle facilities.

- VDOT recognizes the FHWA publication, "Mitigation Strategies for Design Exceptions" as providing mitigation efforts that should be followed when processing design exceptions. This publication is available at: http://safety.fhwa.dot.gov/geometric/pubs/mitigationstrategies/fhwa_sa_07011.pdf

- FHWA approval of Design Exceptions is required in accordance with the most recent FHWA Stewardship and Oversight Agreement.

- Changes to the posted speed limits of highways need to be evaluated by considering applicable design standards. Design exceptions are required whenever the change causes the design features of the roadway to not conform to the minimum criteria for the new speed limit. Isolated changes in design speeds to eliminate a possible design exception are not to be made. Instead, consistency in the design speed for the facility needs be considered. Design exceptions caused by proposed changes in the posted speed that adversely affect the design features of the roadway will not be considered.

- The determination to approve a design exception should only be made after thoroughly reviewing project elements such as maximum service and safety benefits for dollar invested, compatibility with adjacent section of the roadway, and probable time before reconstruction would take place due to increased traffic demand or changed conditions at which time the appropriate standard would be met.

- Design criteria for access control for new or totally reconstructed interchanges will be that which is developed from an operational analysis, but shall not be less than the minimum values of 300 feet for rural and 100 feet for urban areas shown above.

- Project boundaries for design exception determination shall be at logical termini points. Example: Ramp Termini to Ramp Termini. An exception to this would be any transitional work that results from mainline improvements.

VDOT GEOMETRIC DESIGN CRITERIA

- VDOT's Geometric Design Guidelines in Appendix A of the Road Design Manual are based on established design criteria and are generally consistent with AASHTO minimums. Allowances, however, have been provided for some design features such as guardrail, etc. (For RRR projects, see Section A-4 of the Road Design Manual).

- VDOT's Geometric Design Guidelines present basic practical guidelines compatible with traffic, topography and safety; however, due to the restrictive format, all variables cannot be included. The designer is urged to refer to AASHTO's A Policy on Geometric Design of Highways and Streets, and related chapters in the Road Design Manual, for further discussion of design considerations before selecting the proper design criteria for a project.

- The application of the criteria provided in the Geometric Design Guidelines must be made in conjunction with sound engineering judgment to affect a proper design. The economic, environmental and social factors involved in highway design shall also be considered. The designer should always attempt to provide for the highest degree of safety and best level of service that is economically feasible as outlined in IIM-LD-255.

- VDOT Design criteria is provided in the following sources:

  - VDOT's Road Design Manual
  - VDOT's Road and Bridge Standards
  - VDOT's Manual of the Structure and Bridge Division and Structure and Bridge Division Instructional and Informational Memoranda.

TIMING OF DESIGN EXCEPTION REQUEST

- Project Managers or Design Engineers should discuss potential design criteria that may require the need for an exception with the appropriate Assistant State Location and Design Engineer prior to detailed development of the exception or providing a design exception request to the District L & D Engineer (or equivalent Structure and Bridge positions for bridge-related items).

- Design Exceptions should be identified at the Preliminary Field Inspection and requested shortly thereafter. Plans at the Public Hearing Development Stage and the Structure and Bridge Preliminary Plan Development Stage should reflect approved design exceptions for those key design elements or features. Design approval following the Location and Design / Design Public Hearing may be delayed if known or discovered design exceptions or design waivers have not been approved.

- Design exceptions for roadway geometrics approved by the State Location and Design Engineer do not necessarily indicate that the bridge geometrics are automatically approved by the State Structure and Bridge Engineer since present and future costs for bridge widening, etc. may have to be considered. Normally, the roadway designer's and bridge designer's request will be transmitted separately. Location and Design Division exceptions directly impacting a structure and/or bridge shall be coordinated with the District Structure and Bridge Engineer. The Structure and Bridge Designer will determine the impact and provide guidance and recommendations to the Location and Design Project Designer and coordinate the necessary approval from the State Structure and Bridge Engineer for all resulting Structure and Bridge Design Exceptions.

DESIGN EXCEPTION REQUEST FORM LD-440

- All requests for design exceptions shall document all supplemental information necessary and appropriate for the comprehensive review of the engineering details of the exception request. The request shall be submitted via Form LD-440 to the District Location & Design Engineer and/or the District Structure and Bridge Engineer for review and recommendation for submission to the Central Office.

- Any time there is a deviation from published and accepted standards, the designer should clearly document that the deviation is to be made on the basis of an engineering analysis and that the methods of operation chosen are sufficiently protective of persons and property. The approach must incorporate reasons for the decision and approved documentation based on sound engineering judgment.

- The Responsible Person preparing the design exception request shall electronically seal and digitally sign the request in the seal and sign block provided above "Prepared By:"

- Location & Design Division maintains Form LD-440 at the following website: http://vdotforms.vdot.virginia.gov/

DESIGN EXCEPTION SUPPORTING DOCUMENTATION

- Supporting documentation for all design exceptions is to be submitted to the State Location and Design Engineer and/or the State Structure and Bridge Engineer for filing with a copy kept by the Project Manager in the project file.

DOCUMENTING DESIGN EXCEPTIONS ON PROJECT TITLE SHEET

- All design exceptions shall be shown on the project title sheet.

  - Whenever a project design element(s) does not meet AASHTO minimum design criteria (for example, shoulder width, horizontal curve radius) the location(s) and criteria are to be noted on the project title sheet. In order to alert everyone concerned, it will be necessary to identify these locations from the earliest stages of plan development. If changes are made during plan development that would alter the situation, then the title sheet must be corrected to reflect the new design. The following methods will be used to show design exceptions:

Plans with Functional Classification block:

EXAMPLE:

DESIGN EXCEPTIONS			
Sta. To Sta.	Design Speed (mph)	Exception for:	Approval Date
102+75 to 104+75		Shoulder Width	October 28, 2010
621+00 to 624+50	60	Horizontal Curve Radius	October 28, 2010

The data as indicated in the previous example is to be shown directly below the Functional Classification block.

Plans without Functional Classification block: Exceptions should be noted inside the title sheet borderlines immediately following the design speed classification as follows:

EXAMPLE:

V = 60 mph Exceptions: 102 + 75 - 104 + 75 Shoulder Width (Approval Date)
621 + 00 - 624 + 00 (35 mph) Horizontal Curve Radius (Approval Date)

- For information on the placement of approved design exceptions on the Structure & Bridge title sheet, see Manual of Structure and Bridge Division, Part 2.

EXAMPLES OF WHEN A DESIGN EXCEPTION IS **NOT** REQUIRED

- On State funded rural projects where design constraints require that the overall design speed selected for the project is less than the design speed which would normally be selected based on terrain, a design exception is not required if the speed falls within the range of design speeds for that class of roadway shown in the AASHTO Green Book.

- A Design Exception is not required for Design Speed within the functional area of a Roundabout in accordance with the FHWA Roundabout Informational Guide (NCHRP 672) Chapter 6, available at:
http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_672.pdf

- When approaching a stop control intersection, deceleration length to the intersection should be calculated based on the entering taper length (L2) the deceleration length (L3) and the storage length (L4) found in the 2011 AASHTO Green Book, page 9-125, Section 9.7.2 Deceleration Lanes. A design exception is not required for horizontal curve radius, maximum grade, cross slope, superelevation or stopping sight distance within this calculated physical length when the road does or does not have a turn lane.

- A design exception is not required for overlays and the installation of rumble strips or rumble stripes.

- Design exceptions are generally not required for pavement transitions within VDOT defined "transition areas" of a project. The transition length (L) shall be in accordance with RDM, Appendix A (Lane/Pavement Transitions). However, the Designer shall contact the appropriate Regional Traffic Engineer when reviewing the accident history for the past three (3) years as locations showing accident rates higher than the statewide average for that roadway classification attributable to the substandard design criteria may require a design exception.

- The intent of establishing project termini for the majority of projects scoped as "Bridge Only" is to tie into the existing approach alignment as quickly as possible and in accordance with, and defined and described in, the Manual of the Structure and Bridge Division, Part 2 (See "Bridge Only" projects).

  Unless there is a specific safety problem at the project site attributable to any substandard geometric feature, then substandard approach roadway geometrics associated with these "Bridge Only" projects do not require corrections and do not require design exceptions or design waivers unless the existing conditions are made worse.

- A design exception is not required for geometric elements of the ramp proper: Superelevation rate, lane width, horizontal curve radius, maximum grade, etc. Should these elements not meet VDOT minimums, then a design waiver is required. (This does not include minimum acceleration or deceleration lengths as shown in 2011 AASHTO Green Book Table 10.3,10.4 & 10.5)

- A design exception / design waiver is not required for Spot Safety and Operational Improvement Projects (as long as existing geometric features are not made worse) on **non-NHS** roadways with a scope limited to one or more of these elements:

  - Turn lane extensions
  - Vertical curve adjustment
  - Horizontal curve adjustment
  - Signal Optimization/Retiming
  - Adaptive Signals operation
  - ITS devices and systems to improve safety & operational efficiency
  - Sign upgrade to comply with latest MUTCD requirements
  - Flashing Beacons/Warnings
  - Acceleration Lanes on non-interstate system
  - Pedestrian and Bicycle accommodation such as bicycle lanes, shared use path, pedestrian refuge, sidewalk and crosswalk projects
  - Roadway Lighting, Signs, Signals, Raised Pavement Markers, Pavement Markings
  - Installation or adjustment of Guardrail Systems to meet VDOT's current policy and/or standards
  - Shoulder Widening up to 4 ft.
  - Paving existing graded shoulder
  - High friction surfacing
  - Safety edge
  - Rumble strip installation

- A design exception / design waiver is not required for safety and operational projects such as HSIP and ITS projects on **NHS** roadways in accordance with the Memorandum dated August 28, 2013: *http://www.virginiadot.org/business/trafficeng-productlists.asp*. This agreement is not applicable to Preventative Maintenance, 3R Projects and projects that add capacity to the roadway. Additional projects may be eligible on a case by case basis if approved by the Office of the State Traffic Engineer in coordination with the Federal Highway Administration as appropriate.

DESIGN EXCEPTION POLICY (APPLICABLE TO VDOT STRUCTURES & BRIDGES)

- In addition to the ten (10) controlling criteria, the State Structure and Bridge Engineer has identified the following items as requiring a design exception:

  - Modifications to VDOT parapet/rail standards except as indicated in VDOT's Manual of the Structure and Bridge Division, Part 2

  - Proposed new crash-tested parapets / rails (other than VDOT)

- Design exceptions shall be requested for all structures and/or bridges on the Interstate, Primary and Secondary System that do **not** meet AASHTO minimum design standards regardless of who owns and maintains the structure and/or bridge.

- For additional information on design exceptions with regard to structures and/or bridges, see Manual of Structure and Bridge Division, Part 1 at: http://www.virginiadot.org/business/bridge-manuals.asp.

- Design exceptions for design loading structural capacity, vertical clearance and shoulder width (where the roadway shoulders meet AASHTO minimums, but the bridge shoulder(s) do not) are typically prepared by the bridge designer and submitted to the State Structure and Bridge Engineer through the District Structure and Bridge Engineer. Form LD-440 shall be utilized for the request.

DESIGN WAIVER POLICY FOR ROADWAY DESIGN
(APPLICABLE TO VDOT OWNED AND MAINTAINED ROADWAYS **ONLY**)

- Design waivers are required when deviations from VDOT's design criteria occur on VDOT owned and maintained roadways only. When design criteria meet or exceed AASHTO and Americans with Disabilities Act Accessibility Guidelines (ADAAG) minimum design standards, but fall short of VDOT's minimum design standards, a design waiver shall be required. Design waivers will be applicable to all projects regardless of functional classification and funding and shall be documented and approved in accordance with the Design Waiver Request Form LD-448.

- Items requiring a design waiver include, but are not limited to, the following:
  - Ramp Geometrics
  - Paved Shoulder Width
  - Curb and Gutter
  - Minimum Radius
  - Bike and Pedestrian Accessibility Compliance (See IIM-LD-55 & RDM)
  - Ditch Width
  - Lane Shifts / Tapers
  - Buffer Strip Width
  - Superelevation
  - Intersection Sight Distance
  - Total Shoulder Width

DESIGN WAIVER POLICY FOR HYDRAULIC DESIGN
(APPLICABLE TO VDOT OWNED AND MAINTAINED ROADWAYS **ONLY**)

- Design waivers are required when deviations from VDOT's hydraulic design criteria occur on VDOT owned and maintained roadways only, regardless of functional classification and funding. When design criteria fall short of VDOT's minimum design standards, a design waiver shall be requested by the District Hydraulics Engineer. Design Waivers shall be documented and approved in accordance with the Design Waiver Request Form LD-448.

DESIGN WAIVER POLICY (APPLICABLE TO VDOT STRUCTURES & BRIDGES)

- Design waivers are required when deviations from VDOT's design criteria occur on VDOT owned and maintained structures only.

- For additional information on design waivers, see Manual of Structure and Bridge Division, Part 1 at: http://www.virginiadot.org/business/bridge-manuals.asp.

DESIGN WAIVER POLICY (APPLICABLE TO LAND DEVELOPMENT REVIEW)

- For additional information on design waivers, see the Office of Land Development IIM's.

DESIGN WAIVER REQUEST FORM LD-448

- L&D design waiver requests shall utilize Design Waiver Request Form LD-448 and document all supplemental information necessary and appropriate for the comprehensive review of the engineering details of the waiver request.

- Any time there is a deviation from published and accepted standards, the designer should clearly document that the deviation is to be made on the basis of an engineering analysis and that the methods of operation chosen are sufficiently protective of persons and property. The approach must incorporate reasons for the decision and approved documentation based on sound engineering judgment.

- The Responsible Person preparing the design waiver request shall electronically seal and digitally sign the request in the seal and sign block provided above "Prepared By:"

- Location and Design Division maintains Form LD-448 at the following website: http://vdotforms.vdot.virginia.gov/

REQUESTS FOR A DESIGN WAIVER (FORM LD-448)

- Requests for a Design Waiver (Form LD-448) must contain the following:

  - Established design criteria versus proposed and existing criteria.
  - Reason the appropriate design criteria cannot be met.
  - Justification for the proposed criteria.
  - Any background information which documents, supports or justifies the request.
  - Any mitigation that will be provided to further support or justify the request.
  - Cost to meet design criteria.

- Submittal Process

  - Design waiver requests shall be prepared by the Project Designer and submitted to the District Location and Design Engineer.

  - For roadway projects designed by localities that are VDOT owned and maintained, requests for design waivers shall be submitted to the VDOT Project Manager/Coordinator under the criteria and format described in this IIM.

- Approval Authority

  - Location and Design Division Waivers shall be reviewed and approved by the appropriate District Location and Design Engineer.

  - Approval authority shall not be delegated to a lower position without the approval of the State Location and Design Engineer.

  - Complete documentation should be retained by the Project Manager in the project file and a copy of the approved waiver sent to the appropriate Assistant State Location and Design Engineer and the State Geometric Engineer for means of compliancy and oversight purposes.

  - Location and Design Division Waivers directly impacting a structure and/or bridge shall be coordinated with the District Structure and Bridge Engineer. The structure and bridge designer will determine the impact and provide guidance and recommendations to the Location and Design Project Designer and coordinate the necessary approval from the State Structure and Bridge Engineer for all resulting Structure and Bridge Design Waivers.

- Designers are expected to adhere to the typical sections and requirements for roadways and structures with bicycle and/or pedestrian facilities found in VDOT's Road Design Manual and VDOT's Manual of the Structure and Bridge Division, Part 2. When it is determined to use bicycle and/or pedestrian facility geometrics that do not meet the design criteria in the above mentioned manuals, a design waiver is required only from the District Location and Design Engineer.

- Project Title Sheet
  - Design waivers are **not** to be shown on the Project Title Sheet.

DESIGN WAIVER POLICY FOR MULTIMODAL DESIGN STANDARDS FOR MIXED-USE URBAN CENTERS (APPLICABLE TO BOTH VDOT OWNED AND MAINTAINED ROADWAYS AND LOCALITY OWNED AND MAINTAINED ROADWAYS)

- When "**optimal"** values cannot be met for the modal emphasis primary element(s) mentioned on the Design Waiver Request Form for Mixed-Use Urban Centers, the Design Waiver Form LD-452 shall be submitted in accordance with this IIM.

- Mixed-use Urban Centers Waivers shall be reviewed and approved by the appropriate District Location and Design Engineer.

DESIGN WAIVER REQUEST FORM LD-452 FOR MULTIMODAL DESIGN STANDARDS FOR MIXED-USE URBAN CENTERS

- Design Waiver Request Form LD-452 shall be completed and all supplemental information necessary and appropriate for the comprehensive review of the engineering details of the waiver request shall be included in the submission.

- Location and Design Division maintains Form LD-452 at the following website: http://vdotforms.vdot.virginia.gov/

- REQUESTS, SUBMITTALS and APPROVALS for this Design Waiver (Form LD-452) shall follow the current Design Waiver (Form LD-448) process as mentioned in this IIM.

ACCESS MANAGEMENT WAIVER REQUEST AM-E, AM-W

- Access Management waivers shall be completed following the requirements set forth in Appendix F of VDOT's Road Design Manual and the Access Management Regulations found in the Virginia Administrative Code 24 VAC 30-72 and 24 VAC 30-73.

VIRGINIA DEPARTMENT OF TRANSPORTATION

LOCATION AND DESIGN DIVISION

INSTRUCTIONAL AND INFORMATIONAL MEMORANDUM

GENERAL SUBJECT: CRITICAL INFRASTRUCTURE INFORMATION (CII)/ SENSITIVE SECURITY INFORMATION (SSI)		NUMBER: IIM-LD-236 S&B-71
SPECIFIC SUBJECT: PROCEDURES FOR PROTECTING SENSITIVE INFORMATION		DATE: MARCH 8, 2005
		SUPERSEDES:
LOCATION & DESIGN DIV. APPROVAL: Mohammad Mirshahi, PE February 8, 2005	STRUCTURE & BRIDGE DIV. APPROVAL: George M. Clendenin, PE February 1, 2005	SECURITY & EMERGENCY MANAGEMENT DIV. APPROVAL: Steven M. Mondul January 28, 2005

BACKGROUND

- VDOT's "Critical Infrastructure Information/Sensitive Security Information (CII/SSI) Policy" was created in response to the 2004 Freedom of Information Act (FOIA) changes and laws passed in 2003 regarding the security of certain records. This policy directs the development of measures to prevent, or reduce, harmful consequences of disasters, or disclosure of information related to the protection of the nation's critical infrastructure sectors and components. Everyone is responsible for safeguarding CII/SSI.

- The Security and Emergency Management Division's (SEMD) Critical Infrastructure Information/Personal Surety (CII/PS) Section has been assigned responsibility for overseeing this task.

- A copy of VDOT's "Critical Infrastructure Information/Sensitive Security Information (CII/SSI) Policy" is available within VDOT at:

  http://insidevdot/default.aspx , click on "Policies", then on "Security".

- The two main aspects of the program developed to support this policy are:

  - Identifying CII/SSI, regardless of form (physical structure, drawings, plans, text, cyber, etc.)

  - Protecting CII/SSI

RESTRICTED VDOT INFORMATION

- Restricted Information is designated as follows:

  - Critical Infrastructure Information (CII) is a document designation and not a classification. This designation is used by VDOT to identify information or material related to critical infrastructure, or protected systems. CII is not customarily public knowledge, but only available on a "need-to-know" basis.

  - Sensitive Security Information (SSI) is a document designation used to identify unclassified information of a sensitive nature, that if publicly disclosed could be expected to have a harmful impact on the security of VDOT operations or assets, public health or safety of the citizens/residents of Virginia, or Virginia's long-term economic prosperity.

  - For the purposes of VDOT Policy, sensitive information is referred to collectively as Critical Infrastructure Information/Sensitive Security Information (CII/SSI).

- CII/SSI can occur in any physical structure (Critical Infrastructure or not) or in information in any form (printed, cyber, optical, verbal, etc.) For assistance in making this determination, refer to the "Guideline to Identifying Possible CII/SSI", available at:

  http://www.extranet.vdot.state.va.us/forms/
  Search by Division: "Security and Emergency Management Division".

PROJECTS CONTAINING CII/SSI

- Compliance with this policy is specifically the responsibility of the District Administrators and Division Administrators but application of the policy applies to everyone who has control over, access to, are in receipt of, or are responsible for the creation, care, storage and proper marking of CII/SSI.

- Identifying and marking CII/SSI is the responsibility of the person who has possession of the material. If assistance is needed, the Division/District member of the CII/SSI Taskforce should be consulted. If further assistance is needed, contact Security and Emergency Management Division's CII/PS Section or complete a "*Critical Infrastructure Information/Sensitive Security Information Request for Review*" form, available at:

  http://insidevdot/default.aspx , click on "Forms", then on "Security".

- Whoever has possession of CII/SSI is responsible for protecting it at all times. Each person who works with CII/SSI is personally responsible for taking proper precautions to ensure that unauthorized persons do not gain access to it.

- Questions are to be directed to VDOT's Security and Emergency Management Division (SEMD), Critical Infrastructure Information/Personnel Surety (CII/PS) Section.

- Prior to releasing material designated as CII/SSI see heading for "REQUEST/RELEASE PROCEDURE" below.

PLAN NOTATION

- Projects that contain information designated as CII/SSI must contain a notation on each appropriate sheet as well a note on the Title Sheet.

- The following note, available in the 2000.cel CADD Cell Library, is to be shown below the note that reads "THE ORIGINAL APPROVED TITLE SHEET(S) ……." on the Project Title Sheet of CII/SSI projects:

PORTIONS OF THESE PLANS CONTAIN CRITICAL INFRASTRUCTURE INFORMATION/SENSITIVE SECURITY INFORMATION (CII/SSI). UNAUTHORIZED RELEASE OR REPRODUCTION OF THESE DOCUMENTS MAY RESULT IN CIVIL PENALTY OR OTHER ACTION.

- The following note, available in the sheet2000.cel CADD Cell Library, is to be shown on each plan sheet containing CII/SSI:

— RESTRICTED —
Critical Infrastructure Information
Sensitive Security Information

USE/STORAGE OF CII/SSI INFORMATION

- During working hours, reasonable steps shall be taken to minimize the risks of access to CII/SSI by unauthorized persons.

- After working hours, CII/SSI shall be secured in a secure container, such as a locked desk, file cabinet or facility where contract security is provided.

REPRODUCTION

- Documents or material containing CII/SSI may be reproduced to the minimum extent necessary to carry out official duties provided that the reproduced material is marked and protected in the same manner as the original material.

DISPOSAL

- Material containing CII/SSI shall be disposed of by destroying or returning it to the source. It cannot be disposed of by throwing it out or recycling.

REQUEST/RELEASE PROCEDURE

- When a request is received for information that is/contains CII/SSI, the following steps are to be followed:

    1. Establish the identity of the person making the request. Picture ID is desirable when practical.

    2. Establish that the person making the request has a legitimate VDOT related need-to-know in regard to the requested CII/SSI Information. (If not, can the CII/SSI be separated out and withheld?)

3. Obtain a signed non-disclosure agreement.

   - If the release is being made to an individual (other than as part of an awarded contract) an "*Agreement for the Release of CII/SSI*" form is required.

   - If the release is being made as part of an awarded contract an "*Agreement Establishing a Company Representative*" form is required.

   - Each individual having access to CII/SSI on an awarded contract is required to complete a "*CII/SSI Individual Non-Disclosure Agreement*".

   - These forms are available inside VDOT at:

     http://insidevdot/default.aspx , click on "Forms", then on "Security".

     The *"Agreement to Establishing a Company Representative" form and the* "*CII/SSI Individual Non-Disclosure Agreement" form* are also available outside of VDOT at:

     http://www.extranet.vdot.state.va.us/forms/
     Search by Division: "Security and Emergency Management Division".

TRANSMISSION

- CII/SSI shall be transmitted only by VDOT Courier, US First Class, Express, Certified or Registered Mail, or through secure electronic means.

FREEDOM OF INFORMATION ACT (FOIA)

- Plan sheets, or pages within a document, that contain CII/SSI are not subject to disclosure under FOIA. The remaining sheets/pages are subject to discloser under FOIA. Questions regarding FOIA requests related to CII/SSI should be directed to the State Director of the Security and Emergency Management Division.

REPORTING UNAUTHORIZED DISCLOSURE

- Each individual is responsible for safeguarding CII/SSI to ensure that the contents will remain confidential and used only as necessary to accomplish VDOT's mission.
- Each individual is responsible for reporting any activities that are suspected to compromise the confidentiality of CII/SSI to VDOT's Security and Emergency Management Division (SEMD).
- Reports made to SEMD will be held in confidence to the extent permitted by law, including the name of the individual reporting the activity.
- Anyone receiving known CII/SSI that is not labeled should mark appropriately and inform the sender of the omission.

PENALTY FOR NON-COMPLIANCE WITH THIS POLICY

- All VDOT employees are subject to the provisions of CII/SSI.
- Failure to comply with this policy may result in the application of a Group II Offense.
- Unauthorized removal of records may result in the application of a Group III Offense.
- Failure to comply with this policy may be found in violation of Federal Laws including the Homeland Security Act of 2002.

VIRGINIA DEPARTMENT OF TRANSPORTATION

STRUCTURE AND BRIDGE DIVISION

INSTRUCTIONAL AND INFORMATIONAL MEMORANDUM

GENERAL SUBJECT: CROSSING OF EMERGENCY RESPONSE VEHICLES OVER POSTED BRIDGES OR CULVERTS	NUMBER: IIM-S&B-75
SPECIFIC SUBJECT:	Date: DECEMBER 3, 2007
	SUPERSEDES: N/A
DIVISION ADMINISTRATOR APPROVAL: Kendal R. Walus, P.E. / Original Signed State Structure and Bridge Engineer Approved December 3, 2007	

Changes are shaded.

CURRENT REVISION

- Converted to electronic format. The subject matter of the IIM did not change.

EFFECTIVE DATE

- This memorandum is effective upon receipt.

POLICY

Implementation Process for HB 1679 and SB 742

Introduction:

During the General Assembly's (GA) session in January 2007, the GA has approved an amendment to the Code of Virginia section 46.2-1130 that allows the responsible agency or entity to grant authorization to certain emergency response vehicles to cross over posted bridges or culverts provided that an engineering analysis is performed by a licensed professional engineer. The amendment was proposed under two similar bills, Senate Bill 742

and House Bill 1679 and the new law will be in affect July 1, 2007. Copies of the approved Acts are included in Appendix A at the end of this document.

To facilitate the requirements of the new law, the Department will implement the described below process effective July 1, 2007.

For the purpose of this document the term “structure” shall mean a bridge or culvert.

The Department will utilize the existing Land Use Permit (LUP) program being administered by the Residencies to facilitate this special process. This process applies to structures maintained only by the Department.

Authorization Process:

Phase 1 (Access Authorization for Condition Assessment and Evaluation of Posted Structure)

1. All LUP applications must be submitted by the appropriate locality to VDOT’s corresponding Residency office.
2. The application will be initiated by completing and submitting a Land Use Permit form LUP-A.
3. The application shall identify the posted structure(s) that are requested to be crossed. The identification information of the posted structure(s) shall be provided in the “Request Permission” section of LUP-A form.
    a. Location information shall include:
        i. County name
        ii. Route name and number
        iii. Name of the facility crossed by the structure (i.e. waterway, railroad or route name)
        iv. Distance of the posted structure to the nearest road intersection (i.e. 4.2 miles from Route 625, and 1.2 miles from Rte 600)
        v. Bridge name if available
        vi. Bridge number, if available. The bridge number is a four (4) digit number typically painted on the structure on the right side of the structure as you begin to cross the structure.
4. The Residency LUP manager will forward the application to the District Structure and Bridge Engineer (DSBE) within five (5) working days of receiving the application packet.
5. The DSBE or his/her designee within five (5) working days of receiving the request from the Residency will provide the LUP manager with copies of the latest safety inspection report, as built plans, VDOT’s latest load rating policy in the Structure and Bridge Division Instructional and Informational Memorandum (SB-27.5 or current version), and any other material that would assist the applicant in performing the required engineering load rating analysis.
6. The Residency LUP manager within five (5) working days of receiving the information from the DSBE will contact the applicant and provide them with the material received from the DSBE in order to perform the load rating calculations and provide the required information listed in section 8 for approval.

7. The Residency LUP manager will grant the applicant site access authorization for the purpose of onsite condition assessment and evaluation of the posted structure(s) by the applicant or their engineer in order to perform the required load rating calculations.

Phase 2 (Crossing Authorization)

8. The applicant is required to submit two (2) copies of each of the below listed items to the Residency LUP manager.
    a. Vehicle Identification Number (VIN) of the emergency response vehicle (ERV).
    b. Copy of the vehicle registration
    c. ERV's configuration (axle weight and spacing), empty weight empty and gross weight (vehicle's weight loaded with water, equipment, etc).
    d. Load rating calculations for each posted structure that is requested in the LUP application to be crossed by the ERV.
        i. The load rating calculations must be performed and signed and sealed by a licensed professional engineer in the Commonwealth of Virginia.
        ii. The load rating calculations must be performed in accordance with the American Association of State Highway Transportation Official's (AASHTO's) "Manual for the Condition and Evaluation of Bridges" and the latest applicable guidelines and requirements that are established by the National Bridge Inspection Standards, and the Virginia Department of Transportation (VDOT). The load rating method shall conform to the original load design method, i.e. Working Stress, Load Factor Design, etc.
        iii. A Crossing Authorization Summary Sheet (see Appendix B) for each load rated structure showing the load carrying capacity, posted capacity, and the authorized capacity in tonnage for the posted structure that is proposed to be crossed by the ERV.
        iv. Endorsement statement by the Professional Engineer to allow the ERV to cross the Posted structure.
9. The Residency LUP manager will retain a copy of the information packet and send the other copy to the DSBE.
10. The DSBE or his/her designee will review the information and respond to the Residency LUP manager with an acceptance or denial, within ten (10) working days of receiving the application packet, using a standard authorization form.
11. The Residency LUP manager within five (5) working days of receiving the authorization form from the DSBE shall then contact the locality and provide them the authorization form indicating the status of their request (Approved or Denied).
12. The authorization will be valid for a twelve (12) month period effective on the date the authorization form is signed by the DSBE.
13. Renewal of this authorization is required every twelve (12) months or upon a change in the condition of the structure. The renewal process does not require the locality to reapply for a LUP with the Residency to access the structure for the purpose of performing condition assessment and evaluation. The locality shall submit updated calculations conforming to the requirements listed in section 8 of this document to the Residency for review and approval.
14. If the posted capacity of a structure is reduced during the term of a current ERV twelve (12) month authorization period the DSBE or his/her designee shall immediately notify the Residency LUP manager in writing of the change in condition and nullify the authorization to cross the affected structure. The Residency LUP manager shall then contact the locality and inform them of the nullification of the authorization to cross the affected structure and the need for them to submit a request for renewal along with updated calculations.

APPENDIX A

CHAPTER 177

An Act to amend the Code of Virginia by adding a section numbered 46.2-1130.1, relating to issuance of overweight permits granted to cross bridges and culverts by certain emergency response vehicles responding to an emergency call.

[H 1679]

Approved March 9, 2007

Be it enacted by the General Assembly of Virginia:

1. That the Code of Virginia is amended by adding a section numbered 46.2-1130.1 as follows:

§ 46.2-1130.1. Overweight permits granted to cross bridges and culverts by certain emergency response vehicles responding to an emergency call.

Notwithstanding the provisions of §§ 46.2-1104 and 46.2-1130, emergency response vehicles, including fire and emergency medical apparatus responding to and returning from an emergency call, may be permitted to exceed the gross weight limit posted on a bridge or culvert, except those maintained by a railroad, provided that a determination has been made by a licensed professional engineer, qualified in the appropriate discipline, that the emergency response vehicle can safely cross that bridge or culvert and that determination has been documented by the issuance of a written permit or letter of authorization by the agency or entity responsible for the maintenance of that bridge or culvert.

The permitting agency or entity shall not be held liable for any damage or injury caused as a result of an emergency response vehicle crossing a bridge or culvert while responding to or returning from an emergency call under the conditions specified in the overweight permit pursuant to this section.

APPENDIX A (continued)

CHAPTER 540

An Act to amend the Code of Virginia by adding a section numbered 46.2-1130.1, relating to issuance of overweight permits granted to cross bridges and culverts by certain emergency response vehicles responding to an emergency call.

[S 742]

Approved March 19, 2007

Be it enacted by the General Assembly of Virginia:

1. That the Code of Virginia is amended by adding a section numbered 46.2-1130.1 as follows:

§ 46.2-1130.1. Overweight permits granted to cross bridges and culverts by certain emergency response vehicles responding to an emergency call.

Notwithstanding the provisions of §§ 46.2-1104 and 46.2-1130, emergency response vehicles, including fire and emergency medical apparatus responding to and returning from an emergency call, may be permitted to exceed the gross weight limit posted on a bridge or culvert, except those maintained by a railroad, provided that a determination has been made by a licensed professional engineer, qualified in the appropriate discipline, that the emergency response vehicle can safely cross that bridge or culvert and that determination has been documented by the issuance of a written permit or letter of authorization by the agency or entity responsible for the maintenance of that bridge or culvert.

The permitting agency or entity shall not be held liable for any damage or injury caused as a result of an emergency response vehicle crossing a bridge or culvert while responding to or returning from an emergency call under the conditions specified in the overweight permit pursuant to this section.

APPENDIX B

CROSSING AUTHORIZATION SUMMARY SHEET

NAME OF APPLICANT _____

EMERGENCY RESPONSE VEHICLE CONFIGURATION

Empty Vehicle Weight (lbs) _____ Gross Vehicle Weight (lbs) _____

AXLE NUMBER	SPACING (feet)	EMPTY WEIGHT AXLE LOAD (lbs)	GROSS WEIGHT AXLE LOAD (lbs)
Axle 1			
Axle 2			
Axle 3			
Axle 4			
Axle 5			
Axle 6			
Axle 7			

LOCATION OF STRUCTURE

County _____
Route _____
Feature Crossed _____
Structure Number _____

Load Carrying Capacity (Virginia Legal Vehicle) _____ Tons
Posted Capacity (Virginia Legal Vehicle) _____ Tons
Authorized Capacity (Emergency Response Vehicle _____ Tons

ENDORSEMENT STATEMENT

I have reviewed all data submitted to me by the applicant and the Virginia Department of Transportation and have taken into account all items that will affect the ability of the stated structure to carry the indicated Emergency Response Vehicle. The indicated Emergency Response Vehicle can safely cross the indicated structure.

Signature of the Professional Engineer who completed the attached calculations _____

Date _____

Please attach all calculations

The below is to be filled out by a representative of the Virginia Department of Transportation.

Approved ____ Comments: _____

Denied ____ _____

District Structure and Bridge Engineer _____

Date _____

VIRGINIA DEPARTMENT OF TRANSPORTATION

STRUCTURE AND BRIDGE DIVISION

INSTRUCTIONAL AND INFORMATIONAL MEMORANDUM

GENERAL SUBJECT: Adhesive Anchors for Structural Applications	NUMBER: IIM-S&B-76.3
SPECIFIC SUBJECT:	Date: December 16, 2010
	SUPERSEDES: IIM-S&B-76.2
DIVISION ADMINISTRATOR APPROVAL: /original signed/ Kendal R. Walus, P.E. State Structure and Bridge Engineer Approved: December 16, 2010	

The memorandum by the State Structure and Bridge Engineer, SUBJECT: Attachment of Signs and Sign Structures to Bridge Parapets dated January 22, 1991, is **VOIDED**.

Changes are shaded.

Introduction: The use of adhesive anchors is limited to applications in which the anchors (bolts) are subject only to shear. They are not to be used for applications in which the anchors are subject to tension (axial loads or flexure loads) due to sustained, cyclical or fatigue loadings. The term adhesive (anchors) includes, but is not limited to, epoxies and grouts (including non-shrink grouts).

Sign Structure Parapet Mounts:

Parapet mounted sign structures are no longer permitted for attachment to bridge structures. See Joint Memorandum by the Chief Engineer and Chief of System Operations dated July 24, 2008, Subject: Moratorium and Removal of Parapet Mounted Sign Structures on Bridges.

Should a design waiver be approved for a sign structure parapert mount, the attachment to the concrerte parapet/rail shall be with thru-bolts, i.e., the bolts extend through the parapet/rail. The anchorage on the traffic side shall be recessed and flush with the parapet/rail face. The use of adhesive anchors will not be permitted.

Temporary Traffic Barriers:

Concrete deck slabs supported by concrete or steel beams/girders: The attachment of traffic barrier service parapet (single face or double face) to the concrete bridge deck shall be by means of bolting through the full depth of the deck slab. Adhesive anchors may be used provided that the temporary barrier will be in service for less than one year. (Restrictions deleted.)

Prestressed or reinforced concrete slab spans: The attachment of traffic barrier service parapet (single face or double face) to the concrete slab may be made with adhesive anchors provided that the temporary barrier will be in service for less than one year.

Permanent Parapets/Rail Posts/Barriers:

The use of adhesive anchors to attach permanent parapets, rail posts, barriers, etc. to the concrete bridge deck shall not be permitted.

Tunnels:

The use of adhesive anchors in the support of tunnel ceiling panels is not permitted.

Other Bolting Attachments:

Other attachments (e.g., fencing) to bridge superstructure concrete shall normally be with the use of embedded threaded inserts and mechanical anchors.

Slip Forming:

Slip forming of parapets will not be permitted in the regions where embedded anchorages are indicated in the plans.

Exceptions/Waivers:

Request for variance to the above noted guidelines will require approval by the State Structure and Bridge Engineer. The request shall be in writing, shall include all pertinent information as to why an adhesive anchor system is the only viable solution and shall indicate why the standard cannot be met.

If the waiver is for exceeding the construction time, the waiver shall indicate what mitigation efforts will be recommended, for example, pull out test(s), etc.

CC: Chief Engineer
Chief of Systems Operations
Traffic Engineering Division Director
Asset Management Division Director
District Construction Engineers
District Maintenance Engineers
District Structure and Bridge Engineers
Regional Traffic Engineers
Residency Administrators
Smart Traffic Center Mangers
Structure and Bridge Program Managers
FHWA Division Bridge Engineer

VIRGINIA DEPARTMENT OF TRANSPORTATION

STRUCTURE AND BRIDGE DIVISION

INSTRUCTIONAL AND INFORMATIONAL MEMORANDUM

GENERAL SUBJECT: ESTABLISHING STRUCTURE IDENTIFICATION NUMBERS	NUMBER: IIM-S&B-77
SPECIFIC SUBJECT: CAPTURING COSTS INCURRED DURING THE PRELIMINARY ENGINEERING PHASE OF HIGHWAY STRUCTURES	Date: DECEMBER 3, 2007 SUPERSEDES: S&B-03-69
DIVISION ADMINISTRATOR APPROVAL: Kendal R. Walus, P.E. / Original Signed State Structure and Bridge Engineer Approved December 3, 2007	

Changes are shaded.

CURRENT REVISION

- Revised the IIM number to eliminate conflict with IIM-S&B-69.2 (Traffic Control Device Structures).

EFFECTIVE DATE

- This memorandum is effective upon receipt.

POLICY

PURPOSE:

The purpose of these guidelines is to set forth a method of identifying and capturing costs incurred during the preliminary engineering (PE) phase of designing highway bridges and culverts. These costs will be used by the Asset Management Division in tracking the life cycle costs of the bridges and culverts, and on applicable projects, VDOT may use the FHWA's highway bridge replacement and rehabilitation funds.

INSTRUCTIONS:

For projects having new bridges and culverts or replacement bridges and culverts, a new five- digit structure identification number (Structure ID) is to be assigned in conjunction with the bridge/drainage structure job number (Bxxx, Dxxx) assignment. For rehabilitation or improvement projects, the Structure ID of the existing structure will be used.

Programming Division staff will notify the District Structure and Bridge Engineers of project number assignments so that they can provide the needed Structure ID's. The Programming Division will not provide PE authorization on these bridge projects until the five-digit Structure ID is available for entry into FMS II.

The District Construction Engineer, or Resident Administration on secondary projects, shall include with the LD-430 'Scoping Report' information about the existing structures on the project. The information needed is the four-digit Virginia Structure Number, and the Structure ID. For new structures and replacement structures, the new Structure ID's shall also be included with the Scoping Report.

The four-digit Virginia Structure Number and the Structure ID shall be obtained from the District Structure and Bridge Section.

When the Scoping Report is received, the Programming Division will assure the structure Information is included in the bridge maintenance screen in PPMS. The structure information shall be added to the PPMS Bridge Maintenance Screen by the District Structure and Bridge Section. The Programming Division will provide the five-digit Structure ID number to Fiscal Division/FMS II so that the PE costs can be tracked by Structure ID. For existing structures being rehabilitated or improved, the county-route association is automatically copied from the road inventory and added to FMS II by a batch program. For new or replacement structures, the Programming Division will also have a county-route association for the structure added to FMS II.

In order to identify and track PE costs, the Structure ID number must be used in conjunction with the universal project code (UPC) on all accounting documents.

CC: Chief Engineer
Chief of SystemsOperations
Director of Virginia Transportation Research Council
Division Administrators under the Chief Engineer
Chief Financial Officer
Division Administrators under the Chief Financial Officer
Chief of Planning and the Environment
Division Administrators under the Chief of Planning and the Environment
District Administrators
Assistant State Structure and Bridge Engineers
Structure and Bridge Transportation Engineer Program Supervisors
Federal Highway Administration

VIRGINIA DEPARTMENT OF TRANSPORTATION

STRUCTURE AND BRIDGE DIVISION

INSTRUCTIONAL AND INFORMATIONAL MEMORANDUM

GENERAL SUBJECT: Bridge Safety Inspection QC/QA Program	NUMBER: IIM-S&B-78
SPECIFIC SUBJECT: Establishing Quality Control and Quality Assurance Procedures to Maintain a High Degree of Accuracy and Consistency in the Inspection Program	Date: January 7, 2008 SUPERSEDES: None
DIVISION ADMINISTRATOR APPROVAL: Kendal R. Walus, P.E. / Original Signed State Structure and Bridge Engineer Approved January 7, 2008	

EFFECTIVE DATE: This memorandum is effective upon receipt.

PURPOSE:
The NBIS in Title 23 (Highways) of the Code of Federal Regulations Part 650.313(g) was amended in January 2005, which requires each state to "Assure systematic quality control and quality assurance procedures are used to maintain a high degree of accuracy and consistency in the inspection program. Include periodic field review of inspection teams, periodic bridge inspection refresher training for Program Managers and Team Leaders, and independent review of inspection reports and computations." The following outlines the minimum acceptable standards for VDOT's quality control and quality assurance program.

INTRODUCTION

Bridge safety inspection is required by the Federal Highway Administration (FHWA) and state policy. Inspection procedures and requirements are detailed in the National Bridge Inspection Standards (NBIS) in Title 23 (Highways) of the Code of Federal Regulations Part 650 and in the latest Virginia Department of Transportation (VDOT) Informational & Instructional Memorandum dealing with bridge inspection. Accuracy, thoroughness and completeness of bridge safety inspections are essential for the evaluation of a structure's safety and for decisions on planning, budgeting, and performing of maintenance, repair, rehabilitation and replacement of our bridges. Since 1991 VDOT has had in place a policy for the quality control and quality assurance of the bridge safety inspection program. The NBIS in Title 23 (Highways) of the Code of Federal Regulations Part 650.313(g) was amended in January 2005, which requires each state to "Assure systematic quality control and quality assurance procedures are used to maintain a high degree of accuracy and consistency in the inspection program. Include periodic field review of inspection teams, periodic bridge inspection refresher training for Program Managers and Team Leaders, and independent review of inspection reports and computations." The following outlines the minimum acceptable standards for VDOT's quality control and quality assurance program.

The procedures set forth herein apply to employees of VDOT, employees of any consultant firm providing inspection services to VDOT and to agencies and municipalities that have the responsibility of providing inspection services to structures that they maintain.

Where applicable, VDOT has adopted the definitions and qualifications as set forth in the NBIS. This has been noted in the pertinent sections that follow.

Unless otherwise stated the term 'Team Leader' within this document refers to the individual who is in charge of an inspection team.

DEFINITIONS

Quality Assurance (QA)

The NBIS gives the following definition – "The use of sampling and other measures to assure the adequacy of quality control procedures in order to verify or measure the quality level of the entire bridge inspection and load rating program."

Quality Control (QC)

The NBIS gives the following definition – "Procedures that are intended to maintain the quality of a bridge inspection and load rating at or above a specified level."

Program Manager

The NBIS give the following definition – "The individual in charge of the program, that has been assigned or delegated the duties and responsibilities for bridge inspection, reporting, or inventory. The program manager provides overall leadership and is available to inspection team leaders to provide guidance."

Each District shall have one individual with the qualifications of a Program Manager who is responsible for the bridge inspection program within the District. In addition, the Central Office shall have one individual with the qualifications of a

Program Manager who is responsible for the bridge inspection program statewide.

Team Leader

The NBIS gives the following definition – "Individual in charge of an inspection team responsible for planning, preparing, and performing field inspection of the bridge."

The Team Leader is responsible for the overall management/supervision of an inspection team composed of one or more inspectors. The Team Leader assures that inspections within the jurisdiction of the team are performed on-time and in accordance with the NBIS and VDOT's latest policies and procedures.

Inspector Senior

This position is not defined by the NBIS. This position meets the minimum NBIS qualification of a team leader. VDOT defines this position as the individual who may be in charge of an inspection team and is responsible for the planning and preparation required before performing a field inspection of a bridge.

This position differs from a Team Leader in that the Inspector Senior is not responsible for the overall management of a team, may not have supervisory responsibilities of other inspectors and may not lead a team on a daily basis.

Inspector

This position is not defined by the NBIS. VDOT defines this position as the individual who assists a Team Leader or Inspector Senior in the inspection of a structure.

Load Rater

This role is responsible for determining the safe load-carrying capacity of a structure in accordance with the 'Manual for Condition Evaluation of Bridges', published by the American Association of State Highway Transportation Officials (AASHTO), and VDOT's current load rating guidelines.

QUALIFICATIONS

For Program Managers, Team Leaders and Inspector Seniors performing or supervising inspections in Virginia and for those performing load ratings, the 'Qualification of Personnel' form in Appendix A shall be submitted to and approved by the Central Office Structure and Bridge Division prior to the individual performing inspections or rating bridges. The form shall be resubmitted when data other than years of experience changes.

Program Manager

The qualifications are the same as those detailed for a Program Manager in the NBIS. A Program Manager must, at a minimum:

(1) Be a registered professional engineer, or have ten years bridge inspection experience; and
(2) Successfully complete a FHWA approved comprehensive bridge inspection training course.

Team Leader

The qualifications are the same as those detailed for a Team Leader in the NBIS.

There are five ways to qualify as a team leader. A team leader must, at a minimum:

(1) Have the qualifications specified for the Program Manager; or

(2) Have five years bridge inspection experience and have successfully completed an FHWA approved comprehensive bridge inspection training course; or

(3) Be certified as a Level III or IV Bridge Safety Inspector under the National Society of Professional Engineer's program for National Certification in Engineering Technologies (NICET) and have successfully completed an FHWA approved comprehensive bridge inspection training course; or

(4) Have all of the following:

- (i) A bachelor's degree in engineering from a college or university accredited by or determined as substantially equivalent by the Accreditation Board for Engineering and Technology;
- (ii) Successfully passed the National Council of Examiners for Engineering and Surveying Fundamentals of Engineering examination;
- (iii) Two years of bridge inspection experience; and
- (iv) Successfully completed an FHWA approved comprehensive bridge inspection training course; or

(5) Have all of the following:

- (i) An associate's degree in engineering or engineering technology from a college or university accredited by or determined as substantially equivalent by the Accreditation Board for Engineering and Technology;
- (ii) Four years of bridge inspection experience; and
- (iii) Successfully completed an FHWA approved comprehensive bridge inspection training course.

Inspector Senior

This position requires the same qualifications as a Team Leader.

Inspector

This is considered an entry level position and there are no specific qualification requirements. However, it is preferred that the individual have a background in bridge maintenance or construction.

Load Rater

The NBIS states that the individual charged with the overall responsibility for load rating structures must be a registered professional engineer. In addition, VDOT prefers that the individual also have a background in bridge design, bridge inspection, and bridge maintenance and/or bridge construction.

Underwater Bridge Inspection Diver

The qualifications are the same as those detailed for underwater bridge inspection diver in the NBIS.

An underwater bridge inspection diver must complete an FHWA approved comprehensive bridge inspection training course or other FHWA approved underwater diver bridge inspection training course, and shall meet the qualifications for diving as set forth in the VDOT 'Dive Safety Manual'.

TRAINING AND CERTIFICATION

The NBIS requires Program Managers and Team Leaders to successfully complete an FHWA approved comprehensive bridge inspection training course, within VDOT all bridge safety inspection personnel shall successfully complete the National Highway Institute (NHI) course 'Safety Inspection of In-Service Bridges' (FHWA-NHI-130055) within the first five years of employment in bridge inspection. In addition, VDOT inspection personnel shall successfully complete the NHI course 'Bridge Inspection Refresher Training' (FHWA-NHI-130053) every three years. Successful completion of either course shall mean obtaining a grade of 70 or better.

VDOT's Employee Health and Safety Division requires additional training and/or certification for bridge safety inspectors which may include, but are not limited to the following: CPR, Fall Protection, Confined Space, Lead Base Abatement, etc. It's the responsibility of the Program Managers in the districts and central office to ensure full compliance with all required training and certification.

Additionally, VDOT underwater inspectors shall fulfill the training requirements as set forth in the VDOT 'Dive Safety Manual'.

Other recommended training is:

- Engineering Concepts for Bridge Inspectors (FHWA-NHI-130054)
- Fracture Critical Inspection Techniques for Steel Bridges (FHWA-NHI-130078)
- Bridge Coatings Inspections (FHWA-NHI-130079)
- Inspection and Maintenance of Ancillary Highway Structures (FHWA-NHI-130087)
- Hazardous Bridge Coatings: Design and Management of Maintenance and Removal Operations (FHWA-NHI-130069)
- College level courses in statics, steel design, concrete design and strength of materials.

REVIEW AND VALIDATION PROCEDURES

Both the Central Office and the Districts have a responsibility to review and validate inspection reports and inventory data. Discrepancies found during field and office reviews performed by both District and Central Office personnel shall be documented in a written report and shared with all parties involved. An action plan shall be developed to address any found discrepancies. The action plan shall include the discrepancy found, the corrective action required, an estimated compliance date and the responsible person (see Appendix B).

It is important that 'best practices' are shared throughout the state. It is also important to correct inaccuracies that are discovered that indicate a misunderstanding or misapplication of a policy/procedure. Each year a summary report shall be compiled of the findings of the Central Office review and sent to all Districts by March of each year.

District – General

The District Program Manager shall select, at a minimum one municipality or agency per year within the District for review and validation of inspection reports, inventory data and their overall program. This review shall be at the same level as the review performed on VDOT inspectors and records. The review requirements are described below under the office and field reviews.

For Districts that have three or less municipalities or agencies, the District Program Manager shall assure that each entity is reviewed at least once every three years.

District - Office Review

An office review of every inspection report including structures owned by municipalities and other entities shall be made by the District Program Manager or their designee. If the review process is conducted by a designated individual other than the Program Manager, the designee, at minimum shall have the same qualifications as a Team Leader.

The review shall be documented by the reviewer initialing and dating the inspection report. While not considered a comprehensive list, the reports should be reviewed for their:

- Organization
- Quantification
- General condition ratings within 1(+/-) of the reviewers estimate
- Element data
- Maintenance and repair recommendations
- Fracture critical documentation and sketches
- Fatigue prone documentation and sketches
- Timely completion of the report
- Timely completion of load rating analysis when necessary
- Other required supporting documentation, including photographs, sketches, etc.

District - Field Review

Field reviews of structures shall be made by the District Program Manager. These reviews shall consist of a minimum of four structures per team per year and shall include consultant inspectors. All selected structures for review shall have received an inspection within six months of the field review. It is recommended that the inspections reviewed be selected from those structures that have:

- A significant change in the condition rating(s) since the last inspection.
- A second opinion requested by the inspector.
- Condition ratings appearing questionable.
- A designation of structurally deficient or functionally obsolete.
- The possibility of posting or reducing the posting due to items found during an inspection.
- Critical or near critical conditions.
- Special inspection requirements.
- Fracture critical structures
- Field posted structures

At a minimum, one field review shall be performed while an inspection is being performed for each inspection team. Reviews should also include a cursory verification of the information on the structure inventory sheets.

A standard 'check list' shall be used during the field reviews to assist in assuring all items to be reviewed have been considered (See Appendix C). Findings during the field review shall be discussed with the lead inspector when a discrepancy is detected. A list of all structures reviewed in the field along with all associated documentation shall be kept on file for a minimum of a two (2) year period.

Central Office – General

The Central Office Program Manager is responsible for reviewing the inspection programs in all nine Districts. Every effort will be made to review the inspection program of all nine Districts annually, however, at minimum four District's inspection programs will be reviewed annually. The review will focus on validation of inspection reports, inventory data and the overall program within the respective District. In each District an office review and field reviews shall be performed. All structures selected for review shall have received an inspection within six months of the review and a minimum of two reports shall be selected for each inspector that has signed a report including consultant inspectors within that six months. The selection of structures shall include structures with special inspection needs such as fracture critical members, fatigue prone details, etc. and structures that have had 'Critical Recommendations'
During the review, one municipality or agency within the District shall be chosen for review and validation of inspection reports, inventory data and the overall program within the municipality or agency. This review shall be at the same level as the District review.

In addition to the overall review of the Districts inspection programs, the Central Office Program Manager or his designee will review a minimum of five percent of all completed inspection reports annually. The review shall be documented by the reviewer and tracked by the Program Manager. All discrepancies shall be documented and brought to the attention of the responsible program manager in the district.

Central Office – Office Review

During the office review, items to be examined for adherence to federal and state policy and guidelines shall include but are not limited to the following:

- District's documentation of its quality assurance reviews
- District's process for notifying Residencies of emergency work and/or posting required
- 'Critical Recommendations'
    - Distribution when required
    - Work completed in a timely manner
    - Follow-up inspections are performed in a timely manner on the completed work
- Maintenance and repair recommendations
- Inspection folder
    - Organization
    - Complete history available
    - Fracture critical members documentation and sketches
    - Fatigue prone details documentation and sketches
    - Ultrasonic inspection documentation

    - Vertical clearance documentation
    - Load Rating Analysis information
    - Pertinent plan sheets available
    - Encroachment documentation
    - Scour reports
- Inspection reports
    - Organization
    - Proper quantification
    - Condition ratings are within 1(+/-) of the reviewers estimate.
    - Reviewer's initials (Program Manager or designee)
    - Fracture critical members documentation and sketches
    - Fatigue prone details documentation and sketches
    - Timely completion of inspection reports
    - Timely completion of load rating analysis
- Check for past due and/or delinquent inspections. Is there an action plan for having these structures inspected? If the structures are in another entity was the proper notification made?
- Load rating analysis being performed when required and in a timely manner
- Updates to the electronic databases (HTRIS, Pontis, Teamsite, etc) are done in a timely manner
- Use of 'Preventative Maintenance Forms'
- Review qualifications of personnel
- Certifications and medical checks current (Standard First Aid, CPR, lead testing, etc.)
- Review previous QA's performed and the Districts follow-up on recommendations

Central Office – Field Review

A standard 'check sheet' shall be used during the field reviews to assist in assuring all items to be reviewed have been considered (see Appendix C). During the field review items to be examined for adherence to federal and state policy and guidelines shall include but are not limited to the following:

Inspection reports
    - Accurate representation of field conditions
    - Organization
    - Proper quantification
    - Reviewer's initials by the District Program Manager or their designee
    - Fracture critical members documentation and sketches
    - Fatigue prone details documentation and sketches
    - Adherence to NBI and Pontis rating guidelines
    - Appropriate use of photos
    - Appropriate use of sketches and tables
    - Channel profile documentation and sketches
    - Underwater inspection reports included and/or referenced
    - Appropriate recommendations are made
    - Proper weight restriction and advance warning signs, including placement

CC: Chief Engineer
Chief of Systems Operations
Division Administrators under the Chief Engineer
Division Administrators under the Chief of Systems Operations
Local Assistance Division Director
District Administrators
District Maintenance Engineers
District Structure and Bridge Engineers
Assistant State Structure and Bridge Engineers
Structure and Bridge Transportation Engineer Program Supervisors
Federal Highway Administration

APPENDIX A

QUALIFICATION OF PERSONNEL

NAME: _____

FIRM: _____

INSPECTION LOCALE: _____

Use a separate form for each District/Office, municipality or other entity where inspections are performed.

TITLE (within your organization)**:** _____

DATE FORM COMPLETED: _____

1. Within your organization, does the individual listed above have the duties of:
   - ☐ Program Manager - The individual in charge of the program, that has been assigned or delegated the duties and responsibilities for bridge inspection, reporting, or inventory. The program manager provides overall leadership and is available to inspection Team Leaders to provide guidance.
   - ☐ Team Leader - Individual in charge of an inspection team responsible for planning, preparing, and performing field inspection of the bridge.
   - ☐ Inspector Senior - individual who may be in charge of an inspection team and is responsible for the planning and preparation required before performing a field inspection of a bridge..
   - ☐ Load Rater - Individual who is responsible for determining the safe load-carrying capacity of a structure.

2. Is the individual listed above a registered professional engineer? ☐ Yes ☐ No
   If yes, in what state(s)? _____.

3. Has the individual listed above successfully completed a Federal Highway Administration (FHWA) approved comprehensive bridge inspection training course? ☐ Yes ☐ No
   If yes, note the date of the latest course completed _____.

4. Has the individual listed above successfully completed a Federal Highway Administration (FHWA) approved bridge inspection refresher training course? ☐ Yes ☐ No
   If yes, note the date of the latest course completed _____.

5. Is the individual listed above certified as a Level III or IV Bridge Safety Inspector under the National Society of Professional Engineer's program for National Institute for Certification in Engineering Technologies (NICET)? ☐ Yes ☐ No
   If yes, note the level and certification number _____.

6. Does the individual listed above possess a bachelor's degree in engineering from a college or university accredited by or determined as substantially equivalent by the Accreditation Board for Engineering and Technology? ☐ Yes ☐ No

7. Does the individual listed above possess an associate's degree in engineering or engineering technology from a college or university accredited by or determined as substantially equivalent by the Accreditation Board for Engineering and Technology? ☐ Yes ☐ No

8. Has the individual listed above successfully passed the National Council of Examiners for Engineering and Surveying Fundamentals of Engineering examination? ☐ Yes ☐ No

9. List the number of years the individual listed above has actively participated in bridge inspections in accordance with the NBIS, in either a field inspection, supervisory, or management role. A combination of bridge design, bridge maintenance, bridge construction and bridge inspection experience, with the predominant amount, or more than fifty percent, in bridge inspection, is acceptable. _____ years.

APPENDIX B

ACTION PLAN

ITEM NO.	REVIEW CONCERN	CORRECTIVE ACTION	ESTIMATED COMPLIANCE DATE	RESPONSIBLE PERSON/POSITION	RESPONSE BY DISTRICT/MUNICIPALITY
1					
2					
3					
4					
5					
6					
7					
8					
9					

APPENDIX C

STRUCTURE & BRIDGE
QA INSPECTION

County/Str. No.		**Date of QA Inspection:**	
Route:		**Name of QA Inspector:**	
Facility Carried:			
Feature Intersected:		**Date of Inspection:**	
		Name of Team Leader:	

NBI ITEM	Q/A GENERAL CONDITION RATING	REPORT GENERAL CONDITION RATING
Deck		
Superstructure		
Substructure		
Channel		
Culvert		

PONTIS	ELEMENT NUMBER	UNIT	CONDITION STATE 1	CONDITION STATE 2	CONDITION STATE 3	CONDITION STATE 4	CONDITION STATE 5
REPORT							
QA							
REPORT							
QA							
REPORT							
QA							
REPORT							
QA							
REPORT							
QA							
REPORT							
QA							
REPORT							
QA							
REPORT							
QA							
REPORT							
QA							

(use additional sheets if necessary)

COMMENTS (use additional sheets if necessary)

VIRGINIA DEPARTMENT OF TRANSPORTATION

STRUCTURE AND BRIDGE DIVISION

INSTRUCTIONAL AND INFORMATIONAL MEMORANDUM

GENERAL SUBJECT: Sealing and Signing of Plans and Documents	NUMBER: IIM-S&B-79.3
SPECIFIC SUBJECT: Sealing and Signing in the Structure and Bridge Division (C.O. and Districts)	Date: January 31, 2013 SUPERSEDES: IIM-S&B-79.2
DIVISION ADMINISTRATOR APPROVAL:	/original signed/ Kendal R. Walus, P.E. State Structure and Bridge Engineer Approved: January 31, 2013

Changes are shaded.

Introduction: This I&IM by the Structure and Bridge Division outlines sealing and signing requirements of the responsible person for bridge or structural specific plans and related documents. The memorandum supplements the memorandum issued by the Chief Engineer dated February 18, 2009, subject: Sealing and Signing of Plans and Documents.

Effective dates: This memorandum is effective upon receipt.

Responsible person: The responsible persons for the Structure and Bridge Division in the Central Office will be designated by the State Structure and Bridge Engineer. The responsible persons for the Structure and Bridge Division in the Districts will be designated by the State Structure and Bridge Engineer in coordination with the District Structure and Bridge Engineer. The responsible person generally supervises the plan production (designer or checker and in many cases both), has day-to-day oversight of the plans or documents being prepared and is actively involved in decisions that affect the project.

In the event that the designated responsible person is unable to seal and sign the plans (position not filled, on leave, etc.) the next higher level supervisor will be required to seal and sign the plans/documents with appropriate review.

Unless noted otherwise, the responsible person referred to in this memorandum is the engineer in the Structure and Bridge Division (Central Office or District). The reference to sealing and signing is to a licensed Professional Engineer registered in the Commonwealth of Virginia.

Areas covered by this document: This memorandum deals with plans and documents specific to Structure and Bridge:

Tier 1 and Tier 2 Projects

Tier 1 – No Plan Projects and Special Advertisement and Award Process (SAAP) Projects

Other plans with work done by State Forces and others

Load rating summaries/calculations

Design exceptions

Other plans/documents

Tier 1 and Tier 2 projects: For bridge/structure plans included in a set of road plans or for bridge only projects, all sheets shall be sealed and signed by the responsible person. A sheet may require multiple seals if more than one discipline is involved. For example, a substructure sheet may require both structural design as well as geotechnical design.

Tier 1 – No Plan and SAAP projects: The title sheet as well as sheets with engineering details or drawings shall be sealed and signed by the responsible person. Sketches and details that have no engineering components shall not be sealed and signed, for example, details showing the areas and limits of shotcrete repair for a pier. Plans in which there are no engineering details or drawings, for example a contract for painting, require only the title sheet to be sealed and signed.

Other plans and work done by State Forces or others: Any plans that involve engineering decisions shall have the title sheet sealed and signed by the responsible person. This includes superstructure and substructure modifications/repairs including standards or standard details whether the work is to be done by State Forces or others.

Load rating summaries/calculations: The summary sheet of all load ratings shall be sealed and signed by the responsible person. See latest I&IM-S&B-27, Subject: Bridge Safety Inspections.

Design exceptions: Requests for design exception(s) (geometrics, clearances, structural capacity and other areas specifically noted in the Manuals of the Structure and Bridge Division or in the Modifications to the AASHTO bridge specifications (Standard and LRFD)) on bridge or structure projects shall be submitted to the State Structure and Bridge Engineer on L&D Form 440, Design Exception Request, and shall be sealed and signed by:

Project completed in the C.O.: Design Engineering Program Manager or Engineering Services Program Manager
Project completed in the District: District Structure and Bridge Engineer
Project completed by Consultant: Consultant (in accordance with Department of Professional and Occupational Regulation)

PPTA /Design Build/Locally Administered project: Consultant (in accordance with Department of Professional and Occupational Regulation)

Other plans and documents: The handling of other plans or parts of plans shall be in accordance with procedures developed by other divisions. Examples include:

Project specific copied notes and project specific special provisions, field revisions (Scheduling and Contract Division)
Insertable sheets (VDOT Road and Bridge Standards) (Location and Design Division)
Plats and surveying (Location and Design Division)
Traffic management plans and maintenance of traffic plans (Traffic Engineering Division)
Geotechnical reports (Materials Division)
Locally administered projects (refer to the *Guide for Local Administration of Virginia Department of Transportation Projects* which can be found on the Local Assistance Division webpage at: http://www.virginiadot.org/business/local-assistance.asp.

The following documents will not be required to be sealed and signed:

Bridge Safety Inspection Reports

Inspection Reports for Ancillary Structures (traffic control devices, for example, sign structures (overhead, cantilever and bridge parapet mounts), mast arms, signal poles, light poles, etc.)

Bridge Feasibility Reports

General drafting requirements: The general drafting requirements dealing with the sealing and signing of plans shall be in accordance with VDOT, Manual of the Structure and Bridge Division, Volume V – Part 2, Chapter 1, Section 16: Sealing and Signing of Plans and Documents. Additional information on electronic signatures may also be found at that location.

CC: Chief Engineer
Deputy Chief Engineer
Division Administrators
District Administrators
District Construction Engineers
District Maintenance Engineers
Residency Administrators
Assistant State Structure and Bridge Engineers
District Structure and Bridge Engineers
FHWA: Bridge Section

VIRGINIA DEPARTMENT OF TRANSPORTATION

STRUCTURE AND BRIDGE DIVISION

INSTRUCTIONAL AND INFORMATIONAL MEMORANDUM

GENERAL SUBJECT: VDOT Modifications to the AASHTO *LRFD Bridge Design Specifications*, 6th Edition, 2012 VDOT Modifications to the AASHTO *LRFD Guide Specifications for the Design of Pedestrian Bridges*, 2009	NUMBER: IIM-S&B-80.4
SPECIFIC SUBJECT:	Date: January 31, 2013
	SUPERSEDES: IIM-S&B-80.3
DIVISION ADMINISTRATOR APPROVAL: /original signed/ Kendal R. Walus, P.E. State Structure and Bridge Engineer Approved : January 31, 2013	

Changes are shaded.

The following VDOT Modifications to the AASHTO *LRFD Bridge Design Specifications*, 6th Edition, 2012, and the VDOT Modifications to the *LRFD Guide Specifications for the Design of Pedestrian Bridges,* 2009, are effective for projects with a PAC Meeting date after July 2013. The LRFD specifications are applicable to new construction, superstructure and substructure replacements, widening projects, etc.

Variance from the VDOT Modifications and the specifications shall require a design waiver and shall be requested in writing to the State Structure and Bridge Engineer. The request shall include appropriate documentation citing the specific section reference number, what is being requested and the reason for the waiver. Areas requiring a design exception shall follow the procedures as outlined in the current L&D IIM 227 utilizing the LD Form 440 addressed to the State Structure and Bridge Engineer.

AASHTO *LRFD Bridge Design Specifications*, 6th Edition, 2012

SECTION 1: INTRODUCTION:

Load modifiers: For all load modifiers ($\acute{\eta}_i$, $\acute{\eta}_D$, $\acute{\eta}_R$ and $\acute{\eta}_I$), use a default value of 1.0 for all limit states.

SECTION 2: GENERAL DESIGN AND LOCATION FEATURES:

Deflections: Deflection limits as noted in Article 2.5.2.6.2 shall be adhered to.

Span-to-Depth Ratios: Span to depth ratios as noted in Article 2.5.2.6.3, including Table 2.5.2.6.3-1, shall be used.

Drainage: See Manual of the Structure and Bridge Division, Volume V – Part 2, Chapter 22 for guidance. Gutter flow shall be intercepted at cross slope transitions to prevent flow across the bridge deck.

SECTION 3: LOADS AND LOAD FACTORS:

Future Wearing Surface: An allowance of 15 psf minimum shall be used.

Construction Tolerances/Construction Methods: An allowance of 20 psf carried by the non-composite section of beam/girder span(s) having cast-in-place slabs shall be used. This allowance is sufficient to cover additional loads incurred by the use of stay-in-place metal forms and extra slab thickness caused by construction tolerances. The 20 psf shall be applied to the entire area of the deck not only where stay in place forms are used.

An allowance of 10 psf shall be applied to prestressed concrete voided slabs, adjacent box beams, etc. which will have cast-in-place concrete slabs.

Wearing Surface: All concrete deck slabs shall be considered to have a ½" integral wearing surface which shall be included in the loads but not considered as part of the design section.

Multiple Presence Factors: When designing superstructure or substructure elements which are not capable of redistribution of load (single columns, hammerhead piers, concrete straddle bents) or are fracture critical (steel straddle bents), the multiple presence factors in Section 3.6.1.1.2 shall not be taken as less than 1.0 regardless of the number of lanes loaded on the structure for average tributary spans greater than 120 feet. For spans less than 100 feet, the multiple presence factor shall be taken as 1.2 for all configurations. For average lengths between 100 and 120 feet, the multiple presence factor shall vary linearly from 1.2 to 1.0.

Settlements: Unless approved by the State Structure and Bridge Engineer:

Total settlement shall be limited to 2 inch at each substructure unit. Post construction settlement shall be limited to 1 inch at each substructure unit. Total settlement (S_{TOT}) is defined as the arithmetic sum:

$$S_{TOT} = \text{Elastic settlement} + \text{Consolidation settlement} + \text{Secondary settlement}$$

Differential settlement at a single substructure unit shall be limited to a vertical value which does not exceed a slope of from the horizontal of 0.001 radians between as measured from the center to center of columns or of footings. Differential settlement is not allowed to exceed 0.001 radians during or after construction.

Force Effects Due to Superimposed Deformations: The design thermal movement range associated with a uniform temperature change shall be calculated using Procedure A Temperature Ranges, Table 3.12.2.1-1. The moderate climate range shall be used for steel or aluminum superstructures and cold climate range shall be used for concrete superstructures.

The full design thermal movement range associated with a uniform temperature change shall be used for joint design. 65% of the design thermal movement range associated with a uniform temperature change shall be used for non-slip expansion bearing design and the determination of superstructure forces transferred to the substructure for non-slip expansion and fixed bearings. Shrinkage shall also be considered for joint, bearing and substructure design of concrete superstructures using a shrinkage coefficient of 0.0003 except for segmentally constructed bridges which shall be estimated in accordance with Article 5.4.2.3. For typical multi-beam/girder prestressed concrete superstructures not integral with the substructure, the shrinkage coefficient can be considered to include superstructure creep effects.

See Manual of the Structure and Bridge Division, Volume V – Part 2, Chapter 15, Section 4 for specific modeling requirements and examples.

Load Factors for Uniform Temperature, TU: From Article 3.4.1 including Table 3.4.1-1, Load Combinations and Load Factors:

For deformations (e.g., joint and bearing design):
LF_{TU} = 1.2 for both strength and service load

For all other effects (e.g., temperature forces transferred to the substructure):
LF_{TU} = 0.5 for strength limit state (LS) for simplified analysis using gross moment of inertia
LF_{TU} = 1.0 for strength LS for refined analysis using partially cracked moment of inertia
LF_{TU} = 1.0 for service limit state

SECTION 5: CONCRETE STRUCTURES:

Classes of Concrete: Classes of concrete and corresponding compressive strengths shall be designated in the plans (General Notes, table of quantities and on other plans sheets as needed).

Concrete Class	General Use	Specified Compressive Strength (f'_c) (ksi)
A5	Prestressed members	5 - 10
A4	Superstructures (incl. deck slabs, integral backwalls, sidewalks, rails, parapets, terminal walls, medians and median barriers); box culverts; rigid frames; reinforced substructures when needed for strength	4
A3	Reinforced substructures	3
B2	Massive or lightly reinforced substructures	2.2
C1	Massive unreinforced substructures; bag riprap	1.5
T3	Tremie seal	3

Reinforcing Steel: Structures shall be designed using Grade 60 reinforcement (deformed bars) and shall be noted on the plans.

Reinforcing Steel Bar Lengths:
The maximum length of any type bar shall be 60 feet. Bar lengths greater than 40 feet will require oversized vehicles for hauling. The designer should take into account the total number of bars in excess of 40 feet to justify using longer bars.

Bars in deck slabs may be detailed as one piece bars (up to 60 feet fabrication length) with a note in the reinforcing steel schedule as follows: “If fabrication of deck slab bar(s) is not possible for length detailed and multiple bars are required, bars shall have the least number of Class B splices possible. Splices shall be located approximately at points of contraflexure and splices in alternate bars shall be located in different bays.”

NOTE: The usage of galvanized reinforcing steel and epoxy-coated reinforcing steel has been terminated since the implementation of corrosion resistant reinforcing steel. See current IIM-S&B-81.

CRR steel shall be one of three types:

Solid stainless
Stainless clad
ASTM 1035 (MMFX-2)

Starting with the March 2013 ad date, CRR steels are bid by Class which may contain several of the types listed above.

For the type of CRR to be used and location(s), see current IIM-S&B-81.

Design shall be based on a yield strength of 60 ksi for all three types of CRR.

Minimum Concrete Cover: The following minimum cover shall be provided for reinforcement:

Location	**Minimum cover (inches)**
Pier caps, bridge seats and backwalls:	
Principal reinforcement	2 ¾
Stirrups and ties	2 ¼
Footings and pier columns:	
Principal reinforcement	3
Stirrups and ties	2 ½
Cast-in-place deck slabs:	
Top reinforcement	2 ½†
Bottom reinforcement	1 ¼
Cast-in-place slab spans:	
Top reinforcement	2 ½†
Bottom reinforcement	2
Slabs and box beams: top steel	1 ¾
Reinforcement concrete box culverts and rigid frames with more than 2 ft. fill over top of slab:	
All reinforcement	1 ½
Reinforcement concrete box culverts and rigid frames with less than 2 ft. fill over top of slab:	
Top slab – top reinforcement	2 ½
Top slab – bottom reinforcement	2
All other reinforcement	1 ½
Rails, rail posts, curbs and parapets:	
Principal reinforcement	1 ½
Stirrups, ties and spirals	1
Concrete piles cast against and/or permanently exposed to earth	2
Drilled shafts:	
Principal reinforcement	4
Ties and spirals	3 ½
All other components not indicated above:	
Principal reinforcement	2 ½
Stirrups and ties	2

† Includes ½ inch monolithic (integral) wearing surface.

Cover for Corrosive/Marine Environments: In corrosive or marine environments or other severe exposure conditions, the minimum cover required shall be increased by 1 inch.

Control of Cracking by Distribution Reinforcement: Class 2 exposure condition shall only be used for segmental concrete box girders.

Column Reinforcement: Circular columns are to be designed as tied columns with continuous ties (#3 reinforcing bars minimum) or welded wire fabric unless special circumstances warrant the use of spirally reinforced columns.

Hauling Prestressed Concrete Members:

The weight of any transported member shall be limited to 72 kips. Weights up to 100 kips may be used with the approval of the District Bridge Engineer.

Preferably the length shall be limited to 75 feet to allow for hauling by truck. Lengths up to 135 feet may be used with the approval of the District Bridge Engineer.

Strength of Prestressed Members:

High performance concrete strengths from 5 to 8 ksi may be used.

Strengths between 8 to 10 ksi may be used with the approval of the State Structure and Bridge Engineer.

Maximum strength of lightweight concrete shall be limited to 6 ksi. Strengths between 6 and 8 ksi may be used with the approval of the State Structure and Bridge Engineer.

Deck Panels: The diameter of prestressing strands shall not exceed 3/8".

Spacing of Strands: Normally the spacing of strands shall be 2 inches c-c minimum for strands up to 0.6 inches in diameter.

Prestress Loss: Gains due to elastic deformations shall not be used to determine total prestress losses.

Post-tensioned Structures: Structures requiring post-tensioning (using ducts and grouting) shall not be used without the approval of the State Structure and Bridge Engineer. Exempt are prestressed voided concrete slabs with transverse ties (Manual of the Structure and Bridge Division, Volume V – Part 5, PSS-series) or prestressed concrete boxes with transverse ties.

SECTION 6: STEEL STRUCTURES:

Composite Sections:

All simple spans and the positive moment regions of continuous spans shall be designed as composite sections and shall be proportioned so that the neutral axis lies below the top surface of the steel beam/girder. Concrete on the tension side of the neutral axis shall not be considered in calculating stresses or resisting moments. The gross section of beam/girder and slab throughout the entire length of the beam/girder shall be used for the distribution of moments and computation of deflections.

In the negative region(s) of continuous spans, the longitudinal reinforcement shall be provided as required for a composite section; however, the additional contribution to capacity of the longitudinal reinforcing steel shall be ignored when evaluating service or strength resistance.

Continuous composite beams/girders shall be designed with shear connectors throughout the entire length.

The actual bolster (haunch) height shall be used in computing moments of inertia; however, the bolster itself shall not be considered for strength (width = 0) in computing moments of inertia.

Hauling Steel Members:

Lengths of beams/girders up to 135 feet may be shipped with permit by truck on Interstate or Arterial Systems. Members over 90 feet shall be designed with one or more permissible field bolted splices, limiting the shipping length to 90 feet or less, unless approved by the District Structure and Bridge Engineer.

Weight of any shipped length shall be limited to 72 kips. Weights up to 100 kips may be used with the approval of the District Bridge Engineer.

Materials:

ASTM A709 Grade 50W shall be used in accordance with the guidelines of the FHWA Technical Advisory T5140.22 dated October 3, 1989. ASTM A709 Grade HPS 50W shall be used for fracture critical members.

ASTM A709 Grade HPS 50W, 70W and 100/100W steels shall not be used without the approval of the State Structure and Bridge Engineer.

The use of hybrid structures should be proposed for approval during Stage I (TS&L) plan development when these options will be cost effective.

Welded Cover Plates: Welded cover plates on steel beams shall be limited to one on any flange. Partial length cover plates shall be extended beyond the theoretical end by the terminal distance and shall extend within 3 feet of the centerline of bearing. Plates and welds shall be detailed with square ends. Cover plates wider than the flange to which attached shall not be permitted. Minimum thickness of cover plates shall be 5/8”. Cover plates shall not be used in the negative moment regions.

Flange Plates: Changes in areas of flange plates or cover plates at welded splices shall ordinarily be made by changing the thickness while maintaining the same width.

High Strength Bolts: High strength ASTM A325 bolts shall be used. Use 7/8” diameter bolts. Bolts shall be galvanized except when used with unpainted weathering steel in which case the bolts shall be ASTM A325 Type III.

ASTM A490 bolts shall not be used. ASTM A490 bolts cannot be galvanized.

Splices: Where an option is noted on the plans allowing a thicker web to eliminate transverse stiffeners, no change in the web splice design will be made for the thicker web.

Splice and Connection Design: Splices and connections shall be detailed for standard holes but shall be designed for oversize and short slotted holes (K_h = 0.85) and for a Class B surface condition (K_s = 0.50).

Bolted splices shall be considered equivalent to a transverse stiffener placed at the center line of the splice.

Steel Plate Girders:
The minimum thickness of any flange shall be ¾".

The maximum thickness of any flange shall be limited to 2 ½" if the flange is to be field welded (butt spliced). Otherwise, the maximum thickness of flange plates shall be in accordance with the limits indicated in the specifications.

The addition of cover plates to girder flanges shall not be permitted.

Shear Connectors: Use 7/8" diameter connectors. The maximum pitch of shear connectors shall not exceed 24" including negative moment regions of continuous spans. At simply supported ends (simple and continuous spans), shear connectors shall be as close as practical to the end of the beam/girder (approx. 3") and have a maximum pitch of 6" within a distance of 36" from the end of the beam/girder.

SECTION 9: DECKS AND DECK SYSTEMS:

Deck Design: Cast-in-place concrete deck slabs supported on beams/girders (steel or prestressed concrete) shall be designed by the strip method. Crack control shall not be applied for deck slab design including deck slab extensions. The maximum spacing of reinforcement shall not exceed the slab depth minus ½" wearing surface. Bars larger than #5 shall not be used for transverse reinforcement. Distribution bars shall be limited to #4 bars except in the negative moment areas where the maximum bar size shall be limited to #6 bars.

The empirical method for deck slab design shall not be used.

The cantilever deck slab shall be designed/detailed with additional #5 bars between the transverse bars in the top layer. The bars shall extend past the exterior beam/girder with the development length extending past the contraflexure point in the slab. Yield-line analysis will not be required if all four of the following requirements are met:

beam/girder spacing is less than or equal 12'-0"

cantilever length is less than or equal to 0.3 x beam/girder spacing

railing/parapet type (if any on the cantilever) is an approved VDOT crash tested system

additional loads (i.e. soundwall, utilities, etc.) are not added to the cantilever except for fencing as shown in BPF-series standards.

For all other cases, the designer will be required to adhere to the yield-line analysis as noted in the specifications.

Designer shall consider additional loads on the cantilever or blister. Examples include fencing, soundwall attachments, supports for sign structures, etc.

Integral Wearing Surface: The ½" integral wearing surface shall not be included in the computation of section properties of composite beams/girders or for deck slab design; however, it shall be used in the computation of dead loads.

SECTION 10: FOUNDATIONS:

Spacing of Piles:

Concrete piles: Not less than 3 x diameter or side dimension of the piles.

Steel H- piles: As friction piles: Not less than 3.5 x nominal size of the piles.
As bearing piles: Not less than 2'-6".

Timber piles: Not less than 2'-6".

Edge Distance of Piles: The distance from the side of any pile to the nearest edge of the footing shall not be less than 9".

Driving Tolerance of Piles: Driving tolerance(s) for piles shall be considered when determining shear at the critical section.

Driving Tolerances for Steel and Concrete Piles *		
Pile Location/Condition	**Tolerance for Single Pile**	**Direction**
For elements supported by a single row of piles (plumb, battered or staggered). Includes but is not limited to bent caps, full integral abutments and abutments behind MSE walls.	± 3"	About long axis of footing
Footings for column piers	± 6"	About both major axes
Footings for abutments, retaining walls and piers except as noted above.	± 6"	About long axis of footing

* For driving tolerances of timber piles and other information, see VDOT *Road and Bridge Specifications*, Section 403 and Table IV-1.

Projection (Embedment) of Piles in Caps/Footings:

Pile type	Minimum projection (embedment)
Cast-in-place or precast concrete piles (including cylinder piles and drilled shafts)	6" into concrete with reinforcement projecting to obtain development as required by the design
Steel H-piles	12" into footings
Steel H-piles: when subjected to intermittent uplift (under any loading conditions) in areas subject to uplift under seismic load	18" into footing unless other methods of anchoring the pile to the footing are provided 18" plus a positive method of anchoring the pile to the footing
Timber piles	12" into footings

Minimum Footing Depth: Minimum footing depth shall be 3'-0".

Pile Bents: Cast-in-place piles shall not be used in pile bents or in soils which may induce shell collapse during driving.

Collision Walls: For details and requirements, see Manual of the Structure and Bridge Division, Volume V – Part 2, Chapter 15.

SECTION 11: ABUTMENTS, PIERS, AND WALLS:

Temperature and Shrinkage Forces Transferred to Substructure: Temperature and shrinkage forces where applicable shall be computed taking into account fixity, bearing type and pier stiffness.

For non-slip expansion and fixed bearings, the maximum superstructure movement at each substructure unit for force determination is as follows:

$$\Delta_O = (0.65 \times \Delta_T) + (\text{shrinkage}) = 0.65 \times (\alpha \times T_R \times L_{exp}) + (L_{exp} \times 0.0003)$$

where: Δ_O = maximum horizontal displacement of the superstructure, in.
$\Delta_T = \alpha \times T_R \times L_{exp}$ = the design thermal movement range, in.
α = coefficient of thermal expansion, in./in./°F
T_R = temperature range, °F (See Section 3 modifications)
L_{exp} = expansion length, in.

Uniform Temperature, TU, and Shrinkage, SH, are summed in the equation for Δ_O above. The force effects of both can be considered together because load factors for TU (all other effects) and SH are the same in both the strength and service limit states. Load factors are not shown in the equation for Δ_O above, but are applied to the force effects derived from the maximum horizontal displacement of the superstructure, Δ_O. Note that the load factors for force effects for both Uniform Temperature, TU, and Shrinkage, SH, in the strength limit state depend on whether I_g or $I_{effective}$ was used to derive forces.

Typical pier and abutment software apply load factors to derived forces internally. Designers shall ensure that the appropriate load factors are used in abutment and pier software programs for TU and SH. Designers must apply the appropriate load factors for the load combination limit state to the derived forces in any hand computations.

For slip expansion bearings, the maximum superstructure movement at each substructure unit for force determination need not be taken larger than the deformation corresponding to first slip using the extreme values of the friction coefficient between the sliding surfaces.

SECTION 13: RAILINGS:

Crash tested parapets/rails shall be used on all projects. See Manual of the Structure and Bridge Division, Volume V – Part 2, Chapter 25 for additional information, especially on design exceptions and waivers.

The minimum height of a pedestrian and/or bicycle railing shall not be less than 54" measured from the top of the walkway/riding surface. See also Manual of the Structure and Bridge Division, Volume V – Part 2: Chapter 6 (Geometrics), Chapter 25 (Parapets, Railing, etc.) and Chapter 30 (Pedestrian Fencing).

The designer shall consider the use of open rails/parapets for structures over bodies of water in accordance with the Commonwealth Transportation Board resolution dated July 20, 1995.

For the timber initiative, FHWA crash tested timber rail shall be used.

SECTION 14: JOINTS AND BEARINGS:

Modular Joints: The use of modular joints is not permitted.

Joint Design: All joints shall be sized and designed for the corresponding movement [deformation] with shrinkage where applicable in the service limit state:

$$LF_{TU} \times (\Delta_T) + LF_{SH} \times (\text{shrinkage}) = 1.2 \times (\alpha \times T_R \times L_{exp}) + 1.0 \times (L_{exp} \times 0.0003)$$

where: LF_{TU} = Load Factor from Table 3.4.1-1 for TU deformation = 1.2
LF_{SH} = Load Factor from Table 3.4.1-1 for shrinkage = 1.0
$\Delta_T = \alpha \times T_R \times L_{exp}$ = the design thermal movement range, in.
α = coefficient of thermal expansion, in./in./°F
T_R = temperature range, °F (See Section 3 modifications)
L_{exp} = expansion length, in.

Steel Reinforced Elastomeric Bearings: Steel reinforced elastomeric pads shall be designed by Method A, Article 14.7.6. For expansion bearings, the maximum total shear deformation of the bearing, Δ_S, shall be calculated as follows with shrinkage where applicable in the service limit state:

$$\Delta_S = LF_{TU} \times (0.65 \times \Delta_T) + LF_{SH} \times (\text{shrinkage})$$
$$= 1.2 \times (0.65 \times \alpha \times T_R \times L_{exp}) + 1.0 \times (L_{exp} \times 0.0003)$$

where: Δ_S = maximum total shear deformation of the bearing, in.
LF_{TU} = Load Factor from Table 3.4.1-1 for deformation = 1.2
LF_{SH} = Load Factor from Table 3.4.1-1 for shrinkage = 1.0
$\Delta_T = \alpha \times T_R \times L_{exp}$ = the design thermal movement range, in.
α = coefficient of thermal expansion, in./in./°F
T_R = temperature range, °F (See Section 3 modifications)
L_{exp} = expansion length, in.

From Eq. 14.7.6.3.4-1, $h_{rt} \geq 2 \times \Delta_S$

where: h_{rt} = total elastomer thickness, in.

SECTION 15: DESIGN OF SOUND BARRIERS:

AASHTO *Guide Specifications for Structural Design of Sound Barriers*, 1989 with 1992 and 2002 Interims shall be used.

AASHTO *LRFD Guide Specifications for the Design of Pedestrian Bridges*, 2009

Pedestrian and Multi-Use Bridges: A dead load wearing surface of 12 psf shall be added for pedestrian bridges wider than 12 feet between handrails if it is anticipated that the bridge could be overlaid in the future.

CC: Assistant State Structure and Bridge Engineers
District Structure and Bridge Engineers
FHWA: Bridge Section

VIRGINIA DEPARTMENT OF TRANSPORTATION

STRUCTURE AND BRIDGE DIVISION

INSTRUCTIONAL AND INFORMATIONAL MEMORANDUM

GENERAL SUBJECT: VDOT Modifications to the AASHTO *LRFD Bridge Design Specifications*, 7th Edition, 2014 VDOT Modifications to the AASHTO *LRFD Guide Specifications for the Design of Pedestrian Bridges*, 2009	NUMBER: IIM-S&B-80.5
SPECIFIC SUBJECT:	Date: August 25, 2015
	SUPERSEDES: IIM-S&B-80.4
DIVISION ADMINISTRATOR APPROVAL: /original signed/ Kendal R. Walus, P.E. State Structure and Bridge Engineer Approved : August 25, 2015	

Changes are shaded.

The following VDOT Modifications to the AASHTO *LRFD Bridge Design Specifications*, 7th Edition, 2014, and the VDOT Modifications to the *LRFD Guide Specifications for the Design of Pedestrian Bridges,* 2009, are effective for projects with an Advertisement date after June 14, 2016. The LRFD specifications are applicable to new construction, total bridge replacement, superstructure replacement, widening projects, etc.

Variance from the VDOT Modifications to the specifications shall require a design exception, design waiver or design approval. For complete information on and requirements of design exceptions/waivers/approvals, see Section Pre.02 of Part 1 of the Manual of the Structure and Bridge Division.

The requirements of Part 2 of the Manual of the Structure and Bridge Division shall be adhered to in conjunction with this IIM.

AASHTO *LRFD Bridge Design Specifications*, 7th Edition, 2014

SECTION 1: INTRODUCTION:

Load modifiers:

Load modifiers specified below shall be used. Each condition shall be compounded when applied.

1. For fracture critical elements, η_R shall be taken as 1.05 for service and strength limit states.
2. For permanent vehicular structures which cannot be easily widened (including, but not limited to, trusses, concrete segmental boxes and bridges supported by Straddle Bents or Integral Caps, η_R shall be taken as 1.05 for strength limit states.
3. For all post-tensioned concrete superstructures, the superstructure(s) shall be taken as η_I =1.05 for service limit states. And when superstructure is post-tensioned, integral pier substructures (including but not limited to, Integral Straddle Bents, Integral Caps and pier caps) shall be designed using η_I = 1.05 for both service and strength limit states. Integral abutments shall be designed for η_I = 1.0.
4. When external tendons and/or unbonded internal tendons are used (for superstructure or substructure), elements shall be designed using η_R = 1.05 for both service and strength limit states and η_D = 1.05 for strength limit states.

For other conditions, all load modifiers (η_D, η_I , η_R and η_i) shall be 1.0 for all limit states.

Situation 1: Fracture Critical Structures				
		η_I	η_D	η_R
Sub structure	Service	1.0	1.0	1.05
	Strength	1.0	1.0	1.05
Super structure	Service	1.0	1.0	1.05
	Strength	1.0	1.0	1.05

Situation 2: Not Easily Widened Structures				
		η_I	η_D	η_R
Sub structure	Service	1.0	1.0	1.0
	Strength	1.0	1.0	1.05
Super structure	Service	1.0	1.0	1.0
	Strength	1.0	1.0	1.05

Situation 3: Post-tensioned Superstructures				
		η_I	η_D	η_R
Sub* structure	Service	1.05	1.0	1.0
	Strength	1.05	1.0	1.0
Super structure	Service	1.05	1.0	1.0
	Strength	1.0	1.0	1.0

* Only for integral pier substructures

Situation 4: Structures with tendons (External or Unbonded internal)				
		η_I	η_D	η_R
Sub structure	Service	1.0	1.0	1.05
	Strength	1.0	1.05	1.05
Super structure	Service	1.0	1.0	1.05
	Strength	1.0	1.05	1.05

All Other Structures				
		η_I	η_D	η_R
Sub structure	Service	1.0	1.0	1.0
	Strength	1.0	1.0	1.0
Super structure	Service	1.0	1.0	1.0
	Strength	1.0	1.0	1.0

Examples:

Structure Type		Condition	Limit State	η_I	η_D	η_R	η_i
Steel straddle bent with multiple beam/girders	Sub Str.	1: Yes	Service	1.0	1.0	1.05	Service = 1.05 Strength = 1.103
			Strength	1.0	1.0	1.05	
		2: Yes	Service	1.0	1.0	1.0	
			Strength	1.0	1.0	1.05	
		3: No	Service	1.0	1.0	1.0	
			Strength	1.0	1.0	1.0	
		4: No	Service	1.0	1.0	1.0	
			Strength	1.0	1.0	1.0	
		Final	**Service**	**1.0**	**1.0**	**1.05**	
			Strength	**1.0**	**1.0**	**1.103**	
	Super Str.	1: No	Service	1.0	1.0	1.0	Service = 1.0 Strength = 1.05
			Strength	1.0	1.0	1.0	
		2: Yes	Service	1.0	1.0	1.0	
			Strength	1.0	1.0	1.05	
		3: No	Service	1.0	1.0	1.0	
			Strength	1.0	1.0	1.0	
		4: No	Service	1.0	1.0	1.0	
			Strength	1.0	1.0	1.0	
		Final	**Service**	**1.0**	**1.0**	**1.0**	
			Strength	**1.0**	**1.0**	**1.05**	

Structure Type		Condition	Limit State	η_I	η_D	η_R	η_i
An integral concrete straddle bent with unbonded internal tendons and post-tensioned superstructure	Sub Str.	1: No	Service	1.0	1.0	1.0	Service = 1.103 Strength = 1.216
			Strength	1.0	1.0	1.0	
		2: Yes	Service	1.0	1.0	1.0	
			Strength	1.0	1.0	1.05	
		3: Yes	Service	1.05	1.0	1.0	
			Strength	1.05	1.0	1.0	
		4: Yes	Service	1.0	1.0	1.05	
			Strength	1.0	1.05	1.05	
		Final	**Service**	**1.05**	**1.0**	**1.05**	
			Strength	**1.05**	**1.05**	**1.103**	
	Super Str.	1: No	Service	1.0	1.0	1.0	Service = 1.103 Strength = 1.158
			Strength	1.0	1.0	1.0	
		2: Yes	Service	1.0	1.0	1.0	
			Strength	1.0	1.0	1.05	
		3: Yes	Service	1.05	1.0	1.0	
			Strength	1.0	1.0	1.0	
		4: Yes	Service	1.0	1.0	1.05	
			Strength	1.0	1.05	1.05	
		Final	**Service**	**1.05**	**1.0**	**1.05**	
			Strength	**1.0**	**1.05**	**1.103**	

SECTION 2: GENERAL DESIGN AND LOCATION FEATURES:

Deflections: Deflection limits as noted in Article 2.5.2.6.2 shall be adhered to.

Maximum Span Lengths: Maximum span lengths shall be limited by applicability of distribution factors for cross section types as shown in Article 4.6.2.2.2—*Distribution Factor Method for Moment and Shear* even when a refined analysis is used.

Span-to-Depth Ratios: Span to depth ratios as noted in Article 2.5.2.6.3, including Table 2.5.2.6.3-1, shall be used. For variable web depth structures, the maximum ratio between the deeper web depth and the shallower web depth shall be less than or equal to 2.0.

Drainage: See Chapter 22 of Part 2 of the Manual of the Structure and Bridge Division for guidance. Gutter flow shall be intercepted at cross slope transitions to prevent flow across the bridge deck.

SECTION 3: LOADS AND LOAD FACTORS:

Application of Vehicular Live Load:
In Article 3.6.1.3.1 - General, the following shall be added to the list of extreme force effects:

The Notional Rating Load (NRL) rating factors shall be computed under conditions required by current VDOT IIM-S&B-86. Bridge shall be designed so that the rating factors exceed 1.0. Substructures need not be checked for NRL.

Calculation of Seismic Design Forces: The seismic design forces shall be determined in accordance with the 2015 Interim Revisions in conjunction with the AASHTO LRFD Bridge Design Specifications.

Future Wearing Surface: An allowance of 15 psf minimum shall be used.

Construction Tolerances/Construction Methods: An allowance of 20 psf carried by the non-composite section of beam/girder span(s) having cast-in-place slabs shall be used. This allowance is sufficient to cover additional loads incurred by the use of stay-in-place metal forms and extra slab thickness caused by construction tolerances. The 20 psf shall be applied to the entire area of the deck not only where stay in place forms are used.

An allowance of 10 psf shall be applied where metal stay-in-place forms are not required, for example, prestressed concrete voided slabs, adjacent box beams, etc. which will have cast-in-place concrete slabs or asphalt overlays.

Wearing Surface: All concrete deck slabs shall be considered to have a ½" integral wearing surface which shall be included in the loads but not considered as part of the design section.

Multiple Presence Factors: When designing superstructure or substructure elements which are not capable of redistribution of load (single columns, hammerhead piers, concrete straddle bents) or are fracture critical (steel straddle bents), the multiple presence factors in Section 3.6.1.1.2 shall not be taken as less than 1.0 regardless of the number of lanes loaded on the structure for average tributary spans greater than 120 feet. For spans less than 100 feet, the multiple presence factor shall be taken as 1.2 for all configurations. For average lengths between 100 and 120 feet, the multiple presence factor shall vary linearly from 1.2 to 1.0.

Pier protection:

Pier protection or strengthening shall be provided when the edge of a permanent traffic through lane is within 30 feet of the pier. Edge of pavement, edge of roadway, edge of traveled way and edge of traffic lane are all equivalent in the context of the clarification above for the purposes of Article 3.6.5.1.

Settlements:

Total settlement shall be limited to 2 inches at each substructure unit. Post construction settlement shall be limited to 1 inch at each substructure unit. Total settlement (S_{TOT}) is defined as the arithmetic sum:

$$S_{TOT} = \text{Elastic settlement} + \text{Consolidation settlement} + \text{Secondary settlement}$$

Differential settlement at a single substructure unit shall be limited to a vertical value which does not exceed a slope of from the horizontal of 0.001 radians between as measured from the center to center of columns or of footings. The combined construction and post construction differential settlement shall not exceed 0.001 radians.

Force Effects Due to Superimposed Deformations: The design thermal movement range associated with a uniform temperature change shall be calculated using Procedure A Temperature Ranges, Table 3.12.2.1-1. The moderate climate range shall be used for steel or aluminum superstructures and cold climate range shall be used for concrete superstructures.

The full design thermal movement range associated with a uniform temperature change shall be used for joint design. 65% of the design thermal movement range associated with a uniform temperature change shall be used for non-slip expansion bearing design and the determination of superstructure forces transferred to the substructure for non-slip expansion and fixed bearings. Shrinkage shall also be considered for joint, bearing and substructure design of concrete superstructures using a shrinkage coefficient of 0.0003 except for segmentally constructed bridges which shall be estimated in accordance with Article 5.4.2.3. For typical multi-beam/girder prestressed concrete superstructures not integral with the substructure, the shrinkage coefficient can be considered to include superstructure creep effects.

See the Manual of the Structure and Bridge Division, Part 2, Chapter 15, Section 4 for specific modeling requirements and examples.

Load Factors for Uniform Temperature, TU: From Article 3.4.1 including Table 3.4.1-1, Load Combinations and Load Factors:

For deformations (e.g., joint and bearing design):
LF_{TU} = 1.2 for both strength and service load

For all other effects (e.g., temperature forces transferred to the substructure):
LF_{TU} = 0.5 for strength limit state (LS) for simplified analysis using gross moment of inertia
LF_{TU} = 1.0 for strength LS for refined analysis using partially cracked moment of inertia
LF_{TU} = 1.0 for service limit state

SECTION 5: CONCRETE STRUCTURES:

Classes of Concrete: Classes of concrete and corresponding compressive strengths shall be designated in the plans (General Notes, table of quantities and on other plans sheets as needed).

Concrete Class	General Use	Specified Compressive Strength (f'_c) (ksi)
A5	Prestressed members	5 - 10
A4	Superstructures (incl. deck slabs, integral backwalls, sidewalk rails, parapets, terminal walls, medians and median barriers); box culverts; rigid frames; reinforced substructures when needed for strength	4
A3	Reinforced substructures	3
B2	Massive or lightly reinforced substructures	2.2
C1	Massive unreinforced substructures; bag riprap	1.5
T3	Tremie seal	3

Reinforcing Steel: Structures shall be designed using Grade 60 reinforcement (deformed bars) and shall be noted on the plans.

Some structure elements require Corrosion Resistance Reinforcing (CRR) steel. For the type of CRR to be used and location(s), see current IIM-S&B-81. Design shall be based on a yield strength of 60 ksi for all types of CRR.

Galvanized reinforcing steel (except for use with prestressed piles) and epoxy-coated reinforcing steel shall not be used.

Reinforcing Steel Bar Lengths:
The maximum length of any type bar shall be 60 feet. Bar lengths greater than 40 feet will require oversized vehicles for hauling. The designer should take into account the total number of bars in excess of 40 feet to justify using longer bars.

Bars in deck slabs may be detailed as one piece bars (up to 60 feet fabrication length) with a note in the reinforcing steel schedule as follows: “If fabrication of deck slab bar(s) is not

possible for length detailed and multiple bars are required, bars shall have the least number of Class B splices possible. Splices shall be located approximately at points of contraflexure and splices in alternate bars shall be located in different bays."

Control of Cracking by Distribution Reinforcement: Class 2 exposure condition shall only be used for segmental concrete box girders.

Column Reinforcement: Circular columns are to be designed as tied columns. However, the confinement steel shall be spirals (#3 reinforcing bars minimum) or welded wire fabric. The pitch of the spiral shall be taken as the required spacing for ties.

Strength of Prestressed Members:
Concrete strengths from 5 to 10 ksi may be used.

Strengths greater than 10 ksi require a design waiver approved by the State Structure and Bridge Engineer. The rebar development length and lap splice length shall be determined in accordance with the 2015 Interim Revisions in conjunction with the AASHTO LRFD Bridge Design Specification for concrete strength greater than 10 ksi.

Maximum strength of lightweight concrete shall be limited to 8 ksi. Strengths between 8 ksi and 10 ksi require a design waiver approved by the State Structure and Bridge Engineer.

Spacing of Strands: The spacing of strands shall be 2 inches c-c minimum for strands up to 0.6 inches in diameter.

Prestress Loss: Gains due to elastic deformations shall not be used to determine total prestress losses.

Post-tensioned Structures: Structures requiring post-tensioning (using ducts and grouting) shall not be used without a design waiver approved by the State Structure and Bridge Engineer. Exempt are prestressed voided concrete slabs with transverse ties (Manual of the Structure and Bridge Division, Part 5, PSS-series) or prestressed concrete boxes with transverse ties.

For Precast Segmental and Cast-in-Place Post-tensioned Segmental boxes, the tensile stress limit at service limit states, due to permanent loads only, shall be 0 ksi (no tension). This limitation shall apply to all portions of superstructure not replaceable by conventional means.

Post-tensioned straddle bents shall not allow concrete tension under service limits.

Minimum Concrete Cover: The following minimum cover (inches) shall be provided for reinforcement:

Location	Normal Condition	Corrosive Environment(1)	Marine(2)
Pier caps, bridge seats and backwalls:			
Principal reinforcement	2 ¾ *	3 ¾	4
Stirrups and ties	2 ¼ *	3 ¼	3 ½
Footings and pier columns:			
Principal reinforcement	3	4	4
Stirrups and ties	2 ½	3 ½	3 ½
Cast-in-place deck slabs:			
Top reinforcement	2 ½†	2 ½†	2 ½†
Bottom reinforcement	1 ¼	1 ¼	2
Precast and cast-in-place slab spans:			
Top reinforcement	2 ½†	2 ½†	2 ½†
Bottom reinforcement	2	2	3
Prestressed slabs and box beams:			
Top steel	1 ¾	2 ¾	2 ¾
Reinforcement concrete box culverts and rigid frames with more than 2 ft. fill over top of slab:			
Top slab – top reinforcement	1 ½	2 ½	3
Top slab – bottom reinforcement	1 ½	2 ½	3
Inside walls and bottom slab top mat	1 ½	2 ½	3
Outside walls and bottom slab bottom mat	1 ½	2 ½	3
Reinforcement concrete box culverts and rigid frames with less than 2 ft. fill over top of slab:			
Top slab – top reinforcement	2 ½	2 ½	3
Top slab – bottom reinforcement	2	2 ½	3
Inside walls and bottom slab top mat	1 ½	2 ½	3
Outside walls and bottom slab bottom mat	1 ½	2 ½	3
Rails, rail posts, curbs and parapets:			
Principal reinforcement	1 ½	1 ½	1 ½
Stirrups, ties and spirals	1	1	1
Concrete piles cast against and/or permanently exposed to earth (not applicable for prestressed concrete):	2	3	3
Drilled shafts:			
Principal reinforcement	4	5	5
Ties and spirals	3 ½	4 ½	4 ½
All other components not indicated above:			
Principal reinforcement	2 ½	3 ½	3 ½
Stirrups and ties	2	3	3

* For piers at open joint locations, increase cover by 1”.
† Includes ½ inch monolithic (integral) wearing surface.
(1) Corrosive environment affects cover where concrete surface is in permanent contact with corrosive soil.
(2) Marine includes all locations with direct exposure to brackish and salt water.

SECTION 6: STEEL STRUCTURES:

The requirements of Chapter 11 of Part 2 of the VDOT's Manual of the Structure and Bridge Division shall be adhered to.

SECTION 9: DECKS AND DECK SYSTEMS:

Deck Design: Cast-in-place concrete deck slabs supported on beams/girders (steel or prestressed concrete) shall be designed by the strip method. Crack control shall not be applied for deck slab design including deck slab extensions. The maximum spacing of reinforcement shall not exceed the slab depth minus ½" wearing surface. Bars larger than #5 shall not be used for transverse reinforcement. Distribution bars shall be limited to #4 bars except in the negative moment areas where the maximum bar size shall be limited to #6 bars.

The empirical method for deck slab design shall not be used.

Cantilever Deck Slab Design: If all of the following requirements are met, the cantilever deck slab shall be detailed with additional #5 bars between the transverse bars in the top layer. This is the minimum requirement of reinforcement with or without additional analysis. The bars shall extend past the exterior beam/girder with the development length extending past the contraflexure point in the slab.

- beam/girder spacing is less than or equal 12'-0"
- cantilever length is less than or equal to 0.3 x beam/girder spacing
- railing/parapet type (if any on the cantilever) is an approved VDOT crash tested system
- additional loads (i.e. soundwall, utilities, etc.) are not added to the cantilever except for fencing as shown in BPF-series standards.

If any of the above requirements is not met, the cantilever deck slab shall be designed in accordance with AASHTO LRFD A13.4 with the revisions described in "Decks supporting concrete parapet railings" and "Decks supporting Post-and-Beam railings":

For the VDOT approved Kansas Corral rails: The deck overhang may be designed with the method described in "Decks supporting concrete parapet railings" (section below) when the Kansas Corral rails are used for TL-2 situation. The Kansas Corral rails shall not be used for a TL-4 situation without a design exception approved by the State Structure and Bridge Engineer.

Decks supporting concrete parapet railings: For Design Case 1 in AASHTO LRFD A13.4.1, the deck overhang shall be designed to resist the combined effects of tensile force T and moment M_s, and other applicable forces at the inside face of the parapet or the gutter line, as specified as follows:

For an interior parapet segment

$$T = \frac{1.2F_t}{L_t + 2H}$$

$$M_s = \frac{1.2F_t H}{L_t + 2H}$$

For an end parapet segment

$$T = \frac{1.2F_t}{L_t + H}$$

$$M_s = \frac{1.2F_t H}{L_t + H}$$

F_t = transverse force specified in Table A13.2-1 (kips) of AASHTO LRFD
L_t = longitudinal length of distribution of impact force F_t (ft)
H = height of wall (ft)
T = tensile force per unit of deck length (kip/ft)
M_s = design moment in the deck overhang due to F_t (kip-ft/ft), not greater than 110% of the average of M_c of the bridge railing/parapet, M_{c_ave}
M_c = resistance of the parapet about an axis parallel to the longitudinal axis of the bridge (kip-ft/ft)
L_t + 2H = Distribution length for interior parapet section at the gutter line
L_t + H = Distribution length for end parapet section at the gutter line

The following design values may be used to design the deck overhang.

Railing Type (Test Level)	**T (kip/ft)**		**M_{c_ave} (kip-ft/ft)**		**M_s (kip-ft/ft)**	
	Interior	End	Interior	End	Interior	End
32” F-shape (TL-4)	7.3	10.5	12.5	12.5	13.8	13.8
42” F-shape (TL-5)	10.0	13.0	21.6	21.6	23.8	23.8
BR27C (TL-4)	8.6	11.8	13.7	13.7	13.7	13.7
BR27D (TL-4)	10.0	13.0	13.7	13.7	13.7	13.7

At the sections other than the gutter line in the deck overhang, T and M_s may be distributed over a length which equals the distribution length at the gutter line plus 2*(distance from the gutter line)*tan(30°) for an interior parapet segment, and the distribution length at the gutter line plus the distance from the gutter line*tan(30°) for an end parapet segment.

<u>Decks supporting Post-and-Beam railings:</u> the deck overhang shall be designed in accordance with the AASHTO LRFD A13.4.3.

Designer shall consider additional loads on the cantilever or blister. Examples include fencing, soundwall attachments, supports for sign structures, etc.

Integral Wearing Surface: The ½" integral wearing surface shall not be included in the computation of section properties of composite beams/girders or for deck slab design, however, it shall be used in the computation of dead loads.

SECTION 10: FOUNDATIONS:

Spacing of Piles:

Concrete piles: Not less than 3 x diameter or side dimension of the piles.
Not greater than 10'-0" for piles within a row.

Steel H- piles: As friction piles: Not less than 3.5 x nominal size of the piles.
As bearing piles: Not less than 2'-6".
Not greater than 10'-0" for piles within a row.

Timber piles: Not less than 2'-6".
Not greater than 10'-0" for piles within a row.

Edge Distance of Piles: The distance from the side of any pile to the nearest edge of the footing shall not be less than 9".

Driving Tolerance of Piles: Driving tolerance(s) for piles shall be considered when determining shear at the critical section.

Driving Tolerances for Steel and Concrete Piles *		
Pile Location/Condition	**Tolerance for Single Pile**	**Direction**
For elements supported by a single row of piles (plumb, battered or staggered). Includes but is not limited to bent caps, full integral abutments and abutments behind MSE walls.	± 3"	About long axis of footing
Footings for column piers	± 6"	About both major axes
Footings for abutments, retaining walls and piers except as noted above.	± 6"	About long axis of footing

* For driving tolerances of timber piles and other information, see VDOT *Road and Bridge Specifications*, Section 403 and Table IV-1.

Projection (Embedment) of Piles in Caps/Footings:

Pile type	Minimum projection (embedment)
Cast-in-place or precast concrete piles (including cylinder piles and drilled shafts)	6" into concrete with reinforcement projecting to obtain development as required by the design
Steel H-piles	12" into footings
Steel H-piles: when subjected to intermittent uplift (under any loading conditions) in areas subject to uplift under seismic load	18" into footing unless other methods of anchoring the pile to the footing are provided 18" plus a positive method of anchoring the pile to the footing
Timber piles	12" into footings

Minimum Footing Depth: Minimum footing depth shall be 3'-0".

Pile Bents: Cast-in-place piles shall not be used in pile bents or in soils which may induce shell collapse during driving.

Collision Walls: For details and requirements, see the Manual of the Structure and Bridge Division, Part 2, Chapter 15.

SECTION 11: ABUTMENTS, PIERS, AND WALLS:

Temperature and Shrinkage Forces Transferred to Substructure: Temperature and shrinkage forces where applicable shall be computed taking into account fixity, bearing type and pier stiffness.

For non-slip expansion and fixed bearings, the maximum superstructure movement at each substructure unit for force determination is as follows:

$$\Delta_O = (0.65 \times \Delta_T) + (\text{shrinkage}) = 0.65 \times (\alpha \times T_R \times L_{exp}) + (L_{exp} \times 0.0003)$$

where: Δ_O = maximum horizontal displacement of the superstructure, in.
$\Delta_T = \alpha \times T_R \times L_{exp}$ = the design thermal movement range, in.
α = coefficient of thermal expansion, in./in./°F
T_R = temperature range, °F (See Section 3 modifications)
L_{exp} = expansion length, in.

Uniform Temperature, TU, and Shrinkage, SH, are summed in the equation for Δ_O above. The force effects of both can be considered together because load factors for TU (all other effects) and SH are the same in both the strength and service limit states. Load factors are not shown in the equation for Δ_O above, but are applied to the force effects derived from the maximum horizontal displacement of the superstructure, Δ_O. Note that the load factors for force effects for both Uniform Temperature, TU, and Shrinkage, SH, in the strength limit state depend on whether I_g or $I_{effective}$ was used to derive forces.

Typical pier and abutment software apply load factors to derived forces internally. Designers shall ensure that the appropriate load factors are used in abutment and pier software programs for TU and SH. Designers must apply the appropriate load factors for the load combination limit state to the derived forces in any hand computations.

For slip expansion bearings, the maximum superstructure movement at each substructure unit for force determination need not be taken larger than the deformation corresponding to first slip using the extreme values of the friction coefficient between the sliding surfaces. Designers are cautioned that friction values often vary with compression stress, since slip velocity is low, coefficient of friction values used to initiate slip shall correspond to DL, even when the load combination includes both DL and LL.

Substructure: Substructures shall be self-supporting under all service life conditions including superstructure replacement. Superstructure shall not participate in the stability or strength of the substructure. Three (3) sided precast rigid frames are exempt from the self-supporting requirement.

SECTION 13: RAILINGS:

Crash tested parapets/rails shall be used on all projects. See Chapter 25 of Part 2 of the Manual of the Structure and Bridge Division for additional information.

The minimum height of a pedestrian and/or bicycle railing shall not be less than 54" measured from the top of the walkway/riding surface. See also Chapter 6 (Geometrics), Chapter 25 (Parapets, Railing, etc.) and Chapter 30 (Pedestrian Fencing) of Part 2 of the Manual of the Structure and Bridge Division.

The designer shall consider the use of open rails/parapets for structures over bodies of water in accordance with the Commonwealth Transportation Board resolution dated July 20, 1995.

For the timber initiative, FHWA crash tested timber rail shall be used.

SECTION 14: JOINTS AND BEARINGS:

Modular Joints: The use of modular joints is not permitted.

Joint Design: All joints shall be sized and designed for the corresponding movement [deformation] with shrinkage where applicable in the service limit state:

$$LF_{TU} \times (\Delta_T) + LF_{SH} \times (\text{shrinkage}) = 1.2 \times (\alpha \times T_R \times L_{exp}) + 1.0 \times (L_{exp} \times 0.0003)$$

where: LF_{TU} = Load Factor from Table 3.4.1-1 for TU deformation = 1.2
LF_{SH} = Load Factor from Table 3.4.1-1 for shrinkage = 1.0
$\Delta_T = \alpha \times T_R \times L_{exp}$ = the design thermal movement range, in.
α = coefficient of thermal expansion, in./in./°F
T_R = temperature range, °F (See Section 3 modifications)
L_{exp} = expansion length, in.

Steel Reinforced Elastomeric Bearings: Steel reinforced elastomeric pads shall be designed by Method A, Article 14.7.6. For expansion bearings, the maximum total shear deformation of the bearing, Δ_S, shall be calculated as follows with shrinkage where applicable in the service limit state:

$$\Delta_S = LF_{TU} \times (0.65 \times \Delta_T) + LF_{SH} \times (\text{shrinkage}) + LF_{ED} \times (ED)$$
$$= 1.2 \times (0.65 \times \alpha \times T_R \times L_{exp}) + 1.0 \times (L_{exp} \times 0.0003) + 1.0 \times (ED)$$

where: Δ_S = maximum total shear deformation of the bearing, in.
LF_{TU} = Load Factor from Table 3.4.1-1 for temperature deformation = 1.2
LF_{SH} = Load Factor from Table 3.4.1-1 for shrinkage = 1.0
LF_{ED} = Load Factor for expansion due to dead load deflection = 1.0
$\Delta_T = \alpha \times T_R \times L_{exp}$ = the design thermal movement range, in.
α = coefficient of thermal expansion, in./in./°F
T_R = temperature range, °F (See Section 3 modifications)
L_{exp} = expansion length, in.
ED = Expansion due to dead load deflection. ED may be only considered for expansion bearings at the abutments. ED may be ignored if jacking the superstructure and resetting the bearings are included in the plans. This is of particular concern in long span steel structures with high cambers. ED may be estimated with the equations on Page 7-70 and 7-71 of the Manual of Steel Construction, Volume II, 9th Edition, 1992.

From Eq. 14.7.6.3.4-1, $h_{rt} \geq 2 \times \Delta_S$

where: h_{rt} = total elastomer thickness, in.

SECTION 15: DESIGN OF SOUND BARRIERS:

AASHTO *Guide Specifications for Structural Design of Sound Barriers*, 1989 with 1992 and 2002 Interims shall be used in place of Section 15 for design of sound barriers.

AASHTO *LRFD Guide Specifications for the Design of Pedestrian Bridges*, 2009

Pedestrian and Multi-Use Bridges: A dead load wearing surface of 12 psf shall be added for pedestrian bridges wider than 12 feet between handrails if it is anticipated that the bridge could be overlaid in the future.

CC: Assistant State Structure and Bridge Engineers
District Structure and Bridge Engineers
FHWA: Bridge Section

VIRGINIA DEPARTMENT OF TRANSPORTATION

STRUCTURE AND BRIDGE DIVISION

INSTRUCTIONAL AND INFORMATIONAL MEMORANDUM

GENERAL SUBJECT: Corrosion Resistant Reinforcing Steels (CRR)	NUMBER: IIM-S&B-81.7
SPECIFIC SUBJECT: Plan Modifications for Projects with CRR	Date: December 13, 2016
	SUPERSEDES: IIM-S&B-81.6
DIVISION ADMINISTRATOR APPROVAL: /original signed/ Kendal R. Walus, P.E. State Structure and Bridge Engineer Approved: December 13, 2016	

Changes are shaded.

The following two types of corrosion resistant reinforcing (CRR) steel deformed bars shall be used in the structural elements identified in this document for all VDOT projects:

1. Low-carbon, chromium, steel reinforcing bars conforming to ASTM A1035/A1035M Alloy Type 1035 CS with a minimum chromium content of 9.2%.

2. Solid stainless steel reinforcing bars conforming to AASHTO Designation: MP 18M/MP 18-15. UNS* Designations S24000, S24100, S30400, S31603, S31653, S31803, S32101 and S32304.

VDOT defines three classes of CRR below allowing VDOT to specify alternative CRR steels within a specified Class.

Corrosion Resistant Reinforcing Steel, Class I: Steel shall conform to ASTM A1035/A1035M – Standard Specification for Deformed and Plain, Low-Carbon, Chromium, Steel Bars for Concrete Reinforcement Alloy Type 1035 CS with a minimum chromium content of 9.2%; or shall conform to AASHTO Designation: MP 18M/MP 18-15, Standard Specification for Uncoated, Corrosion-Resistant, Deformed and Plain Chromium Alloyed, Billet-Steel Bars for Concrete Reinforcement and Dowels, UNS* Designation: S24100.

Corrosion Resistant Reinforcing Steel, Class II: Steel shall conform to AASHTO Designation: MP 18M/MP 18-15, Standard Specification for Uncoated, Corrosion-Resistant, Deformed and Plain Chromium Alloyed, Billet-Steel Bars for Concrete Reinforcement and Dowels. UNS* Designation: S32101.

Corrosion Resistant Reinforcing Steel, Class III: Steel shall conform to AASHTO Designation: MP 18M/MP 18-15, Standard Specification for Uncoated, Corrosion-Resistant, Deformed and Plain Chromium Alloyed, Billet-Steel Bars for Concrete Reinforcement and Dowels. UNS* Designations: S24000, S30400, S31603, S31653, S31803 and S32304.

* Unified Numbering System for Metals and Alloys

The Class(es) of CRR steel(s) required on a project is/are to be denoted in the plans. CRR Class II or Class III may be substituted for Class I. CRR Class III may be substituted for Class II. CRR with a lower class designation than specified shall not be used.

REINFORCING STEELS DESIGNATED AS CRR:

CRR steels shall be used as indicated herein on all projects including new construction, widening, deck replacement, superstructure replacement, repair and rehabilitation projects.

For the following structural elements, the Class of CRR used shall be based on functional classification:

Concrete deck slabs (including bolster): All reinforcement.

Raised medians and sidewalks: All reinforcement.

Parapets, rails, median barriers and terminal walls: All reinforcement including that extending into the concrete deck slab, approach slab, retaining wall or moment slab.

Approach slabs and retaining walls: All reinforcing extending into parapet/rail.

Moment slabs: All reinforcement.

Integral backwalls for full integral, semi-integral and VA abutments: All reinforcement.

Concrete diaphragms (end, intermediate and continuity) for prestressed concrete beams: All reinforcement.

Prestressed concrete slabs (including Inverted-Tee beams, Box beams and Voided slabs): All reinforcement.

Precast concrete slab beam: All reinforcement.

Reinforced concrete slab spans: All reinforcement.

Functional Classification	CRR Steel Class I	CRR Steel Class II	CRR Steel Class III
Freeway			X
Rural Principal Arterial			X
Rural Minor Arterial		X	
Rural Collector Road	X		
Rural Local Road	X		
Urban Principal Arterial			X
Urban Minor Arterial		X	
Urban Collector Street	X		
Urban Local Street	X		

All Pedestrian Bridges	X		

Notes: x = all districts, all counties

For the following structural elements, CRR Steel shall be Class I:

Substructure units in tidal waters: All reinforcement.

Substructure units located within 22 feet from the edge of the traveled way (splash zone): All neat reinforcement including footing bars extending into neat concrete in the substructure units (abutments, protection barriers, piers, architecture treatment panels, etc.)

Portions of retaining walls located within 22 feet from the edge of the traveled way (splash zone): All reinforcement in MSE wall panels or any other retaining walls including facing of anchored type walls and architecture treatment panels. See APPENDIX A - Splash Zones.

Substructure units located outside 22 feet from the edge of the traveled way:

Piers or bents located under joints: All reinforcement in cap section, columns, walls and bent piles.

Conventional abutments without deck slab extensions or VA Abutments: All neat reinforcement.

MSE Wall Coping: All reinforcement.

Footings of full integral abutments: All reinforcement.

Box culverts (CIP and precast) with 0 to 2 foot fill: All reinforcement.

Rigid frames with less than 2 foot fill: All reinforcement in and extending into the top slab.

Prestressed concrete (Bulb-T and AASHTO) beams: Stirrups and other reinforcement extending into the concrete deck slab, full and semi-integral backwalls and continuity diaphragms.

Where the existing element does not contain CRR and where supplemental reinforcing steel is required, the supplemental reinforcing steel shall be CRR Class I for the following repair applications:

> Concrete superstructure surface repair (excluding concrete deck patching) and concrete substructure surface repair located within 22 feet from the edge of traveled way (splash zone) on restorative maintenance work.

Examples of applications where CRR is not required include box culverts (CIP and precast) with fill greater than 2 feet, precast wingwalls of culverts and approach slabs (except as noted above).

DESIGN ISSUES:

Design shall be based on yield strength of 60 ksi for all three Classes of CRR. This allows substitution of other types/Classes of CRR steel should there be availability/supply issues.

Hooks, lap lengths and development lengths are in accordance with the design specifications using yield strength of 60 ksi. See also the office practice (*Manual of the Structure and Bridge Division*, Part 2), Chapter 7.

When expanding or replacing any portion of an existing structure using CRR in accordance with this IIM, CRR can be spliced with the existing carbon (black) or epoxy coated reinforcing steel.

DETAILING ISSUES:

Availability of bars sizes (#3 through #11) and bar lengths:

	CRR **Low Carbon/ Chromium**	**CRR** **Solid Stainless**
Bar sizes	All	All
Bar lengths	40 feet – all sizes 60 feet all except #3*****	40 feet – all sizes 60 feet – all sizes

***** Standard fabrication bar length for #3 is 40 feet. Longer length is available by special order.

CRR STEEL: INSERTS, TIES, SPLICERS, CHAIRS/BAR SUPPORTS AND SPACERS:

Supplemental Section 406 – Reinforcing Steel to the VDOT *Road and Bridge Specifications* includes the following items addressing corrosion resistant reinforcing steels:

INSERTS:

All inserts, rods, clips, angles and other steel hardware that will remain in the concrete superstructure or deck shall be galvanized or stainless unless otherwise specified by the Engineer.

TIES:

Unless otherwise specified by the Engineer, tie wires used with corrosion resistant reinforcing steel shall be: plastic; solid stainless; epoxy-coated carbon (black) steel wire or plastic-coated carbon (black) steel wire.

MECHANICAL BUTT SPLICERS (CONNECTORS):

For corrosion resistant reinforcing bars, mechanical butt splicers shall be of the same material as the bars being spliced.

CHAIRS/BAR SUPPORTS:

Plastic (composite) chairs may be used to support Corrosion Resistant Reinforcement (CRR) in precast concrete elements; otherwise, CRR in structures shall be supported by steel bar supports as follows, unless otherwise specified by the Engineer:

1. For Class I CRR, steel bar supports shall be: plastic-protected wire bar supports (per CRSI Class 1 – Maximum Protection) when stay-in-place forms are not used and the steel bar support will be exposed; and epoxy-coated bright basic wire bar supports (per CRSI Class 1A – Maximum Protection) when either stay-in-place forms are used or the steel bar support will not be exposed.

2. For Class II and Class III CRR, steel bar supports shall be: either stainless steel wire bar supports or plastic-protected wire bar supports (per CRSI Class 1 – Maximum Protection) when stay-in-place forms are not used and the steel bar support will be exposed; and epoxy-coated bright basic wire bar supports (per CRSI Class 1A – Maximum Protection) when either stay-in-place forms are used or the steel bar support will not be exposed.

Steel bar supports for CRR shall be fabricated from cold-drawn carbon steel wire conforming to the CRSI corrosion protection class listed above for their specific use, except for plastic-protected wire bar supports, which shall be epoxy-coated with plastic protection applied by dipping legs (i.e., capping legs with pre-molded plastic tips is prohibited).

SIDE-FORM SPACERS:

Side-form spacers shall meet the same corrosion protection level as the bar supports.

SUPPLEMENTAL SPECIFICATIONS

See: Supplemental Section 223 and Supplemental Section 406

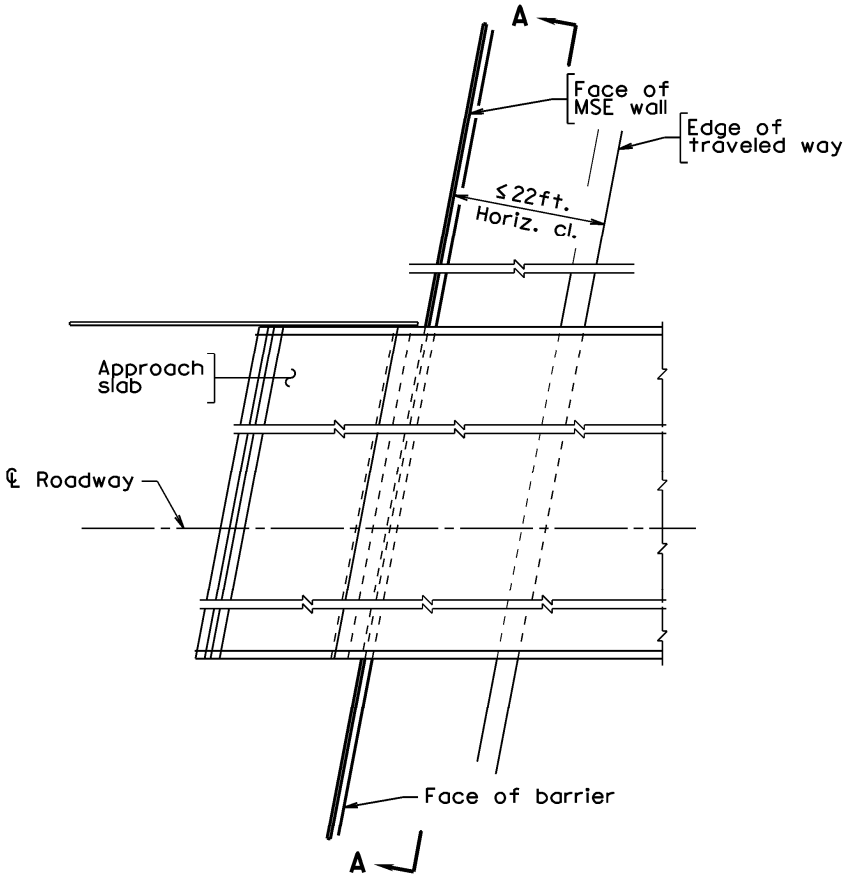
SPLASH ZONES

See: Appendix A – Splash Zones

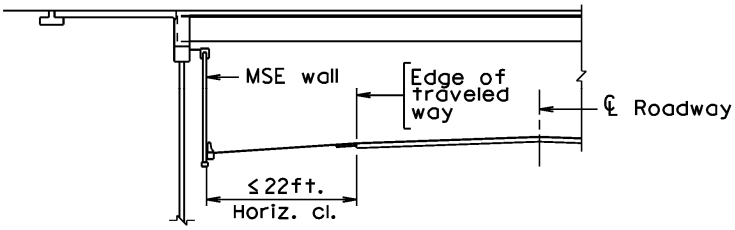
CC: Chief Engineer
Division Administrators
District Administrators
District Construction Engineers
District Maintenance Engineers
Assistant State Structure and Bridge Engineers
District Structure and Bridge Engineers
Residency Administrators/Engineers
Structure and Bridge Program Managers
FHWA: Bridge Section

APPENDIX A – SPLASH ZONES:

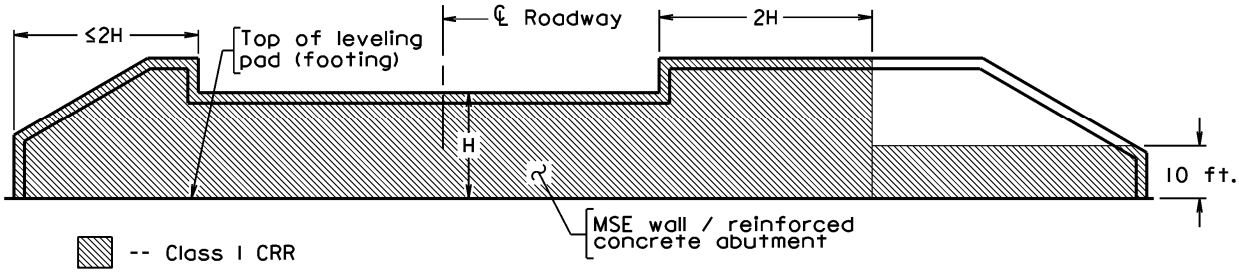
Example 1: MSE wall or reinforced concrete abutment retaining wall parallel to roadway



PLAN



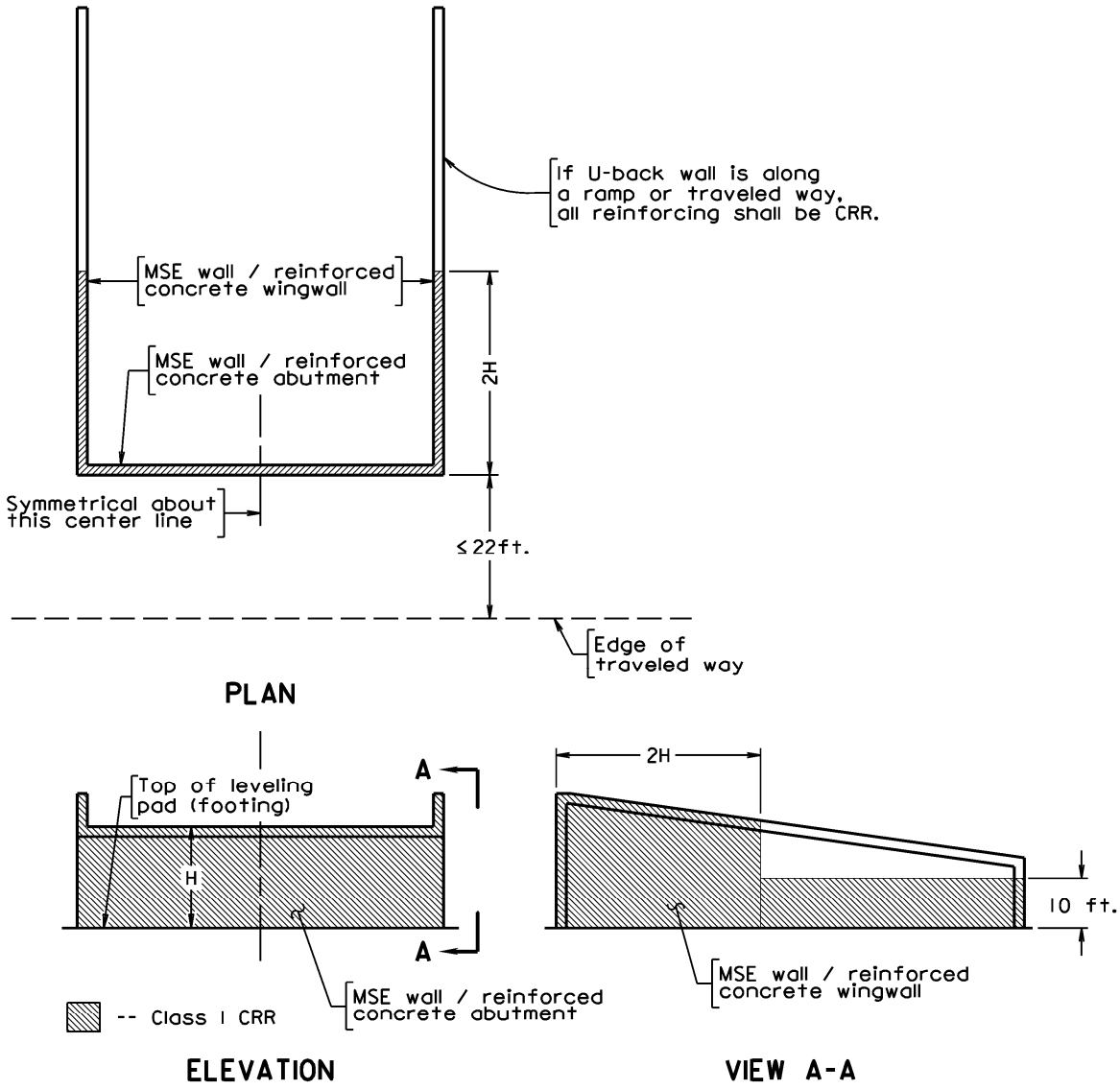
ELEVATION



VIEW A-A
(MSE Wall without Barrier)

APPENDIX A – SPLASH ZONES: (Cont'd)

Example 2: U-back MSE wall or reinforced concrete abutment and wing wall



VIRGINIA DEPARTMENT OF TRANSPORTATION

STRUCTURE AND BRIDGE DIVISION

INSTRUCTIONAL AND INFORMATIONAL MEMORANDUM

GENERAL SUBJECT: Traffic Structures	NUMBER: IIM-S&B-82 TED- 357
SPECIFIC SUBJECT: Establishing procedures for shop plans, modifications, maintenance, and inspection of traffic structures.	Date: July 23, 2008
	SUPERSEDES: SB-69-02/TE-310 SB-66.1/MM-322 MM-323
DIVISION ADMINISTRATOR APPROVAL: Kendal R. Walus, P.E. /Original Signed State Structure and Bridge Engineer Approved: July 23, 2008 R. J. Khoury, P.E. /Original Signed State Traffic Engineer Approved: July 23, 2008	

EFFECTIVE DATE: This memorandum is effective upon receipt.

This I&IM replaces the following memorandums: SB-69-02/TE-310 *Modifications of Traffic Control Device Structures*, SB-66.1/MM-322 *Inventory of Traffic Control Device Structures*, and MM-323 *Procedure for Review and Retention of Traffic Control Device Shop Drawing/Catalog Cut Submittals*

This memo addresses the following types of traffic structures:

- Overhead span sign structure
- Cantilever sign structure
- Bridge parapet mounted sign structure
- Traffic signal structure
- Offset lighting pole
- Butterfly sign structure
- High mast lighting structure
- Camera pole
- Conventional lighting pole

The purpose of this memorandum is to clarify and update previous memoranda between the Structure and Bridge Division and Traffic Engineering Division and addresses the following areas related to traffic structures: review/retention of shop plans, modifications to structures,

maintenance of structures, and safety inspection. Hereinafter, these structures will be collectively referred to as traffic structures.

Review/Retention of Shop Plans:

The Construction Manager or other manager as appropriate shall forward all but one copy of the plans, computations, and shop drawings for the traffic structures to the Regional Operations Maintenance Manager or other section engineer as appropriate for verification of vertical clearance, sign panel location and size, and other non-structural related requirements. The Construction Manager or other manager as appropriate shall forward one copy of the plans, computations, and shop drawings for the traffic structures listed above to the District Structure and Bridge Engineer for a structural review. The District Structure and Bridge Engineer shall provide a set of comments and/or marked up drawings to the Regional Operations Maintenance Manager or other section engineer as appropriate so that joint comments may be developed in order to avoid conflicting reviews on submittals. The Regional Operations Maintenance Manager or other section engineer as appropriate shall return the comments to the Construction Manager or other manager as appropriate for distribution upon completion of the project to the following:

- Contractor
- Regional Operations Maintenance Manager
- Regional Traffic Engineer
- Municipality
- Project Engineer
- State Materials Engineer response letter only
- District Materials Engineer response letter only
- District Structure and Bridge Engineer
- State Structure and Bridge Engineer (Attention: Engineering Services)

Based on business need, this policy may be modified on projects where consultants are retained by the Department for shop drawing review; however, the District Structure and Bridge Engineer shall be sent a copy of the final approved submittal(s) to assist in the initial acceptance inspection.

The Regional Operations Maintenance Manager or other section engineer as appropriate shall be responsible for maintaining an archive of the As-Built contract plans, shop plans, calculations, and correspondence.

Modifications to Traffic Structures:

No modifications shall be performed / executed on traffic structures without approval of the District Structure and Bridge Engineer. These modifications shall include but not be limited to the following: movement of signals or signs, increase in number or size of signals, sign panels, etc.

Prior to performing modifications to existing traffic structures, the Section Engineer responsible for the design of the modification shall prompt the Regional Operations Maintenance Manager to request a structural review to be performed by the District Structure and Bridge Engineer. At the time of the request, they should provide a copy of the As-Built shop drawings and computations for the traffic structure and plans for the proposed modifications.

The District Structure and Bridge Engineer may coordinate this review as necessary with the Central Office Structure and Bridge Division or a consultant.

For modifications to traffic structures during construction, the Construction Manager or other manager as appropriate shall have the fabricator/designer provide revised computations and plans reflecting the actual field conditions for review and approval.

Maintenance of Traffic Structures:

The Regional Operations Maintenance Manager or other section engineer as appropriate shall be responsible for coordinating and funding all maintenance activities associated with traffic structures, including the development of replacement or relocation plans when warranted. As required, the District Structure Bridge Office will provide structural engineering support.

Safety Inspection:

All inspections on traffic structures shall be performed by the District Structure and Bridge Office or authorized consultant.

Initial Acceptance Inspection:

It is the responsibility of the Construction Manager or other manager as appropriate to notify the District Structure and Bridge Engineer, in writing, upon completion of construction and prior to final acceptance of traffic structures and to provide the following information:

1. Memo requesting the inspection of the traffic structures. This memo is included with this document in appendix A or may be obtained in Microsoft Word ® format on the internet at the following link:

   http://www.extranet.vdot.state.va.us/locdes/electronic%20pubs/Bridge%20Manuals/IIM/SBIIM.pdf

   Click on the link in the table of contents for IIM-S&B-82 and then click on the attachment tab on the left hand side.

2. Upon receipt of the request, the District Structure and Bridge Engineer shall perform the following:
   a. Set up a separate file folder for each traffic structure and add the traffic structure to the appropriate database.
   b. Establish a unique structure number and stencil the number on the traffic structure during the initial inspection.
   c. Complete the inspection report for each traffic structure per the manual, *Procedures for Inventory and Inspection of Traffic Control Device Structure*.

3. The Construction Manager or other manager as appropriate shall coordinate with the Contractor to provide access to the traffic structures to the District Structure and Bridge Engineer representative to perform the inspection and to provide traffic control as needed for the inspection.

4. The District Structure and Bridge Engineer shall notify the Construction Project Manager and Regional Operations Maintenance Manager or other section engineer as appropriate of all deficiencies that require corrective action.

5. Following any corrective action needed from the initial inspection, the Construction Manager or other manager as appropriate shall request in writing from the District Structure and Bridge Engineer the re-inspection of the traffic structures using the same form in step one.

Scheduled Inspection:

The District Structure and Bridge office shall perform scheduled inspection(s) for the traffic structures in accordance with the procedures set forth in the manual, *Procedures for Inventory and Inspection of Traffic Control Device Structures*. The District Structure and Bridge Engineer will perform the following tasks:

1. Re-inspect traffic structures per the established frequency. Typically, traffic structures are inspected every 5 years, but may require more frequent inspection. For example, traffic structures that show signs of section loss, corrosion of anchor bolt, etc. may require a more frequent inspection frequency.

2. After the inspection, forward an electronic copy of the completed inspection report to the Regional Operations Maintenance Manager or other engineer as appropriate and the Residency Administrator.

3. Structural deficiencies, required correction and priority order as noted in the inspection report will be brought to the attention of the Regional Operations Maintenance Manager or other section engineer as appropriate.

Non-scheduled Inspection:

The Regional Operations Maintenance Manager or other section engineer as appropriate shall request a re-inspection by the District Structure and Bridge Engineer of these traffic structures following any planned upgrade, improvement and/or modification.

Upon request, the District Structure and Bridge office shall perform the inspection for the traffic structures in accordance with the procedures set forth in the manual, *Procedures for Inventory and Inspection of Traffic Control Device Structures*. The District Structure and Bridge Engineer will perform the following tasks:

1. Re-inspect traffic structures.

2. After the inspection, forward an electronic copy of the completed inspection report to the Regional Operations Maintenance Manager or the Regional Traffic Operations Manager (as appropriate) and the Residency Administrator.

3. Structural deficiencies requiring correction as noted in the inspection report will be brought to the attention of the Regional Operations Maintenance Manager or other section engineer as appropriate.

Removal from Service:

The Regional Operations Maintenance Manager or other section engineer as appropriate shall inform the District Structure and Bridge Engineer when these traffic structures are removed from service so that they may be removed from the database.

CC:

Chief Engineer
Chief of Systems Operations
Traffic Engineering Division Director
Asset Management Division Director
District Construction Engineers
District PE Managers
District Maintenance Engineers
District Structure and Bridge Engineers
Regional Operations Maintenance Manager
Regional Operations Directors
Residency Administrators
Regional Traffic Operations Manager
Regional Traffic Engineer

Enclosures

Appendix A

REQUEST FOR INSPECTION OF TRAFFIC CONTROL STRUCTURES

INTEROFFICE MEMORANDUM

Date:

Project Number:

Universal Project Code (UPC):

TO:

FROM:

The following traffic control structures require an inspection prior to acceptance by VDOT/City/County:

Structure ID *	Location	Type of Structure	Structure Number

* As referenced on the traffic/sign plans.
(Attach additional sheets if necessary)

Enclosed you will find:

____ 1) A set of traffic/sign plans (plan sheets and layout sheets).
____ 2) PE stamped and approved shop plans (structure fabrication plans).
____ 3) PE stamped and approved foundation plans (if applicable).
____ 4) Computer output/manual design calculations -- superstructure and foundation.
____ 5) Miscellaneous correspondence indicating fabricator, contractor and PE stamped review.

VIRGINIA DEPARTMENT OF TRANSPORTATION

STRUCTURE AND BRIDGE DIVISION

INSTRUCTIONAL AND INFORMATIONAL MEMORANDUM

GENERAL SUBJECT: Bridge Touchdown Points	NUMBER: IIM-S&B-83
SPECIFIC SUBJECT: Procedure for Establishing HPB Funding Eligibility	DATE: June 17, 2009
	SUPERSEDES: None
DIVISION ADMINISTRATOR APPROVAL: /original signed/ Kendal R. Walus, P.E. State Structure and Bridge Engineer Approved: June 17, 2009	

Changes are shaded.

EFFECTIVE DATE:

This memorandum is effective upon receipt.

POLICY:

This memorandum establishes criteria for determining project eligibility and project limits (touchdown points) utilizing Highway Bridge Program (HBP) Funding.

CRITERIA FOR DETERMINING ELIGIBILITY OF BRIDGE WORK FOR HBP FUNDING:

The following <u>four criteria</u> must be met for a structure to qualify for (HBP) funding previously known as Highway Bridge Rehabilitation and Replacement Program (HBRRP):

1. BRIDGE MUST HAVE AN OPENING MEASURED ALONG THE CENTER OF THE ROADWAY OF MORE THAN TWENTY (20) FEET between undercopings of abutments or springlines of arches, or extreme ends of the openings for multiple boxes or pipes.

2. BRIDGE MUST NOT HAVE BEEN REPLACED OR REHABILITATED DURING THE PAST TEN YEARS (the “10-year rule”).

3. BRIDGE MUST BE STRUCTURALLY DEFICIENT OR FUNCTIONALLY OBSOLETE.

4. BRIDGE MUST HAVE A SUFFICIENCY RATING (SR) OF:

≤ 80 FOR REHABILITATION / RECONSTRUCTION
< 50 FOR REPLACEMENT

A classification of **STRUCTURALLY DEFICIENT** (Bridge Inventory Records) will be determined as follows:

GENERAL CONDITION RATING OF “4” OR LESS for one of the following:

- Decks (Item 58)
- Superstructures (Item 59)
- Substructures (Item 60)
- Culverts (Item 62)

(Item 62 is applicable only if Item 43 is coded 19)

- or -

APPRAISAL RATING OF “2” OR LESS for one of the following:

- Structural Condition (Item 67)
- Waterway Adequacy (Item 71)

(Item 71 applies only if the last digit of Item 42 is coded 0, 5, 6, 7, 8, or 9)

A classification of **FUNCTIONALLY OBSOLETE** (Bridge Inventory Records) will be determined as follows:

APPRAISAL RATING OF “3” or less for one of the following:

- Deck Geometry (Item 68)
- Under-clearances (Item 69)

(Item 69 applies only if the last digit of item 42 is coded 0, 1 2, 4, 6, 7 or 8)

- Approach Roadway Alignment (Item 72)

- or -

APPRAISAL RATING OF "3" for one of the following:

- Structural Condition (Item 67)
- Waterway Adequacy (Item 71)

(Item 71 applies only if the last digit of item 42 is coded 0, 5, 6, 7, 8 or 9)

QUALIFYING APPROACH WORK ITEMS AND SAFETY APPURTANCES:

1. Transitions to existing roadway to accommodate minimum design criteria.
2. Temporary detours (when used).
3. Temporary drainage.
4. Approach slabs (when used).
5. Guardrail and attachments.
6. Earthwork for bridge fill.
7. Right of way costs (except utilities).
8. Preliminary Engineering costs.
9. Construction costs.

NON-QUALIFYING ITEMS (when constructed beyond the approved touchdown points):

1. Interchanges and ramps.
2. Long approach fills.
3. Connecting roadways.
4. Causeways.
5. Construction of extensive earth structures.
6. Utility work.

PROCEDURE FOR ESTABLISHING TOUCHDOWN POINTS FOR ELIGIBLE BRIDGES:

Requirements specified in 23 CFR Sec. 650.405 under "Eligible Projects", available at: http://a257.g.akamaitech.net/7/257/2422/12feb20041500/edocket.access.gpo.gov/cfr_2004/aprqtr/pdf/23cfr650.405.pdf shall be considered in establishing reasonable touchdown points for approach work to be funded with HBP funds.

Every deficient bridge scheduled for rehabilitation or replacement shall be evaluated individually to establish reasonable touchdown points for approach work.

The Project Manager shall submit a completed Form SB 107 (Federal Bridge Replacement Program Determination of Touchdown Points) for approval to the Assistant State Structure and Bridge Engineer for Inspection and Maintenance. See Appendix B for a completed sample form.

The reasonable touchdown points for all eligible bridges shall be determined by the Project Manager based on the following two criteria:

1. The cost of the approach work funded with HBP funds does not exceed 25% of the bridge rehabilitation or replacement cost on the Federal-aid System and 50% on the Off-System.

2. The length of the eligible approach work on each side of the bridge is less than 600 feet. For ease in establishing project limits, the Project Manager may adjust the approach work limits to just one side of the bridge not to exceed 1200 feet for ease in determining quantities and cost.

If the Project Manager feels that the reasonable touchdown points should exceed both of the criteria above, then the project shall be submitted to FHWA with supporting documentation for review and approval.

EXAMPLES:

See examples in Appendix A for eligible work.

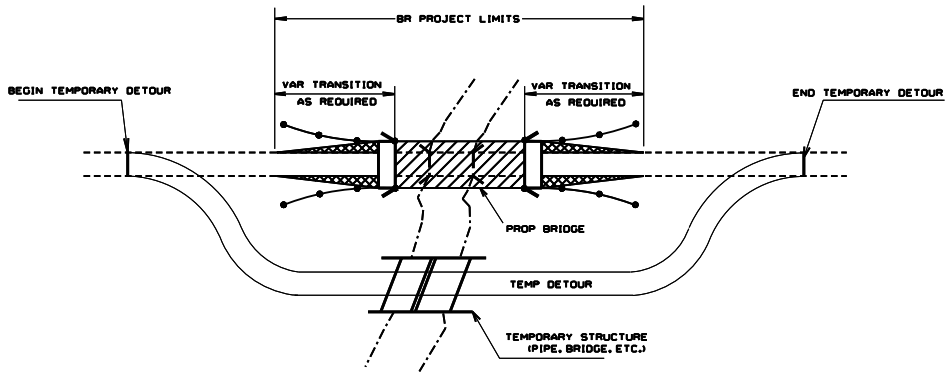
Cc: Chief Engineer
Chief Financial Officer
Location and Design Division Administrator
Local Assistance Division Administrator
Programming Division Administrator
Assistant State Structure and Bridge Engineers
District Preliminary Engineering Managers
District Structure and Bridge Engineers
Structure and Bridge Program Managers

APPENDIX A

EXAMPLE 1 : SUBSTANDARD BRIDGE ON EXISTING LOCATION (Bridge Project Only):

When replacing or rehabilitating a substandard bridge to minimum standards or greater, on existing grade and location, all approach work items required to transition back into the existing roadway and safety appurtenances pertaining to the bridge are eligible. The cost of any temporary detour required for maintenance of traffic while the structure is being built is eligible.

EXISTING LOCATION - BRIDGE ONLY
SUBSTANDARD STRUCTURE ON EXISTING LOCATION AND GRADE

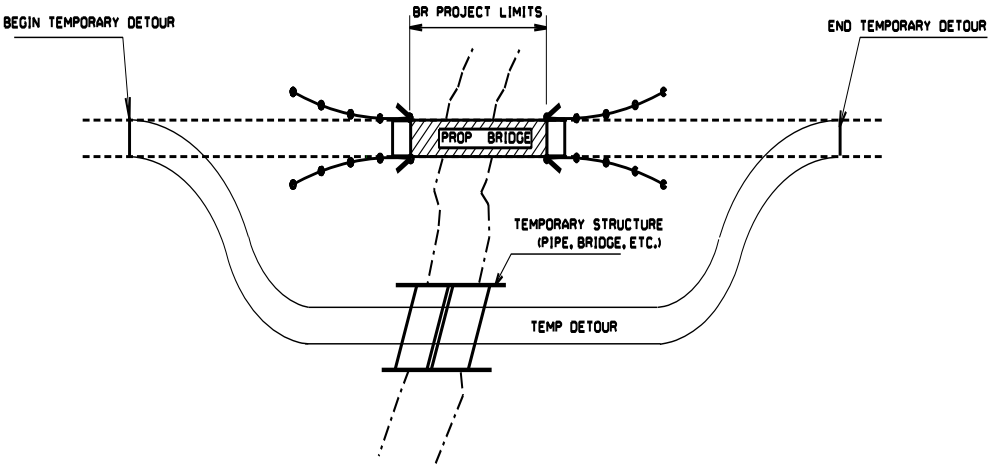


APPENDIX A

EXAMPLE 2: STANDARDS COMPLIANT BRIDGE ON EXISTING LOCATION

When replacing a bridge that conforms to standard widths on existing grade and location, all approach work items and safety appurtenances pertaining to the bridge are eligible. The cost of any temporary detour required for maintenance of traffic while the structure is being built is eligible.

EXISTING LOCATION- BRIDGE ONLY
STRUCTURE CONFORMS TO STANDARD WIDTHS – ON EXISTING LOCATION AND GRADE

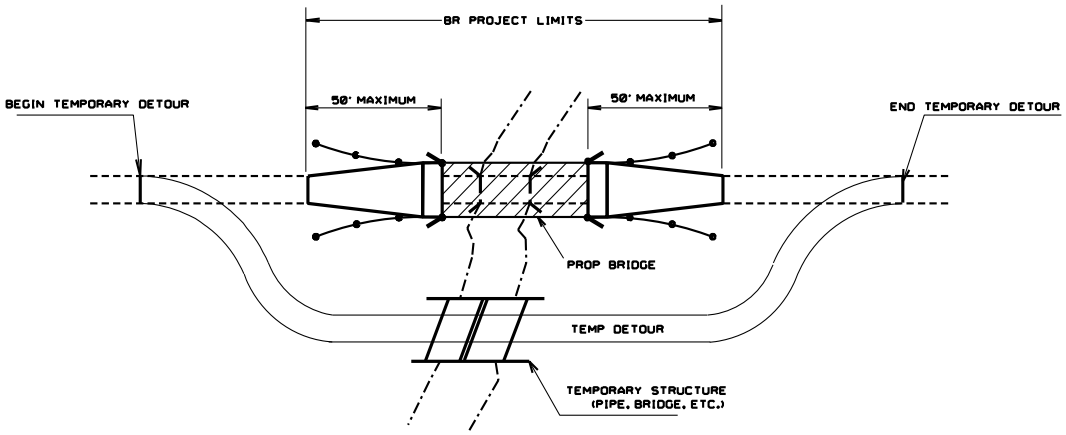


APPENDIX A

EXAMPLE 3: SUBSTANDARD BRIDGE AND ROADWAY ON EXISTING LOCATION (Project to upgrade roadway and rehabilitate or replace a deficient bridge):
When replacing or rehabilitating a substandard bridge to minimum standards or greater, on existing grade and location, bridge work items will be limited to 50 feet of approach work at beginning and end of bridge.

All approach work items within 100 feet are eligible for consideration. (This allows the coverage of the cost of approach slabs, select material behind the abutments, guardrail attachments and other approach work items.) If a detour is required, associated roadway costs required for maintenance of traffic while the structure is being built are eligible.

EXISTING LOCATION –
BRIDGE AND ROADWAY UPGRADE
SUBSTANDARD STRUCTURE - EXISTING LOCATION & GRADE



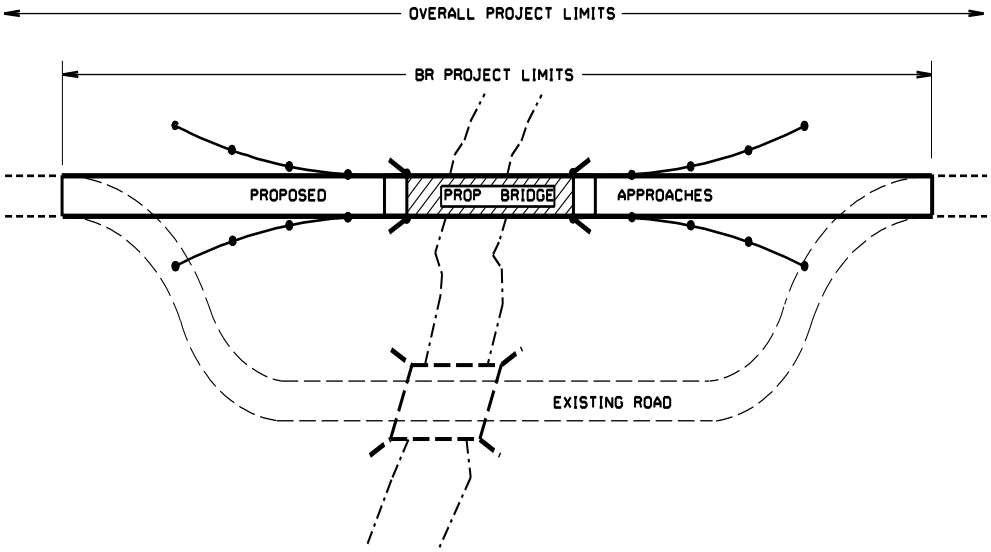
APPENDIX A

EXAMPLE 4: SUBSTANDARD BRIDGE ON NEW LOCATION

When replacing a bridge that needs to be raised or relocated due to substandard vertical and horizontal alignment, substandard clearances, hydraulic design issues, constructability issues, etc., the minimum amount of approach roadway work necessary to tie the relocated alignment back into the existing roadway is eligible. The alignment will conform to current AASHTO standards based on the functional classification and projected traffic volumes for that particular roadway.

When a section of roadway that has poor geometry is being upgraded, and this roadway section includes the replacement of a bridge that does not have a geometric problem, engineering judgment shall be used in determining the amount of approach work to be funded with HBRRP funds.

BRIDGE ON NEW LOCATION
REPLACEMENT OF QUALIFYING STRUCTURE ON RELOCATED ALIGNMENT



APPENDIX B

SAMPLE FORM

DETERMINATION OF TOUCHDOWN POINTS			
DISTRICT:	Bristol	PROJECT NO.:	0058-084-120,B601
ROUTE NO.:	58	UPC:	77344
COUNTY/CITY:	Scott County	PROJ. MNGR.:	John Smith
PROJECT LIMITS	FROM STA.: 10+00	DATE SUBMITTED:	June 1, 2009
	TO STA.: 28+00		

EXISTING STRUCTURE		PROJECT ESTIMATED COST	
CROSSING OVER:	Deer Crossing Creek	PE:	$ 500,000
VA STRUC. NO.:	1012	ROW/UTIL:	$ 250,000
FED. STRUC ID.:	189675	CONSTR:	$ 4,000,000
STRUC. LENGTH (ft):	120	TOTAL:	$ 4,750,000
SUFF. RATING :	30		

PROPOSED STRUCTURE		BRIDGE EST. COST	
BEGIN STA.:	15+00	PE:	$ 150,000
END STA.:	18+50	ROW:	$ 50,000
BRIDGE LENGTH (ft):	150	CONSTR.:	$ 2,000,000
APPROACHES (ft):	200	APPROACHES:	$ 100,000
TOTAL LENGTH (ft):	350	TOTAL:	$ 2,300,000

APPROVED STRUCTURE REPLACEMENT PROJECT LIMITS			
BEGIN STA.:	15+00		
END STA.:	18+50	APPROVED BY:	Anwar S. Ahmad, P.E.
BRIDGE LENGTH (ft):	150		For State S&B Engineer
APPROACHES (ft):	200		
TOTAL LENGTH (ft):	350	DATE:	June 05, 2009

Comments: The proposed bridge replacement and approach roadway limits are approved.
This request doesn't require FHWA approval.

FHWA REVIEW AND APPROVAL*

APPROVED BY: DATE:

Comments:

* Submit this form to FHWA for review and approval when **BOTH** the cost of the approach roadway work exceeds 25% the cost of the bridge located on Federal Aid route or 50% of the bridge located on non-Federal Aid route **AND** the total length of approaches exceed 1200 feet.

CC: Programming Division Administrator
Local Assistance Division Administrator
FHWA (Attn: VA Division Bridge Engineer)
District Preliminary Engineer
State Structure & Bridge Engineer

VIRGINIA DEPARTMENT OF TRANSPORTATION

STRUCTURE AND BRIDGE DIVISION

INSTRUCTIONAL AND INFORMATIONAL MEMORANDUM

GENERAL SUBJECT:	NUMBER:
Recording and Tracking Bridge Maintenance Work	IIM-S&B-85.2 IIM-CD-2013-18.01
SPECIFIC SUBJECT:	Date: August 9, 2013
	SUPERSEDES: IIM-S&B-85.1
DIVISION ADMINISTRATOR APPROVAL:	
/original signed/ Mark E. Cacamis, P.E. State Construction Engineer Approved: August 9, 2013	/original signed/ Kendal R. Walus, P.E. State Structure and Bridge Engineer Approved: August 9, 2013

Changes are shaded.

INTRODUCTION:

This joint I&IM by the Structure and Bridge Division and the Construction Division establishes guidelines for capturing bridge maintenance work accomplishment activities.

EFFECTIVE DATE: This memorandum is effective upon receipt.

SCOPE:

All bridge maintenance and construction personnel shall adhere to the requirements herein.

In order to properly manage the bridges and structures owned and maintained by VDOT it is essential to properly capture all work accomplishment activities performed on the bridge and large culvert assets. This includes work performed by both State Forces and by Contract. In order to do this in the most efficient manner, *the Work Accomplishment Module in AMS and SiteManager Plug-In tool shall be used for capturing and reporting all maintenance work performed on VDOT owned or maintained bridges and culverts.*

All work performed on bridges and culverts by State Forces shall be reported in the Maintenance Division's Work Accomplishment Module in AMS. The module will support the adequate management of VDOT's structures by capturing all work activities as well as resource usage in terms of labor, equipment and materials.
The five-digit bridge maintenance activity codes (Cardinal Tasks) and associated quantities shall be used when coding work in the Work Accomplishments Module. A list of bridge maintenance activity codes can be found in the Appendix at the end of this document.

The Work Accomplishment Module in AMS is located at the following link:

http://amsworkaccp/Pages/Search/Search.aspx

A large portion of work performed on bridges is accomplished by contract. In order to capture this work it is necessary to capture the extent and costs associated with contracted work managed by the Construction Division. The SiteManager Plug-In tool will capture the contract bridge work data we need to help manage our structures. Since the SiteManager Plug-in is in use by the Construction Division for all contracted work it only requires adding the five-digit bridge maintenance activity codes (Cardinal Tasks) for use in capturing bridge work performed. Instructions for how to use the Site Manager Plug in can be found in the following link:

http://insidevdot/sites/Structure_andBridgeDivisionTeamSite/Bridge_Management/Shared%20Documents/Bridge%20Maintenance%20Work%20Reporting/21-Appendix%20F-Maintenance%20Charges%20Plug-in.pdf

The District Structure and Bridge Section will provide the Construction Inspectors with information on the bridge maintenance activity codes and the Federal Bridge Identification numbers that are to be used on the contracts in addition to the normal information supplied for the contract at the time of the preconstruction meeting. The Construction Inspectors will then be responsible for reporting expenses against the Structure Identification Numbers for the work performed using the SiteManager Plug-In tool.

CC: Chief Engineer
Deputy Chief Engineer
Division Administrators
District Administrators
District Construction Engineers
District Maintenance Engineers
Assistant State Structure and Bridge Engineers
District Structure and Bridge Engineers
Residency Administrators
Structure and Bridge Program Managers

APPENDIX A

Bridge Maintenance Activity Codes (Cardinal Tasks)											
Bridge Deck		Bridge Superstructure		Bridge Substructure		Culvert (> 36SF)		Bridge Misc.		Inspection & Engineering	
Code	Name	Code	Name	Code	Name	Code	Name	Code	Name	Code	Name
70700	Ordinary Maintenance	70720	Ordinary Maintenance	70740	Ordinary Maintenance	70750	Ordinary Maintenance	70760	Ordinary Maintenance	75780	Safety Insp - Interstate
71701	Deck Patching	721		741		751		761		75781	Safety Insp - Primary
71702	Seal Cracks	722		742		752		762		75782	Safety Insp - Secondary
71703	Thin Overlay	72211	Movable - Mech Repairs	743		753		763		783	
71704	Joint Rehabilitation	72500	Movable - Corrective Maintenance (Includes Elec Repairs)	744		754		764		784	
72705	Rigid Overlay	72725	Conc. Superstr Repair	72745	Substr Surface Repair	72755	Surface Repair	72765	Approach Slab	785	
72706	Rail Repair	72726	Steel Superstr Repair	72746	Repair Undermining	72756	Repair Undermining	766		786	
72707	Timber Rehabilitation	72727	Bearing Repair	747		757		767		787	
72708	Asphalt Overlay	72728	Paint	748		74758	Major Rehabilitation	768		788	
709		72729	Spot Painting	74749	Major Rehabilitation	74759	Culvert Replacement	769		789	
710		730						770		75790	Bridge Rating - Interstate
711		731						771		75791	Bridge Rating - Primary
712		732						772		75792	Bridge Rating - Secondary
713		733						773		793	
714		734						774		794	
715		735						775		795	
716		736						74771	Mobilization	796	
717		737						74772	Maintenance of Traffic	797	
718		738						74773	Misc. Roadway Items	75798	Bridge Management
74719	Deck Replacement	74739	Superstr Replacement					74779	Bridge Replacement	75799	Preliminary Engineering

Legend

Color Code	Bridge Program	Activity Code Series
	Ordinary Maintenance	70XXX Series
	Inspection & Engineering	75XXX Series
	PM	71XXX Series
	Restorative / Paint	72XXX Series
	Rehabilitation/Replacement	74XXX Series

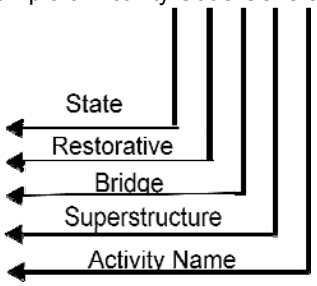
Cost Centers for Stationary Bridges

11173550	Interstate
11153550	Primary
11163550	Secondary

Cost Centers for Movable Bridges

11173680	Interstate
11153680	Primary
11163680	Secondary

Example of Activity Code Generation



Code Digit	Meaning	Legend
1	State / Federal	7 - State; 6* - Federal
2	Program	0 - Ordinary Maintenance, 1 - PM; 2-Restorative / Paint; 4 - Rehabilitation / Replacement; 5 - Inspection & Engineering
3	Asset	7 - Bridge
4	Asset Group	0, 1 - Deck; 2, 3 - Superstructure; 4 - Substructure; 5 - Culvert; 6, 7 - Bridge; 8,9 - Inspection & Engineering
5	Action	Activity Name

*** 6XXXX activities can only be used if the work to be performed qualifies for federal reimbursement.**

When washing a bridge you will use one of the Ordinary Maintenance (routine preventive maintenance) activities associated with bridges. Depending on what portion of the bridge is being washed, one of the following activities is to be used:

When *only the deck is washed* use 70700 (Ordinary Maintenance – Deck)
When *only the superstructure is washed* use 70720 (Ordinary Maintenance – Superstructure)

When *only the substructure is washed* use 70740 (Ordinary Maintenance – Substructure)
When *more than one portion of the bridge is washed* use 70760 (Ordinary Maintenance – Bridge)

Bridge Maintenance Activity Codes (Cardinal Tasks)

Activity Number				
Federal*	State	Activity Name	Activity Description	Unit of Measure
60700	70700	Ordinary Maintenance - Deck	Minor maintenance work that preserves/extends the life of the deck or corrects minor defects. Examples: bridge deck cleaning, temporary deck patching.	SY
60720	70720	Ordinary Maintenance - Superstructure	Minor maintenance work that preserves/extends the life of the superstructure or corrects minor defects. Examples: superstructure cleaning, cleaning /lubricating bearings.	EA
60740	70740	Ordinary Maintenance - Substructure	Minor maintenance work that preserves/extends the life of the substructure or corrects minor defects. Examples: substructure cleaning, erosion stabilization, debris/vegetation removal.	EA
60750	70750	Ordinary Maintenance - Culvert	Minor maintenance work that preserves/extends the life of the culvert or corrects minor defects. Examples: culvert cleaning, erosion stabilization, debris/vegetation removal.	EA
60760	70760	Ordinary Maintenance - Miscellaneous	Minor maintenance work that preserves/extends the life of other elements of a structure or corrects minor defects. Examples: stream bank stabilization, debris/vegetation removal.	EA
61701	71701	Deck Patching	Permanent patching to bridge decks.	SY
61702	71702	Seal Cracks - Deck	Sealing of cracks in bituminous or concrete deck surfaces.	LF
61703	71703	Thin Overlay	Application of thin-bonded overlay to bridge decks.	SY
61704	71704	Joint Rehabilitation	Maintenance of bridge deck joints. Examples: removal/replacement of joint material, repair/patching of joint walls.	LF
62705	72705	Rigid Overlay	Application of latex/silica fume overlay to bridge decks.	SY
62706	72706	Rail repair	Repairing or maintaining the railing system on a bridge. This includes rails, parapets, curbs, safety walks and all associated supports and connections.	LF
62707	72707	Timber Rehabilitation - Deck	Maintenance actions exclusive to timber bridge decks. Examples: application of wood preservatives, repairing/replacing a portion of the timber deck boards, tightening/replacing deck fasteners.	EA
62708	72708	Asphalt Overlay	Application of asphalt overlay to bridge decks.	SY

Bridge Maintenance Activity Codes (Cardinal Tasks)

Activity Number				
Federal*	State	Activity Name	Activity Description	Unit of Measure
62725	72725	Concrete Superstructure Repair	Repairs to the exposed surfaces of bridge superstructures.	SY
62726	72726	Steel superstructure Repair	Repairs to steel bridge superstructures and all related supporting activities, such as blocking and jacking of the superstructure.	EA
62727	72727	Bearing Repair	Repair, realignment or replacement of bridge bearing devices.	EA
62728	72728	Paint - Superstructure	Painting or coating structural steel on a bridge.	EA
62729	72729	Paint - Superstructure	Spot painting	SF
62745	72745	Substructure Surface Repair	Repairs to the exposed surfaces of bridge substructures.	SY
62746	72746	Substructure - Repair Undermining	Filling scour holes, installing rip-rap or other scour countermeasures to prevent or stabilize scour at bridge substructure.	Ton
62755	72755	Culvert - Surface Repair	Repairs to culvert and all related supporting activities. Examples: patching spalls/delaminations, sealing cracks, repairing damaged headwalls/endwalls.	SY
62756	72756	Culvert - Repair Undermining	Filling scour holes, installing rip-rap or other scour countermeasures to prevent or stabilize scour at culvert.	Ton
62765	72765	Approach Slab Repair	Maintenance of bridge approach slabs. Examples: repairing settlement, repairing cracks, patching, installing/repairing pressure relief joints, replacing overlay.	EA
64719	74719	Deck Replacement	Replacement of bridge deck.	EA
64739	74739	Superstructure Replacement	Replacement of bridge superstructure.	EA

Bridge Maintenance Activity Codes (Cardinal Tasks)

Activity Number				
Federal*	State	Activity Name	Activity Description	Unit of Measure
62211	72211	Movable bridge Mechanical Repairs	Repair on Moveable Parts , Repair on engines, gears, or machined parts	EA
62500	72500	Movable bridge Corrective Maintenance	Corrective Maintenance - Includes electrical Repairs	EA
64749	74749	Substructure Major Rehabilitation	Replacement/major rehabilitation of bridge substructure.	EA
64758	74758	Culvert Major Rehabilitation	Rehabilitation/restoration of culvert. Examples: extending existing pipe or box culvert, sleeve installation, flowline restoration.	LF
64759	74759	Culvert Replacement	Replacement of culvert.	EA
64779	74779	Bridge Replacement	Replacement of total bridge structure.	EA
64771	74771	Mobilization	Mobilization & Demobilization of Crew to the project or bridge	EA
64772	74772	Maintenance of Traffic	MOT for the entire project	EA
64773	74773	Misc. Roadway Items	Pavement planning, asphalt base mix, asphalt surface mix, guardrail, etc.	EA
65780	75780	Safety Inspection - Interstate	Inspection of Interstate System Structures (NBI - 65780, Non-NBI - 75780)	EA
65781	75781	Safety Inspection - Primary	Inspection of Primary System Structures (NBI - 65781, Non-NBI - 75781)	EA
65782	75782	Safety Inspection - Secondary	Inspection of Secondary System Structures (NBI - 65782, Non-NBI - 75782)	EA
65790	75790	Bridge Rating - Interstate	Performance of Load Rating analysis on Interstate System Structures. Performed by District Structure & Bridge personnel.	EA
65791	75791	Bridge Rating - Primary	Performance of Load Rating analysis on Primary System Structures. Performed by District Structure & Bridge personnel.	EA
65792	75792	Bridge Rating - Secondary	Performance of Load Rating analysis on Secondary System Structures. Performed by District Structure & Bridge personnel.	EA
65798	75798	Bridge Management	Management tasks performed by District Structure & Bridge personnel. Examples: developing bridge maintenance work schedules, planning and budgeting future work needs, overseeing work associated with structures.	EA
65799	75799	Preliminary Engineering	Development of plans, specifications and/or contract documents for structures identified as needing rehabilitation or replacement.	EA

* 6XXXX activities can only be used if the work to be performed qualifies for federal reimbursement.

VIRGINIA DEPARTMENT OF TRANSPORTATION

STRUCTURE AND BRIDGE DIVISION

INSTRUCTIONAL AND INFORMATIONAL MEMORANDUM

GENERAL SUBJECT: Load Rating and Posting of Structures (Bridges and Culverts)	NUMBER: IIM-S&B-86.1
SPECIFIC SUBJECT: N/A	Date: December 13, 2016
	SUPERSEDES: IIM-S&B-86.0
DIVISION ADMINISTRATOR APPROVAL: /original signed/ Kendal R. Walus, P.E. State Structure and Bridge Engineer Approved: December 13, 2016	

Changes are shaded.

EFFECTIVE DATE:

This memorandum is effective upon receipt.

PURPOSE

To establish guidelines for load rating and posting of structures (bridges and culverts).

SCOPE

Individuals or entities performing load rating services for the Virginia Department of Transportation (VDOT) shall adhere to the requirements herein. Entities must meet Federal and State statutory and regulatory requirements. VDOT preferences and guidance are strongly encouraged to provide consistent treatment to motorists statewide.

ANALYSIS METHOD, SOFTWARE REQUIREMENTS AND LOAD RATING PROCESS

The load rating of all structures shall be performed in accordance with these guidelines and the latest American Association of State Highway and Transportation Officials (AASHTO), "*Manual for Bridge Evaluation*" (MBE). All load rating analyses shall use the Load and Resistance Factor Rating (LRFR) method, except for those structures noted under either the "SPECIAL CRITERIA" or "SAFE POSTING LOAD" sections below.

Typically, only superstructure elements, including integral pier caps, will need to be load rated except as follows:

- Decks shall be evaluated where the condition or geometry (supported by two girders/beams or single cell box, excessive span between girders/beams, etc.) of the deck is suspected to govern the load rating.
- Substructure elements shall be evaluated where the condition or geometry of the substructure element(s) are suspected to govern the load rating. Scenarios of where substructure element conditions may prompt a load rating include extensive section loss, scour/undermining, settlement, collision damage and as needed for reviewing over weight load permit requests. Timber substructures (i.e. Bent Caps) can often control the load rating for a structure.
- Should any primary load carrying member or detail be suspected of not performing up to its design capacity, that member or detail shall be considered in the overall structural analysis.
- Unless otherwise directed by the Assistant District Bridge Engineer for Safety Inspection, the Load Rating Program Manager, or their designee(s), cross frames in curved girders and in highly skewed bridges need not be rated.

Except for exceptional circumstances, with prior approval of the Load Rating Program Manager, steel structures may not be rated using plastic analysis.

AASHTOWare Br|R® (Formerly Virtis®) software shall be used for load rating bridges, except as follows: Steel curved girders shall be rated using DESCUS® software. Ratings of all other structures that are beyond the capabilities of BrIR® and DESCUS including segmental or/and spliced Bulb Tee sections shall be completed using LARSA 4D. Other software platforms may be used in exceptional circumstances with prior approval of the Load Rating Program Manager. All structures analyzed in LARSA 4D or other exceptional use software shall be rated for the additional special permit vehicles available by emailing haulingpermits@vdot.virginia.gov.

Information regarding the VDOT approved version of AASHTOWARE Br|R®, DESCUS® and LARSA 4D may be found on the VDOT Structure and Bridge web site under “Useful Information.”

When using Br|R®, each bridge shall be entered as a system of girders, not as single structural elements (line girder analysis). In addition, a bridge alternative(s) must be defined and appropriately marked to allow for the load rating to be run from the Bridge Explorer window. After each significant change in condition, collision incident and/or construction event (including As-Built conditions, maintenance/rehabilitation activities, etc.) a new bridge alternative shall be developed and the structure re-rated.

Culverts shall be evaluated using current guidance and load rating principles included in Appendix A of this document.

WHEN LOAD RATINGS ARE REQUIRED

An updated or new load rating will be required in accordance with the table below.

Reason for Rating	Timeframe to Complete	Commentary
New structures Widenings Superstructure replacements Repairs/Rehabilitation[4]	As-designed load rating(s) shall be submitted with final plan submissions For Design-Build or similar processes, as-designed load rating(s) shall be submitted as part of the process to obtain plan approval before superstructure construction begins The As-Built load rating shall be submitted within 90 days after opening the structure or portion of the structure to traffic [1], [3]	Where applicable, the load rating shall accurately model all stages of construction
Changes in loading (overlay, etc.) and changes in condition due to deterioration[5] (section loss, etc.), repairs, rehabilitation, and collision damage.	Within 90 days after becoming aware of the change [1], [2], [3]	

[1] If the changes in loadings or conditions (including shop drawings review or As-built) are significant, the changes shall be evaluated immediately by the District Bridge Engineer or their designee. As a precautionary measure, engineering judgment may be used to lower the load rating capacity of the structure for the safety of the traveling public until the load rating is performed. This determination shall be recorded in the load rating documentation.

[2] For complex and unusual structures, the deadline may be extended as approved by the Assistant State Structure and Bridge Engineer for Safety and Inspection as necessary to initiate a load rating contract. Until a contract can be initiated, the District Bridge Engineer or their designee as a precautionary measure may exercise engineering judgment to assign the load rating capacity of the structure.

[3] All load rating values that are entered into the bridge inventory, from engineering calculation, or if lowered by engineering judgment, shall be sealed and placed in the bridge file.

[4] Any temporary measure left in place under live traffic during a repair, such as jacking and blocking, shall be evaluated to determine if it controls the rating for the affected portion of the structure while in place. All conditions that lower the controlling rating shall be reported to the permitting section 30 days prior to being in place along with the expected duration and dates of the temporary condition. Item 103 in the inventory shall be coded appropriately for temporary conditions.

[5] An updated load rating shall be considered for all structures when the Superstructure or Culvert General Condition Rating (GCR) drops to 4.

As a part of each structure's regular safety inspection, the District Bridge Engineer or their designee will determine if the load rating on file reflects the current capacity of the structure and will be responsible for updating the load rating as necessary. If a new load rating is not warranted, this determination shall be recorded in the "Structural Analysis" section of the safety inspection report.

DOCUMENTS REQUIRED FOR LOAD RATINGS

The District Bridge Engineer or their designee is responsible for ensuring that all supporting documentation is available to rate the structure in its current condition. At a minimum, the following information is required:

- Plans or drawings/sketches of a structure (including original and rehabilitation plans)
- Latest safety inspection report
- The average daily traffic (ADT) and percent truck traffic
- Prior load rating files (as applicable)

If there is insufficient documentation to load rate a structure (i.e. missing or incomplete data regarding field conditions, size of structure elements or the geometry of the structure), a site visit may be warranted to complete the load rating. See the "SPECIAL CRITERIA" section below for additional guidance.

SPECIAL CRITERIA

I. BRIDGES WITH UNKNOWN DETAILS

For bridges where necessary details for load rating are not available from plans or field measurements (e.g. concrete bridges with unknown reinforcement); knowledge of the live load used in the original design, the current condition and/or live load history of the structure may be used to provide a basis for assigning a safe load capacity. The assumptions made to determine the safe load capacity shall be documented on the VDOT Load Rating Summary Form (SB502).

Additionally, load tests may be performed to establish a safe load capacity of such bridges.

In general, concrete bridges with unknown reinforcement details need not be posted for restricted loading if they have been carrying normal traffic and show no signs of distress. For simple span structures, see Appendix B for determining rating capacities. For other requirements on restrictions, see sheet 13 for the "INSTRUCTIONS FOR STRUCTURE RESTRICTION AND POSTING" section below.

II. FATIGUE ANALYSIS

Fatigue analysis and fatigue evaluation are not required when performing load rating analysis.

III. TRUSS AND STRINGER/FLOORBEAM BRIDGE SYSTEMS

Bridges whose superstructure elements include trusses and/or stringer/floorbeam systems may be rated using Load Factor Rating (LFR) until Br|R® has the capability to rate these elements in LRFR.

IV. SEGMENTAL AND/OR SPLICED BULB TEE STRUCTURES

This IIM is not intended to replace AASHTO MBE, AASHTO LRFD, VDOT Specifications, Post Tensioning Institute (PTI), American Segmental Bridge Institute (ASBI) or other VDOT requirements. It is to clarify issues related to post-tensioning, supplement existing requirements, and provide guidance for rating a structure that will carry traffic for 75 or more years.

Analysis requirements:

New Structures: Principle stresses shall be evaluated for all post-tensioned structure webs, joints, or D-regions using LRFR/LRFD

Design Load Rating Requirements:

The design shall incorporate all IIM-S&B-80 modifications.

Losses:

Losses due to elastic shortening shall be calculated in accordance with AASHTO LRFD 7th Edition (2014) Article 5.9.5.2.3

Time-dependent losses shall be computed in accordance with AASHTO LRFD 7th Edition (2014) article 5.9.5.4 for time-dependent losses, even when another method is allowed by AASHTO.

At Pre Award Construction (PAC), or when the plans are submitted to be approved for construction, the Engineer of Record (EOR) shall submit a sealed rating which meets the following two additional requirements to those established elsewhere in this IIM:

Ideal condition:

For the as-designed condition, the structure shall be rated in a bonded state for all tendon ducts filled with grout. The controlling rating factors for all loadings prescribed by this IIM shall be greater than 1.0.

For the as-designed condition, in an unbonded state for all tendon ducts filled with flexible filler, the controlling rating factors for all loadings prescribed by this IIM shall be greater than 1.0.

Corroded condition:

In addition to IIM-S&B-80 requirements, the designer shall consider the loss and replacement of all original tendons where flexible filler is required. Loss of tendons shall be considered one at a time. The failure of any one tendon shall not result in any

rating condition defined by this IIM having a Rating Factor (RF) less than 1.0.

Existing Structures: Structures designed and opened prior to January 1, 2007 may be rated using LFR. Principle stresses, and other serviceability checks, may be considered, but the final rating may be based on the strength of the member.

GENERAL CRITERIA FOR LRFR

All factors and methodology that are not discussed in this document shall be as defined in the AASHTO Manual for Bridge Evaluation (MBE).

The following factors shall be as defined in the same version of the AASHTO LRFD Bridge Design Specifications with any modifications that are in use by the Department at the time of rating.

- Live load distribution factors
- Dead load distribution factors
- Dynamic Load Allowance (IM, impact factor); and no reduction shall be applied for riding surface conditions.

LIMIT STATES: The following table shows applied limit states for LRFR.

Bridge Type	Limit State	Design	Legal	SHV	Permit
		HL-93 HS-20	VA Type 3, VA Type 3-S2, EV2, EV3, CHDT	SU4, SU5, SU6, SU7 NRL	BP-90, BP-115
Steel	Strength I	✓	✓	✓	
	Strength II				✓
	Service II	✓	✓	✓	✓
Reinforced Concrete	Strength I	✓	✓	✓	
	Strength II				✓
	Service I				✓
Prestressed Concrete (non-segmental)	Strength I	✓	✓	✓	
	Strength II				✓
	Service III	✓[6]	✓	✓	
	Service I				✓
Prestressed Concrete (segmental)	Strength I	✓	✓	✓	
	Strength II				✓
	Service III	✓	✓	✓	
	Service I				✓
Timber	Strength I	✓	✓	✓	
	Strength II				✓

(6) For non-segmental Prestressed Concrete bridges, Service III need not be checked for HL-93 at the Operating Level as Service III is a Design level check for crack control in prestressed components.

CONDITION FACTOR: Unless otherwise specified by the District Bridge Engineer, the following condition factors shall be used in load rating bridges:

Structural Condition of Member	Condition Factor
Good/Satisfactory/Fair	1.00
Poor	0.9

The factors in this table are from MBE Table 6A.4.2.3-1 adjusted upward by 0.05 for section properties that are accurately verified by field measurements.

VEHICLE CONFIGURATIONS FOR LOAD RATING

As defined below and/or as defined in the MBE, all structures shall be evaluated for the following vehicles except as noted:

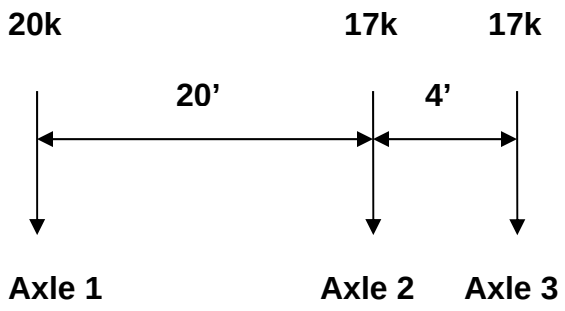
I. DESIGN LOAD:

a. HL-93 (only used for LRFR ratings)
b. HS-20

II. LEGAL LOAD:

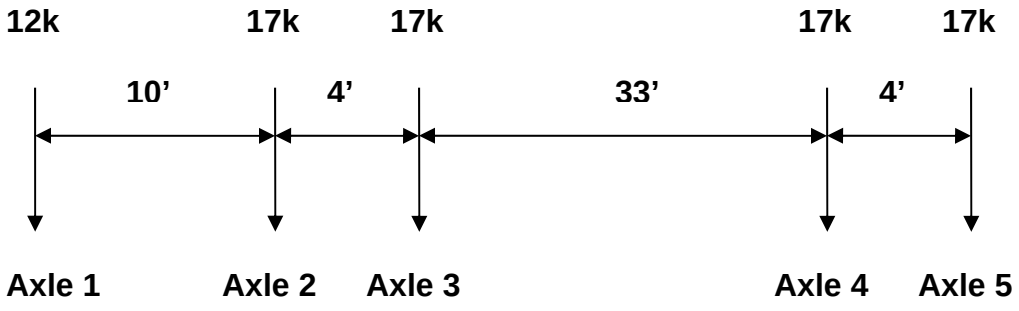
a. Virginia Legal Loads

1. VA Type 3 (Single Unit Truck)



GVW = 27 Tons, CG is 13.85' from Axle 1

2. VA Type 3S2 (Truck and Semi Trailer)



GVW = 40 Tons, CG is 25.92' from Axle 1

b. AASHTO Lane-Type Legal Loads for structures meeting the criteria below. (only used for LRFR ratings)

- Negative moment and interior reaction for all span lengths
- Spans greater than 200 ft

c. AASHTO Specialized Hauling Vehicles (SHV)

1. SU4
2. SU5
3. SU6
4. SU7
5. Notional Rating Load (NRL)

d. Fixing America's Surface Transportation (FAST) Act (Public Law 114-94)

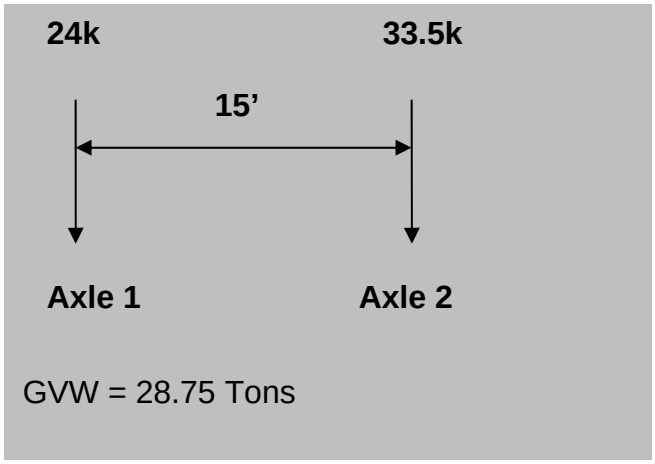
Load Ratings for the FAST Act vehicles in this section shall be done for all bridges on, or within reasonable access to the Interstate Highway System. Reasonable access is set at one road mile by 23 CFR § 658.19 (d). The rating shall be done at the Operating (LFR) or Legal Load Rating (LRFR) level in accordance with the methods specified in the AASHTO MBE with two exceptions:

1. Multiple presence: If necessary, when combined with other unrestricted loads for rating purposes, the emergency vehicle needs only to be considered in a single lane of one direction of a structure.
2. Live load factor: A live load factor of 1.3 should be utilized in the LRFR or LFR methods.

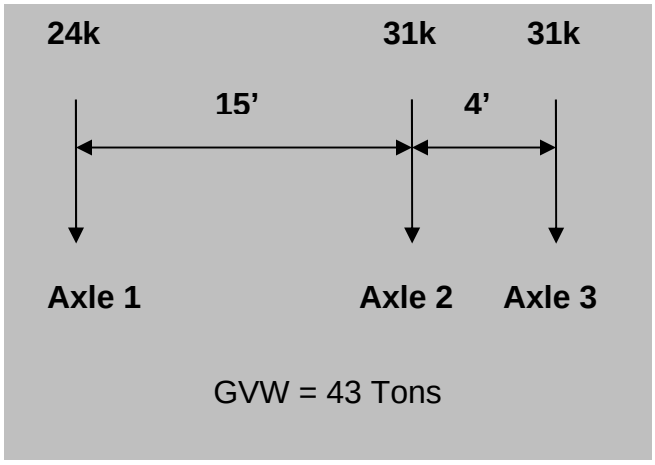
Posting of the FAST Act vehicles will be discussed separately.

1. Emergency Vehicles (EV2 and EV3)

- EV2

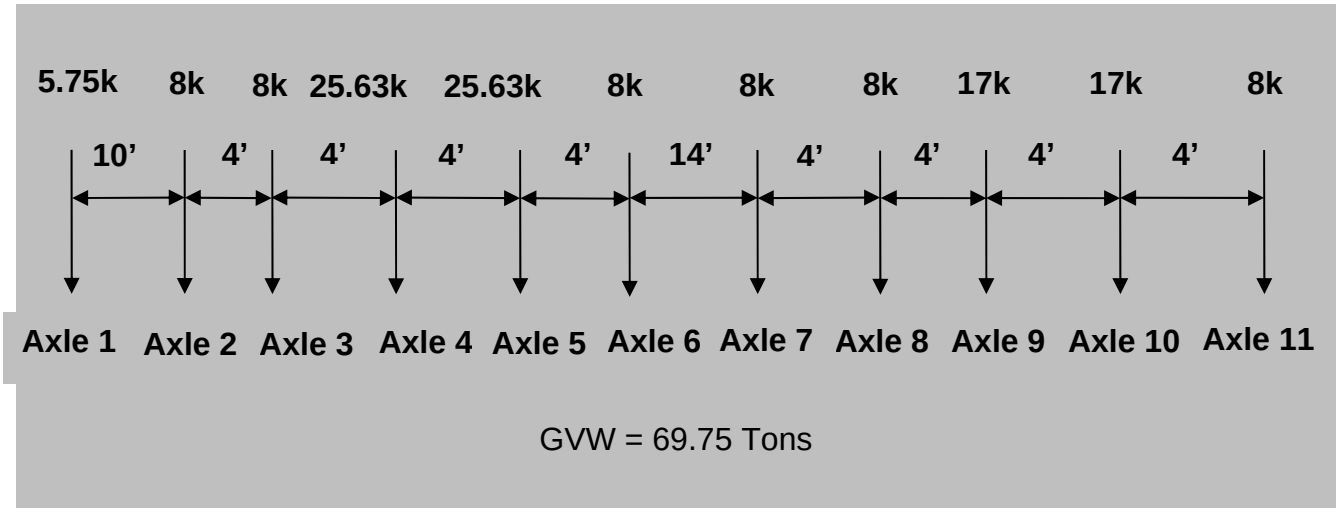


- EV3



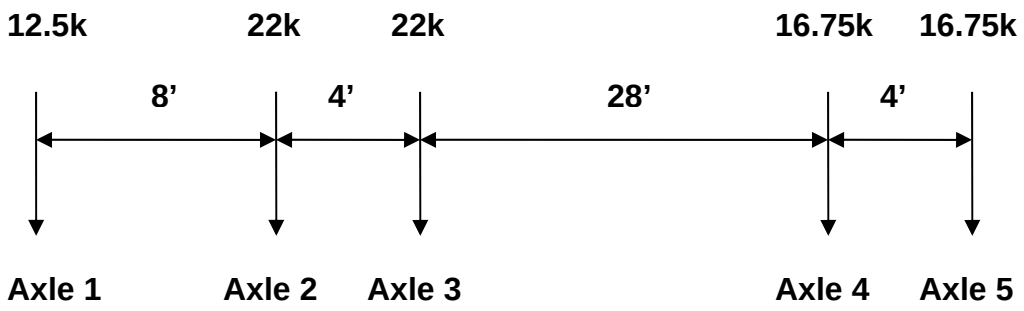
2. Covered Heavy Duty Tow and Recovery Vehicle

- CHDTR



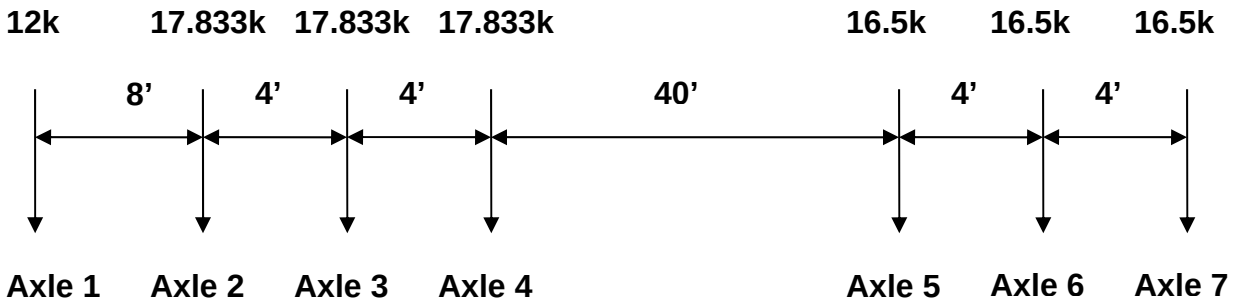
III. PERMIT LOAD:

e. BP-90: 90,000 lb vehicle



GVW = 45 Tons, CG is 20.52’ from Axle 1

f. BP-115: 115,000 lb vehicle



GVW = 57.5 Tons, CG is 31.41’ from Axle 1

SAFE POSTING LOAD

LRFR METHOD:

- When the RF (Rating factor) for the Notional Rating Load (NRL) is ≤ 1.0, the full suite of SU vehicles must be rated to determine the required posting level.

- When the RF for one or both Virginia Legal Loads is < 1.0, the structure shall be posted[7]:

- If the RF ≥ 1.0 for the Virginia Legal Loads and the RF < 1.0 for NRL, a posting analysis will be performed to resolve posting requirements based on the capacity ratings of the Virginia Legal Loads and the Specialized Hauling Vehicles.

- In LRFR, the safe posting load of Legal Load, Specialized Hauling, and FAST ACT vehicles shall be based on the legal load rating value.

LOAD FACTOR RATING (LFR) METHOD:

For structures not designed using LRFD and where a load rating in LRFR results in a lower rating capacity or rating factor than when using other evaluation methods (LFR / engineering judgment), or vice versa **and** this situation affects the posting condition of the structure; the District Bridge Engineer or designee may determine which method (LRFR / LFR / engineering judgment)* of evaluation will be used for rating**. This decision shall be documented on the Load Rating Summary Form for Structures (SB502) and only the ratings and/or rating factors for the method of evaluation used will be entered in the form.

In LFR, The safe posting load of Legal Load and Specialized Hauling Vehicles shall be as follows[7]:

- Steel or timber superstructures - the capacity at a load level midway between inventory and operating shall be used[7].
- Concrete superstructures - the capacity at the operating level shall be used.
- If the HS20 Operating load < 3 Tons, the bridge shall be closed[7].

Equivalent Capacity Coefficients for various trucks and simple span lengths are shown in Appendix B of this document with an example in Appendix C.

The methodology/actions taken to arrive at the safe posting load shall be documented. In special situations, which shall be documented on the Load Rating Summary Form for Structures (SB502), engineering judgment may be used to post or not post a structure.

* Note: Timber and masonry members may still be rated in ASD per FHWA's policy exception while it remains in place.
** Note: Once a method of rating for a structure has been established, subsequent analyses shall be only performed using that method, or LRFR.
(7) See page 14 for Note 7.

INSTRUCTIONS FOR STRUCTURE RESTRICTION AND POSTING

In accordance with the "SAFE POSTING LOAD" section above, if the Rating Factor (RF) for any Specialized Hauling Vehicle is less than 1.0, that structure shall be posted for the safe posting load(s) for the legal and Specialized Hauling Vehicles.

Structures which require a weight restriction for the five-axle, BP-90 (45 ton blanket permit vehicle) at operating level shall be posted for legal vehicles[7].

Structures which do not require a weight restriction for the BP-90, but do require a weight restriction for the seven-axle, BP-115 (57.5 ton blanket permit vehicle) at operating level shall be denoted on the Restricted Structures Map if located on an interstate or primary in accordance with the current IIM-S&B-35 with a symbol of "45T" and State Item 50 in the inventory system shall be coded 'T'[7].

Bridges that do not have plans of their structural details, have been carrying traffic for a substantial length of time, and do not show signs of distress need not be posted; However, these structures shall be denoted on the Restricted Structures Map with a symbol of "45T" and State Item 50 in the inventory system shall be coded 'T'[7].

Structures that have gusset plates on main members shall have all gusset plates rated. Where the gusset plate rating controls the rating of the structure, all capacity and posting decisions for the structure shall be determined from the gusset plate rating.

Concrete slab span structures are rated for interior and exterior strips. The rating for the exterior strip need not control the rating of the structure if it is not located in the travelway.

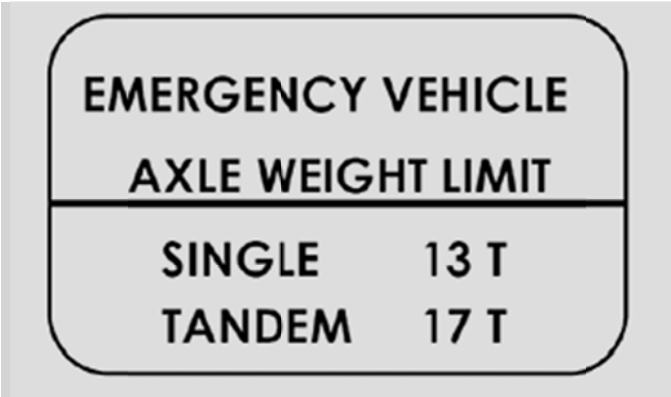
The R12-V2 Sign may be annotated as follows:

2-3 Axles……. Use the Virginia 27 Ton Vehicle
4-5 Axles……. Use the minimum of the SU-4 and SU-5 vehicle
6+ Axles……. Use the minimum of the SU-6 and SU-7 vehicle
Semi……. Use the Virginia 40 Ton Vehicle[3]

If the load posting values are 15 Tons and below, Consideration should be given to using a R12-1 sign with a single tonnage called out. [7]

For the FAST Act Emergency vehicles in section II.) d., when a load rating results in a rating factor less than 1.0 for LFR or LRFR, the bridge shall be appropriately posted for both the governing single axle weight limit and tandem axle weight limit derived from the emergency vehicle configurations. (23 CFR 650.313(c)). When posting is necessary, the following sign format using the appropriate weight limits should be considered:

(7) See page 14 for Note 7.



Posting guidance for the Covered Heavy Duty Tow and Recovery vehicle is pending from FHWA.

Information regarding restrictive signage may be found in the current IIM-S&B-27 and for the Restricted Structure Atlas may be found in the current IIM-S&B-35.

(7) The District Bridge Engineer or his/her designee may elect to assign loads using Allowable Stress Design or engineering judgment for posting purposes. This shall be sealed and documented along with any rating and posting values provided by LFR or LRFR analysis methods and placed in the bridge file.

REQUIRED DOCUMENTATION

All supporting documentation regarding the load rating of a structure shall be placed under the Multi-Media attachments for the corresponding structure in the Br|R® database.

Every structure shall have a Br|R® file in the VDOT database. If a structure is rated by a means other than Br|R® (e.g. DESCUS), the file in the database shall give clear guidance where the appropriate deliverables are to be found.

STRUCTURES RATED IN Br|R®

A typical Br|R® load rating analysis submittal includes the following deliverables electronically:

1. A Br|R® XML export file for VDOT's database, for which the load rating can be run from the Bridge Explorer Window
2. Signed and Sealed, PDF of the completed Load Rating Summary Form for Structures (SB502) with all of the assumptions clearly stated. PDF may be signed and sealed electronically in accordance with the current IIM-S&B-79.
3. Screenshot of "Bridge Rating Results" from Br|R®
4. Hand calculations of the dead loads, lived load distribution factors, and assumptions as needed in Microsoft Word or Excel, Mathcad, or PDF format
5. If applicable, standard plan sheets (in TIFF or PDF format) used for load rating

Consultants performing load ratings for VDOT may have additional requirements as specified in the Memorandum of Agreement and/or Letter of Agreement.

STRUCTURES NOT RATED IN Br|R®

For the structures that are not rated in Br|R®, an independent load rating report is required. The load rating report shall include the Load Rating Summary Form for Structures (SB502) with all assumptions clearly stated, the standards and/or plans and which type of software, including version, was used for the load rating. In addition, a brief description of how the evaluation was performed and the analysis documentation (or where it is located) shall be placed into the Br|R® file in the VDOT database for the structure. As appropriate, hand calculations and/or the electronic input and output of the software program used shall be noted in the report; including the controlling rating and conditions (force and location) for all rated members clearly identified in a table format.

QUALITY CONTROL AND QUALITY ASSURANCE PROCESS

Load ratings shall be performed and checked by different persons. One of the individuals (rater / checker / reviewer) shall be a Professional Engineer in the Commonwealth of Virginia, who will sign and seal the Load Rating Summary Form for Structures (SB502).

The quality control (QC) review will verify that appropriate assumptions were made to develop the load rating, calculations were performed correctly and any discrepancies were satisfactorily addressed.

The quality assurance (QA) review will verify that the load rating analysis, including the load rating output and calculations, has been performed, checked and/or reviewed by a Professional Engineer in the Commonwealth of Virginia and assure that the results and assumptions are reasonable.

LOAD RATING PERFORMED BY VDOT PERSONNEL

QC and QA reviews are required for all load ratings performed by VDOT personnel. QC reviews will be performed by the checker, and QA reviews will be performed by the checker or an independent reviewer.

LOAD RATING PERFORMED BY CONSULTANTS

District personnel shall perform QA/QC reviews of load ratings developed by consultants. QC shall be performed for a minimum of five percent (5%) of the load ratings performed in a calendar year. QA reviews shall be performed for all load ratings.

LOAD RATING SUBMITTED BY THE LOCALITIES

The District Office should receive a signed and sealed copy of the load ratings provided by the localities, municipalities and other entities. QA reviews shall be performed for all the bridges.

UPDATING INVENTORY RECORDS

Updating the inventory signifies that the load ratings have been accepted by the District Office. The table below summarizes the coding guidance for some of the Federal and State items. For a structure, all vehicle ratings and safe posting load shall be from one method of analysis (i.e. LRFR or LFR or Engineering Judgment).

	LRFR	**LFD**	**Engineering Judgment**
FED ITEM 63	3	1	0
FED ITEM 64	HS20 OPR Ratings	HS20 OPR Ratings	See Appendix C
FED ITEM 65	3	1	0
FED ITEM 66	HS20 INV Ratings	HS20 INV Ratings	See Appendix C
STATE ITEM 47	O	O for Concrete M for steel	O
STATE ITEM 48	R	L	A

In addition, Central Office load rating personnel will perform QA and QC reviews, which will be at a minimum, one bridge per District per quarter.

All QC reviews must be documented along with any findings.

CC: Chief Engineer
Deputy Chief Engineer
Division Administrators
District Administrators
District Construction Engineers
District Maintenance Engineers
Assistant State Structure and Bridge Engineers
District Structure and Bridge Engineers
Residency Administrators
Structure and Bridge Program Managers

VDOT Virginia Department of Transportation

Structure and Bridge

LOAD RATING SUMMARY FORM FOR STRUCTURES

Rte.:

Over:

VA Structure No.:

FED. ID:

County:

District:

Rated By: Date:

Checked By: Date:

VDOT Reviewer: _____

PE Seal

SIGNATURE:_____

NAME: _____

CALCULATION TOOLS AND METHOD USED:

REASON FOR RATING:

	GVW (TONS)	RATING	CONTROLLING MEMBERS	CONTROLLING LOCATION	CONTROLLING FORCE
DESIGN LOAD		FACTOR			
HL-93 (INV)	N/A		***		
HL-93 (OPR)	N/A		***		
		TONS			
HS-20 (INV)	36				
HS-20 (OPR)	36				
LEGAL LOADS		TONS	**		
VA Type 3	27				
VA Type 3S2	40				
*LANE	40		***		
PERMIT LOAD		TONS			
BP-90	45				
BP-115	57.5				
SH VEHICLES		TONS	**		
NRL:	40				
SU4:	27				
SU5:	31				
SU6:	34.75				
SU7:	38.75				

* Not applicable for single spans less than and equal to 200 feet.

** FOR LFR or ASD: Denote if it is a mid range or operating level for posting and provide the safe posting load. ASD is only applicable for timber or masonry members.

*** Not applicable for LF/AS rating methods.

Firm name or logo

VDOT Virginia Department of Transportation

Structure and Bridge

LOAD RATING SUMMARY FORM FOR STRUCTURES

	GVW (TONS)	RATING	CONTROLLING MEMBERS	CONTROLLING LOCATION	CONTROLLING FORCE
EV2 VEHICLES		TONS	**		
Single Axle					
Gross Weight					
EV3 VEHICLES		TONS	**		
Single Axle					
Tandem Axles					
Gross Weight					
T&R VEHICLES		TONS	**		

** FOR LFR or ASD: Denote if it is a mid range or operating level for posting and provide the safe posting load. ASD is only applicable for timber or masonry members.

Firm name or logo

Structure and Bridge

LOAD RATING SUMMARY FORM FOR STRUCTURES

INSPECTION REPORT USED FOR THIS RATING:

ASSUMPTIONS/COMMENTS BY LOAD RATING ENGINEER:

Latest version of this form is SB502 and is available on the VDOT Structure and Bridge web site under “Useful Information.”

Sample of Completed Load rating Summary For

VDOT Virginia Department of Transportation

Structure and Bridge

LOAD RATING SUMMARY FORM FOR STRUCTURES

Route: Indian Village Trail (Route 666)
Over: Wolf Creek

VA Str. No.: 6061
FED. ID: 03124

County: Bland
District: Bristol

Rated By: CK Date: Jul, 2010
Checked By: JR Date: Jul, 2010
VDOT Reviewer: RFR
Calculation Tools/Method Used: Virtis 6.1
Basis for Rating: Conversion to LRFR

COMMONWEALTH OF VIRGINIA
YOUR NAME
Lic. No. 000
PROFESSIONAL ENGINEER

Signature: YOUR SIGNATURE
Name: YOUR NAME

	GVW (TONS)	RATING	CONTROLLING MEMBERS	CONTROLLING LOCATION	CONTROLLING FORCE
DESIGN LOAD		FACTOR			
HL-93 (INV)	N/A	1.161	Typical Exterior Girder	0.5L	Flexure
HL-93 (OPR)	N/A	1.506	Typical Exterior Girder	0.5L	Flexure
		TONS			
HS-20 (INV)	36	54.6	Typical Exterior Girder	0.269L	Flexure
HS-20 (OPR)	36	70.8	Typical Exterior Girder	0.269L	Flexure
LEGAL LOAD		TONS			
SINGLE	27	69.2	Typical Exterior Girder	0.269L	Flexure
TRUCK & SEMI	40	92.6	Typical Exterior Girder	0.269L	Flexure
*LANE	40	-	-		
PERMIT LOAD		TONS			
BP-90	45	86.6	Typical Exterior Girder	0.269L	Flexure
BP-115	57.5	115.2	Typical Exterior Girder	0.269L	Flexure
SH VEHICLES		TONS			
NRL	40	66.2	Typical Exterior Girder	0.5L	Flexure
SU4	27	63.1	Typical Exterior Girder	0.5L	Flexure
SU5	31	65.3	Typical Exterior Girder	0.5L	Flexure
SU6	34.75	65.6	Typical Exterior Girder	0.5L	Flexure
SU7	38.75	66.8	Typical Exterior Girder	0.5L	Flexure

* Not applicable for simple span less than 200 feet.

Virginia Department of Transportation

Structure and Bridge

ASSUMPTIONS/COMMENTS BY LOAD RATING ENGINEER:

Comments:

1. HS-20 Truck is the controlling HS-20 load case.
2. The controlling Design Loads (Inventory) and Legal Limit states are Strength I.
3. The controlling Design Loads (Operating) and Permit Limit States are Strength II.

Assumptions:

Bridge No: 03124 - 3 Span Steel Multi-Girder Bridge.

1. Material properties not noted in the plans are based on the year of construction. Materials used for the analysis are Structural Steel, ASTM A36, Grade 36, Cast-In-Place Concrete, Class A4, f'c =4.0 ksi, Reinforcing steel, Grade 40.
2. The slab thickness was reduced by 0.5" per VDOT, IIM-S&B-80 for composite properties.
3. Superimposed dead load was distributed uniformly to all girders.
4. LRFD Live load distribution factors were computed by Virtis.
5. 1¼" thick Latex or concrete overlay was used for IR Analysis. After scarifying ½" there is a net increase of ¾" to the deck thickness.
6. The LRFD effective slab width used for composite properties was the full tributary width as outlined in Section 4.6.2.6 of the AASHTO LRFD Bridge Design Specifications (2008 Interims).
7. The following deteriorations were taken into consideration in the IR Analysis:

Span 1 (Beam 4@Pier 1) 1.4% web loss 0' to 1.33'

Span 1 (Beam 5@Pier 1) 2.8% web loss 0' to 1.33'

Span 2 (Beam 5@Pier 1) 2.8% web loss 0' to 1.84'

Span 2 (Beam 2@Pier 2) 1.7% web loss 0' to 2.0'

Span 2 (Interior Beams) 15% Bottom flange loss 0' to 3.0'

Span 3 (Beam 4@Pier 2) 1.7% web loss 0' to 2.0'

Span 3 (Beam 5@Pier 2) 40% Bottom flange loss 0' to 2.0'

8. Per IR, Condition factor for the bridge was used corresponding to Fair (Superstructure Rating= 5); ϕc=1.00

Sample Screen Shot of Bridge Rating Results

Bridge Rating Results

System of Units: (•) US Customary ( ) SI / Metric

Lane/Impact Loading Type: (•) As Requested ( ) Detailed

Display Format: Mutiple rating levels per row

Bridge Id	Vehicle	Inventory Rating Factor	Operating Rating Factor	Legal Rating Factor	Permit Rating Factor	nventory Rating Method	Operating Rating Method	Legal Rating Method	Permit Rating Metho	Inventory Capacity (Ton)	Operating Capacity (Ton)	Legal Capacity (Ton)	Permit Capacity (Ton)	
03124	HL-93 (US)	1.161	1.506			LRFR	LRFR			41.81	54.20			Tu
03124	Blanket Permit 115				2.004				LRFR				115.23	Tu
03124	Blanket Permit 90				1.924				LRFR				86.58	Tu
03124	HS-20-Lane Load Only	2.765	3.584			LRFR	LRFR			0.00	0.00			Tu
03124	HS-20-Tandem	1.921	2.490			LRFR	LRFR			46.11	59.77			Tu
03124	HS-20-Truck Only	1.517	1.966			LRFR	LRFR			54.61	70.79			Tu
03124	Notional Rating Load-NRL			1.654				LRFR				66.17		Tu
03124	SU4			2.336				LRFR				63.08		Tu
03124	SU5			2.106				LRFR				65.30		Tu
03124	SU6			1.888				LRFR				65.60		Tu
03124	SU7			1.725				LRFR				66.85		Tu
03124	VA Semi			2.316				LRFR				92.64		Tu
03124	VA Single			2.564				LRFR				69.24		Tu

[x] Show up-to-date results only

View Structure Rating Results | Save All | Close

APPENDIX A

ANALYSIS AND RATING CODES FOR CULVERTS AND PIPES

GENERAL NOTES

When an analysis is not required or if there is not enough information to perform an analysis a rating should be 'assumed'. If the structure has been carrying highway traffic and shows no signs of distress, it can be assumed that the structure can carry legal loads.

Analysis of culverts may be completed using Br|R®. If Br|R® is used to model other non-culvert structures, care shall be taken to review the live load factor applied by the program and determine if it is appropriate to use the culvert, or bridge value.

For concrete box culverts and concrete pipes the definition of "no signs of distress" will be the same as that used for concrete slabs.

For metal pipes the definition of "no signs of distress" will include, but not be limited to:

- No excessive cross-section deformation.
- Changes to measured dimensions of installed metal pipe <u>not</u> greater than five percent (5%) of design dimensions.
- No visible signs of plate cracking, crimping or bolt hole tears.
- Plates appear to be properly fitted.
- Bolts in longitudinal seams show no signs of fatigue or overstress.
- No visible signs of measurable section loss.
- No lifting of the invert at either end of the pipe.
- No piping. Piping is referred as seepage along the outside of the culvert barrel that may remove supporting material.

When signs of distress are evident, the affect of the distress on the load carrying capacity of the structure must be considered. If an analysis has been previously performed, it should be modified to include the areas of distress and a new rating generated. When an analysis is possible, the Central Office will perform the rating. If the rating was assumed, consideration must be given to reducing the load carrying capacity of the structure to some level below legal limit. The appropriate assumed load limit shall be determined on a case-by-case basis and using engineering judgment.

In the past, a fill height less than 15 feet would indicate that live load should be applied to a culvert or a pipe when an analysis was prepared. Due to existing design criteria for precast concrete box culverts, 20 feet would be a more conservative approach for these types of structures. For simplicity, the instructions below use 20 feet as the cut-off for all types of pipes and culverts. It is still considered appropriate to use 15 feet for non-precast concrete box culverts.

<u>FILL HEIGHTS GREATER THAN OR EQUAL TO 20 FEET</u>

CONCRETE BOX CULVERTS (PRE-CAST AND CAST-IN-PLACE) AND PIPES OF ALL MATERIAL AND DESIGN TYPES

For fill heights greater than or equal to 20 feet, VDOT considers the effect of the live load to be insignificant. Therefore, an analysis is not required.

- Federal Item 66 (Inventory Rating) will be coded 99.
- Federal Item 64 (Operating Rating) will be coded 99.
- State Item 45 (Rated Capacity, Single Unit) will be coded 99.
- State Item 46 (Rated Capacity, Semi) will be coded 99.
- State Item 48 (Method of Analysis) will be coded 'L'.
- State Item 49A (Computer File Name) shall be coded as the "brkey" of the structure (5 digit Federal ID).
- State Item 49B (Last Run Date) shall be left blank.
- For Concrete Culverts - State Item 47 (Stress Level) shall be coded as 'O' (Operating).
- For Metal Culverts - State Item 47 (Stress Level) shall be coded as 'M' (Midrange).

FILL HEIGHTS LESS THAN 20 FEET

CONCRETE BOX CULVERTS (PRE-CAST AND CAST-IN-PLACE)
BUILT 1988 OR BEFORE
BUILT USING A PLAN OR STANDARD

- Analysis must be performed (using the load factor method) to determine:
    - Federal Item 66 (Inventory Rating)
    - Federal Item 64 (Operating Rating)
    - State Item 45 (Rated Capacity, Single Unit)
    - State Item 46 (Rated Capacity, Semi).
- State Item 49A (Computer File Name) shall be coded as the "brkey" of the structure (5 digit Federal ID).
- State Item 49B (Last Run Date) shall be left blank.
- State Item 47 (Stress Level) shall be coded as 'O' (Operating).

CONCRETE BOX CULVERTS (PRE-CAST AND CAST-IN-PLACE)
BUILT AFTER 1988
BUILT USING A STANDARD OR A PLAN

- If built to a standard, use the chart attached to determine:
    - Federal Item 66 (Inventory Rating).
    - Federal Item 64 (Operating Rating).
- State Item 48 (Method of Analysis) will be coded 'L' (charts were developed using load factor analysis).
- If built to a plan, an analysis (using the load factor method) must be performed to determine:
    - Federal Item 66 (Inventory Rating)
    - Federal Item 64 (Operating Rating)
    - State Item 45 (Rated Capacity, Single Unit)
    - State Item 46 (Rated Capacity, Semi).
- State Item 48 (Method of Analysis) will be coded 'L'.

- State Item 45 (Rated Capacity, Single Unit)
  Apply Federal Item 64 (Operating Rating) (see above) to the 'Equivalent Capacity Coefficients' chart in Appendix B. The span length used in the chart shall be taken from State Item 23 (Drainage Structure – Width or Diameter).
- State Item 46 (Rated Capacity, Semi)
  Apply Federal Item 64 (Operating Rating) (see above) to the 'Equivalent Capacity Coefficients' chart in Appendix B. The span length used in the chart shall be taken from State Item 23 (Drainage Structure – Width or Diameter).
- State Item 49A (Computer File Name) shall be coded as the "brkey" of the structure (5 digit Federal ID).
- State Item 49B (Last Run Date) shall be left blank.
- State Item 47 (Stress Level) shall be coded as 'O' (Operating).

CONCRETE BOX CULVERTS (PRE-CAST AND CAST-IN-PLACE) NOT BUILT BY A STANDARD OR A PLAN

- Federal Item 66 (Inventory Rating) code 36.
- Federal Item 64 (Operating Rating) code 49.
- State Item 45 (Rated Capacity, Single Unit) code 27
- State Item 46 (Rated Capacity, Semi) code 40.
- State Item 48 (Method of Analysis) will be coded 'A' (Assumed). It will be unknown which AASHTO design standards were used.

All CONCRETE AND METAL PIPES

- Federal Item 66 (Inventory Rating) code 36.
- Federal Item 64 (Operating Rating) code 49.
- State Item 45 (Rated Capacity, Single Unit) code 27
- State Item 46 (Rated Capacity, Semi) code 40.
- State Item 48 (Method of Analysis) will be coded 'A' (Assumed) since it will be unknown which AASHTO standards were used to design the specific structure.
- State Item 49A (Computer File Name) shall be coded as the "brkey" of the structure (5 digit Federal ID).
- State Item 49B (Last Run Date) shall be left blank.
- Concrete pipes
  - State Item 47 (Stress Level) shall be coded 'O' (Operating).
- Metal pipes
  - State Item 47 (Stress Level) shall be coded 'M' (Midrange).

Rating Chart for BOX CULVERTS

		SINGLE								DOUBLE							
SPAN	HEIGHT	HEIGHT OF FILL								HEIGHT OF FILL							
		0 TO 2		2 TO 5		5 TO 10		10 TO 15		0 TO 2		2 TO 5		5 TO 10		10 TO 15	
		INV	OPR	INV	OPR	INV	OPR	INV	OPR	INV	OPR	INV	OPR	INV	OPR	INV	OPR
3	3	46	77	96	99	99	99	99	99	62	99	99	99	99	99	99	99
3	4	60	99	86	99	99	99	99	99	62	99	99	99	99	99	99	99
4	3	54	90	99	99	99	99	99	99	52	87	99	99	99	99	99	99
4	4	51	86	91	99	99	99	99	99	52	87	99	99	99	99	99	99
4	5	49	83	84	99	99	99	99	99	51	85	99	99	99	99	99	99
4	6	51	86	77	99	99	99	99	99	50	83	99	99	99	99	99	99
5	3	50	84	71	99	99	99	99	99	45	76	99	99	99	99	99	99
5	4	48	81	67	99	99	99	99	99	48	81	99	99	99	99	99	99
5	5	51	85	63	99	99	99	99	99	47	78	99	99	99	99	99	99
5	6	48	80	82	99	99	99	99	99	46	77	99	99	99	99	99	99
5	7	51	85	78	99	99	99	99	99	46	77	96	99	99	99	99	99
6	4	50	84	74	99	99	99	99	99	45	76	82	99	99	99	99	99
6	5	48	81	66	99	99	99	99	99	46	76	79	99	99	99	99	99
6	6	47	78	64	99	99	99	99	99	48	80	76	99	99	99	99	99
6	7	49	83	72	99	99	99	99	99	47	79	73	99	99	99	99	99
6	8	55	92	75	99	99	99	99	99	46	77	70	99	99	99	99	99
7	4	45	75	65	99	99	99	99	99	45	75	71	99	96	99	99	99
7	6	46	77	67	99	97	99	99	99	47	79	65	99	85	99	99	99
7	8	48	81	68	99	86	99	99	99	46	76	66	99	75	99	99	99
7	10	52	87	79	99	85	99	99	99	46	77	67	99	79	99	99	99
8	4	45	76	64	99	91	99	99	99	49	81	64	99	71	99	99	99
8	6	49	82	56	94	79	99	99	99	46	77	68	99	67	99	99	99
8	8	44	74	64	99	78	99	99	99	46	77	63	99	76	99	99	99
8	10	50	84	58	97	73	99	99	99	47	78	64	99	75	99	99	99
9	4	48	80	59	99	74	99	99	99	46	76	64	99	66	99	99	99
9	6	43	72	47	79	83	99	99	99	48	80	56	93	79	99	99	99
9	8	46	77	50	84	74	99	99	99	45	76	60	99	76	99	99	99
9	10	44	74	52	86	81	99	99	99	48	81	63	99	68	99	99	99
9	12	52	87	49	83	96	99	99	99	48	81	64	99	78	99	99	99
10	4	43	73	61	99	59	99	99	99	47	79	57	95	64	99	99	99
10	6	39	65	62	99	76	99	99	99	45	76	55	93	79	99	99	99
10	8	46	77	55	91	63	99	99	99	48	81	57	96	78	99	99	99
10	10	41	69	55	91	61	99	99	99	48	81	59	98	62	99	99	99
10	12	45	75	57	96	36	56	99	99	46	77	63	99	59	99	99	99
12	6	46	78	47	79	73	99	99	99	43	73	50	84	64	99	99	99
12	8	48	80	57	96	56	93	99	99	45	75	50	83	63	99	99	99
12	10	40	66	47	79	64	93	99	99	48	81	48	81	63	99	99	99
12	12	44	74	55	91	67	93	99	99	44	74	48	81	61	99	99	99

		TRIPLE								QUADRUPLE							
SPAN	HEIGHT	HEIGHT OF FILL								HEIGHT OF FILL							
		0 TO 2		2 TO 5		5 TO 10		10 TO 15		0 TO 2		2 TO 5		5 TO 10		10 TO 15	
		INV	OPR	INV	OPR	INV	OPR	INV	OPR	INV	OPR	INV	OPR	INV	OPR	INV	OPR
3	3	60	99	99	99	99	99	99	99	59	98	99	99	99	99	99	99
3	4	58	97	99	99	99	99	99	99	51	85	99	99	99	99	99	99
4	3	51	85	99	99	99	99	99	99	49	82	99	99	99	99	99	99
4	4	49	82	99	99	99	99	99	99	45	75	88	99	99	99	99	99
4	5	47	79	99	99	99	99	99	99	47	79	88	99	99	99	99	99
4	6	46	77	99	99	99	99	99	99	45	76	89	99	99	99	99	99
5	3	52	87	96	99	99	99	99	99	45	75	89	99	99	99	99	99
5	4	45	75	96	99	99	99	99	99	43	72	73	99	99	99	99	99
5	5	44	73	92	99	99	99	99	99	42	70	67	99	99	99	99	99
5	6	43	71	86	99	99	99	99	99	43	72	64	99	99	99	99	99
5	7	45	76	82	99	99	99	99	99	43	72	64	99	99	99	99	99
6	4	42	71	64	99	99	99	99	99	43	72	57	95	99	99	99	99
6	5	44	74	64	99	99	99	99	99	41	69	56	93	99	99	99	99
6	6	44	73	64	99	99	99	99	99	41	68	55	91	99	99	99	99
6	7	46	77	63	99	99	99	99	99	39	66	59	99	99	99	99	99
6	8	46	77	67	99	99	99	99	99	42	70	62	99	99	99	99	99
7	4	43	72	67	99	94	99	99	99	42	71	63	99	94	99	99	99
7	6	43	72	67	99	81	99	99	99	40	67	61	99	81	99	99	99
7	8	44	73	63	99	72	99	99	99	42	71	58	98	70	99	99	99
7	10	43	71	61	99	75	99	99	99	42	70	59	98	75	99	99	99
8	4	41	68	57	95	70	99	99	99	44	74	62	99	65	99	99	99
8	6	40	66	65	99	77	99	99	99	45	76	53	88	65	99	99	99
8	8	42	71	63	99	71	99	99	99	44	74	58	97	70	99	99	99
8	10	44	74	61	99	77	99	99	99	45	76	58	97	77	99	99	99
9	4	42	70	44	74	61	99	99	99	44	74	70	99	80	99	99	99
9	6	38	63	40	66	62	99	99	99	46	77	70	99	72	99	99	99
9	8	42	70	45	75	64	99	99	99	44	74	68	99	68	99	99	99
9	10	43	72	48	80	64	99	99	99	44	74	65	99	65	99	99	99
9	12	44	73	44	74	65	99	99	99	44	74	55	93	64	99	99	99
10	4	43	72	46	76	76	99	99	99	46	76	64	99	68	99	99	99
10	6	40	67	42	70	71	99	99	99	42	70	65	99	68	99	99	99
10	8	42	71	45	75	86	99	99	99	48	81	72	99	65	99	99	99
10	10	42	71	45	75	85	99	99	99	48	81	73	99	72	99	99	99
10	12	43	71	45	76	68	99	99	99	46	77	61	99	66	99	99	99
12	6	43	71	45	76	56	93	99	99	44	73	49	83	56	93	99	99
12	8	43	72	45	76	57	95	99	99	45	76	48	81	43	72	99	99
12	10	43	72	46	77	72	99	99	99	45	76	49	83	52	87	99	99
12	12	43	73	46	77	69	99	99	99	46	78	59	99	65	99	99	99

SPAN	HEIGHT	OVERSIZE							
		0 TO 2		2 TO 5		5 TO 10		10 TO 15	
		INV	OPR	INV	OPR	INV	OPR	INV	OPR
12	14	47	78	55	93	65	99	99	99
12	16	55	92	60	99	72	99	99	99

SPAN	HEIGHT	OVERSIZE							
		0 TO 2		2 TO 5		5 TO 10		10 TO 15	
		INV	OPR	INV	OPR	INV	OPR	INV	OPR
14	8	38	64	46	76	60	99	99	99
14	10	40	67	50	84	61	99	99	99

SPAN	HEIGHT	OVERSIZE							
		0 TO 2		2 TO 5		5 TO 10		10 TO 15	
		INV	OPR	INV	OPR	INV	OPR	INV	OPR
14	12	40	68	45	75	55	92	99	99
14	14	43	73	49	83	62	99	99	99
14	16	49	82	53	89	57	95	99	99

APPENDIX B

Equivalent Capacity Coefficients - Simple Spans

(For longitudinal members controlled by flexure)

Span (FT.)	HS20 GROSS	VA Type 3	VA Type 3S2	SU4	SU5	SU6	SU7	NRL	PERMIT BP-90	PERMIT BP-115
2	1	1.200	2.092	1.412	1.621	1.817	2.026	2.092	1.818	2.866
4	1	1.200	2.092	1.412	1.621	1.817	2.026	2.092	1.818	2.866
6	1	1.200	2.092	1.412	1.621	1.817	2.026	2.092	1.818	2.866
8	1	1.200	1.859	1.255	1.441	1.615	1.801	1.859	1.616	2.548
10	1	1.103	1.634	1.076	1.236	1.385	1.545	1.594	1.420	2.047
12	1	1.016	1.506	0.940	1.079	1.209	1.349	1.392	1.309	1.720
14	1	0.961	1.423	0.861	0.989	1.108	1.236	1.276	1.237	1.543
16	1	0.922	1.366	0.810	0.930	1.020	1.137	1.174	1.187	1.433
18	1	0.893	1.324	0.775	0.866	0.944	1.052	1.086	1.123	1.358
20	1	0.871	1.291	0.748	0.819	0.876	0.977	1.009	1.061	1.303
22	1	0.854	1.225	0.728	0.785	0.828	0.923	0.953	1.015	1.261
24	1	0.843	1.172	0.714	0.760	0.794	0.876	0.904	0.983	1.217
26	1	0.885	1.201	0.746	0.787	0.815	0.887	0.910	1.016	1.243
28	1	0.921	1.225	0.766	0.809	0.833	0.897	0.909	1.045	1.266
30	1	0.953	1.247	0.773	0.829	0.848	0.906	0.908	1.069	1.286
32	1	0.980	1.265	0.780	0.846	0.861	0.914	0.909	1.091	1.303
34	1	1.006	1.283	0.787	0.860	0.875	0.922	0.911	1.112	1.320
36	1	1.041	1.314	0.802	0.871	0.890	0.940	0.923	1.143	1.350
38	1	1.063	1.341	0.815	0.880	0.898	0.946	0.934	1.170	1.376
40	1	1.058	1.364	0.827	0.888	0.904	0.949	0.943	1.194	1.399
42	1	1.055	1.385	0.837	0.895	0.910	0.952	0.949	1.215	1.419
44	1	1.051	1.404	0.846	0.902	0.915	0.955	0.947	1.234	1.437
46	1	1.048	1.420	0.854	0.907	0.920	0.957	0.946	1.252	1.453
48	1	1.046	1.436	0.861	0.912	0.924	0.959	0.944	1.267	1.468
50	1	1.044	1.449	0.868	0.917	0.928	0.960	0.943	1.282	1.481
52	1	1.042	1.462	0.874	0.921	0.931	0.962	0.943	1.295	1.493
54	1	1.040	1.474	0.879	0.924	0.934	0.964	0.942	1.307	1.504
56	1	1.038	1.484	0.884	0.928	0.937	0.965	0.941	1.318	1.515
58	1	1.036	1.494	0.889	0.931	0.939	0.966	0.941	1.328	1.524
60	1	1.035	1.503	0.893	0.933	0.942	0.967	0.940	1.334	1.533
62	1	1.034	1.511	0.897	0.936	0.944	0.969	0.940	1.316	1.541
64	1	1.032	1.519	0.901	0.938	0.946	0.970	0.939	1.300	1.548
66	1	1.031	1.527	0.904	0.941	0.948	0.971	0.939	1.286	1.555
68	1	1.030	1.532	0.907	0.943	0.949	0.972	0.939	1.273	1.562
70	1	1.029	1.505	0.910	0.945	0.951	0.972	0.939	1.261	1.568
75	1	1.027	1.448	0.917	0.949	0.955	0.974	0.938	1.236	1.582
80	1	1.025	1.403	0.923	0.953	0.958	0.976	0.938	1.215	1.593
85	1	1.023	1.366	0.928	0.956	0.961	0.977	0.937	1.197	1.604
90	1	1.022	1.335	0.932	0.959	0.963	0.979	0.937	1.182	1.560
95	1	1.021	1.309	0.936	0.961	0.965	0.980	0.937	1.169	1.513
100	1	1.019	1.287	0.939	0.963	0.967	0.981	0.936	1.158	1.473
105	1	1.018	1.268	0.942	0.965	0.969	0.982	0.936	1.148	1.439

Span (FT.)	HS20 GROSS	VA Type 3	VA Type 3S2	SU4	SU5	SU6	SU7	NRL	PERMIT BP-90	PERMIT BP-115
110	1	1.018	1.251	0.945	0.967	0.970	0.983	0.936	1.140	1.408
115	1	1.017	1.236	0.948	0.968	0.972	0.984	0.936	1.132	1.381
120	1	1.016	1.223	0.950	0.970	0.973	0.984	0.936	1.125	1.358
125	1	1.015	1.211	0.952	0.971	0.974	0.985	0.936	1.119	1.337
130	1	1.015	1.201	0.954	0.972	0.975	0.985	0.936	1.113	1.319
135	1	1.014	1.191	0.956	0.974	0.976	0.986	0.936	1.108	1.303
140	1	1.014	1.183	0.958	0.975	0.977	0.987	0.936	1.104	1.288
145*	1	1.014	1.176	0.960	0.976	0.979	0.988	0.936	1.100	1.275
150*	1	1.035	1.193	0.981	0.998	1.000	1.009	0.956	1.119	1.289
160*	1	1.076	1.228	1.024	1.040	1.042	1.051	0.995	1.158	1.319
170*	1	1.118	1.265	1.068	1.083	1.085	1.094	1.035	1.197	1.352
180*	1	1.160	1.302	1.111	1.126	1.128	1.137	1.074	1.237	1.386
190*	1	1.203	1.341	1.155	1.169	1.171	1.180	1.114	1.278	1.421
200*	1	1.246	1.380	1.198	1.213	1.215	1.223	1.155	1.319	1.458

*HS20 LANE LOAD WAS USED FOR THESE SPANS

Equivalent Capacity Coefficients - Simple Spans
(For longitudinal members controlled by shear at bearings)

Span (FT.)	HS20 GROSS	VA Type 3	VA Type 3S2	SU4	SU5	SU6	SU7	NRL	PERMIT BP-90	PERMIT BP-115
2	1	1.200	2.092	1.412	1.621	1.817	2.026	2.092	1.818	2.866
4	1	1.200	2.092	1.412	1.621	1.817	2.026	2.092	1.818	2.866
6	1	1.059	1.569	1.059	1.216	1.363	1.520	1.569	1.364	2.150
8	1	0.941	1.394	0.941	1.081	1.211	1.351	1.394	1.212	1.911
10	1	0.882	1.307	0.833	0.957	1.073	1.196	1.235	1.136	1.592
12	1	0.847	1.255	0.774	0.889	0.996	1.111	1.147	1.091	1.433
14	1	0.824	1.220	0.737	0.817	0.916	1.022	1.055	1.013	1.338
16	1	0.908	1.280	0.800	0.867	0.972	1.084	1.119	1.081	1.433
18	1	0.971	1.321	0.846	0.902	1.011	1.128	1.161	1.130	1.455
20	1	1.020	1.352	0.852	0.928	1.040	1.160	1.171	1.166	1.470
22	1	1.059	1.375	0.857	0.948	1.063	1.185	1.178	1.194	1.482
24	1	1.091	1.393	0.861	0.941	1.055	1.177	1.183	1.216	1.490
26	1	1.065	1.407	0.864	0.935	1.050	1.171	1.188	1.235	1.497
28	1	1.046	1.420	0.866	0.930	1.045	1.166	1.191	1.250	1.503
30	1	1.041	1.445	0.877	0.937	1.053	1.174	1.202	1.277	1.525
32	1	1.037	1.467	0.887	0.942	1.052	1.173	1.203	1.299	1.542
34	1	1.034	1.486	0.895	0.946	1.048	1.169	1.199	1.319	1.558
36	1	1.032	1.502	0.902	0.950	1.044	1.158	1.189	1.336	1.571
38	1	1.029	1.517	0.908	0.954	1.041	1.145	1.181	1.351	1.583
40	1	1.027	1.530	0.914	0.956	1.038	1.134	1.174	1.365	1.593
42	1	1.026	1.541	0.919	0.959	1.036	1.125	1.168	1.377	1.602
44	1	1.024	1.551	0.923	0.961	1.034	1.117	1.159	1.388	1.610
46	1	1.023	1.560	0.927	0.963	1.032	1.110	1.149	1.398	1.617
48	1	1.022	1.569	0.930	0.965	1.030	1.104	1.141	1.407	1.624
50	1	1.020	1.576	0.934	0.967	1.029	1.098	1.133	1.391	1.630
52	1	1.019	1.583	0.937	0.968	1.027	1.093	1.126	1.366	1.636
54	1	1.019	1.544	0.939	0.970	1.026	1.089	1.119	1.344	1.641
56	1	1.018	1.509	0.942	0.971	1.025	1.084	1.114	1.325	1.645
58	1	1.017	1.478	0.944	0.972	1.024	1.081	1.109	1.307	1.650
60	1	1.016	1.451	0.946	0.973	1.023	1.077	1.104	1.292	1.653
62	1	1.016	1.426	0.948	0.974	1.022	1.074	1.100	1.277	1.657
64	1	1.015	1.404	0.950	0.975	1.021	1.071	1.096	1.265	1.661
66	1	1.015	1.385	0.951	0.976	1.020	1.069	1.092	1.253	1.636
68	1	1.014	1.367	0.953	0.977	1.020	1.066	1.088	1.242	1.610
70	1	1.014	1.350	0.955	0.977	1.019	1.064	1.085	1.232	1.582
75	1	1.013	1.315	0.958	0.979	1.017	1.059	1.078	1.211	1.515
80	1	1.012	1.287	0.961	0.981	1.016	1.054	1.072	1.193	1.462
85	1	1.011	1.263	0.963	0.982	1.015	1.050	1.067	1.178	1.419
90	1	1.010	1.242	0.965	0.983	1.014	1.047	1.063	1.165	1.383
95	1	1.010	1.225	0.967	0.984	1.013	1.044	1.059	1.154	1.352
100	1	1.009	1.210	0.969	0.985	1.013	1.042	1.055	1.144	1.327
105	1	1.009	1.197	0.971	0.986	1.012	1.039	1.052	1.136	1.304

Span (FT.)	HS20 GROSS	VA Type 3	VA Type 3S2	SU4	SU5	SU6	SU7	NRL	PERMIT BP-90	PERMIT BP-115
110	1	1.008	1.185	0.972	0.986	1.011	1.037	1.050	1.128	1.285
115	1	1.008	1.175	0.973	0.987	1.011	1.036	1.047	1.121	1.268
120	1	1.007	1.166	0.975	0.988	1.010	1.034	1.045	1.115	1.253
125	1	1.007	1.158	0.976	0.988	1.010	1.032	1.043	1.110	1.239
130*	1	1.018	1.163	0.988	1.000	1.021	1.043	1.053	1.117	1.241
135*	1	1.039	1.180	1.009	1.021	1.042	1.063	1.073	1.136	1.256
140*	1	1.060	1.198	1.031	1.042	1.063	1.084	1.093	1.155	1.271
145*	1	1.081	1.216	1.052	1.064	1.084	1.104	1.114	1.174	1.286
150*	1	1.102	1.234	1.074	1.085	1.105	1.125	1.134	1.193	1.303
160*	1	1.145	1.271	1.117	1.128	1.147	1.167	1.176	1.232	1.337
170*	1	1.188	1.310	1.161	1.171	1.190	1.209	1.218	1.272	1.372
180*	1	1.230	1.349	1.204	1.215	1.233	1.251	1.260	1.313	1.409
190*	1	1.274	1.389	1.248	1.258	1.276	1.294	1.302	1.354	1.447
200*	1	1.317	1.429	1.292	1.302	1.319	1.337	1.345	1.395	1.485

* HS20 LANE LOAD WAS USED FOR THESE SPANS

APPENDIX C
EXAMPLE OF A RATING PROCEDURE
BRIDGES FOR WHICH PLANS ARE NOT AVAILABLE

If a normal bridge does not show signs of distress, has been carrying normal traffic for an appreciable length of time and capable of carrying legal loads at operating level, the steps to calculate ratings for other vehicles are as follows:

Assume:

Operating level rating for VA Type 3 (Single Unit Truck) as 27 tons
Operating level rating for VA Type 3S2 (Truck and Semi Trailer) as 40 tons

Refer to Appendix B (Equivalent Capacity Coefficients - Simple Spans) for the coefficients. Generally, shear does not control the rating.

For a span of 40':

Coefficients from the table in Appendix B for 40' span:

Span (FT.)	HS20 GROSS	VA Type 3	VA Type 3S2	SU4	SU5	SU6	SU7	NRL	PERMIT BP-90	PERMIT BP-115
40	1	1.058	1.364	0.827	0.888	0.904	0.949	0.943	1.194	1.399

First, find the HS20 operating rating:

HS20 operating rating = 27 tons / 1.058 = 25.51 tons, round to 26 tons
= 40 tons / 1.364 = 29.32 tons, round to 29 tons

Minimum of these two values is the HS20 operating rating,

Therefore, HS operating rating = 26 tons.

Using LFR coefficients: HS inventory rating = 26 tons /1.67 = 15 tons

From the HS20 operating rating, rating for other vehicles can be obtained.

BP-90 operating rating = 26 tons x 1.194 = 31.03 tons, round to 31 tons
BP-115 operating rating = 26 tons x 1.399 = 36.37 tons, round to 36 tons

VIRGINIA DEPARTMENT OF TRANSPORTATION

STRUCTURE AND BRIDGE DIVISION

INSTRUCTIONAL AND INFORMATIONAL MEMORANDUM

GENERAL SUBJECT: Structure Replacement Funding	NUMBER: IIM-S&B-87.2
SPECIFIC SUBJECT: Limitations on the use of Maintenance Funding for Structure Replacement Projects	Date: October 27, 2015 SUPERSEDES: IIM-S&B-87.1
DIVISION ADMINISTRATOR APPROVAL: /original signed/ E. Kevin Gregg State Maintenance Administrator Approved: October 27, 2015	/original signed/ Kendal R. Walus, P.E. State Structure and Bridge Engineer Approved: October 27, 2015

IIM totally revised

EFFECTIVE DATE

This Memorandum is effective immediately.

DESCRIPTION

The purpose of this IIM is to establish guidance for the use of Maintenance Funds on bridge and Large Culvert replacement projects.

CRITERIA FOR DETERMINING THE ELIGIBILITY OF A STRUCTURE REPLACEMENT

The following criteria must be met for a structure to qualify for Maintenance Funding:

- The structure must be classified as Structurally Deficient (SD) or have an element (deck, superstructure, substructure or culvert) with a general condition rating of 5 (on the verge of becoming SD).

- The structure must not have been replaced nor had rehabilitation during the past 10 years.

- The ratio of rehabilitation cost/replacement cost to be 65% or greater in order to replace a structure.

CC: Chief Engineer
Chief of Systems Operations
Division Administrators
District Administrators
District Construction Engineers
District Maintenance Managers
Assistant State Structure and Bridge Engineers
District Structure and Bridge Engineers
Residency Administrators
Structure and Bridge Program Managers
FHWA – Bridge Section

VIRGINIA DEPARTMENT OF TRANSPORTATION

Joint – Operations & Security Division and Structure & Bridge Division

Instructional and Informational (I&I) Memorandum

General Subject	VDOT's Authority Having Jurisdiction (AHJ) Process
Number	IIM-S&B-88 IIM-OSD-01
Specific Subject	This I&I Memo outlines and formalizes the Authority Having Jurisdiction (AHJ) process within VDOT.
Date	December 12, 2011
Supersedes	N/A
Division Administrator Approval	**/Original Signed/** **Thomas H. Phillips** **Operations & Security Division Administrator** **Approved: December 12, 2011** _____ Thomas H. Phillips, Division Administrator, Operations & Security Division **/Original Signed/** **Kendal R. Walus, P.E.** **State Structure and Bridge Engineer** **Approved: December 12, 2011** _____ Kendal R. Walus, P.E., Division Administrator, Structure & Bridge Division

Background	VDOT has recently adopted the National Fire Protection Association (NFPA) 502 as its fire protection and fire, life, and safety standard for roadway tunnels. Within NFPA 502, the Authority Having Jurisdiction (AHJ) is defined as "an organization, office, or individual responsible for enforcing the requirements of a code, or standard, or for approving equipment, an installation, or procedures." Provisions within NFPA 502 give the AHJ discretion to determine the reasonable application of NFPA 502.
Purpose	The purpose of this I&I Memo is to outline and formalize the Authority Having Jurisdiction (AHJ) process within VDOT. The process for requesting Authority Having Jurisdiction (AHJ) approval on various fire protection and fire, life, and safety issues will be handled through a review by the Statewide Tunnels Oversight Committee (STOC) Executive Steering Committee (ESC) and if approved, the STOC ESC Chair will make a recommendation for approval of the request to the AHJ. Final approval is required by the AHJ. The AHJ within VDOT is the Chief Engineer.
Process	**Any and all fire protection and fire, life, and safety issues related to the AHJ Process will be addressed through the STOC ESC. Any requests for AHJ review will be coordinated through the Operations & Security Division (OSD). OSD will coordinate the request and schedule a time on the next STOC ESC meeting agenda to review the AHJ Request. The technical lead will present the AHJ Request to the STOC ESC for consideration. If the AHJ Request is approved by the STOC ESC, a Decision Paper will be developed by the technical lead to be sent from the STOC ESC Chair to the Chief Engineer with a recommendation for approval.** The Decision Paper Memorandum will include the following categories: (1) Decision, (2) Scope, (3) Background and Discussion, (4) Impacts, (5) Recommendation, (6) Timeline, (7) Attachments, (8) AHJ Decision Recommendation, and (9) AHJ Decision Approval. Copies of records that are approved will remain in the Operations & Security Division and Structure & Bridge Division. See example Decision Paper Template in Appendix A.

Appendix A:

VDOT'S AUTHORITY HAVING JURISDICTION (AHJ) REVIEW

DECISION PAPER

DATE

MEMORANDUM

TO: *Chief Engineer*

CC: *(1) Chief of System Operations;*
(2) Operations & Security Division Administrator (or his designee); and
(3) Structure & Bridge Division Administrator (or his designee).

FROM: *Statewide Tunnels Oversight Committee Executive Steering Committee, Chair*

SUBJECT: *Subject of the Decision Paper*

1. DECISION:

Describe the desired policy change or new method of applying / interpreting NFPA 502 (hereafter referred to as "the standard")

2. SCOPE:

Introduction

Describe the scope of the decision paper

Relevant Sections and Referenced Documents

List the section(s) / subsection(s) of NFPA addressed in the paper

List any other documents referenced in the preparation of the paper

Stakeholders

List key stakeholders that will be affected by the decision

Purpose

Briefly state the reason the AHJ is being requested (preparer will expand on / discuss purpose of the request in the following section)

3. BACKGROUND AND DISCUSSION:

Provide rationale for the change; background information / other related information such as current situation – and reason for desired change

4. IMPACTS:

Impact Area Table

Check Impacted Area(s)	☐ Tunnel Closure & Traffic Control	☐ Water-based Fire-Fighting Systems	☐ Control of Hazardous Materials
☐ Protection of Structural Elements	☐ Fire Apparatus	☐ Emergency Ventilation	☐ Means of Egress
☐ Fire Alarm and Detection	☐ Standpipe, Fire Hydrants, and Water Supply	☐ Tunnel Drainage System	☐ Other
☐ Emergency Communications Systems	☐ Portable Fire Extinguishers	☐ Alternative Fuels	

Describe the impacts that the decision will have – change from the current situation. Include reference to impact areas selected in table above

5. RECOMMENDATION:

Describe proposed recommendation to resolve the decision

6. TIMELINE:

Describe the timeline and/or how long the decision will remain in place.

7. ATTACHMENTS:

Provide as attachments all the relevant sections / subsections of NFPA and referred documents stated in the scope of the document

8. AHJ DECISION RECOMMENDATION

SIGNATURE

STOC ESC Chair _____

Signature/Date

9. AHJ DECISION APPROVAL

SIGNATURE

Chief Engineer _____

Signature/Date

VIRGINIA DEPARTMENT OF TRANSPORTATION

STRUCTURE AND BRIDGE DIVISION

INSTRUCTIONAL AND INFORMATIONAL MEMORANDUM

GENERAL SUBJECT: VDOT Modifications to the AASHTO *Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals.*	NUMBER: IIM-S&B-89 IIM-LD - 250 TE – 375.0
SPECIFIC SUBJECT: Maximum Span Length Limits for Ancillary Structures and Bridge Parapet Mounts.	Date: October 11, 2013 SUPERSEDES: IIM-S&B-74 TE-347.0
DIVISION ADMINISTRATOR APPROVAL: /original signed/ Raymond J. Khoury, P.E. State Traffic Engineer Approved: October 17, 2013 /original signed/ Barton A. Thrasher, P.E. State Location and Design Engineer Approved: October 11, 2013 /original signed/ Kendal R. Walus, P.E. State Structure and Bridge Engineer Approved: October 18, 2013	

Changes are shaded.

EFFECTIVE DATE:

The following requirements for maximum span limits are effective for all projects with an advertisement on or after **June 1, 2014**. The moratorium on new bridge parapet mount sign structures remains in effect on all projects.

BACKGROUND:

In 2012 as a result of the Quality Assurance and Condition Assessment of Cantilever Sign Structures, the Department reviewed the design requirements used for construction of Ancillary (or Sign) Structures. It was determined that the Department should establish reasonable span limits for ancillary structures in lieu of the minimal guidance currently provided to traffic designers on this issue. The following span length limits are established for use in plan development for traffic structures.

SPAN LENGTH LIMITS FOR ANCILLARY STRUCTURES:

The following span limits shall apply to structures:

Maximum Span Length		
Structure Type	**Span Length*, ft.**	**Supplemental Requirements**
Overhead Sign Structure	150	Structure shall not have a center support.
Overhead Sign Cantilever	50	VMS or CMS signs shall not be erected on cantilever structures. **
Signal Mast Arm	78	
Overhead Signal Structure	190	Signal structure shall have a single chord or twin chord only.
Signal Twin Mast Arms	70 single arm	Maximum combined length for both arms is 130 feet.
Span Wire Signal	225	

* Span length is defined as center-to-center of column for span structure and face-of-column to tip of arm for cantilever and signal structures.

** This IIM supersedes Structure and Bridge IIM-S&B-74 and reiterates that there is a moratorium on erecting any cantilever sign structures with variable message sign(s) (VMS) or changeable message sign(s) (CMS). The original decision was based on a failure that occurred near the I-81 weigh station near Troutville. These cantilever structures were subject to other wind phenomena which were not adequately addressed by the AASHTO *Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals* at that time. Although now addressed in the current specifications, it is felt that a span type structure or butterfly is more suitable for the design if VMS/CMS is/are included.

BRIDGE PARAPET MOUNTS:

Based on the Chief Engineer and Chief of Systems Operations joint memorandum issued on July 24, 2008, the moratorium on new bridge parapet mount structures remains in effect and new bridge parapet structures shall not be allowed. The Department has undertaken a program to remove these structures from bridges because of the use of adhesive anchors and inability to adequately inspect these structures. Design Waivers for new bridge parapet mounted structures will not be approved.

DESIGN WAIVERS:

Deviation from these span limits and supplemental requirements shall require a design waiver and shall be requested in writing to the Assistant State Traffic Engineer for Traffic Control Devices for approval by the Assistant State Structure and Bridge Engineer in charge of Engineering Services. Form LD-448 shall be utilized following the procedures outlined in IIM-LD-227. The request should include the following information: (see sample completed form in Appendix A)

- Maximum length from table above and proposed length.
- Reason(s) why the maximum length criteria cannot be met.
- Justification for waiver.
- Any background information which documents or justifies the request including why an alternative structure is not feasible. Examples include the following: location/site view and/or an aerial photo with proposed placement of ancillary structure, proposed sign message, location(s) of proposed signal and other traffic control devices, etc.
- Any mitigation to further support or justify the waiver request.

CC: Chief Engineer
Deputy Chief Engineer
State Location and Design Engineer
State Structure and Bridge Engineer
State Traffic Engineer
State Operations Engineer
Assistant State Structure and Bridge Engineers
Assistant State Traffic Engineer – Traffic Control Devices
District Structure and Bridge Engineers
State Traffic Design Program Manager
Regional Operations Directors
Regional Operations Maintenance Managers
Regional Traffic Engineers
FHWA – Bridge Section

Appendix A

LD-448
(10-9-13)

DEPARTMENT OF TRANSPORTATION
LOCATION AND DESIGN/STRUCTURE & BRIDGE
DESIGN WAIVER REQUEST

(See IIM-LD-227 for the definition of Design Waiver)

Com-plete this part

To: _____ Date: _____
Assist. State Structure and Bridge Engineer

From: _____
Project Designer (L&D or S&B)

State Project Number: _____ Federal Project Number: _____

County/City: _____ District: _____ Funding Source: _____

Project Description
From: _____ UPC: _____
To: _____

Functional Classification: N/A Minimum VDOT GS Standard: N/A

Min. VDOT Standard: (Value from Table) Min. AASHTO Standard: N/A

A Design Waiver is requested for the following:

- ☐ Clear Zone
- ☐ Total Shoulder Width
- ☐ Paved Shoulders Width
- ☐ Curb and Gutter
- ☐ Minimum Radius
- ☐ Pedestrian Accessibility Compliance (See IIM-LD-55)
- ☐ Intersection Sight Distance
- ☐ Ditch Width
- ☐ Lane Tapers
- ☐ Buffer Strip Width
- ☐ Superelevation
- ☒ Other (Check Here)

Design Waiver request must address the following:

- Established design criteria versus proposed and existing criteria (including traffic data, design speed and posted speed)
- Reason the appropriate design criteria cannot be met
- Justification for the proposed criteria
- Any background information which documents, supports or justifies the request
- Any mitigation that will be provided to further support or justify the request
- Safety implications of the request
- Cost to meet standard versus project cost

Attach all supporting documentation to this exhibit including crash history (past three years).

Provide this information plus additional information as requested in I&IM. Crash history is not required.

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* To be completed by C.O. Traffic Engineering Division

Recommend for Approval by: _____ Date: _____
Assist. State Traffic Engineer-Traffic Control Dev

* To be completed by C.O Structure and Bridge Division

Drop List by: _____ Date: _____
Assist. State Structure and Bridge Engineer

CC: Appropriate Assistant State Location and Design Engineer
Project Manager
State Geometric Engineer
State Structure and Bridge Engineer
Assistant State Traffic Engineer – Traffic Control Devices
Assistant District Structure and Bridge Engineer

VIRGINIA DEPARTMENT OF TRANSPORTATION

STRUCTURE AND BRIDGE DIVISION

INSTRUCTIONAL AND INFORMATIONAL MEMORANDUM

GENERAL SUBJECT: Ancillary Structures	NUMBER: IIM-S&B-90.2 IIM-TE-382.1
SPECIFIC SUBJECT: VDOT Guidelines to AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaries, and Traffic Signals, 6th Edition, 2013 with 2015 interims	Date: April 28, 2016 SUPERSEDES: IIM-S&B-90.1
DIVISION ADMINISTRATOR APPROVAL: /original signed/ Kendal R. Walus, P.E. State Structure and Bridge Engineer Approved: April 28, 2016	/original signed/ Raymond J. Khoury, P.E. State Traffic Engineer Approved: April 28, 2016

Changes are shaded.

The following VDOT Guidelines to the AASHTO *Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals, 6th Edition (LTS-6), 2013 with 2015 interims*, are effective for projects as stated below.

Effective Date:

Future contracts: This Memorandum shall be effective for all contracts with an advertisement on or after July 1, 2016.

Existing contracts: Requirements in this Memorandum may be applied under existing contracts (including existing Regional Traffic Signal Construction Contracts) if the change is approved by the Project Engineer.

Land use permit for private developments: this Memorandum shall be effective for all projects where the design is submitted to VDOT on or after July 1, 2016.

Design-Build or PPTA projects: this Policy shall be effective for projects with RFP released on or after July 1, 2016.

General Requirements:

Variance from the VDOT Guidelines to these specifications shall require a Design Waiver. For complete information on and requirements of Design Waivers, see Section Pre.02 of Part 1 of the Manual of the Structure and Bridge Division.

Any AASHTO Specification optional design parameter noted as "may be used at the discretion of the owner" that are not addressed in this document shall not be used for design.

Square tube sign post, wood post, SSP-VA and SSP-VIA structures shall be provided in accordance with the requirements as shown in the *VDOT Road and Bridge Standards*.

Lighting (conventional and high mast), signal (overhead, mast arm and span wire), pedestal poles, overhead (span, cantilever and butterfly) sign structures and ITS structures (camera poles, dynamic message signs (DMS), etc.) shall conform to the requirements of the AASHTO *Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals, 6th Edition (LTS-6), 2013 with 2015 interims* with the following clarifications:

SECTION 2: GENERAL FEATURES OF DESIGN:

For additional requirements related to general features of design, see *VDOT Road and Bridge Specifications*, Section 700 and *VDOT Road and Bridge Standards*, Section 1300. See current IIM-S&B-89 for maximum span limits on ancillary structures and moratorium on bridge mounted sign structures.

SECTION 3: LOADS:

Wind Loading**:** (LTS-6 Article 3.8 and Appendix C) The alternate method for wind pressures provided in AASHTO Appendix C shall be used. Linear interpolation between wind contours is not permitted. The next higher contour shall be used for design. Reduced forces shall not be used for free swinging traffic signal and free swinging sign wind loadings. See Appendix A for wind maps of Virginia.

For special wind regions in Bristol District shown on maps in Appendix A, the selection of the design wind speed shall consider localized effects. The minimum design wind speed for 50 year mean in these areas is 90 MPH, 25 year mean in these areas is 80 MPH and 10 year mean in these areas is 70 MPH.

For bridge mounted structures/light poles and other site condition where structures may be elevated above the surrounding terrain, the height factor used shall be increased to account for the increased wind effects.

(LTS-6 Article C.2) Wind speeds using 50-year mean recurrence shall be used for all conventional light poles, high mast light poles, ITS device support poles and overhead sign structures (span, cantilever and butterfly). Wind speeds using the 10-year mean recurrence shall be used for SSP-VA, SSP-VIA, square tube post and other ground mounted structures.

SECTION 3: LOADS: (cont'd)

(LTS-6 Article C.2) Mast arm signal poles, mast arms, and strain poles shall be designed using the following wind speeds:

VDOT Traffic Operations Region	VDOT Districts Within That Region	Design Wind Speed for strain poles, mast arms, and mast arm poles
Southwest	Bristol, Salem, and Lynchburg	70 MPH
Northwest	Staunton and Culpeper	70 MPH
Northern	Northern Virginia	80 MPH
Central	Richmond and Fredericksburg	80 MPH
Eastern	Hampton Roads	90 MPH

Mast arm signal pole and strain pole foundations shall be designed for wind speeds at the foundation location using the 25-year mean recurrence.

SECTION 5: STEEL DESIGN:

Laminated Structures**:** (LTS-6 Article C5.1) Laminated or multi-ply structures shall only be used in tapered sections.

Holes and Cutouts (Unreinforced and Reinforced): (LTS-6 Article 5.14.5) The location and size of hand holes and cutouts shall be in accordance with the details as shown in the *VDOT Road and Bridge Standards.* For high mast light poles, the width of unreinforced and reinforced holes and cutouts in the cross-sectional plane of the tube shall not be greater than 50 percent of the tube diameter at that section.

Welding: A connection detail using a full penetration groove weld with a backing ring may be considered for signal mast arms and high mast light poles. The backing ring shall be attached at the top and bottom face of the ring using a continuous fillet weld.

SECTION 11: FATIGUE DESIGN:

Fatigue Importance Categories: (LTS-6 Article 11.6)

The following fatigue importance categories shall apply to structures:

Fatigue Importance Categories		
Structure Type	**Span Length*, ft.**	**Fatigue Category**
All structures supporting dynamic message signs	All span lengths	Category I
Overhead sign span structure	> 150	Category I
	≤ 150	Category II
Overhead sign cantilever structure	> 50	Category I
	≤ 50	Category II
Overhead sign butterfly structure	All span lengths	Category II
Signal mast arm structure**	> 75	Category I
	50 to ≤ 75	Category II
	< 50	No fatigue design required
Overhead signal structure	> 190	Category I
	≤ 190	Category II
High mast light poles	All lengths	Category I
Signal span wires, conventional lights poles and ITS device support poles (excluding DMS)		No fatigue design required

* Span length is defined as center-to-center of column(s) for span structure and face-of-column to tip of arm for cantilever and signal structures.

** For twin mast arms, The pole, arms and connections shall be designed for the applicable fatigue category for the longest arm attached.

Mitigation Devices: (LTS-6 Article 11.6 and 11.7.1) Mitigation devices shall not be used in lieu of designing for fatigue.

Aluminum Light Poles: (LTS-6 Article 11.6 and 11.7.1): Internal first and second mode vibration dampeners shall be provided and installed according to the manufacturer's instructions in all cases. External dampeners may be used if approved by the Engineer.

Galloping Loads: (LTS-6 Article 11.7.1) Galloping loads shall not be considered in the design of overhead sign cantilevered structures with four chord trusses, signal mast arm structures, and multi-chord overhead signal structures.

Truck-Induced Gust Loads: (LTS-6 Article 11.7.1.3) Truck induced gust loads shall not be considered in the design of signal mast arm and overhead signal structures.

Vertical Deflection: (LTS-6 Article 11.8) The vertical deflection of the free end of the arm for overhead sign cantilevered structures due to the wind load effects of galloping or truck-induced gusts shall not exceed 8".

Section 13: FOUNDATION DESIGN:

(This section provides guidance/modifications on the AASHTO Standard Specifications for Highway Bridges, 1996; 1997 and 1998 Interim Specifications as referenced in the AASHTO *Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals*.)

Geotechnical Design**:** The factor of safety shall be as follows:

MINIMUM FACTORS OF SAFETY			
	Drilled Shaft		Spread Footing
	Overhead Sign Structures and all other types of ancillary structures except for Mast arm traffic Signals	Mast arm traffic Signals	
Tip resistance/Bearing pressure	1.75	1.75	2.0
Torsion/Sliding/Skin Friction	2.0(1)	1.3(1)	1.2(2)
Overturning (Broms Method)	2.25	2.25	1.5

((The factors of safety shown above already account for the 1.33/1.40 group overload/overstress factor. No reduction shall be applied to the design loading used in the analysis.))

(1) Torsion Resistance shall be evaluated as specified by the AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS (Version adopted by current IIM-S&B-80) Section 10.8.3.5- Nominal Axial Compression Resistance of Single Drilled Shafts. A value of 1.0 shall be used in lieu of the resistance factors as shown in Table 10.5.5.2.4-1.

(2) Passive resistance shall be reduced by 50% to limit foundation movement.

Geotechnical Design**:** In capacity calculations for the foundation design of a drilled shaft, the soil resistance of the top 1.5 feet shall be neglected in the analysis for torsion/skin friction/tip resistance. The full length of the shaft from the ground surface to the tip may be used in overturning/horizontal deflection. The remainder of the shaft may be assumed to be fully effective in supporting applied loads.

Horizontal Deflection: In lieu of Broms method, COM624P or other commercially available software may be used to evaluate the overturning of shafts and to estimate shaft deflections. For mast arm signals and span wire signals, the total horizontal deflection shall be limited to 0.75 inches at the ground level and the tip of the pile deflection shall not exceed -0.25 inches. For other structures, the total horizontal deflection shall be limited to 0.50 inches at the ground level and the tip of the pile deflection shall not exceed -0.15 inches. The loading used in the analysis shall not be reduced by the allowable overload/overstress factor. The shafts shall be modeled such that the nonlinear flexural rigidity (non-linear EI, or “cracked” section) is accounted for when the horizontal deflections are calculated.

Section 13: FOUNDATION DESIGN:(Cont'd)

Reinforcement: Where tremie placement of concrete is anticipated, a minimum spacing of 5 inches or 10 times the size of the largest coarse aggregate whichever is greater shall be provided in both horizontal and vertical direction. For dry shafts, a smaller space of 5 times the size of the largest coarse aggregate may be considered. A dry shaft is when the amount of standing water in the base of the shaft prior to concreting is less than or equal to 3 inches and water is entering the shaft at a rate of less than 12 inches/hour.

CC: Chief Engineer
Deputy Chief Engineer
State Operations Engineer
State Location and Design Engineer
State Operations Engineer
Assistant State Structure and Bridge Engineers
Assistant State Traffic Engineer – Traffic Control Devices
District Structure and Bridge Engineers
State Traffic Design Program Manager
Regional Operations Directors
District Transportation & Land Use Directors
Regional Operations Maintenance Managers
Regional Traffic Engineers
FHWA Virginia Administrator
FHWA – Bridge Section

Appendix A

(Wind maps developed based on charts from Appendix C AASHTO *Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals, 6th Edition, 2013)*

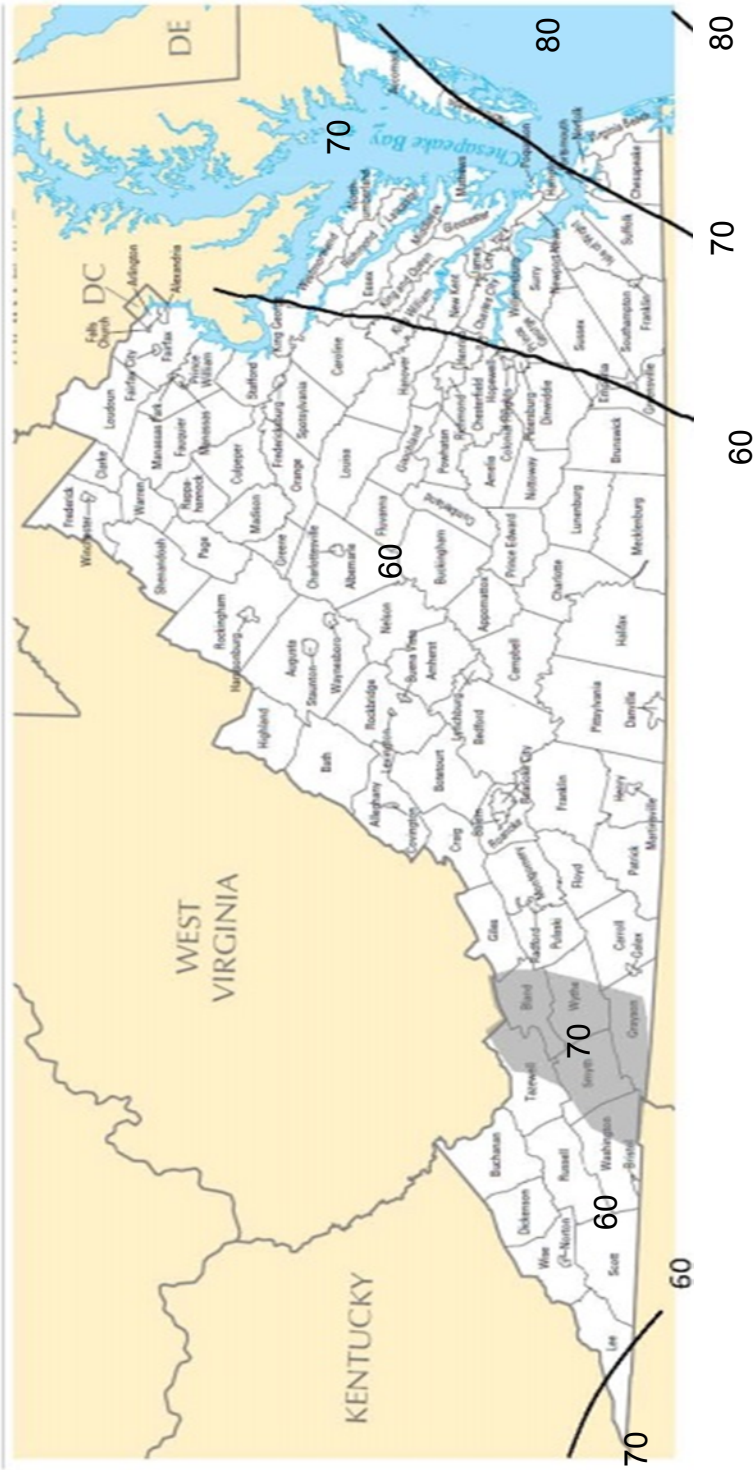

Figure A.3-1—Isotach 0.10 Quantiles in mph: Annual Extreme-Mile 9.1 m (30 ft) Above Ground, 10-yr Mean Recurrence Interval; Virginia

Special Wind Region

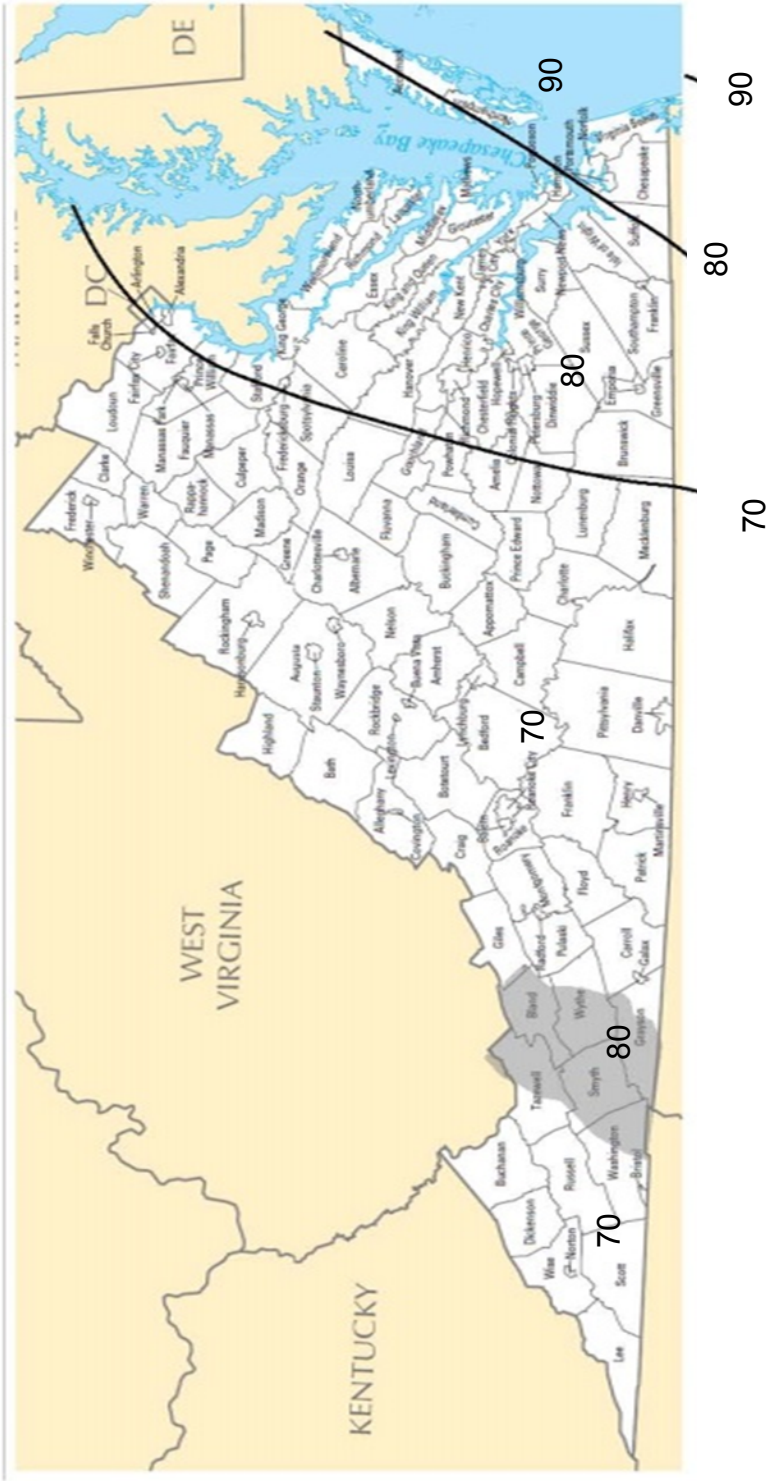

Figure A.3-2—Isotach 0.04 Quantiles in mph: Annual Extreme-Mile 9.1 m (30 ft) Above Ground, 25-yr Mean Recurrence Interval; Virginia

Special Wind Region

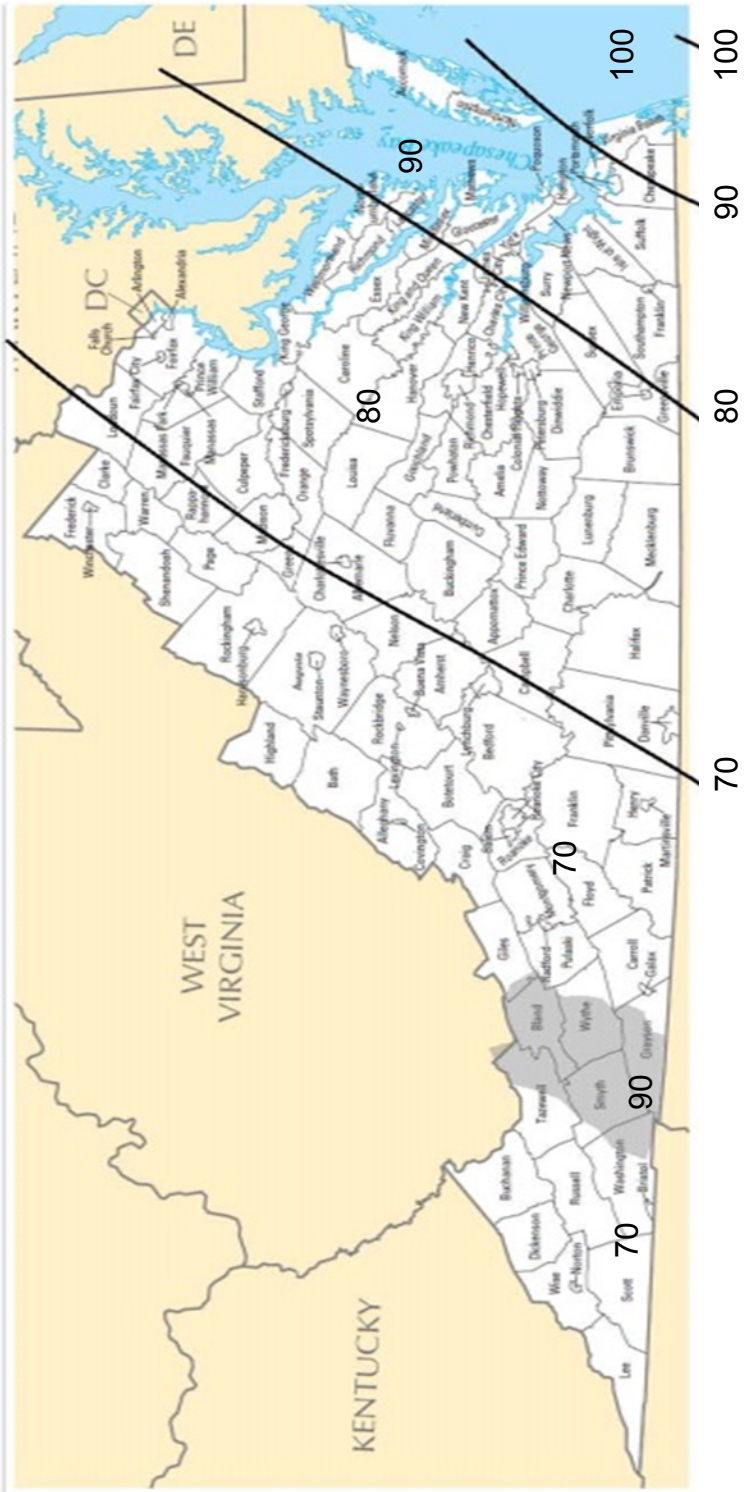

Figure A.3-3—Isotach 0.02 Quantiles in mph: Annual Extreme-Mile 9.1 m (30 ft) Above Ground, 50-yr Mean Recurrence Interval; Virginia

Special Wind Region

VIRGINIA DEPARTMENT OF TRANSPORTATION

STRUCTURE AND BRIDGE DIVISION

INSTRUCTIONAL AND INFORMATIONAL MEMORANDUM

GENERAL SUBJECT: Post-Tensioned Bridge Structures	NUMBER: IIM-S&B-91
SPECIFIC SUBJECT: General Requirements for the Usage, Design and Specification of Post-Tensioned Bridge Superstructures	Date: December 13, 2016 SUPERSEDES: None
DIVISION ADMINISTRATOR APPROVAL: /original signed/ Kendal R. Walus, P.E. State Structure and Bridge Engineer Approved: December 13, 2016	

New IIM

EFFECTIVE DATE:

This Memorandum is effective on December 13, 2016.

GENERAL:

The General Requirements for the Usage, Design and Specification of Post-Tensioned Bridge Superstructures shall be in accordance with AASHTO LRFD Bridge Design Specifications, 7th ed. and VDOT Modifications, Post-Tensioning Institute/American Segmental Bridge Institute (PTI/ASBI) M50-3.12, PTI M55-1.12(13) and Special Provisions referenced herein, except as modified by the following:

POST-TENSIONING STRANDS:

All post-tensioning strands shall be in accordance with the following:

- Strands required for strength and serviceability of the structure (i.e., corrosion would reduce the load rating):
  - External strands shall be carbon steel in accordance with the Special Provision for Prestressing Steel in Post-Tensioned Structures for Design-Build and PPTA Contracts.
  - Internal strands shall be stainless steel in accordance with the Special Provision for Prestressing Steel in Post-Tensioned Structures for Design-Build and PPTA Contracts.

- Strands required for erection purposes only (i.e. do not contribute to serviceability):
  - External and internal strands shall be carbon steel in accordance with the Special Provision for Prestressing Steel in Post-Tensioned Structures for Design-Build and PPTA Contracts.

The steel bars for prestressing concrete members shall conform to the requirements of ASTM A722, Type II.

DUCTS:

All ducts shall be in accordance with the following:

- External ducts shall meet the requirements of the PTI/ASBI M50-3.12 Section 4.3.5.3; shall be smooth high density polyethylene (HDPE) and shall be connectionless between anchorages and shall be positively sealed. Metal ducts shall not be used for external ducts.
- Internal ducts shall be galvanized steel and shall meet the requirements of the PTI/ASBI M50-3.12 Section 4.3.5.1.

FILLER MATERIAL:

Where tendons are considered for the strength and serviceability of the structure, the following shall apply:

- Internal ducts shall be filled with grout and may be considered bonded for the purposes of design and load rating.
- External tendons shall be filled with flexible filler and shall be considered unbonded for the purposes of design and load rating.

Where tendons are for erection purposes only, the following shall apply:

- Internal tendons shall be de-tensioned and removed or ducts shall be filled with grout.
- External tendons shall be de-tensioned and removed or ducts shall be filled with flexible filler.

Grout shall be in accordance with Special Provision for Post-Tensioning System for Design-Build and PPTA Contracts.

Grouting shall be in accordance with (PTI/ASBI) M50-3.12, PTI M55-1.12(13) and Special Provision for Post-Tensioning System for Design-Build and PPTA Contracts.

Flexible Filler shall be in accordance with Special Provision for Flexible Filler for Post-Tensioned Structures for Design-Build and PPTA Contracts.

Flexible Filler Operations shall be in accordance with Special Provision for Post-Tensioning System for Design-Build and PPTA Contracts, including all referenced specifications.

Grout shall meet the requirements for Class B and C grout as outlined in PTI M55.1-12(13), Table 3.1 and the additional requirements in IIM-S&B-94.

DESIGN AND DETAILING:

The bridge substructure and layout shall be developed to minimize long-term maintenance and inspection costs for VDOT. Bridge elements shall be designed and detailed to ensure the easiest access for inspection, evaluation, repair and retrofit consistent with ensuring long-term maintenance, inspection and repair of the structure.

Provision shall be made for the access, anchorage attachments, pass-through openings, and deviation block attachments to permit future addition of corrosion-protected unbonded external tendons located inside the box section symmetrically about the bridge centerline for a post-tensioning force of not less than 20 percent of the positive moment and negative moment post-tensioning force.

All post-tensioning strand embedded in flexible filler shall be detailed to allow for replacement.

All post-tensioned structures shall meet the requirements for inspectability of post-tensioned structures as outlined in IIM-S&B-93 Minimum Inspectability Requirements for Post-Tensioned Bridges.

Tendon deviators shall incorporate Diabolos ("concrete duct forms").

Anchorages shall be detailed to incorporate plastic protection caps at each end and facilitate tendon replacement with flexible filler.

All substructures for post-tensioned structures shall meet the requirements outlined in IIM-S&B-92.

POST-TENSIONING BARS:

Either flexible filler or grout shall be used to protect post-tensioning bars, with the exception of permanent vertical post-tensioning bars.

Permanent vertical post-tensioning bars shall be protected with flexible filler when required for strength and serviceability in the final structure.

Temporary vertical post-tensioning bars not required for strength and serviceability shall be de-tensioned and removed or ducts shall be filled with flexible filler.

ACOUSTIC EMISSIONS SYSTEM:

Acoustic emissions health monitoring systems shall be installed on all post-tensioned structures. The system shall be in accordance with the Special Provision for Acoustic Emission Monitoring System for Detecting and Locating Wire Breaks in Strands in Tendons for Design-Build and PPTA Contracts.

OVERLAY REQUIREMENTS:

Riding surface for all segmental post-tensioned structures shall be a rigid concrete overlay installed on a surface prepared with Type A hydro-demolition in accordance with Section 425 of the most recent VDOT Road and Bridge Specifications.

Any overlays between 1¼" and 4" depth shall be in accordance with most recent Road and Bridge Specifications.

Any overlay over 4” in depth shall require the use of structural fibers or additional #3 reinforcement spaced no more than 6” in each direction.

The bridge deck riding surface shall be evaluated in accordance with the Special Provision for Rideability for Concrete Bridge Decks for Design-Build and PPTA Contracts.

CONSTRUCTION INSPECTION:

The Design Builder shall propose Construction Engineering and Inspection (CEI) Qualifications, Quality Control (QC) and Quality Assurance (QA) program to be approved by the Department. The program shall meet or exceed all requirements of ASBI (Grouting Certification), PTI (Post-Tensioning Operations Certification) and Precast/Prestressed Concrete Institute (PCI), as applicable. Where conflicts exist, the Design Builder’s program shall define a specific detailed solution and order of precedence for each conflict.

The QC/QA program shall include verification and approval by the Design Builder’s Engineer of all work submitted for approval.

Qualifications for post-tensioning personnel shall be in accordance with the Special Provision for Supplemental Post-Tensioning Personnel Qualifications for Design-Build and PPTA Contracts.

OWNER’S QUALITY ASSURANCE:

Owner witness activities and hold points shall be in accordance with the Special Provision for Supplemental Owner Quality Assurance During Post-Tensioned Structure and Bridge Construction for Design-Build and PPTA Contracts.

SPECIAL PROVISIONS and SUPPLEMENTAL SPECIFICATIONS

See: APPENDIX A

CC: Chief Engineer
Division Administrators
District Administrators
District Construction Engineers
District Maintenance Engineers
Assistant State Structure and Bridge Engineers
District Structure and Bridge Engineers
Residency Administrators/Engineers
Structure and Bridge Program Managers
FHWA: Bridge Section

APPENDIX A

Special Provision for Post-Tensioning System for Design-Build and PPTA Contracts

Special Provision Copied Note for Stainless Steel Strand for Design-Build and PPTA Contracts

Special Provision for Flexible Filler for Post Tensioned Structures for Design-Build and PPTA Contracts

Special Provision for Post-Tensioning Components for Design-Build and PPTA Contracts

Special Provision for Prestressing Steel in Post-Tensioned Structures for Design-Build and PPTA Contracts

Special Provision for Supplemental Post-Tensioning Personnel Qualifications for Design-Build and PPTA Contracts

Special Provision for Precast Concrete Segmental Superstructure Construction for Design-Build and PPTA Contracts

Special Provision for Acoustic Emission Monitoring System for Detecting and Locating Wire Breaks in Strands in Tendons for Design-Build and PPTA Contracts

Special Provision Copied Note for High Performance Concrete for Design-Build and PPTA Contracts

Special Provision for Epoxy Jointing of Precast Concrete Segments for Design-Build and PPTA Contracts

Special Provision for Rideability for Concrete Bridge Decks for Design-Build and PPTA Contracts

Special Provision for Supplemental Owner Quality Assurance During Post-Tensioned Structure and Bridge Construction for Design-Build and PPTA Contracts

FDOT 450: Precast Prestressed Concrete Construction

FDOT 452: Precast Segmental Bridge Construction

FDOT 453: Epoxy Jointing of Precast Segments

FDOT 462: Post-Tensioning

FDOT 926: Epoxy Compounds

FDOT 930: Materials for Concrete Repair

FDOT 938: Duct Filler for Post-Tensioned Structures (sub section 5, Flexible Filler – Microcrystalline Wax only)

FDOT 960: Post-Tensioning Components

FDOT 975: Structural Coating Materials

VIRGINIA DEPARTMENT OF TRANSPORTATION
SPECIAL PROVISION FOR
POST-TENSIONING SYSTEM
for Design-Build and PPTA Contracts

December 9, 2016

I. DESCRIPTION

A. General

The work specified in this Section shall consist of furnishing, installing, stressing and filling ducts for prestressing steel in accordance with the Approved for Construction (AFC) plans plans and the requirements of these specifications.

This special provision incorporates by reference the:

- Florida Department of Transportation Standard Specifications for Road and Bridge Construction Specification Section 462, including its referenced specifications.

  http://www.fdot.gov/programmanagement/Implemented/SpecBooks/January2016/JANUARY2016BK.shtm

- PTI/ASBI M50.3-12: Guide Specification for Grouted Post-Tensioning

  http://www.post-tensioning.org/store/PTI_M50.3-12:_Guide_Specification_for_Grouted_PT

- PTI M55.1-12(13): Specification for Grouting of Post-Tensioned Structures

  http://www.post-tensioning.org/store/PTI_M55.1-12:_Specification_for_Grouting_of_PT_Structures?filter_name=M55

- PTI M50.1-98: Acceptance Standards for Post-Tensioning Systems

  http://www.post-tensioning.org/store/PTI_M50.1-98:_Acceptance_Standards_for_Post-Tensioning_Systems?filter_name=post-tension&page=2

In the event that a conflict(s) exists between this Special Provision and the above referenced specifications, the following order of precedence shall be followed:

- This Special Provision shall govern over the PTI, PTI/ASBI and FDOT specifications.
- The FDOT specification and its references shall govern over the PTI and PTI/ASBI specifications.

The intent of this Special Provision is that the Post-Tensioning System be compliant with the latest Florida Department of Transportation (FDOT) Post-Tensioning Specification 462, except as modified herein.

FDOT 462 compliant Duct Couplers shall be utilized. Any duct coupler system proposed for use by the Contractor shall be pre-verified to fit with all existing PT bar and PT tendon geometrics, concrete cross-section dimensions and all embedded items.

This work shall also include the furnishing and installing of any appurtenant items necessary for the particular prestressing system used, including but not limited to anchorage assemblies, additional reinforcing bars required to resist stresses caused by anchorage assemblies, ducts, vents, inlets, outlets and duct filler used for pressure filling ducts. All post-tensioning components which remain in the completed structure shall comply with the requirements of this Special Provision and FDOT Specification 462.

Fill ducts with approved duct filler to fill all voids and install protection at end anchorage; grout shall be in conformance the requirements set forth in this Specification and flexible filler shall be in conformance with Special Provision for Flexible Filler for Post-Tensioned Structures and this Specification. Provide fully filled duct and anchorage assemblies free from leaks, blockages and

voids. Provide sufficient test data to the Design Builder's Engineer of Record to verify that the work meets the requirements of this Section. Perform filler injection operations in accordance with FDOT Specification 462-4 and this Specification.

B. Definitions and Terminology

Definitions and terminology shall be in accordance with Section 2.1 of the PTI/ASBI M50.3-12 Guide Specification for Grouted Post-Tensioning and with Section 1.4 of the PTI M55.1-12(13) Specification for Grouting of Post-Tensioned Structures, as modified by the following terms, which apply to the prestressing of segmental bridge construction:

1. Anticipated Set: Anticipated set is that set which was assumed to occur in the design calculation of the post-tensioning forces immediately after load transfer.
2. Bar: Post-tensioning bars used in post-tensioning are normally available from 5/8" to 2½" diameter and usually threaded with very coarse thread.
3. Duct Filler: an approved material, grout or flexible filler (ie, microcrystalline wax), pumped into ducts to fill voids and protect tendons from corrosion.
4. Duct Filler Cap (Grout Cap): A device that contains the duct filler and forms a protective cover sealing the post-tensioning steel at the anchorage. Duct filler caps shall be removable.
5. Duct system: A proprietary assembly of specific models of hardware, including but not limited to, anchorage assemblies, inlets, outlets, vents, couplers, ducts, duct connections and couplers that is used to construct the path for a prestressing steel tendon of a particular size and type. The entire assembly shall meet the system pressure testing requirement. Internal and external systems are considered independent of one another.
6. Family of Systems: Group of post-tensioning tendon assemblies of various sizes which use common anchorage devices and design. All components within the family of systems shall be furnished by a single supplier and shall have a common design with varying sizes.
7. Flexible Filler: A microcrystalline wax, primarily grease and petroleum based waxes which provide alternatives to cementitious grout in unbonded tendons.
8. Inlet (also inlet pipe or grout/filler injection port): Small diameter tubing or duct used for injection of grout/flexible filler into a duct. Inlets shall have a positive, reversible method of closure (valve or similar) capable of resisting pressure greater than the pressure rating of the duct.
9. Local Zone Reinforcement: Reinforcement confining the volume of concrete immediately ahead of and surrounding the anchorage device.
10. Microcrystalline Wax: a flexible filler used as an alternative to cementitious grout for unbonded tendons; material is incapable of transferring force through bond between tendon and surrounding concrete.
11. Outlet (also ejection pipe or grout/filler outlet vent or vent): A small diameter tubing or duct used to allow the escape of air, water, grout/flexible filler and bleed water. Outlets shall have a positive, reversible method of closure (valve or similar) capable of resisting pressure greater than the pressure rating of the duct.
12. Permanent Bar/Tendon: A bar or strand tendon that remains in the completed structure, regardless of its original use.
13. Post-Tensioning System: A proprietary assembly of specific models of hardware, including but not limited to prestressing strands, anchorages, local zone reinforcement, ducts, trumpets, couplers, duct filler caps, inlets, outlets, all supplied by a single supplier and used to construct and stress a tendon of a particular size and type. The entire assembly shall meet the system force testing, reparability, isolation, and requirement. Internal and external systems are considered independent of one another.

14. Pressure Rating: The estimated maximum pressure that water in a duct or in a duct component can exert continuously with a high degree of certainty that failure of the duct or duct component (including inlets and outlets) shall not occur (commonly referred to as working pressure). Duct shall be air tight to a working pressure of 150 psi.

15. Prestressing Steel: High strength steel strand or bar. The steel element of a post-tensioning tendon, which is elongated and anchored to provide the necessary permanent prestressing force.

16. Set (Also Anchor Set, Wedge Set or Anticipated Set): Set is the total movement of a point on the strand just behind the anchoring wedges during load transfer from the jack to the permanent anchorages. Set movement is the sum of slippage of the wedges with respect to the anchorage head and the elastic deformation of the anchor components. For bars, set is the total movement of a point on the bar just behind the anchor nut at transfer and is the sum of slippage of the bar and the elastic deformation of the anchorage components.

17. Set of Grout

    a. Final Set of Grout: A degree of stiffening of the grout mixture greater than the initial set, indicating the time in hours and minutes required for the grout to stiffen sufficiently to resist to an established degree, the penetration of a weighted test needle per ASTM C191.

    b. Initial Set of Grout: a degree of stiffening of the grout mixture less than the final set, indicating the time in hours and minutes required for the grout to stiffen sufficiently to resist to an established degree, the penetration of a weighted test needle per ASTM C191.

18. Specialty Engineer: The engineer responsible for shop drawings related to any element of the post-tensioning system or for shop drawings related to each element being post-tensioned. The specialty engineer shall be a registered Professional Engineer licensed to practice in the Commonwealth of Virginia.

    a. Strand, seven-wire: An assembly consisting of seven wires having a center wire enclosed tightly by six helically placed outer wires with a uniform pitch of not less than 12 and not more than 16 times the nominal diameter of the strand. Strands may be ASTM A416 Grade 250 Low-Relaxation; Type 2205 (UNS S32205) stainless steel in accordance with Special Provision Copied Note for Stainless Steel Strand in Design-Build and PPTA Contracts.

19. Temporary Bar/Tendon: A bar or strand tendon that does not remain in the completed structure, regardless of its original use.

20. Tendon: A single or group of prestressing elements and their anchorage assemblies, which impart prestressing to a structural member or the ground. Also included are ducts, grouting attachments, grout and corrosion protection filler materials or coatings. The main prestressing element is usually a high-strength steel member made up of a number of strands, wires or bars.

21. Tendon Type: A description (full or short-hand) of the relative location of the tendon to the concrete shape including orientation (vertical, draped, straight, continuity) and location (internal or external).

22. Waterproof Tape – Tape conforming to ASTM D5486 Type IV.

23. Wire: A single, small diameter, high-strength steel member and, normally, the basic component of strand, although some proprietary post-tensioning systems are made up of individual or groups of single wires.

24. FDOT Specifications - Any reference to the VDOT Specifications herein are referring to the 2016 Florida Department of Transportation Standard Specifications for Road and Bridge

Construction.

C. DESIGN AND DETAILING

1. Design and detailing shall be in accordance with IIM-S&B-91.

II. MATERIALS

A. General

1. The materials to be incorporated into work covered by this Section shall conform to the requirements set out herein.

2. Test and include required local zone reinforcement in the system shop drawings that are submitted for system approval. Final design and details of local zone reinforcement are to be project-specific and are the responsibility of the post-tensioning system supplier. Design project-specific local zone reinforcement for the maximum number of strands that could be used with a particular anchorage. Do not design the project specific local zone reinforcement for a reduced system capacity based on a reduced number of strands. Submit signed and sealed details of the local zone reinforcement to the Design Builder's Engineer of Record.

3. If any component of the post-tensioning system is modified or replaced, at any time, excluding local zone reinforcement, the appropriate component test and entire system test, if applicable, shall be repeated in accordance with the requirements herein and updated test reports and revised system drawings submitted to the Design Builder's Engineer of Record.

4. Ensure that all components of the system are stamped with the suppliers name, trademark model number and size corresponding to catalog designation. Post- tensioning systems consist of an assembly of components for various sizes of strand or bars assembled and pressure tested. Post-tensioning systems shall have to be developed and tested both internal (corrugated duct) and external (smooth duct) applications for each standard tendon designation (i.e. 12 strands, 19 strands, etc.) and each standard bar size designation (i.e. prestressing bar diameter).

B. Prestressing Steel

1. Strand shall meet the requirements of the Special Provision for Prestressing Steel in Post-Tensioned Structures for Design-Build and PPTA Contracts and be in accordance with the Special Provision for Post-Tensioning Components for Design-Build and PPTA Contracts and be in accordance with FDOT Specification 462-2.2.2.1 Strand, as modified by the following:

   a. Strands required for strength and serviceability of the structure (i.e., corrosion would reduce the load rating):

      (1) External strands shall be carbon steel in accordance with the Special Provision for Prestressing Steel in Post-Tensioning Structures for Design-Build and PPTA Contracts.

      (2) Internal strands shall be stainless steel strands in accordance with the Special Provision for Prestressing Steel in Post-Tensioning Structures for Design-Build and PPTA Contracts.

   b. Strands required for Erection purposes only (i.e., do not contribute to serviceability):

      (1) External and internal strands shall be carbon steel in accordance with the Special Provision for Prestressing Steel in Post-Tensioning Structures for Design-Build and PPTA Contracts.

2. Post-tensioning bars, including those required for erection, shall meet the requirements of the Special Provision for Prestressing Steel in Post-Tensioned Structures for Design-Build and PPTA Contracts and be in accordance with the Special Provision for Post-Tensioning Components for Design-Build and PPTA Contracts.

3. Wires meet the requirements of the Special Provision for Prestressing Steel in Post-

Tensioned Structures for Design-Build and PPTA Contracts and be in accordance with the Special Provision for Post-Tensioning Components for Design-Build and PPTA Contracts.

C. Ducts

1. General

a. Ducts for tendons shall meet the requirements of the contract drawings and as set out herein.

b. Provision shall be made for the access, anchorage attachments, pass-through openings, and deviation block attachments to permit future addition of corrosion-protected unbonded external tendons located inside the box section symmetrically about the bridge centerline for a post-tensioning force of not less than 20 percent of the positive moment and negative moment post-tensioning force.

c. All duct material shall be sufficiently rigid to withstand loads in accordance with 4.4.3 of the PTI/ASBI M50.3-12 Guide Specification for Grouted Post-Tensioning.

d. Ensure that all connectors, connections and components of post-tensioning system hardware are air and water tight and pass the pressure test requirements of 4.4.5 of the PTI/ASBI M50.3-12 Guide Specification for Grouted Post-Tensioning.

e. All ducts shall be in accordance with the following:

(1) External ducts shall meet the requirements of the PTI/ASBI M50-3.12 Section 4.3.5.3 and conform to the Special Provision for Post-Tensioning Components for Design-Build and PPTA Contracts; shall be smooth high density polyethylene (HDPE), shall be connectionless between anchorages and shall be positively sealed. Metal ducts shall not be used for external ducts.

(2) Internal ducts shall be galvanized steel and shall meet the requirements of the PTI/ASBI M50-3.12 Section 4.3.5.1 and conform to the Special Provision for Post-Tensioning Components for Design-Build and PPTA Contracts.

(3) Use Type C smooth high-density polyethylene (HDPE) conforming to Special Provision for Post-Tensioning Components for Design-Build and PPTA Contracts in all post-tensioning systems used for external tendons.

f. The duct system, including splices and joints shall effectively prevent leakage of cement paste or water into the system or duct filler out of the system and shall effectively contain pressurized duct filler during operations to fill the duct system. The duct system shall also be capable of withstanding water pressure during flushing of a duct in the event the duct filling operation is aborted.

2. Duct Type Designation: Except as otherwise designated in the Contract Documents, the type of duct material used in specific applications shall in accordance with Special Provision for Post-Tensioning Components for Design-Build and PPTA Contracts.

D. Duct Filler: Duct filler shall conform to the requirements below:

1. Where tendons are considered for the strength and serviceability of the structure, the following shall apply:

a. Internal ducts shall be filled with grout and may be considered bonded for the purposes of design and load rating.

b. External tendons shall be filled with flexible filler and shall be considered unbonded for the purposes of design and load rating.

2. Where tendons are for erection purposes only, the following shall apply:

a. Internal tendons shall be de-tensioned and removed or ducts shall be filled with grout.

b. External tendons shall be de-tensioned and removed or ducts shall be filled with flexible

filler.

3. Grouting shall be in accordance with Grouting shall be in accordance with PTI/ASBI M50-3.12, PTI M55-1.12(13) and this Special Provision.

4. Grout

   a. General

      Grout shall conform to the requirements of this Special Provision. Grout for tendons shall consist of Portland cement, potable water, mineral admixtures for partial cement replacement and other specified or approved admixtures which impart low water content, flow, fluidity, minimal bleeding, non-shrink, thixotropic and, when necessary, set retarding properties to the grout. Grout shall not impart metallic properties to the grout. Also, when specified, the grout shall have enhanced corrosion-resisting properties such as increased resistance to chloride penetration. There shall be no deliberate addition of materials containing chlorides.

      Commercially available, prepackaged, cement-based grout mixtures meeting the requirements of this Special Provision shall be used. Proposed grouts shall be submitted to the Design Builder's Engineer of Record for review. Grout shall meet the requirements of FDOT Specification Section 938.

   b. Classification of Grout

      (1) Grout may be Class B or C in accordance with PTI M55.1-12(13) Table 3.1 and the additional requirements set forth in IIM-S&B 94.

      (2) Commercial Prepackaged Enhanced Grout shall be used and shall:

         (a) exhibit thixotropic properties,

         (b) contain both mineral admixtures for partial cement replacement

         (c) contain chemical admixtures for improved corrosion protection and resistance to bleed.

   c. Water

      (1) General Requirements

         Water for use with cement shall be potable; clear and free from injurious amounts of oil, acid, alkali, chlorides, organic matter, sulfides, sulfates, nitrates and other deleterious substances. It shall not be salty or brackish. If it contains quantities of substances which discolor it or make it smell or taste unusual or objectionable or cause suspicion, it shall not be used unless service records of concrete made with it indicates that it is not injurious to the quality of the concrete or approved by the Design Builder's Engineer of Record. Samples arriving at the Design Builder's independent testing laboratory shall be allowed 14 days for completion of tests. At the discretion of the Department, additional compliance testing may be required at any time, of any water source.

         Water from city water supplies that are approved by a public health department may be accepted without testing. All other sources of water shall meet the requirements 2016 VDOT Road and Bridge Specification Section 216. The Design Builder's independent testing laboratory shall provide certified copies of reports and test data of water samples Quality Assurance Manager (QAM). Water for grout shall be tested monthly.

      (2) Storage

         Store grout and grout constituents in climate and temperature controlled enclosures or other suitable means of providing protection against potential damage due to environmental conditions. All manufacturers' recommendations are to be strictly

followed and no grout is to be stored on site for longer than 30-days.

E. Flexible Filler: Flexible filler shall conform with the requirements set forth in the Special Provision for Flexible Filler for Post-Tensioned Structures for Design-Build and PPTA Contracts.

a. Flexible filler operations shall be in accordance with this Special Provision.

F. Other Materials

Other required materials shall meet the requirements of following:

Water .....VDOT Specification Section 216

Grout .....IIM-S&B-94.0

Epoxy Mortar .....VDOT Specification Section 243

Flexible Filler …… VDOT Special Provision**

Elastomeric Coating System .....FDOT Specification Section 975**

High Molecular Weight Methacrylate .....VDOT Approved List No. 28

Epoxy Primer (EP-3B).....VDOT Specification Section 243

Epoxy (EP-3T)..... VDOT Specification Section 243

** use only products that are currently listed on the Florida Department of Transportation (FDOT) Approved Products List (APL) and that meet the requirements of these specifications.

G. Component Samples

The following samples of materials and devices shall be furnished by the Design Builder, and delivered to selected locations as designated by the Department, at the Design Builder's Expense. Samples shall be in accordance with FDOT Specification 462-2.5 Component Samples, as modified by the following:

1. Prestressing elements shall be sampled in accordance with FDOT Specification 462-2.5.1 Prestressing Steel, as modified by the following:

   a. All testing shall be done in accordance with ASTM Specifications.

   b. With each sample of prestressing strand or bar furnished for testing, the Design Builder shall submit a certification stating the manufacturer's minimum guaranteed ultimate tensile strength of the sample furnished.

   c. One of each of the samples furnished to represent a LOT shall be tested. The remaining samples, properly identified and tagged, shall be stored by the Design Builder's Engineer of Record for future testing. In the event of loss or failure of the component the stored sample shall be utilized to evaluate for minimum strength requirements. For acceptance of the LOT represented, test results shall show 100% of the guaranteed ultimate tensile strength.

      (1) For strand: three randomly selected samples, 5 feet long, per manufacturer, per size of strand, per shipment, with a minimum of one sample set for every ten reels delivered.

      (2) For bars: three randomly selected samples, 5 feet long, per manufacturer, per size of bar, per heat of steel, with a minimum of one sample per shipment.

      (3) If bar couplers are to be used, three samples with two specimens each consisting of four foot lengths of the specific prestressing bar coupled with a bar coupler from the materials to be used on the project.

      (4) One unit of each prestressing anchorage to be used on the project.

      (5) For each type of duct material intended for the project, one sample, four feet long, from each production lot or per 10,000 linear feet, whichever is greater.

d. Samples shall be furnished at least 90 days in advance of the time they are to be incorporated into the work.

e. The Department and Design Builder‘s Engineer of Record each reserves the right to reject for use any material or device which is obviously defective or damaged. Acceptance of any material or device shall not preclude subsequent rejection if material is damaged in transit or later found to be defective for any reason.

2. Grout samples shall be in accordance with FDOT Specification 462-2.5.2 Grout, as modified by the following:

   a. Construct 4-ft high by 2-in diameter sample at the anticipated project low temperature. Slice specimens 4-in long from top and bottom; test for compressive strength at 28 days. Compressive strengths measured for specimens taken from the top and bottom of the sample shall not vary by more than 10%.

III. QUALIFICATIONS

A. Provide all project personnel and crew foreman qualifications in accordance with Special Provision for Supplemental Post-Tensioning Personnel Qualifications for Design-Build and PPTA Contracts.

IV. SUBMITTALS

A. General

Submit shop drawings, working drawings and manuals in accordance with this and other applicable Special Provisions. The Specialty Engineer shall produce, sign and seal all shop drawings related to post-tensioning.

The Design Builder shall detail and engineer shop drawings that include, but are not limited to:

1. A complete description of, and details covering, each of the prestressing systems to be used for permanent and temporary tendons. Prepare shop drawings to address all requirements stated in the Approved for Construction (AFC) plans and the requirements stated herein. Submissions shall:

   a. Be submitted in their entirety as a single electronic file only. Partial submissions shall not be accepted. Partial submissions are defined as including reference to anything that is not part of the AFC plans or specifications. Where resubmission is made to address review comments, revised submittal package, to include all portions of the original submittal, shall be submitted in entirety as a single electronic file.

   b. Show tendon geometry and locations complying with the AFC plans and the limitations of the selected post-tensioning system

   c. Show all inlets, outlets, high point outlet inspection details, anchorage inspection details and permanent filler caps, protection system materials and application limits. Location of outlets shall account for effects of grade and dead load deflections.

   d. Designate and identify the specific prestressing steel, anchorage devices, bar couplers, duct material and accessory items.

   e. Provide properties of each of the components of the prestressing system.

   f. Show details covering assembly of each type of prestressing tendon.

   g. Identify equipment to be used in the prestressing sequence.

   h. Detail procedures and sequence of operations for prestressing and securing tendons.

   i. Show all parameters to be used to calculate the typical tendon force such as: expected friction coefficients, anchor set and prestressing steel relaxation curves.

   j. Provide test results from Independent test lab indicating grout meets requirements of

specifications.

k. Provide QC plan that includes all test results, material details, etc.

2. Complete details of the anchorage system for prestressing including certified copies of the reports covering tests performed on prestressing anchorage devices and details for any reinforcing steel needed due to stresses imposed in the concrete by anchorage plates.

3. Details, materials and procedures for filling prestressing tendon ducts in accordance with the requirements of this Special Provision including, but not limited to, the following: the materials and proportions for duct filler, details of equipment required for placement of duct filler, including methods of mixing and placing grout or required procedures for placement of flexible filler, as applicable. Provide locations and details of inlets and outlets for duct filler and the direction of filling operations.

4. Elongation calculations shall be revised when necessary to properly reflect the modulus of elasticity of the wire or strand as determined from in-place friction testing in accordance with Acceptance and Testing Section VII.

5. Complete details of the apparatus and method to be used for the in-place friction test required by the Acceptance and Testing Section VII.

V. TRANSPORTATION, HANDLING AND STORAGE

A. Manufacturer's Lots (Quality Control): LOT Identification shall conform to FDOT Specification 462-6.2 LOT Identification, modified by the following:

1. Materials, including but not limited to grout materials, with a total time from manufacturer, in excess of six months, shall be retested and certified by the supplier before use or be removed from the project and replaced.

2. Low relaxation strand shall be clearly identified as required by ASTM A416. Any strand not so identified shall be rejected.

3. The Design Builder shall furnish manufacturer's certified reports covering the tests required by this Specification to the Design Builder's Engineer of Record. A certified test report stating the guaranteed minimum ultimate tensile, yield strength, elongation and composition shall be furnished for each lot of prestressing strand. When requested, typical stress-strain curves for prestressing strand shall be furnished. A certified test report stating strength when tested using the type prestressing strand to be used in the work shall be furnished for each Lot of prestressing anchorage devices.

B. Prestressing Steel: Prestressing steel shall conform to FDOT Specification 462-6.3 Prestressing Steel, modified by the following:

1. Any reel that is found to contain broken wires shall be rejected and the reel replaced.

2. Specifically designate low relaxation (stabilized) strands per requirements of ASTM A416. Strands not so designated shall be rejected.

C. Duct Filler: Shipping and handling of filler shall be in accordance with FDOT Specification 462-6.4 Filler.

D. Duct and Pipe: Shipping and handling of duct and pipe shall in accordance with FDOT Specification 462-6.5 Duct and Pipe, and modified by the following:

1. End caps supplied with the duct shall not be removed until the duct is incorporated into the bridge component.

2. Duct shall be stored in a location that is dry and protected from the sun.

3. If necessary, wash exterior of capped duct prior to use to remove any contamination.

4. Flushing duct shall not be permitted except as provided for by IIM-S&B 94.

VI. CONSTRUCTION

Perform all post-tensioning field operations under the direct supervision personnel meeting the qualifications in accordance with Special Provision for Supplemental Post-Tensioning Personnel Qualifications for Design-Build and PPTA Contracts.

A. System Installation: shall be in accordance with FDOT Specification 462-7.2, as modified by the following:

1. General: Accurately and securely fasten all post-tensioning anchorages, ducts, inlet and outlet pipes, miscellaneous hardware, reinforcing bars, and other embedments at the locations shown on the AFC plans or on the approved Shop or Working Drawings or as otherwise approved by the Design Builder's Engineer of Record. Construct tendons using only duct splices shown in the AFC plans or as approved in the shop drawings.

2. Ducts

   a. Ensure that all alignments, including straight portions, curves, and curves in diabolos, are smooth and continuous with no lips, kinks or dents.

   b. Carefully check and repair all ducts in accordance with FDOT Specification 462-7.5 Repair, as necessary before placing any concrete.

   c. After installing the ducts and until duct filler placement is complete, ensure that all ends of ducts, connections to anchorages, splices, inlets and outlets are sealed at all times. Briefly open low point drains just prior to tendon installation and again just prior to filler injection for drainage of any water that may be present within the duct. Provide an absolute seal of anchorage and duct termination locations by using pipe plugs or equal. Duct filler inlets and outlets shall be installed with plugs or valves in the closed position. Tape of any sort shall not, by itself, be allowed as a means to close inlets or outlets. Waterproof tape meeting ASTM D5486 may be used to seal around valves at vents or outlets.

   d. Any additional corrosion resistant reinforcing (CRR) required to support or stabilize post-tensioning ducts shall be supplied at no expense to the Project. Before and after installation in the forms, the ends of ducts shall at all times be sealed to prevent entry of water and debris. The ends may be open during installation, when required.

   e. All splices, joints, couplings, connections (inlet and outlet) and valves shall be part of the approved post-tensioning system. Approved shrink-sleeve material may be used to repair duct. The use of any kind of tape to repair or seal duct shall not be not permitted. Special wrap designed for duct repair may be used with approval of the Design Builder's Engineer of Record.

   f. Installation tolerances shall be in accordance with FDOT Specification 462-7.2 Installation Tolerances.

      (1) In all other cases, ensure that tendons are not out of position by more than plus or minus 1/4 inch in any direction in all other cases not listed in FDOT Specification 462-7.2.

      (2) Angle changes at duct joints shall not be greater than plus or minus 4 degrees in any direction and shall be accomplished with smooth transitions without any kinks. In no case shall the arithmetic difference be greater than 6 degrees.

      (3) If conflicts exist between the reinforcement and post-tensioning duct, the position of the post-tensioning duct shall prevail and the reinforcement shall be adjusted locally with the approval of the Design Builder's Engineer of Record and at no additional expense to the Department.

3. Inlets, Outlets and Drains

   a. Inlets and outlets, as specified in the Special Provision for Precast Concrete Segmental

Box Girder Construction for Design-Build and PPTA Contracts", shall be installed on each duct to serve as injection or vent ports during duct filling operations. These shall be at locations shown on the AFC Plans or approved Shop Drawings and in accordance with the following:

b. Inlets (Filler Injection Ports) shall be provided for injecting duct filler into the duct.

c. Outlets (Filler Exit Vents) shall allow the escape of air, water, duct filler and bleed water, as appropriate. The inner diameter of inlets and outlets shall be at least 3/4 in. for tendons. Unless specifically shown on the AFC plans, Vents and Ports shall be gradually turned down (with no kinks) to exit on the underside of the top slab or to an internal face. Vents and Ports shall only exit the top deck slab surface at barriers.

d. Inlets and Outlets shall be of flexible HDPE pipe.

e. The length of an inlet port or outlet vent shall extend sufficiently out of the concrete to allow for proper closing. At all high points the outlet shall connect at the uppermost part of the duct cross section. At low points the outlet shall connect at the lowest part of the duct cross section.

f. Inlets and Outlets shall be placed at locations shown on the AFC plans including approved shop drawings and on the approved Duct Filling Operation Plan at a minimum, place filler inlets and outlets at locations shown in the following locations:

   (1) At the top of each tendon anchorage and top of filler cap.

   (2) At each high point after accounting for the effects profile grade on the duct profiles of the duct profile when the vertical distance between the highest and lowest point is more than 20" including the effects of grade.

   (3) An outlet at each low point of the tendon.

   (4) An inlet at the lowest point of the tendon after accounting for the effects profile grade on the duct profiles. Judgment should be used in locating the lowest point. For example, if the absolute low point is in a deviation block for an external tendon, then place the inlet close to the block in the accessible portion of the duct.

   (5) At all low points the inlet/outlet shall be free draining.

   (6) At major changes in the cross section of the duct, such as couplers and anchorages.

   (7) At each side of couplers.

   (8) At a distance of approximately 3 ft. from on either side of the high point.

   (9) For external tendons, provide vents as close to the inside face of the diaphragm as practical, located on the top of the duct.

   (10) At other locations recommended by the Design Builder's Engineerof Record.

g. All connections to ducts shall be made with metallic or plastic structural fasteners. Approved shrink-sleeve material shall be used at all connections including vent and duct filling pipes, except where otherwise specified herein. Inlets and outlets, including vents shall be air tight, taped as necessary, and shall provide means for injection of duct filler and for sealing.

h. All inlets and outlets shall be permanently sealed to prevent water infiltration to the filled tendon. Sealing details are to be submitted for approval to the Design Builder's Engineerof Record.

i. All inlets and outlets, including filler injection and vent pipes shall be fitted with positive mechanical shut-off valves and shall be fitted with valves, caps or other devices capable of withstanding the pumping pressures.

4. Tendons: Installation of tendons shall be in accordance with FDOT Specification 462-7.2.4 Tendons, as modified by the following:

   a. Ducts shall not be flushed.

   b. For smooth passage through the duct, round ends of the pre-assembled tendon(s). Cut strands using an abrasive saw or equal. Flame-cutting is not allowed.

   c. Do not install permanent tendons before the completion of testing as required by these Specifications or AFC plans. The two exceptions to this requirement are:

      (1) The tendon to be tested in the In Place Friction Test may be installed for the test.

      (2) Transverse tendons may be preinstalled in precast segmental boxes prior to concrete casting.

B. Post-Tensioning Operations

Post-tensioning operations shall be in accordance with FDOT Specification 462-7.3 Post-Tensioning Operations, as modified by the following:

The design of the structure is based on the assumed friction and wobble coefficient shown in the AFC plans. The post-tensioning forces shown are jacking forces and do not include losses in the system or thermal effects.

1. General

   a. Concrete strength: post-tensioning shall only be applied when the concrete has attained the required compressive strength as determined from test cylinders cured under the same conditions as the structural concrete.

   b. Proving of Post-Tensioning Ducts: Except as described below, upon completion of concrete placement, prove that the post-tensioning ducts are free and clear of any obstructions or damage and are able to accept the intended post-tensioning tendons by passing a torpedo through the ducts. Use a torpedo having the same cross-sectional shape as the duct and that is a 1/4 inch smaller all around than the clear, nominal inside dimensions of the duct. The torpedo shall have smooth corners with 1/16 inch round-overs at each end. Make no deductions to the torpedo section dimensions for tolerances allowed in the manufacture or fixing of the ducts. For straight ducts, use a torpedo at least 2 feet long. For curved ducts, determine the length so that when both ends touch the outermost wall of the duct, the torpedo is 1/4 inch clear of the innermost wall. If the torpedo shall not travel completely through the duct, the Design Builder's Engineer of Record shall reject the member, unless a workable repair can be made to clear the duct. The torpedo shall pass through the duct easily, by hand, without resorting to excessive effort or mechanical assistance. The torpedo shall be passed through the duct in the same direction as the prestressing being placed.

      Alternatively, for 4-strand tendons placed within flat ducts and used for transverse post-tensioning of precast segmental box girders, strands may be preplaced in the ducts prior to concrete casting. Prove that the post-tensioning ducts are free and clear of any obstructions or damage by moving the group of strands back and forth within the duct for a minimum distance of 1 foot in each direction. Ensure the strands are easily moveable within the duct by hand without the need for excessive effort or mechanical assistance. The time limit between initial placement of the strand and grouting of the stressed tendon begins when the strand is first placed in the duct.

      The Design Builder's Engineer of Record shall reject ducts or any part of the work found to be deficient. Perform no remedial or repair work without the Design Builder Engineer of Record's approval.

2. Stressing Equipment: Stressing equipment shall conform with FDOT Specification 462-7.3.1 Stressing Equipment, as modified by the following:

a. For each jack and gauge unit used on the project, furnish certified calibration charts and curves to the Design Builder's Engineer of Record prior to stressing. Supply documentation denoting the load cells calibration date and traceability to NIST (National Institute of Standards and Technology) along with the jack/gauge calibration.

3. Stressing Tendons

a. Tension all post-tensioning strands with hydraulic jacks so that the post- tensioning force is not less than that required by the AFC plans or approved shop drawings, or as otherwise approved by the Design Builder's Engineer of Record.

b. Jacking Maximum Stress: The maximum temporary stress (jacking stress) in the post-tensioning steel shall not exceed the value specified in the Table below. Do not overstress tendons to achieve the expected elongation.

c. Initial and Permanent Stress

(1) The post-tensioning strand shall be anchored at initial stresses that shall result in the long term retention of permanent stresses or forces of no less than those shown on the AFC plans or the approved shop drawings. Unless otherwise approved by the Design Builder's Engineer of Record, the initial stress after anchor set shall not exceed the values specified below:

Strand Type	**Max. Temp. Stress**	**Max. Initial Stress**
Grade 270, Low Relax Strand	80%	70%
Low Relax, Stainless Steel Strand	70%	60%

d. Post-tensioning forces shall not be applied until the concrete has attained the specified compressive strength as evidenced by tests on representative samples of the concrete. These samples shall be stored under the same conditions as the concrete in order to accurately represent the curing condition of the concrete in place.

e. Stressing Sequence Except as noted on the AFC plans or the approved shop drawings, permanent post-tensioning tendons shall be stressed from both ends. The required force may be applied at one end and subsequently at the other end or simultaneously at both ends. Strands over 300ft long shall be jacked from both ends, simultaneously.

(1) Single end stressing is permitted when the following are satisfied:

(a) Space limitations prohibit double end stressing.

(b) The calculated elongation of the post-tensioning steel at the second end is 1/2 inch or less and wedges are power seated.

(c) Single end stressing applied at alternate ends of paired adjacent post- tensioning tendons is required to produce a symmetrical force distribution in agreement with the plan design.

For construction in stages where some tendons are required to be stressed before others, install and stress in accordance with the AFC plans or approved shop drawings or as otherwise approved by the Design Builder's Engineer of Record.

f. Elongation: Procedures for elongation shall be in accordance with FDOT Specification 462-7.3.2.4 Elongation, as modified by the following:

(1) A permanent record shall be kept of gauge pressures and elongations at all times and shall be submitted to the Design Builder's Engineer of Record. The post-

tensioning force may be verified as deemed necessary by the Design Builder's Engineer of Record.

(2) After testing, if the values cannot be reconciled, strands shall be de-tensioned and removed. The empty duct shall be investigated and evaluated prior to reinstalling new strand. Removed strand shall be discarded.

g. Friction: Provide actual expected friction and wobble coefficients and anchor set in the shop drawings; calculations shall be submitted to the Department which show a typical tendon force diagram on shop drawings based upon expected actual coefficients and values for the post-tensioning system to be used.

If, in the opinion of the Design Builder's Engineer of Record, the actual friction significantly varies from the expected friction, revise post-tensioning operations so the final tendon force is in agreement with the AFC plans. When friction shall be reduced, graphite may be used as a lubricant, subject to the approval of the Design Builder's Engineer of Record.

h. Tendon Wire Failure: Wire Failures in Post-Tensioning Tendons shall conform to FDOT Specification 462-7.3.2.6 Tendon Wire Failure, as modified by the following:

(1) Post-tensioning bars and their hardware used to apply temporary post-tensioning may be reused as temporary bars if they are undamaged.

(2) The Post-Tensioning Supplier shall provide written recommendations, to the Design Builder's Engineer of Record, regarding limitations on the numbers of reuses for temporary prestressing components.

i. Cutting of PT Steel shall be in accordance with FDOT Specification 462-7.3.2.7 Cutting of PT Steel.

j. Record of Stressing Operations shall be kept as a written record for each tendon installed in accordance with FDOT Specification 462-7.3.2.8 Post-Tensioning Operations Record, as modified by the following:

(1) Project name

(2) Financial Project ID and Department's Project Number

(3) Design Builder and sub-contractor

(4) Results of pressurization testing including documentation of repairs

(5) Results of torpedo testing including documentation of repairs

(6) Date and time of relevant mock up test

(7) Tendon location, size and type

(8) Date tendon was first installed in ducts

(9) Reel number for strands and heat number for bars

(10) Tendon cross-sectional area

(11) Modulus of elasticity

(12) Date Stressed

(13) Jack and Gauge numbers per end of tendon

(14) Required jacking force

(15) Gauge pressures

(16) Elongations (theoretical and actual)

(17) Anchor sets (anticipated and actual)

(18) Stressing sequence (i.e., tendons to be stressed before and after)

(19) Stressing mode (one end/ two ends/ simultaneous)

(20) Witnesses to stressing operation (Design Builder and inspector)

(21) For Grouted Ducts:

(a) Grout batching and testing information

(b) Grout expiration date

(c) Date ducts filled

(d) Results of post-grouting inspection at each high vent

(22) For Flexible Filler:

(a) Manufacturer and testing information

(b) Flexible filler expiration date

(c) Date ducts filled

(d) Results of post-filling inspection at each high vent

Record any other relevant information. Within 3 days of stressing and/or grouting, provide the Design Builder's Engineer of Record with a complete copy of all Design Builder-recorded stressing and grouting operations data.

4. System Protection shall be in accordance with FDOT Specification 462-.7.3.3 System Protection, as modified by the following:

a. Ducts shall not be flushed in the event that tendon contamination occurs, unless otherwise directed, in writing, by the Department.

b. Before installation of tendons in ducts: Protect all prestressing strands against physical damage and corrosion at all times, from manufacturer to final grouting, placement of flexible filler or encasing in the concrete. The Design Builder's Engineer of Record shall reject prestressing strands that has sustained physical damage. Immediately replace or restore packaging damaged from any cause, to the original condition.

c. During Installation of Prestressing in the Structure

(1) Prestressing steel: For bars located in superstructures and all strands, the time between the cap removal to allow the first installation of the prestressing in the duct and the completion of the stressing and duct filling operations shall not exceed 14 calendar days. Any light surface corrosion forming during this period of time shall not be cause for rejection of the prestressing strands provided the prestressing strands are protected for the entire time from installation through duct filling. If the protection system is breached, prestressing strands may be required to be removed and replaced if strands no longer meet the acceptance criteria found in PTI/ASBI M50.3-12 Section 11.5.

(2) Flushing duct shall not be permitted except as provided for by IIM-S&B 94.

(3) Vacuum grouting is required to repair all voids.

(4) Except when waived, in writing, by the Design Builder's Engineer of Record and in concurrence with the Department's Representative, failure to place duct filler around tendons within the calendar days specified shall result in stoppage of the affected work and removal of at least one prestressing element (strand or bar) for inspection and dehumidification of the duct.

(5) Prestressing shall not be installed while it is raining, snowing or water is otherwise condensing or being deposited on steel (fog, misting, wave action, etc.). Prestressing

strands which have been wetted from any cause shall not be placed until after it has dried.

d. After Installation of Tendons in Ducts

(1) The prestressing steel shall be protected from corrosion; all prestressing strands shall be protected from the elements. The duct system shall be sealed to prevent moisture intrusion from the beginning of tendon installation to completion of grouting, as provided below.

(2) As discussed in Construction Section VI of this specification, the ends of ducts and anchorages and all duct connections shall be sealed at all times during and following installation in the forms to prevent entry of moisture and debris except as required to actually install the prestressing. In addition, all duct filler ports and vents shall be closed or plugged at all times during the period prior to duct filling; all duct filler ports and vents shall be accessible at all times.

(3) Duct filling shall proceed as soon as possible after installation and stressing of the tendons. Typically, the time from installing the tendons in an unstressed condition to duct filling after stressing shall not exceed 10 days, except cantilever tendons, which may fill ducts after erection of the entire cantilever, provided the period between tendon installation and duct filling does not exceed 21 days. This requirement is only waived given the temperature considerations listed in Section VI.B.4 of this specification below.

(4) The time between tendon installation in an unstressed condition to duct filling after stressing shall not exceed the above time limits, or as outlined in Section VI.B.4 of this specification below, without approval of the Design Builder's Engineer of Record:

(a) Tendon Protection Between Installation and Stressing: Measures shall be taken to protect the prestressing strand when there is a period of inactivity (eg. When no crew is working) for more than 3 hours between installation of the tendons in ducts and stressing. Bare strand projecting out of the duct shall be wrapped continuously in plastic sheeting and plastic seams shall be sealed using waterproof tape. The plastic wrap shall extend to the tendon anchorage, and the anchorage opening shall be sealed with plastic and waterproof tape sufficient to prevent moisture intrusion. All duct filler ports and vents shall be closed or plugged, and all duct connections shall be sealed.

(b) Tendon Protection During Staged or Segmental Construction: When AFC plans provide for the tendons to be installed in one unit or segment, either longitudinally, transversely or vertically, with a length of bare strand left projecting for purposes of threading into another unit or segment during later erection operations, the provisions described in Section VI.B.4 shall apply. All of the prestressing strand shall be protected immediately after it is first installed in the first unit or segment until the tendon is protected by duct filler in the second unit or segment.

(c) Tendon Protection Between Stressing and Duct Filling: Anchorages should be capped or otherwise sealed again immediately following stressing and cutting of strand tails.

If permanent duct filler caps are specified, duct filler caps shall be installed within 12 hours of stressing.

If permanent duct filler caps are not specified, the end anchorage region of the tendon shall be sealed against moisture intrusion using plastic sheeting and waterproof tape within 3 hours of stressing except as specified in Section VI.B.4 below.

In all cases, tendons and ducts shall be thoroughly blown dry with oil-free

compressed air immediately prior to sealing or capping of the anchorages. In addition, all duct filler ports and vents shall remain plugged, sealed or otherwise capped, and all duct connections shall be sealed, except as specified in Section VI.B.4 below.

(5) Use of Temporary Corrosion Inhibitors

The use of corrosion inhibitors such as vapor phase inhibitors or water-soluble oils for temporary corrosion protection is not permitted without prior approval of the Design Builder's Engineer of Record. If approved, apply corrosion inhibitors to the strand(s) prior to installation.

(6) Tendons in ducts left unfilled for extended periods shall be permitted given strict compliance with the following specifications.

Allowance for increase in time between stressing and duct filling operations shall only be allowed for post-tensioning which cannot proceed with duct filling operations within the lower temperature limits set forth in this specification, and with the approval of the Design Builder's Engineer of Record. Every effort shall be taken to minimize the length of time and number of unfilled post-tensioning tendons or bars during winter months. Duct filling of previously unfilled post-tensioning shall take top priority when temperature limits allow duct filling operations to continue.

For anchorages where a permanent duct filler cap is not specified a rigid temporary cap capable of providing a seal against moisture intrusion for the duration of time the post-tensioning ducts remain unfilled shall be used. This cap shall be placed within 24 hours of stressing. Permanent caps shall be used where applicable.

All duct filler ports and vents shall remain plugged, sealed or otherwise capped, and all duct connections shall be sealed, 24 hours prior to duct filling, all low vent ports shall be opened. At each low vent port the duct shall be inspected for water. If water is found, then all ports shall be resealed and the duct shall be dried using dry air. Following the drying process all low vents shall be re-inspected. All open vent ports shall not be exposed to the weather for the full length of time the post-tensioning ducts remains unfilled.

Upon inspection, if post-tensioning strands in unfilled ducts shows signs of corrosion (other than light surface rust with no pitting in accordance with PTI/ASBI M50.3-12 Section 11.5); immediate corrective measures shall be taken. Corrective measures may include, but are not necessarily limited to, re-establishing moisture tight seals, alternate corrosion protection, external heating, tendon replacement and restressing.

Details for protecting post-tensioning strands in unfilled ducts through extended periods and the procedures for expeditious filling of the unfilled ducts shall be submitted as a part of the Filler Injection Operations Plan submittal outlined in Section VI.C of this specification.

e. Anchorages shall be in accordance with FDOT Specification 462-7.3.3.2.

C. Filler Injection Operations shall be in accordance with FDOT Specification 462-7.4 Filler Injection Operations, as modified by the following:

1. Grouting Operations

a. Grouting Operations Plan: In addition to the procedures and requirements provided in FDOT Specification 462-7.4.1.1, the plan shall, at a minimum, address these additional items:

(1) Provision for access at alternate inlet sites

(2) Provisions for spoil in order to allow for correction of mixing errors.

(3) Before grouting operations begin (a minimum of 30 days prior), a joint meeting of

the Design Builder, grouting crew, the Design Builder's Engineer of Record, and Department Representative shall be conducted. At the meeting the grouting operation plan, required testing, corrective procedures and any other relevant issues shall be discussed to ensure a mutual understanding of the proposed activities and processes.

(4) After the Design Builder's Grouting Operations Plan is given preliminary approval by the Design Builder's Engineer of Record and before grouting of permanent tendons commences, the performance of a Mock-Up Test in accordance with IIM-S&B-94 shall be required. The purpose of this test is to verify that the materials and procedures proposed shall properly grout the tendons. It shall also serve as training for the grouting personnel on site. The test shall be conducted at the project site.

(5) The Mock-Up Test shall consist of grouting an external tendon in a clear duct with a duct profile as indicated below. The Design Builder shall use the same equipment, materials, connections, and procedures that are in the Approved Grouting Operations Plan.

(a) The Test Specimen shall be in accordance with IIM-S&B-94.

(b) The duct material shall match the size and shape including deformation shape and spacing of the longest tendon being mimicked.

(c) The duct shall be transparent.

(d) A minimum of four (4) grout inlets/outlets shall be placed, one at each end and one at each lower deviation within 4' of the low side of the lowest deviation.

(e) Inside the duct, there shall be the same number and type of prestressing strands in the longest longitudinal tendon; post-tensioning strand is not required to be stressed.

(f) The Design BuilderContractor shall stress the tendon or make other modifications to the grout mock-up as may be required to demonstrate the success of the Design Builder's grout operations; these modifications shall be submitted to the Engineer of Record for review and approval. Modifications shall be considered, but shall be at no additional cost to the Design Builder's Engineer of Record.

(6) The Design Builder shall submit for approval the test set-up including materials, geometrics, procedures to be followed and, the anticipated amount of bleed water for this specimen.

(7) The test shall be considered successful if all of the following conditions are satisfied:

(a) The methods and materials in the approved duct filling plan can completely fill ducts and surround the tendon to the satisfaction of the Design Builder's Engineer of Record in one continuous operation, including filling ducts from multiple locations if included in the Duct Filling Plan.

(b) There are no air voids over 0.5" in diameter in the inclined length after the duct filler has hardened.

(c) Where grout is used, there is not excessive bleed water at either end over the anticipated amount and all grout cures to the required strength.

(8) If the test is run and not considered to be successful by the Design Builder's Engineer of Record then the Design Builder shall resubmit a modified Test Plan after updating procedures to remedy the deficiencies noted by the Design Builder's Engineer of Record. A successful Mock-Up Test shall be completed before post-tensioning operations including stressing can begin.

(9) The cost of all labor, materials and incidental items required to perform this Grouting Mock-Up Test shall be included in the contract unit price bid for Post-Tensioning Strand.

b. Inlets and Outlets shall be in accordance with FDOT Specification 462-7.4.1.2 Inlets and Outlets.

c. Supplies for grouting operations shall be in accordance with FDOT Specification 462-7.4.1.3 Supplies, as modified by the following: where water is not supplied through the public water supply system, a water storage tank of sufficient capacity shall be provided.

d. Equipment for grouting operations shall be in accordance with FDOT Specification 462-7.4.1.4 Equipment, and as modified by the following:

(1) Mixer and Storage Hopper

(a) Evidence of accuracy shall be provided to the Design Builder's Engineer of Record at least one (1) week prior to beginning of grouting operations.

(b) Grouting solids shall be added during the initial mixing by use of pre-bagged materials. Weight of the actual added materials shall be determined to within one percent at the time of initial mixing. The marked bag weight shall not be accepted as the weight of the added material weight. Evidence of the ability to measure the weight of the added materials shall be provided to the Design Builder's Engineer of Record at least 1 week prior to beginning of grouting operations.

(2) Grout Pumping Equipment

(a) The capacity shall be such that an optimal rate of grouting can be achieved. The optimal rate shall be defined in the Grouting Operation Plan.

(3) Stand-by Equipment: During grouting operations, provide a stand-by colloidal grout mixer, pump and other equipment necessary to completely replace the primary system.

e. Grouting shall be in accordance with FDOT Specification 462-7.4.1.5 Grouting, and as modified by the following:

(1) General

(a) Ensure the Design Builder's Engineer of Record is present when any test is performed.

(b) Grout all empty ducts at the stage of construction identified in the construction AFC plans.

(c) Ducts shall be grouted one at a time. However, multiple crews and multiple pieces of equipment may be required to grout a single duct.

(2) Temperature Considerations shall be in accordance with FDOT Specification 462-7.4.1.5.1 Temperature, and as modified by the following:

(a) Use chilled water and/or pre-cooling of the bagged material to maintain mixed grout temperature below the maximum allowed temperature; ice shall not be used to maintain and/or reduce grout temperature.

(b) Grouting operations are prohibited when the temperature of the deck or grout at the inlet exceeds 90°F unless a cooling system has been installed to keep the concrete surrounding the grouted duct below 90°F.

(c) Grouting operations are prohibited when the ambient temperature or the temperature of the concrete surrounding the duct is below 40°F or is 40°F and falling.

(d) Postpone grouting operations if temperatures below 40°F are forecasted to

occur within the next 2 days unless the concrete surrounding the duct is insulated or heated to the extent that the surrounding beam concrete shall stay above 40°F for two (2) days following the completion of grouting.

(e) Check the temperature of the grout at the inlet end of the grout hose at the initiation of the grouting and thereafter at least every 10 minutes.

(3) Mixing and Pumping shall be in accordance with FDOT Specification 462-7.4.1.5.2 Mixing and Pumping, and as modified by the following:

(a) Charging of the mixer and the mixing of grout shall be in accordance with the grout manufacturer's written procedures.

(b) Batches of grout shall be placed within 30 minutes of mixing. No water shall be added to the grout to modify its consistency after the initial mixing process is completed.

(4) Grout Production Test shall be in accordance with FDOT Specification 462-7.4.1.5.3 Production Test, and as modified by the following:

(a) A target fluidity rate shall be established by the manufacturer's representative and shall be within limits established in the approved Grouting Operation Plan, based on ambient weather conditions.

(b) Determine grout fluidity in accordance with FDOT Specification Section 938. Perform fluidity test at a frequency in accordance with IIM-S&B-94 and maintain the correct water to cementitious ratio. Grout which tests outside the allowable flow rates shall not be used.

(c) At the beginning of each day's grouting operation, obtain a representative sample of grout from the day's first production batch of grout and perform a wick induced bleed test in accordance with FDOT Specification Section 938 using this sample. Begin grouting operations after the sample is obtained. If zero bleed is not achieved in the wick induced bleed test at any time during the required test time period, complete the grouting of any partially grouted tendons and do not begin grouting of any new or additional tendons until the grouting operations have been adjusted and further testing shows the grout meets the specified requirements.

(5) Grout Operations shall be in accordance with FDOT Specification 462-7.4.1.5.4 Operations, and as modified by the following:

(a) Unless approved otherwise by the Design Builder's Engineer of Record, pump grout at the lowest possible pressure practical and at a maximum rate of 16 feet per minute for vertical ducts and a rate of 50 feet of duct per minute for horizontal ducts; sloped or draped ducts (ducts with a change of elevation of more than 20") shall be grouted at no more than 33ft of duct per minute.

(b) Grout shall flow from the first and subsequent outlets until any residual water or entrapped air has been removed prior to closing the outlet. Burping shall not be allowed.

(c) For transverse four strand tendons in flat ducts, a minimum of ¼ gallon of uniform grout shall be discharged into a clean receptacle.

(d) Protection of Fresh Grout: Construction Traffic and Operations Causing Vibrations: During grouting and for a period of 4 hours upon completion of grouting, eliminate vibrations from all sources such as moving vehicles, jackhammers, compressors, generators, pile driving operations, soil compaction, etc., that are operating within 300 feet down-station and 300 feet up-station of the ends of the span in which grouting is taking place.

(6) Vertical Grouting

(a) Grouting of cable stays is not covered by this Section.

(b) Provide a standpipe to a minimum of 2% of the total anticipated grout volume used on a particular tendon, at upper end of tendon to store bleed water and grout; maintain grout level above level of prestressing plate and anchorage for all vertical tendons.

(c) Design and size the standpipe to maintain level grout at an elevation that ensures potential bleed will not drop below the highest point of upper anchorage device. Design reservoir, to allow all bleed water, if any, to rise into the reservoir.

(d) Discharge grout and check grout fluidity as described herein. As grouting is completed, the standpipe shall be filled with grout to a level which assures that, as settlement of the grout occurs, the level of the grout shall not drop below the highest point in the upper anchorage device. If the level of the grout drops below the highest point in the anchorage device, immediately add grout to the standpipe. After the grout has hardened, the standpipe shall be removed. In the presence of the Design Engineer of Record, visually inspect for voids using an endoscope or probe. Fill all voids found in the duct using volumetric measuring vacuum grouting processes.

(e) Allow grout to flow from each outlet until all air and water have been purged prior to using a higher elevation outlet for pumping. “Burping” of tendons shall not be allowed.

(f) For vertical tendons, sloped tendons or draped tendons in excess of 100 feet or if the grouting pressure exceeds the maximum recommended pumping pressure, grout shall be pumped at increasingly higher outlets which have been or are ready to be closed as long as a one-way flow of grout is maintained.

(g) Protection of Fresh Grout: Construction Traffic and Operations Causing Vibrations: During grouting and for a period of 4 hours upon completion of grouting, eliminate vibrations from all sources such as moving vehicles, jackhammers, compressors, generators, pile driving operations, soil compaction, etc., that are operating within 300 feet down-station and 300 feet up-station of the ends of the span in which grouting is taking place.

(h) Provide a standpipe for all vertical tendons, which have prestressing steel, at the upper end of the tendon to store any bleed water and allow it to be reabsorbed by the grout. Design this device so that the level of the grout can be brought to an elevation which shall assure that bleeding or subsidence shall at no time cause the level of the grout to drop below the highest point of the upper anchorage device. Design it also such that as bleed water migrates to the top, grout is able to migrate downward to replace it. Provisions are to be made to assure that bleed water rises into the standpipe, not into the uppermost part of the tendon and anchorage device.

(7) Grouting Operations Report shall be in accordance with FDOT Specification 462-7.4.1.5.6 Grouting Operations Report.

2. Information to be noted in the records shall include but not necessarily be limited to the following: Structure, span number, date of tendon installation, identification of the tendon (starting and stopping stations); date grouted; time at the beginning and end of grouting ; number of days from tendon installation to grouting; ambient temperature, temperature of beams, manufacturers name of grout, lot numbers, grout bag temperatures, grout water temperature, water temperature(identify if ice has been used); difference between water and grout temperature; injection end and applied grouting pressure; ratio of actual to theoretical grout quantity; number of bags of grout mixed; total quantity of water used to mix the grout; specific testing performed for grout place in tendon, results of all tests performed; summary

for each test range including max, min, and average of all results. Maximum pressure during grouting time period, summary of any problems encountered and corrective action taken. Identify by name superintendent of grout crew and each person on the grouting team, name of CEI, manufacturer representatives on site. Design Builder's Engineer of Record shall review and confirm that all information in the grouting reports conforms to this Special Provision and the specifications. Flexible Filler Operations shall be in accordance with FDOT Specifications 462-7.4.2 Flexible Filler Operations.

3. Care and Protection of Ducts, Vents, Anchorages and Block-outs

   a. Care shall be taken to ensure that all ducts, anchorages, block-outs, openings and vents are kept clean and free of debris, water, ice, fuel, oils, other contaminants and site trash at all times prior to and after installing the tendons. Temporary plugs, seals and covers shall be used. Use methods to place and consolidate concrete which shall not displace or damage any of the post-tensioning ducts, anchorage assemblies, splices and connections, reinforcement or other embedments. Fabricate all duct splices to prevent kinks in the ducts during concrete placement. Use mandrels as needed to maintain duct alignment and shape.

   b. Minor damage to ducts may be repaired by removing the local damage and splicing duct or couplers onto the intact section (prior to the placing of concrete). Repair of major duct damage requires the removal and replacement of the entire duct section.

   c. Connections from duct filler hose to inlet ports, ejection ports and to vents shall be kept airtight and free from dirt, debris and deleterious substances.

   d. Within 7 days upon completion of the filler injection operations, protect the anchorage of post-tensioning bars and tendons as indicated in the AFC plans. The application of the elastomeric coating may be delayed up to 90 days after grouting. Plug all duct filler inlets/outlets with plugs meeting the requirements specified herein. Use an epoxy mortar, , meeting the requirements of 2016 VDOT Road and Bridge Specification Section 243 to construct all pour-backs located at anchorages.

   e. Remove all laitance, grease, curing compounds, surface treatments, coatings and oils by grit blasting or water blasting using a minimum 10,000 psi nozzle pressure. Flush surface with water and blow dry. Surfaces shall be clean, sound and without any standing water. In case of dispute, use ACI 503 for substrate testing and develop a minimum of 175 psi tension (pull-off value).

   f. Mix and apply epoxy as per manufacturer's current standard technical guidelines. Construct all pour-backs in leak proof forms creating neat lines. The epoxy mortar may require pumping for proper installation. Construct forms to maintain a liquid head to insure intimate contact with the concrete surface. Use vents as needed to provide for the escape of air to insure complete filling of the forms.

   g. Coat the exposed surfaces of all pour-backs and duct filler caps with an elastomeric coating system meeting the requirements of 2016 VDOT Road and Bridge Specification Section 243 and having a thickness of 30 to 45 mils. Assure concrete, duct filler caps or other substrates are structurally sound, clean and dry. Concrete shall be a minimum of 28 days old at the time of coating. Remove all laitance, grease, curing compounds, surface treatments, coatings and oils by grit blasting or water blasting using a minimum 10,000 psi nozzle pressure to establish the anchor pattern. Blow the surface with compressed air to remove the dust or water. For elastomeric coated pour-backs which are to receive a Type EP3T coating, apply a manufacture's approved EP-3B primer over the elastomeric coating before applying the EP3T coating.

   h. Construct a 2 ft x 4 ft concrete test block with a similar surface texture to the surfaces to be coated and coat a vertical face with the elastomeric coating system chosen. Determine the number of coats required to achieve a coating thickness between 30 to 45 mils without runs and drips. Mix and apply elastomeric coating as per manufacturer's

current standard technical specifications. Spray or roller application is permitted, spray application is preferred. Have the coating manufacturer representative on site to supervise and comment on the application of the elastomeric coating onto the test block. Apply coatings using approved and experienced personnel with a minimum of three years of experience applying similar polyurethane systems. Submit the credentials of these persons to the Design Builder's Engineer of Record for review and consideration for approval.

D. Repairs shall be in accordance with FDOT Specification 462-7.Repair, and as modified by the following:

1. Lifting and Access Holes

   a. Repair all access holes and block-outs with Epoxy Mortar meeting the requirements of 2016 VDOT Road and Bridge Specification Section 243 and in accordance with Section 412. During the 24 hours preceding casting the concrete, mating surfaces in access holes and block outs shall be prepared in accordance with the manufacturer's instructions, but preparation shall at least meet the following: mechanically clean and roughen the mating concrete surfaces to remove any laitance and expose the small aggregate. Grit blasting or water blasting with a minimum 10,000 psi nozzle shall be used. Flush surface with water and blow dry with oil free air. Mating surfaces shall be saturated surface dry unless manufacture recommends against this. Form, mix, place and cure the concrete in strict compliance with the manufacturer's recommendations.

2. Inlets and Outlets

   a. Place threaded plastic caps in all inlet/outlet locations required in the AFC plans. Repair inlets/outlets as shown on the AFC plans using an epoxy mortar meeting the requirements of 2016 VDOT Road and Bridge Specification Section 412, Type EP-5 epoxy mortar. Prepare the surface to receive the epoxy material in strict compliance with the manufacturer's recommendations.

      (1) Temperature Considerations

         (a) Grout: When it is anticipated that the air temperature may fall below 32°F, ducts shall be kept free of water so as to avoid freeze damage to ducts. No grouting shall be done when the temperature of the grout mix is below 45°F. The temperature of the concrete and air surrounding the tendon shall be maintained at 40°F or above from the time grout is placed until the compressive strength of the grout, as determined from tests on two- inch cubes cured under the same conditions as the in-place grout, exceeds 800 PSI.

         Under hot weather conditions, grouting shall take place early in the morning when daily temperatures are lowest. No grouting shall be done when the temperature of the grout mix exceeds 90°F. It may be necessary to chill mixing water, chill bagged grout or take other special measures to lower the grout temperature. Ice shall not be added to the mixed grout. If grout exceeds 90°F in the mixer or as a result of pumping between mixer and inlet, then the grout batch shall be discarded.

3. Duct

   a. Heat-shrink wrap material designed for duct repair may be used with approval, in writing, from the Department.

   b. Use approved heat-shrink sleeve material to repair ducts. Install in accordance with manufacturer's instructions.

VII. ACCEPTANCE AND TESTING

A. Design Builder Material Testing

1. General

   a. The Design Builder shall perform certain testing of prestressing tendons as specified herein.

   b. Application of Test Results: Reevaluate the theoretical elongations shown on the post-tensioning shop or working drawings using the results of the tests for Tendon Modulus of Elasticity and In-Place Friction as appropriate and correct as necessary. Submit revisions to the theoretical elongations to the Design Builder's Engineer of Record for approval.

2. Tendon Modulus of Elasticity Test: The Design Builder shall perform a tendon modulus of elasticity test in accordance with FDOT Specification 462-8.1.1 In-Place Wobble and Friction Test, and as modified by the following:

   a. The apparatus and methods used to perform the test shall be submitted to the Design Builder's Engineer of Record for approval at least 60 days before each planned test.

   b. The Design Builder's Engineer of Record shall be notified of the test date at least 30 days before the test. Tests shall be conducted in the Design Builder Engineer of Record's presence.

3. In-Place Wobble and Friction Test shall conform to FDOT Specification 462-8.1.2 In-Place Wobble and Friction Test, modified as follows:

   a. In reconciling theoretical and actual elongations, do not vary the value of the expected friction and wobble coefficients by more than plus or minus 10%. Significant shortfall in elongations is indicative of poor duct alignments and/or obstructions. Correct or compensate for such elongations in a manner proposed by the Design Builder and reviewed and approved by the Design Builder's Engineer of Record at no additional cost to the Department.

   b. The Design Builder's Engineer of Record shall require at least one successful friction test for each tendon group for the project. Every tendon which has been subject to a non-conformance report (NCR) related to poor alignment, and every tendon which has an identified constriction shall be tested in addition to the test regime outlined above.

   c. Changes in jacking equipment, jacking methods or supervisory personnel during the construction of the project shall require additional friction testing at the sole discretion of the Design Builder's Engineer of Record.

   d. Required Reports shall be in accordance with Test report containing the results of the tests (loss due to friction and modulus of elasticity) shall be submitted to the Design Builder's Engineer of Record within two days of completion of any test. Apparatus and methods used to perform the tests shall be proposed by the Design Builder and be subject to the approval of the Design Builder's Engineer of Record. The Design Builder shall notify the Design Builder's Engineer of Record at least two weeks in advance of performing a friction test.

4. Dynamic System Qualifications Test of Unbonded Tendons: Unbonded tendons are defined as tendons located essentially external to the concrete or ducts filled with flexible filler. For each tendon size, the Design Builder shall perform Dynamic System Qualifications Tests in accordance with PTI Acceptance Standards for Post-Tensioning Systems. The period of each cycle involves the change from the lower to the upper stress level and back to the lower. Systems utilizing multiple strands, wires, or bars shall be tested utilizing a test tendon of full-size. The test tendon shall duplicate the behavior for the full-size tendon and generally shall not have less than 10 percent of capacity for the full-size tendon. The Design Builder shall notify the Design Builder's Engineer of Record at least two weeks in advance of performing a dynamic test. In lieu of the dynamic testing, the Design Builder may submit data from prior tests. Acceptance of data from prior tests is subject to the approval of the Design Builder's Engineerof Record.

5. Required reports shall be submitted in accordance with FDOT Specification 462-8.1.3 Required Reports.
6. Test results shall be applied in accordance with FDOT Specification 462-8.1.4 Test Results Application.

B. Design Builder Field Tests shall be in accordance with FDOT Specification 462-8.2 Design Builder Field Tests, PTI/ASBI M50.3-12 Guide Specification for Grouted Post-Tensioning, and as modified by the following:

1. Pressure Test Requirements
   a. System Test Requirements shall conform to Special Provision for Post-Tensioning Components for Design-Build and PPTA Contracts, FDOT Specification 960-3.2.1 and 4.4.5 of the PTI/ASBI M50.3-12 Guide Specification for Grouted Post-Tensioning.
      (1) For each family of post-tensioning systems, test two assemblies (largest and smallest) from the family.
   b. Duct Pressure Field Tests shall be performed prior to and post concrete placement; tests shall be in accordance with FDOT Specification 462-8.2 Design Builder Field Tests.

C. Design Builder Inspections: Design Builder Inspections shall be in accordance with FDOT Specification 462-8.3 Design Builder Field Tests, and as modified by the following:

1. Post Filler Injection Operations
   a. Post Grouting Operations shall be in accordance with FDOT Specification 462-8.3.2.1 Post Grouting Operations, as modified by the following:
      (1) Do not remove or open inlets and outlets until the grout has cured 24 to 48 hours.
      (2) Depending on the geometry of the grout inlets, drilling may be required to penetrate to the inner surface of the trumpet or duct.
      (3) Perform all inspections in the presence of the Design Builder's Engineer of Record using both borescopes and probes where practical.
      (4) Seal and repair all anchorage and inlet/outlet voids that are produced by drilling for inspection purposes. Remove the inlet/outlet to a minimum depth of 2 inches. Use an injection tube to extend to the bottom of the drilled holes for backfilling with epoxy type EP-5 in accordance with 2016 VDOT Road and Bridge Specifications Section 412.
      (5) Post grouting inspection of tendons having a length of less than 150 feet may utilize the following frequency for inspection:
         (a) All end anchorages and tendon highpoint outlets shall be inspected for the presence of voids, bleed water, segregated grout and soft grout behind the anchorage using a flexible fiberscope or videoscope, and probe. Inspection shall be completed within 24 hours and grouting shall not continue from day-to-day until all inspection from the previous day has been completed and accepted.
         (b) If defects are found, Design Builder's shall submit proposed method for repair.
      (6) If tendon grouting operations were prematurely terminated prior to completely filling the tendon, drill into the duct and explore the voided areas with a bore scope. Probing is not allowed. Determine the location and extent of all voided areas. Install grout inlets as needed and fill the voids using volumetric measuring vacuum grouting equipment.

VIII. MEASUREMENT AND PAYMENT

All cost for furnishing, installing, stressing strand and filling ducts for prestressing steel, including all testing required herein, the services of the manufacturer's representative, and all labor, equipment

and incidentals necessary to complete the work as specified above and in the AFC plans should be included in the lump sum contract price.

This work is integral to the relevant work package that is part of the lump sum contract price. There is no separate payment for this work. If an item does not satisfy the criteria stated herein, and in the event the Department accepts this item, the Quality Assurance Manager (QAM) will document the basis of acceptance. The Design Builder and the Department will negotiate an appropriate adjustment in the contract price, warranty, or other specific requirements or adjustments that are appropriate.

VIRGINIA DEPARTMENT OF TRANSPORTATION
SPECIAL PROVISION COPIED NOTE FOR
STAINLESS STEEL STRAND
for Design-Build and PPTA Contracts

December 9, 2016

SECTION 223-STEEL REINFORCEMENT of the Specifications is revised as follows:

223.02(b), paragraph 1 —Detail Requirements is replaced with the following:

(b) **Prestressing Tendons: Seven-wire** low-relaxation strands shall be stainless steel shall have a minimum ultimate strength of 250 ksi. The stainless steel strand shall be Type 2205 (UNS S32205), meet the compositional requirements of ASTM A1022 and meet ASTM A416 except that the minimum elongation at breaking strength shall be 1.2%.

Section 405.05(b) is amended to replace paragraph 7 (which begins with "The final stressing of strands") with the following:

The final stressing of strands shall be performed by applying tension to each strand individually or to all strands as a group. The strand shall be tensioned to the total pre-tensioning force as indicated on the Approved for Construction (AFC) plans, with a maximum applied stress of 60% of the ultimate strength for low relaxation stainless steel strand. The nominal area of the strand shall be confirmed between the precast concrete producer and the stainless steel supplier. Strand shall be furnished in a weldless state. Care should be exercised when cutting the strand to ensure wire does not become raveled.

12-9-16 (SPCN)

SECTION 406-REINFORCING STEEL of the Specifications is revised as follows:

Section 406.02(a) is replaced with the following:

(a) **Steel used for reinforcement** shall conform to the requirements of Section 223, except that spiral bars shall be stainless steel (size number W 3.5) that meets the requirements of ASTM A1022 – Type 304 (UNS S30400), minimum Grade 60. Tie wires shall be Gage 16 stainless steel. Tie wires of other alloys or materials shall be submitted to the Design Builder's Engineer for review.

12-9-16 (SPCN)

VIRGINIA DEPARTMENT OF TRANSPORTATION
SPECIAL PROVISION FOR
FLEXIBLE FILLER FOR POST-TENSIONED STRUCTURES
for Design-Build and PPTA Contracts

December 9, 2016

I. DESCRIPTION

A. General

The work specified in this Section shall cover all post-tensioning components remaining in a completed structure, including temporary post-tensioning left in-place and permanent post-tensioning for strength and serviceability.

This special provision incorporates by reference the:

- Florida Department of Transportation Standard Specifications for Road and Bridge Construction Specification Section 938-5 including its referenced specifications.

  http://www.fdot.gov/programmanagement/Implemented/SpecBooks/January2016/JANUARY2016BK.shtm

In the event that a conflict(s) exists between this Special Provision and the above referenced specifications, the following order of precedence shall be followed:

- This Special Provision shall govern over the FDOT specifications.

B. Approved Product List

1. Only flexible filler material conforming to the requirements of FDOT Section 938-5 Flexible Filler – Microcrystalline Wax shall be used.
2. All flexible filler material shall meet all requirements for evaluation and inclusion on the APL and include certified test reports from an independent laboratory, audited by and meeting the requirements of ISO 9001, showing the material meets all requirements specified herein, and in the referenced specifications.
3. A written certification from the manufacturer that the product meets the requirements of this Specification shall be provided to the Design-Builder's Engineer.
4. Flexible filler material shall be qualified by application (horizontal, vertical or repair).

C. General Requirements

1. Flexible Filler Microcrystalline Wax: General requirements for flexible filler shall be in accordance with FDOT Specification 938-3.2 Flexible Filler Microcrystalline Wax.

D. Flexible Filler – Microcrystalline Wax shall be in conformance with FDOT Specification 938-5 Flexible Filler – Microcrystalline Wax.

VIRGINIA DEPARTMENT OF TRANSPORTATION
SPECIAL PROVISION FOR
POST-TENSIONING COMPONENTS
for Design-Build and PPTA Contracts

December 9, 2016

I. DESCRIPTION

A. General

The work specified in this Section shall cover all post-tensioning components remaining in a completed structure, including temporary post-tensioning left in-place and permanent post-tensioning for serviceability and design capacity.

This special provision incorporates by reference the:

- Florida Department of Transportation Standard Specifications for Road and Bridge Construction Specification Section 960 including its referenced specifications.

  http://www.fdot.gov/programmanagement/Implemented/SpecBooks/January2016/JANUARY2016BK.shtm

- PTI/ASBI M50.3-12: Guide Specification for Grouted Post-Tensioning

  http://www.post-tensioning.org/store/PTI_M50.3-12:_Guide_Specification_for_Grouted_PT

- PTI/ASBI M55.3-12: Specification for Grouting of Post-Tensioned Structures

  http://www.post-tensioning.org/store/PTI_M55.1-12:_Specification_for_Grouting_of_PT_Structures?filter_name=M55

- PTI M50.1-98: Acceptance Standards for Post-Tensioning Systems

  http://www.post-tensioning.org/store/PTI_M50.1-98:_Acceptance_Standards_for_Post-Tensioning_Systems?filter_name=post-tension&page=2

In the event that a conflict(s) exists between this Special Provision and the above referenced specifications, the following order of precedence shall be followed:

- This Special Provision shall govern over the PTI/ASBI and FDOT specifications.
- The FDOT specification and its references shall govern over the PTI/ASBI specification.

1. Material References

Other required materials shall meet the requirements of following:

Water .....VDOT Specification Section 216

Grout .....IIM-S&B-94.0

Epoxy Mortar .....VDOT Specification Section 243

Flexible Filler …… VDOT Special Provision**

Elastomeric Coating System .....FDOT Specification Section 975**

High Molecular Weight Methacrylate .....VDOT Approved List No. 28

Epoxy Primer (EP-3B).....VDOT Specification Section 243

Epoxy (EP-3T)..... VDOT Specification Section 243

** use only products that are currently listed on the Florida Department of Transportation (FDOT) Approved Products List (APL) and that meet the requirements of these specifications.

B. Component Standards

1. Anchorage Assemblies shall be in accordance with FDOT Specification 960-2.1 Anchorage Assembly, and as modified by the following:

   a. Prestressing Anchorages: All prestressing steel shall be secured at the ends by means of permanent type metallic anchoring devices. Anchors manufactured from composite materials shall not be allowed. Prestressing anchorages shall develop at least 95 percent of the minimum specified ultimate tensile strength of the prestressing strand. Wedges shall be three-part (two-part wedges shall not be used). Use only post-tensioning systems that utilize tendons fully-encapsulated in anchorages.

      (1) Galvanize the embedded body of the anchorage in accordance with VDOT Road and Bridge Specifications Section 233. Other components of the anchorage including wedges, wedge plate and local zone reinforcement are not required to be galvanized. Construct the bearing surface and wedge plate from ferrous metal. Equip all anchorages with a permanent duct filler cap that is vented and bolted to the anchorage.

      (2) Cast anchorages with duct filler outlets suitable for inspection from either the top or front of the anchorage. The duct filler outlet shall serve a dual function of duct filler outlet and post-filling duct inspection access. The geometry of the duct filling outlets shall facilitate being drilled using a 3/8 inch diameter straight bit to facilitate inspection directly behind the wedge plate using a borescope. Anchorages may be fabricated to facilitate both inspection locations or may be two separate anchorages of the same type each providing singular inspection entry locations.

      (3) For tendon anchorages, any reinforcement (in addition to the reinforcement shown on the Approved for Construction (AFC) plans) which is needed to resist bursting and splitting stresses imposed on the concrete by the proposed anchorage system shall be the responsibility of the Design Builder and shall be provided at no additional expense to the Department.

      (4) Prestressing anchorage devices shall effectively distribute prestressing loads to the concrete and shall conform to the requirements of Article 5.10.9.7 of the AASHTO LRFD Bridge Design Specifications or be based on the results of acceptance tests as specified in Article 5.10.9.7.3 and described in Article 10.3.2.3 of the AASHTO LRFD Bridge Construction Specifications.

      (5) Unless waived by the Design Builder's Engineer of Record because of previous tests, qualification of anchorages and couplers shall be verified by testing. Anchorages shall be tested to meet or exceed the testing requirements of the AASHTO LRFD Bridge Construction Specification. The test specimen shall be assembled in an unbonded state; the anticipated anchor set shall not be exceeded in testing. Certified copies of test results for the anchorage system shall be supplied to the Design Builder's Engineerof Record. The anchorage system shall be arranged such that the prestressing force in the tendon may be verified prior to the removal of the stressing equipment.

      (6) Bending stresses in the plates or assemblies induced by the pull of the prestressing steel shall not exceed the yield point of the material in the anchorage plate when 95 percent of the minimum specified ultimate strength of the tendon is applied. Nor shall it cause visual distortion of the anchor plate, as determined by the Design Builder's Engineer of Record.

b. Trumpets: Trumpets associated with anchorages shall be made of either ferrous metal or polypropylene plastic material conforming to the requirements herein. The thickness of the trumpet at the transition location shall not be less than the thickness of the duct as established herein. Alternately, the trumpet material may be polyolefin containing antioxidants with a minimum Oxidative Induction Time (OIT) according to ASTM D3895 of not less than 20 minutes. Perform OIT tests on samples taken from the finished product. Test the remolded finished polyolefin material for stress crack resistance using ASTM F2136 at an applied stress of 348 psi resulting in a minimum failure time of 3 hours.

c. Wedge Plates: Provide wedge plates with centering lugs or shoulders to facilitate alignment with the bearing plate.

2. Filler containment assemblies shall be in accordance with FDOT Specification 960-2.2 Filler Containment Assembly.

a. Duct and Pipe: Except as otherwise designated in the Contract Documents, the type of duct material used in specific applications shall be as follows:

(1) Type A - Galvanized Rigid SCH 40 Steel Pipe. Galvanized rigid steel pipe shall be used for all internal ducts and shall conform to 4.3.5.1 of the PTI M50.3-12 Guide Specification for Grouted Post-Tensioning.

(a) Type A duct material which is embedded in a deviation block, beam or diaphragm shall be bent to a uniform radius along a curve extending between tangent points located three inches inward from the face of the deviation block, beam or diaphragm.

(b) Duct tape is not permitted to join or repair duct connections.

(2) Type C - Smooth Plastic: Smooth HPDE duct shall be used for external ducts and shall conform to 4.3.5.3 of the PTI M50.3-12 Guide Specification for Grouted Post-Tensioning, as modified by the following:

(a) duct material shall only be used for external tendons between anchors.

(b) Use continuous, unspliced smooth duct meeting the minimum pressure rating (working pressure) of 150 psi and manufactured according to either ASTM D3035 or ASTM F714.

(c) Duct tape is not permitted to join or repair duct connections.

(3) Minimum Internal Diameter: The interior diameter of ducts shall be in accordance with the requirements of FDOT Specification 960-2.2.1.4 Minimum Internal Diameter and 4.3.5 of the PTI M50.3-12 Guide Specification for Grouted Post-Tensioning.

(4) Connections, Fittings and Tolerance Connections and fittings shall conform to the requirements of FDOT Specification 960-2.2.1.5 Connections, Fittings and Tolerance and 4.3.6 of the PTI M50.3-12 Guide Specification for Grouted Post-Tensioning with the following amendments:

(a) Splices between sections of plastic duct shall be made by heat welding techniques in accordance with the duct manufacturer's instructions, or by mechanical couplers meeting the requirements of this Specification.

(b) All connections shall have a minimum pressure rating of 150 psi. Connections shall have a smooth interior alignment with no lips or kinks.

(c) Steel anchorages may be directly connected to plastic duct through the use of a heat shrinking connector when the inside diameters do not vary more than plus

or minus 1/16 inch and the outside diameter does not vary more than plus or minus 0.08 inches. Use a reducer combined with two heat shrinking connectors when either inside or outside diameter of the duct and anchorages exceed this tolerance.

(d) External Smooth Duct Connections:

(1) Ensure all connections between anchorages and plastic duct are made by using a mechanical coupler or a circular sleeve made of Ethylene Propylene Diene Monomer (EPDM), having a minimum pressure rating (working pressure) of 150 psi.

(2) Use EPDM sleeves having a minimum wall thickness of 3/8 inch and be reinforced with a minimum of four ply polyester reinforcement. Use a 3/8 inch wide power seated band and clamps constructed from Type 316 stainless steel on each end of the boot to seal against leakage of duct filler. Install the band with an 80 to 120 lb seating force.

(5) Mechanical couplers and shrink sleeves shall be in accordance with FDOT Specification 960-2.2.1.6 Segmental Duct Couplers, as modified by the following:

(a) Mechanical couplers shall be made from stainless steel, plastic or a combination of these materials. Plastic resins for couplers shall meet the requirements for plastic ducts. Grade 316 stainless steel shall be used for metallic components.

(b) Shrink sleeves shall be manufactured specifically for the size of duct being coupled consisting of an irradiated and cross-linked high-density polyethylene backing with an adhesive layer that will withstand 150 °F (66 °C) operating temperature, meeting requirements of 4.3.7 of the PTI M50.3-12 Guide Specification for Grouted Post-Tensioning. Polyethylene shall be in accordance with FDOT Specification 960-2.4.5 Polyethylene Resin.

(c) Thread-Bar Couplers and Nuts: Thread-bar couplers shall meet the requirements of AASHTO LRFD Bridge Design Specifications and Bridge Construction Specifications. Bar couplers shall be used only at locations specifically shown on the AFC plans or approved by the Design Builder's Engineer of Record. A bar coupler shall develop at least 95 percent of the required ultimate strength of the bar with a minimum elongation of two percent when tested in the unbonded condition measured in 10 foot gauge lengths, without failure of the coupler or the thread-bar.

(1) Use spherical nuts to anchor thread-bars at bearing plates.

(2) Testing of couplers shall be performed using samples of the prestressing bar to be used on the project. The test specimen shall be assembled in an unbonded state and the anticipated set shall not be exceeded in testing.

(3) Only threaded couplers shall be used with post-tensioning thread bars. Post-tensioning thread-bars shall be threaded into 1/2 the length of the coupler $\pm$ 1/4 inch so that when two bars are mated in a coupler, the length of each bar positively engaged in the coupler shall be half the coupler's length within the acceptable tolerances.

(4) No coupling or splicing with strands shall be permitted.

b. Heat Shrink Sleeves shall be in accordance with FDOT Specification 960-2.2.1.8 Heat Shrink Sleeves and Section 4.3.7 of PTI 50.3-12 Guide Specification for Grouted Post-Tensioning.

c. Attachments

(1) Anchorage Caps shall be in accordance with FDOT Specification 960-2.2.2.1

Anchorage Caps.

(a) Use permanent duct filler caps in accordance with 4.3.3 of the PTI M50.3-12 Guide Specification for Grouted Post-Tensioning, as modified as follows:

(b) Use ASTM A193, Grade B8M, Type 316 stainless steel bolts to attach the cap to the anchorage.

(2) Inlets, Outlets, Drains, Valves and Plugs for Duct Filler connections shall conform to 4.3.12 of the PTI M50.3-12 Guide Specification for Grouted Post-Tensioning, as modified by the following:

(a) Provide permanent duct filler inlets, outlets, and threaded plugs made of Type 316 stainless steel conforming to ASTM A240, nylon or polyolefin conforming to the material specifications provided herein.

(b) Temporary items may be made of any suitable material which meets the pressure rating requirements.

(c) Inlets and outlets shall be located and attached in accordance with these specifications.

3. Steel Reinforcing

a. Mild reinforcing steel shall be in accordance with FDOT Specification 960-2.3.1 Mild.

b. Prestressing strand shall be in accordance with Special Provision for Post-Tensioning System.

4. Post-Tensioning System Materials shall be in accordance with FDOT Specification 960-2.4 PT System Materials, as modified by the following:

a. Stainless Steel shall conform to the Special Provision for Stainless Steel Corrosion Resistant Prestressing Steel in Post-Tensioning.

b. Ethylene Propylene Diene Monomer (EPDM) Sleeves: Use EPDM materials meeting the requirements of ASTM D1171 using Ozone Chamber Exposure Method B (ensure no cracks are exhibited under 2X magnification).

C. System Pre-Approval Requirements

1. Independent testing requirements shall be in accordance with FDOT Specification 960-3.1 Independent Testing, as modified by the following:

a. Prior to installing any post-tensioning hardware, furnish the Design Builder's Engineer of Record with a notarized certification from the Post-tensioning Supplier that the post-tensioning system chosen for the project meets the requirements of this SPECIAL PROVISION and that all supplied system components and materials are consistent with the submitted drawings, test reports, et. al.

b. Material Laboratory

(1) The Design Buildershall submit test results and include certified test reports from an independent laboratory audited by AASHTO Materials Reference Laboratory (AMRL) which shows the post-tensioning system meets all the requirements specified herein. Manufacturers shall also submit fully detailed drawings showing all components of their post-tensioning systems.

(2) Test plastic components in a certified independent laboratory accredited through the laboratory accreditation program of the Geosynthetic Accreditation Institute (GAI) or the American Association for Laboratory Accreditation (A2LA).

(3) Certification of test reports may be performed by an independent laboratory located outside the U.S., if the independent laboratory is pre-approved by the Department.

2. Testing Requirements

a. System Pressure Test shall conform to this specification, FDOT Specification 960-3.2.1 and 4.4.5 of the PTI/ASBI M50.3-12 Guide Specification for Grouted Post-Tensioning, as modified by the following:

(1) When segments are cast off site, each duct shall be pressurized and tested following the requirements of a completed duct system prior to final acceptance of the segment for shipping.

(a) The supplier of each different type and size of duct assembly shall assemble and pressure test 2% of each assembly prior to shipping. In the presence of the Design Builder's Engineer of Record, pressurize the duct to 1.5 psi and lock-off the outside air source then record the pressure loss for a duration of one minute. If the pressure loss exceeds 0.15 psi, find and repair the leaks in the duct assembly using repair methods approved by the Design Builder's Engineer of Record and retest.

(b) Following assembly of each complete duct system, including installation of all ducts, filler inlets and outlets and connections, and immediately prior to placement of the prestressing tendon or after stressing of the tendon, an air pressure test shall be performed on each complete duct system.

(c) The air pressure test shall involve pressurizing the complete duct system with dry, oil- free air to a pressure of at least 5psi. If the pressure can be maintained at 90% or higher for 1 minute after lock off, then the assembly shall be deemed to have passed. If the assembly fails then it shall be pressurized as required to 5psi or higher for the duration required to check for and identify major leaks (external leaks may be identified using bubbles from a soap and water solution) and crossover between ducts (internal leaks shall be identified using a dry solution like smoke). If major leaks and/or crossover are observed, all sources of leakage shall be identified, and measures shall be taken to reduce or eliminate the identified leaks and/or crossover, as approved by the Design Builder's Engineer of Record. Measures shall also be taken to reduce or eliminate the identified leaks and/or crossover from re-occurring in future duct assemblies. A major leak is one which shall allow for either the transmission of duct filler outside of the duct or one that prevents the duct from passing the pressure test.

(d) The operation of each vent shall be tested by blowing dry, oil free air into the duct system and opening and closing each vent in turn.

(2) Filler Containment Assembly Pressure Test shall be in accordance with FDOT Specification 960-3.2.1.1 Filler Containment Assembly Pressure Test.

(3) System testing for external duct systems shall conform to FDOT Specifications 960-3.2.1.2 External Duct Systems. System testing for internal duct systems shall conform to FDOT Specification 960-3.2.1.3 Internal Duct Systems.

(4) Duct Pressure Field Tests shall be performed prior to and post concrete placement; tests shall be in accordance with FDOT Specification 462-8.2 Design Builder's Field Tests.

(5) Systems for use with Vacuum-Assisted Flexible Filler Injection shall be in accordance with FDOT Specification 960-3.2.1.4 Systems for use with Vacuum-Assisted Flexible Filler Injection.

b. Minimum Bending Radius shall be in accordance with FDOT Specification 960-3.2.2 Minimum Bending Radius, as modified by the following:

(1) Minimum Radius of Curvature: Unless specifically identified elsewhere and required by these specifications, or approved by the Design Builder's Engineer of Record; the minimum radius of curvature of ducts shall be as follows:

Radius of 30 feet or more for plastic ducts

Radius of 10 feet or more for sch. 40 steel pipe ducts with 19x0.6 deviated tendons

Radius of 13 feet or more for sch. 40 steel pipe ducts with 27x0.6 deviated tendons

c. Additional Material Tests shall be in accordance with FDOT Specification 960-3.2.3 Additional Material Tests.

3. Required Sizes shall be in accordance with FDOT Specification 960-3.2.4 Required Sizes.

4. System Modifications

a. No changes to pre-approved Post-Tensioning System components shall be made without approval, in writing, from the Department.

b. Repeat all appropriate material, component, and entire system tests if any component of a pre-approved post-tensioning system is modified or replaced, excluding local zone reinforcement.

c. Submit an updated to the Design Builder's Engineer of Record containing test reports and revised system drawings for proposed modified systems.

5. Component Samples:

a. Component samples shall be in accordance with this Specification, Special Provision for Post-Tensioning System, and all reference specifications.

b. Furnish all required material samples to laboratories for testing and to the Department, as requested, at no additional cost to the Department.

6. Calculations, Drawings and Certifications

a. All calculations, drawings and certifications shall be in accordance with this specification, the Special Provision for Post-Tensioning Systems, and all referenced specifications.

b. Prior to installing any post-tensioning hardware, the Design Builder shall furnish the Design Builder's Engineer of Record with a certification from the post-tensioning supplier that the post-tensioning system chosen for the project meets the requirements of this specification, including the supplemental cross references to the various FDOT specification sections contained herein.

II. MEASUREMENT AND PAYMENT

All cost for furnishing post-tensioning components, including the completion of all testing required herein, the services of the manufacturer's representative, and all labor, equipment and incidentals necessary to complete the work as specified above and in the AFC plans should be included in the lump sum contract price.

This work is integral to the relevant work package that is part of the lump sum contract price. There is no separate payment for this work. If an item does not satisfy the criteria stated herein, and in the event the Department accepts this item, the Quality Assurance Manager (QAM) will document the

basis of acceptance. The Design Builder and the Department will negotiate an appropriate adjustment in the contract price, warranty, or other specific requirements or adjustments that are appropriate.

VIRGINIA DEPARTMENT OF TRANSPORTATION
SPECIAL PROVISION FOR
PRESTRESSING STEEL IN POST-TENSIONED STRUCTURES
for Design-Build and PPTA Contracts

December 9, 2016

223.02(c) REINFORCING STEEL TO BE EPOXY COATED of the Specifications is replaced with the following:

(c) Bars and Anchorages for Prestressing:
1. The bars for [restressing concrete members shall conform to the requirements of ASTM A722, Type II
2. Anchorages for Prestressing Bars shall meet the requirements of FDOT Section 960.

12-09-16 (SPCN)

SECTION 405.05(b)-PLACING STRANDS AND WIRES AND APPLYING TRANSFERING PRETENSION of the Specifications paragraph 6 (which begins with "The final stressing of strands") is amended to add the following:

The final stressing of stainless strands shall be performed by applying tension to each strand individually or to all strands as a group. The strand shall be tensioned to the total pre-tensioning force as indicated on the Approved for Construction (AFC) plans, with a maximum applied stress of 60% of the ultimate strength for low relaxation stainless steel strand. The nominal area of the strand shall be confirmed between the precast concrete producer and the stainless steel supplier. Strand shall be furnished in a weldless state. Care should be exercised when cutting the strand to ensure wire does not become raveled.

12-09-16 (SPCN)

SECTION 406.02(a)-STEELS USED FOR REINFORCEMENT of the Specifications is replaced with the following:

(a) **Steel used for reinforcement** shall conform to the requirements of Section 223, except that spiral bars shall be stainless steel (size number W 3.5) that meets the requirements of ASTM A1022 – Type 304 (UNS S30400), minimum Grade 60. Tie wires shall be Gage 16 stainless steel. Tie wires of other alloys or materials shall be submitted to the Design-Builder's Engineer for review.

12-09-16 (SPCN)

VIRGINIA DEPARTMENT OF TRANSPORTATION
SPECIAL PROVISION FOR
SUPPLEMENTAL POST-TENSIONING PERSONNEL QUALIFICATIONS
for Design-Build and PPTA Contracts

December 9, 2016

I. DESCRIPTION

A. General

Designing and detailing post-tensioned elements and structures shall be considered as a discipline. Personnel assigned to design and detail plans for post-tensioned elements, and check designs, plans, and details for post-tensioned elements shall be experienced with designing and checking post-tensioned elements of a similar type and complexity as those required for this project.

Post-Tensioning and Filling Personnel:

A. Supervisory Personnel

1. General: Provide supervisory personnel meeting the qualification requirements herein for all post-tensioned structures. Submit qualifications in accordance with the Supplemental Owner Quality Assurance During Post-Tensioned Structure and Bridge Construction at the pre-construction conference. Do not begin construction until the qualifications of supervisory personnel have been approved.

2. Submit a copy of the Professional Engineers' license issued by the Commonwealth of Virginia Department of Professional and Occupational Regulations indicating that the license is in force and current.

3. Experience Record: Submit the following information for supervisory personnel to substantiate their experience record. The supervisor (project engineer, superintendent/manager or foreman) seeking approval must provide a notarized certification statement attesting to the completeness and accuracy of the information submitted. Provide the following experience information for each individual seeking approval as a supervisor:

   a. Project owner's name and telephone number of an owner's representative, project identification number, state, city, county, highway number and feature intersected.

   b. Provide a detailed description of each bridge construction experience and the level of supervisory authority during that experience. Report the duration in weeks, as well as begin and end dates, for each experience period.

   c. Provide the name, address and telephone number of an individual that can verify that the experience being reported is accurate. This individual should have been an immediate supervisor unless the supervisor cannot be contacted in which case another individual with direct knowledge of the experience is acceptable.

4. Post-Tensioned Concrete Construction Personnel: Ensure the individuals filling the following positions meet the minimum requirements as follows:

   a. Project Engineer: Ensure the project engineer is a registered Professional Engineer with five years of bridge construction experience. Ensure a minimum of three (3) projects in the last ten (10) years of experience is in Post-Tensioned concrete construction engineering of a similar type. When segmental boxes are being constructed experience shall include a minimum of one year in segmental casting yard operations and related surveying, one year in segment erection and related surveying, including post-tensioning and grouting of longitudinal tendons. Minimum experience shall include being project engineer in responsible charge for two completed projects of similar type. Ensure this individual is present at the site of construction at all times while post-tensioning

construction or erection is in progress. Shall have current Post-Tensining Institute (PTI) Level 2 Bonded Post-Tensioned Field Installation Specialist and American Segmental Bridge Institute (ASBI) certification and ASBI grouting and flexible filler certifications.

b. Project Superintendent/Manager: Ensure the project superintendent/manager has a minimum of ten years of bridge construction experience or is a registered Professional Engineer with five years of bridge construction experience. Ensure a minimum of three (3) projects in the last ten (10) years of experience is in Post-Tensioned concrete construction engineering of a similar type. When segmental boxes are being constructed experience shall include a minimum of one year in the casting yard operations and related surveying, one year in segment erection and related surveying including post-tensioning and grouting of longitudinal tendons and a minimum of one year as the project superintendent/manager in responsible charge of segmental box girder construction operations. Ensure this individual is present at the site of construction, at all times while segmental box girder construction or segment erection is in progress. Project Superintendent/Manager shall have current PTI Level 2 Bonded PT Field Installation Specialist and ASBI grouting and flexible filler certifications.

c. Foreman: Ensure that the foreman has a minimum of ten years of bridge construction experience with six (6) years of experience in post tensioned concrete construction. When segmental boxes are being constructed experience shall include a minimum of four (4) years in segmental box girder operations and a minimum of two (2) years as the foreman in responsible charge of segmental box girder new construction operations. Ensure this individual is present at the site of construction, at all times while segmental box girder construction or segment erection is in progress. Shall have current PTI Level 2 Bonded PT Field Installation Specialist and ASBI grouting and flexible filler certifications.

d. Geometry Control Engineer/Manager: When post-tensioning construction includes cast-in-place box segments, ensure that the geometry control engineer/manager for construction of cast-in-place box segments is a registered Professional Engineer with three years of experience, a non-registered Engineer with five (5) years of experience or a registered Professional Land Surveyor with five years of experience in geometry control for casting and erection of cast-in-place box segments. Credit for experience in cast-in-place box girder geometry control will be given for experience in precast box girder geometry control but not vice versa.

   When post-tensioning construction includes precast box segments, ensure that the geometry control engineer/manager for precast box segments is a registered Professional Engineer with three years of experience or non-registered with five (5) years of experience in casting yard geometry control of concrete box segments.

   The geometry control engineer/manager must be responsible for and experienced at implementing the method for establishing and maintaining geometry control for segment casting yard operations and segment erection operations and must be experienced with the use of computer programs for monitoring and adjusting theoretical segment casting curves and geometry. This individual must be experienced at establishing procedures for assuring accurate segment form setup, post-tensioning duct and rebar alignment and effective concrete placement and curing operations as well as for verifying that casting and erection field survey data has been properly gathered and recorded. Ensure this individual is present at the site of construction, at all times while cast-in-place segmental box girder construction is in progress or until casting yard operations and segment erection is complete.

   Ensure that the surveyor in charge of geometry control surveying for box segment casting and/or box segment erection has a minimum of three (3) years of bridge construction surveying experience. Ensure this individual is present at the site of construction, at all times while segmental box girder construction or segment erection is in progress.

e. Post-Tensioning (PT) and Filler Injection Personnel Qualifications: Perform all stressing and filler injection with personnel meeting the qualifications of this article. Coordinate and schedule all PT and filler injection activities to facilitate inspection in accordance with the Supplemental Owner Quality Assurance During Post-Tensioned Structure and Bridge Construction .

f. Post-Tensioning: Perform all PT field operations under the direct supervision of a Post-Tensioning Institute (PTI) Level 2 Bonded PT Field Installation Specialist who must be present at the site of the post-tensioning work during the entire duration of the operation. Twenty five percent or a minimum of three (3), whichever is greater, members of the work crew shall be PTI Level 1 Bonded PT Field Installation Specialist.

g. Grouting: Perform all grouting field operations under the direct supervision of a PTI Level 2 Bonded PT Field Installation Specialist who must be present at the site of the grouting work during the entire duration of the operation. Twenty members of the work crew shall be ASBI Certified Grouting Technicians.

h. Submit the crew foreman's training and experience records in accordance with the Supplemental Owner Quality Assurance During Post-Tensioned Structure and Bridge Construction for approval prior to performing any filling operation.

   In addition to required experience above in filling operations, all vacuum grouting operations shall be performed under the direct supervision of a crew foreman who has also been trained and has experience vacuum grouting including vacuum grouting equipment and procedures. Submit the crew foreman's training and experience records in accordance with the Supplemental Owner Quality Assurance During Post-Tensioned Structure and Bridge Construction for approval prior to performing any vacuum grouting operation.

i. Flexible Filler Injection: Perform all filler injection operations under the direct supervision of a Filler Injection Foreman who has ASBI certification in the flexible filler process. Provide at least two ASBI Grouting Technicians, one of whom must be a PTI Level 2 Bonded PT Field Installation Specialist and an ASBI certified technician in the flexible filler process. Both technicians must be present at the site of the flexible filler injection work during the entire duration of the operation.

   In addition to required experience above in filling operations, perform all flexible filler repair operations under the direct supervision of a crew foreman who has been trained and has verifiable experience in the use of vacuum flexible filler repair equipment and procedures. Submit the crew foreman's training and experience records in accordance with the Supplemental Owner Quality Assurance During Post-Tensioned Structure and Bridge Construction prior to performing any flexible filler operation.

   Quality Control (QC) and Quality Assurance (QA) Personnel: Minimum of two (2) personnel performing QC inspections and testing of post-tensioning system installation and filler injection operations shall have the following PTI/ASBI certifications:

   PTI Level 2 Bonded PTI Field Specialist

   ASBI Certified Grouting Technician

   ASBI Certified Flexible Filler Technician

   Provide a Filler Injection Quality Control (QC) Inspector who has ASBI certification in the flexible filler process. The Filler Injection QC Inspector must be present at the site of the flexible filler injection work during the entire duration of the operation. Submit the crew foreman's training and experience records in accordance with the Supplemental Owner Quality Assurance During Post-Tensioned Structure and Bridge Construction for approval prior to performing any filling operation.

j. Prestressed Concrete Plant Quality Control Personnel: When concrete elements which will be post tensioned are precast, ensure each prestressed concrete plant has an onsite

production manager, an onsite plant quality control manager, a plant engineer, and adequate onsite QC inspectors/technicians to provide complete QC inspections and testing.

Ensure the plant manager for QC has at least five years of related experience and a current PCI QC Personnel Level III certification. Ensure that the QC inspector/technician has current PCI QC Technician/Inspector Level II certification and PTI Level 2 Bonded PT Field Specialist Certification and, if flexible filler will be installed that the plant, ASBI Filler Certifications.

II. FAILURE TO COMPLY WITH QUALIFICATION REQUIREMENTS

Failure to Comply with Post-Tension Construction Qualification Requirements: Make an immediate effort to reestablish compliance. If an immediate effort is not put forth as determined by the Department, construction and related activities will be stopped for up to sixty (60) days. Cease all bridge construction and related activities (casting yard, etc.) if compliance is not met within sixty (60) days, regardless of how much effort is put forth. Resume bridge construction operations only after written approval from the Department stating that compliance is reestablished.

VIRGINIA DEPARTMENT OF TRANSPORTATION
SPECIAL PROVISION FOR
PRECAST CONCRETE SEGMENTAL SUPERSTRUCTURE CONSTRUCTION
for Design-Build and PPTA Contracts

December 9, 2016

I. DESCRIPTION

This SPECIAL PROVISION specifies requirements for precast concrete segmental box girder bridge superstructures. The work shall be performed in accordance with these specifications, applicable provisions of Sections 404, 405 and 406 of the 2016 VDOT Road and Bridge Specifications, the Plans, the Design Documents, and all other Contract requirements. The final structure shall conform to lines, grades and design dimensions shown on the Approved for Construction (AFC) plans and shall conform to the provisions of these Specifications. This work also includes reinforcing steel embedded in the segments along with the cast-in-place closure joints and closure segments.

This special provision incorporates by reference the:

- Florida Department of Transportation Standard Specifications for Road and Bridge Construction Specification Section 452, including its referenced specifications.

http://www.fdot.gov/programmanagement/Implemented/SpecBooks/January2016/JANUARY2016BK.shtm

In the event that a conflict(s) exists between this Special Provision and the above referenced specifications, the following order of precedence shall be followed:

- This Special Provision shall govern over the FDOT specifications.

II. QUALIFICATION REQUIREMENTS FOR SUPERVISORY PERSONNEL

Qualifications shall be in accordance with the Special Provision for Supplemental Qualifications for Post-Tensioning Personnel.

III. DEFINITION OF TERMS

Definition of Terms shall be in accordance with FDOT Specification 452 Precast Segmental Bridge Construction, as modified by the following definitions which apply to segmental bridge construction:

A. Precaster: The firm or organization responsible for manufacturing the precast concrete segments (this may be the Design-Builder or their Sub-Contractors).

B. Post-tensioning Supplier: The company that furnishes the proprietary post-tensioning system.

C. Erector: The firm or organization responsible for the erection of the precast concrete segments in the final structure (this may be the Design-Builder or his Sub-Contractors).

D. Supplier: The firm or organization responsible for supplying certain proprietary material, hardware or equipment for incorporation in the structure.

IV. SUBMITTALS

Submittals shall be in accordance with FDOT Specification 452-4 Shop Drawings, Calculations and Manuals, as modified by the following:

A. The Design-Builder shall submit composite (integrated) shop/placement drawings as defined in AASHTO LRFD Bridge Construction Specifications (3rd Edition with 2010, 2011 and 2012 Interims), Section 10.2.2 for all precast and cast-in-place concrete, whether Prestressed or not. The term “composite shop/placement drawings” shall include the Design-Builder’s reinforcement

bending and fabrication drawings.

B. The Design-Builder shall submit shop drawings to the Design-Builder‘s Engineer of Record for review and approval.

C. Shop drawings shall be 11” by 17” in size. Shop drawings shall be submitted in electronic PDF format. Shop drawings shall be reviewed and returned in electronic PDF format. Shop drawings shall be in compliance with Section 105.10 of the 2016 VDOT Road and Bridge Specifications. All shop drawings shall be in English with US customary units.

D. Segment shop drawings shall include information as required by FDOT Specification 452-4 Shop Drawings, Calculations and Manuals.

E. Other items to be submitted to the Design-Builder‘s Engineer of Record for review and approval include the following:

1. Precast Segment Fabrication System: The precast form supplier shall submit to the Design-Builder‘s Engineer of Record complete details of the proposed precast fabrication system, including casting forms, their foundations, operational details, casting yard layout and precast geometry control observation and measuring system. The casting form details may be provided by presenting a generalized drawing with a table of specific dimensions for the various segment forms.

2. Post-Tensioning System: The Post-tensioning Supplier shall provide the Design-Builder‘s Engineer of Record with complete details for the Design-Builder’s proposed post-tensioning system, including ducts, grout injection and outlet vents, anchorage hardware, any additional anchorage reinforcing, inserts and lifting devices to be embedded in the segments. For any Design-Builder proposed option, a complete geometric layout for each post-tensioning tendon shall also be submitted.

3. Casting Manual: A manual for the casting and geometry control of the segments shall be prepared in accordance with FDOT Specification 452-6.3 Casting Control, the information provided in the AFC Plans, Project Specifications or SPECIAL PROVISIONs and as modified by the following:

   a. Casting curves prepared by and in accordance with the casting and erection methods, schedule, loads, and material properties proposed by the Design-Builder shall be included in the Casting Manual. The casting curves shall be of sufficient accuracy to allow the determination of control point settings for accurately casting the segments.

   b. Preparation of the casting curve shall recognize all deviations from profile grade and deformations due to the final required alignment, self-weight, future imposed dead loads, erection loads, post-tensioning stresses including secondary moments, creep and shrinkage. Each casting curve submittal shall be accompanied by all information (loads, casting and erection schedules, material properties, etc.) considered in its development. In developing casting curves, deformations due to creep and shrinkage and the concrete modulus of elasticity shall be computed using the recommendations of CEB-FIP Model Code for Concrete Structures or ACI 209. CEB-FIB stands for Comite Euro-International De Beton-Federation Internationale De La Preconstrainte.

   c. Preparation of camber and casting curve geometry depends upon the construction sequence, methods and schedule. Thus, if the Design-Builder proposes a change to the assumed construction procedure and schedule shown on the AFC Plans, then new casting curve geometry (developed in a similar manner as the original casting curve) shall be required. To this end, the Design-Builder shall provide the Design-Builder’s Engineer of Record with his proposed construction sequence, methods and schedule, at least sixty (60) days in advance of the start of segment casting. The Design-Builder’s Engineer of Record shall use this to develop new casting curve geometry. The Design-Builder‘s Engineer of Record may waive the need to revise the casting curve geometry if he considers the change to the construction sequence and schedule to be of no significance to the casting curve. In the context of this specification,

"construction sequence, methods and schedule" refers to all activities associated with the fabrication and erection of the precast segments, including the dates of casting, time of storage, and dates of erecting and prestressing the segments in the structure, and all associated temporary equipment loads of support conditions for the erection system.

d. Any changes to the Design-Builder's construction sequence, methods and schedule (for any reason whatsoever) that necessitate a revision to the casting curve geometry (by the Design-Builder's Engineer of Record) shall be made at no additional expense to the Department.

4. Handling, Storage and Transport of Segments: Complete details of handling, storing and transporting segments shall be determined. These details shall include, for each type of segment, the method of lifting (location of any inserts, configuration of lifting devices, etc.) and the method of supporting segments during storage and transportation, the planned route for transporting the segments and the axle loads for the segment hauler. Storage of the segments shall be on a three-point support system. All details of handling, storing and transporting segments shall be provided to the Design-Builder's Engineer of Record for approval.

   If the segments are to be stacked, calculations showing the stresses induced by stacking shall be prepared, compared to allowable stresses and submitted to the Design-Builder's Engineer of Record for approval.

5. Erection Manual: An Erection Manual shall be prepared and submitted in accordance with FDOT Specification 452-4 Shop Drawings, Calculations and Manuals and meet the requirements of 452-8 Erection, as modified by the following:

   a. Submittal shall be made by the Design-Builder to the Design-Builder's Engineer of Record for approval, providing the detailed step by step erection of the segments, including all intermediate procedures relating to any erection equipment, falsework, movement of equipment, counterweights, support jacking, stressing of temporary post- tensioning bars, closure operations identifying any partial stressing across the closure during concrete curing, location and size of shim blocks, main post-tensioning tendon sequences, stressing loads and elongations, erection elevations, the field survey and alignment control methods to be employed for setting the initial and subsequent segments and any other relevant operations.

      The detailed step-by-step procedure for erection of superstructure segments shall include the sequence in which these items are to be erected along with a table of elevations and alignments of the geometry control points as established from the casting of each segment and as then computed (by the Design-Builder) at each stage of erection. Stages for which theoretical positions of control points shall include the segment in place prior to applying post-tensioning and the segment with post-tensioning applied.

      The theoretical position shall be computed taking into consideration:

      1. Effect of as-cast geometry established from surveys during casting of segments.
      2. Effects of construction dead and live load, as applicable.
      3. Effects of post-tensioning.
      4. Effects of creep and shrinkage.
      5. Achieving the final profile of the roadway as shown in the AFC plans.

      The procedure shall also include a method for measuring and recording the elevations and alignment of control points at each stage of erection.

      The Design-Builder shall submit a new erection procedure at any time that he proposes to deviate from the sequence of schedule of erection contained in an

approved erection procedure under which he is operating.

6. Field Survey and Erection Control: Field survey and alignment control methods to be employed for setting the initial and subsequent segments are the responsibility of the Design-Builder.

7. Construction Equipment and Load Testing: Complete details covering equipment to be used to handle segments and incorporate them into the structure, details related to access of post-tensioning stressing equipment, erection methods to be used, the sequence of erection, all loads to be imposed on any portion of the permanent structure by the erection equipment and details covering the time, location and all procedures for load testing of erection equipment shall be submitted to the Design-Builder'sEngineer of Record for review prior to the activity taking place.

8. Calculations: Calculations shall show that the loads imposed on the permanent structure by the erection equipment shall not adversely affect the structural adequacy of the permanent structure, nor exceed allowed stresses during the construction process and shall be prepared under the direction of, and signed and sealed by, a Professional Engineer registered in the Commonwealth of Virginia.

V. QUALITY CONTROL

The Design-Builder is solely responsible for all quality control for the production of precast segments for any part of the structure. Furthermore, the Design-Builder is solely responsible for all quality control for installation and erection of segments and for the construction of all cast-in-place joints and closures. Sub-contractors, including pre-casters and erectors, may be used by the Design-Builder, but the Design-Builder retains all responsibility for all material, operations and the quality of the final work.

The Design-Builder shall submit his detailed Quality Control Plan (QC Plan) for segment casting for the review and approval of the Engineer of Record at least 30 days prior to the commencement of any segment production. . The Design-Builder shall submit his QC Plan for erection to the Design-Builder's Engineer of Record for review and approval at least 30 days prior to the start of segment erection operations. Each plan shall clearly define the QC procedures, QC personnel, frequency of QC activities, record keeping, documentation control, remedial actions if required and other items that are needed in a detailed QC Plan. The Design-Builder shall provide the Design-Builder 's Engineer of Record's Precast Inspector with copies, on a daily basis, of all quality control reports, documents and material certifications related to the fabrication of all precast concrete segmental units. This information shall include but is not limited to, pre- and post-pour casting reports, concrete batching and delivery tickets and any other information requested by the Design-Builder's Engineer of Record. The Design-Builder shall also provide the Design-Builder Engineer of Record's Precast Inspector with copies of all reports related to the production of concrete supplied for the fabrication of precast concrete segmental units. This information shall include, but is not limited to, cement certifications, coarse and fine aggregate delivery tickets, admixture delivery tickets and certifications, equipment calibration and certification reports and any other Quality Control testing activities as required by the approved Quality Control Plan. All Quality Control activities related to the production of the precast concrete segmental units shall be performed at a frequency greater than or equal to that specified in the 2016 VDOT Road and Bridges Specifications or the SPECIAL PROVISIONs. The Contractor shall be responsible for the sampling and testing of fresh concrete to be used for the precast concrete segmental units. Further, the Design-Builder shall be responsible for the molding, curing and testing of concrete compression test cylinders. All activities, equipment and facilities related to the molding, curing and testing of concrete compression test cylinders shall be provided and maintained by the Design-Builder, at no additional cost to the Department. All molding, curing and testing of concrete compression test cylinders shall take place at the precast fabrication yard or plant, convenient to the fabrication activities.

VI. MATERIALS

A. Concrete

All concrete shall conform to Section 217 of the VDOT Standard Specifications, the Design Documents and the following requirements.

1. Description

   This work shall consist of the construction of Portland cement concrete with the use of High Performance Concrete (HPC) for the precast superstructure. It is the intent to obtain concrete for all visible portions of the structure which is of the lightest practical gray color and has the minimum variation in color.

2. Materials

   Materials, admixtures and methods of construction not specifically covered in the AFC plans and these Specifications shall conform to the 2016 VDOT Road and Bridge Specifications, and as stated herein.

   The class of concrete for use in each element of construction shall be as shown in the AFC plans and contained in the Project SPECIAL PROVISIONs. Concrete used to cast closure joints between superstructure segments shall be the same mix as that used to cast the segments.

   The required average strengths to exceed 28-day compressive strengths of 6000psi and 8000psi, and compressive strength at time of stressing, as given in the Contract Documents, shall be the amount determined or calculated in accordance with the requirements of ACI 214R-11 using the standard deviation of the proposed concrete production facility, as described in ACI 214R-11. The average compressive strength shall be verified by laboratory tests at least 14 days prior to the first pour. Projected strength gain curves shall not be accepted.

3. Reinforcing Steel

   All reinforcing steel shall be Corrosion Resistant Reinforcing (CRR) in conformance with Section 223 of the VDOT Standard Specifications, the SPECIAL PROVISIONs, and shall be minimum Grade 60 reinforcement. When approved by the Design-Builder's Engineer of Record, welded reinforcing grillages shall be shop-prepared and shall conform to the requirements of the American Welding Society's Structural Welding Code D1.4. Field-welding of reinforcing steel shall not be permitted.

4. Dry-Packed Mortar

   Dry-packed mortar for uses shown on the AFC plans shall consist of Portland cement conforming to the requirements of AASHTO M-85 (Type I or Type II) and silica sand conforming to AASHTO M-45. Clean, potable water shall be free of substances known as harmful to Portland cement or to reinforcing steel. Admixtures shall be as necessary to impart the required properties to the mortar. Admixtures containing chlorides, sulfites, fluorides, nitrates or aluminum powder shall not be used,

   The Design-Builder shall determine, subject to approval of the Design-Builder 's Engineer of Record, the exact materials and proportions to be used. The mortar shall be of a non-sag consistency containing only enough water to make it lightly adhesive. The mortar shall have the following physical properties:

Properties	Test Value	Test Method
Water Content	Minimal	--
Shrinkage	0%	ASTM C-827
28-day Compressive Strength	*	ASTM-C-109**

   * For superstructure applications, the strength shall be as stated in the plans for superstructure concrete.

   ** The test specimen shall be prepared using the materials and in the

proportions which are to be used in production of the mortar.

Prior to beginning any dry packing of mortar on the project, the Design-Builder's Engineer of Record shall be informed and provided with the results of tests performed by a laboratory approved by the Design-Builder's Engineer of Record demonstrating that the mortar mixture he proposes to use meets the requirements of these Specifications.

A commercially available, cement-based grout mixture that meets the requirements of this Specification may be used, subject to approval by the Design-Builder's Engineer of Record. The ingredients shall be thoroughly blended in a manner that results in a uniform mixture.

5. Ducts for Post-Tensioning Tendons

   Ducts to be embedded in or external to superstructure and substructure segments shall conform to the requirements of the SPECIAL PROVISION for the Post- Tensioning System.

6. Post-Tensioning Systems

   Use post-tensioning components meeting the requirements of Special Provision for Post-Tensioning Systems. Components are not interchangeable and must comply with the details of the approved shop drawings.

B. High Performance Grout for Bearing Plinths. High Performance Grout for Bearing Plinths as shown in the AFC Plans shall be High Performance Grout that is ready-to-use, non-shrink, non-corrosive, non-metallic and achieves a High Early Strength (5000 psi in one day). High Performance Grout shall be Dayton Superior Sure-Grip High Performance Grout or an equal approved by the Design-Builder's Engineer of Record that meets the requirements of ASTM C-1107 Specification for Non-Shrink Grout Grades A, B, & C and requirements of ASTM C-827.

VII. CASTING REQUIREMENTS

All materials, details, and other requirements shall be as specified herein, in conformance with FDOT Specification 452-6 Casting Requirements, or noted in the Contract Documents.

Casting of segments shall not begin until review of required computations, the post- tensioning system and concrete mix design, including a hot weather mix design, has been completed and approved by the Design-Builder's Engineer of Record.

The segments shall be match-cast.

A. Design of Forms

The design and engineering of the forms and falsework, as well as their construction, shall be the responsibility of the Precaster or his specialty Engineer. Forms shall be inspected and approved by the Design-Builder's Engineer of Record prior to authorizing casting operations. Forms that are worn, damaged or otherwise unacceptable to the Design-Builder's Engineer of Record shall be repaired to the Design-Builder's Engineer of Record's satisfaction before the casting of any segment shall be authorized. Any segment cast in forms unacceptable to the Design-Builder's Engineer of Record may be subject to rejection. Forms that shall not produce segments complying with the specified casting tolerances shall not be used until corrections are made have been approved by the Design-Builder's Engineer of Record.

Forms shall be mortar-tight and sufficiently rigid to prevent distortion due to the pressure of the concrete and other loads incidental to the concrete operations, including vibration. Forms shall be capable of casting the segments to required dimensions as shown in the AFC plans.

All exposed surfaces of each element of the structure shall be formed with materials that shall produce a similar surface texture, color and appearance for all concrete surfaces. The form surfaces of casting machines for superstructure shall be made of steel. The metal used for forms shall be of such thickness that the forms shall remain true to shape. All bolt and rivet

heads shall be countersunk. Clamps, pins or other connecting devices shall be designed to hold the forms rigidly together and to allow form removal without injury to the concrete.

The inside surfaces of forms shall be cleaned of all dirt, mortar and foreign material. Forms shall be properly coated with form oil prior to each use. The form oil shall be commercial quality form oil or other equivalent coating that shall permit the ready release of the forms and shall not discolor the concrete. Form oil shall be applied such that the finished surface of each segment is uniform in color as compared to the previously and subsequently cast segments. Form oil shall be applied such that none is deposited on the reinforcement in the forms.

Where sections of forms are to be joined, a maximum offset of 1/16 inch for flat surfaces and 1/8 inch for corners and bends shall be permitted.

The Precaster shall accurately survey forms on a monthly basis for the purpose of monitoring settlements and distortion in shape. If any settlements or distortions are of great enough magnitude to interfere with achieving the required segment tolerances, casting with these forms shall be discontinued until the problem is corrected.

B. Geometry Control

Casting control (geometry control) shall be in accordance with FDOT Specification 452-6.3 Casting Control (Geometry), as modified by the following:

1. Personnel:

   Geometry control at the casting yard and at the bridge site shall be under the direct responsible charge of a Superintendent who is a Professional Land Surveyor or Professional Engineer registered in the state of Virginia. Personnel who directly supervise layout and geometry control measurements shall have experience in geometry control techniques for precast concrete segmental bridges and shall have worked on one precast concrete segmental project in the casting yard in the last 10 years.

2. Superstructure Segments: Casting Yard Geometry Control Operations

   Instruments used in the casting yard for horizontal geometry control shall be mounted on a permanent platform a sufficient height to sight on all control points; platform shall be independent of any other structure. Instruments used in the casting yard for vertical geometry control of superstructure segments shall be firmly supported on a tripod, set on top of the segments being surveyed, or mounted on a rigid permanent platform. Provision shall be made to protect instruments from construction activities and to minimize the effects of wind and temperature variations on the accuracy of readings.

   A minimum of two (2) permanent horizontal control points shall be established on line with the instrument mounting point. Permanent bench-marks shall be established at locations where they shall not be disturbed by construction activities. The horizontal control points and bench-marks shall be located so as to be continuously visible from the instrument's location.

   Prior to beginning casting operations using the short line casting method, horizontal and vertical elevation control points shall be established on the fixed bulkhead. The alignment, elevations and shape of the fixed bulkhead shall be checked each time the geometry of adjoining segments is checked.

3. Segment Hardware and Measurements

   Immediately after casting of a segment is complete, the length of the segment along the line of each web shall be measured and recorded and references for horizontal and vertical control shall be established as follows:

   a. Horizontal Control - A wire stirrup on the horizontal control line at both ends of the segment. A line not more than 0.001 feet in width shall be scribed in a permanent manner into each stirrup. Wire stirrups shall be stainless steel.

b. Vertical Control – A flat head bolt, with a small, countersunk depression in the head shall be set approximately flush with the surface of the concrete over each web at both ends of the segment. The bolts shall be stainless steel or other rigid material approved by the Design-Builder's Engineer of Record.

After a segment is cast, and before bond breaking, the positions of the two adjoining segments shall be checked from established control points. If the positions are not as required, corrections to the geometry shall be made in the next segment cast by utilizing the established control points.

4. Requirements for Short Line Casting of Superstructure Segments

a. Instruments used to measure elevations shall be precision levels equipped with parallel plate micrometers capable of obtaining first order control and one-piece, invar rods with center point bases.

b. Instruments used to make horizontal measurements shall be a centerline sighting theodolite and centerline offset measuring tool directly graduated in intervals of 0.002 feet.

c. Elevation and centerline-offset measurements shall be observed to an accuracy of +0.001 feet.

d. The set-up position of two adjacent segments before casting shall be independently determined by two observers. Casting shall not begin until these surveys agree within the following tolerances:

Elevation:+0.002 feet on any control point.

Horizontal:+0.002 feet on a segment centerline offset.

e. After cast observations shall be independently determined by two observers.

They shall be checked until the independent observations agree within the following tolerances:

Elevation:+0.001 feet on any control point.

Horizontal:+0.001 feet on a segment centerline offset.

Twist error on elevation control points: +0.001 feet (with +0.002 feet maximum on a random error)

C. Preparation for Match-Casting

Preparation for match-casting shall be in accordance with FDOT Specification 452-6.4 Preparation for Match-Casting.

D. Embedded Items

Requirements for Emedded Items shall be in accordance with FDOT Specification 452-6.5 Embedded Items, as modified by the following:

In the plane of the reinforcement parallel to the nearest surface of concrete, bars shall not vary from plan placement by more than 1/2 inch, or 1/12 of the spacing between bars, whichever is less.

In the event of a conflict between post-tensioning ducts and reinforcing bars, the post- tensioning shall generally have priority and the position of the bars shall be adjusted in a manner approved by the Design-Builder's Engineer of Record. All such conflicts shall be brought to the attention of the Design-Builder's Engineer of Record for resolution and approval.

Embedded ducts for tendons shall be positioned accurately within 1/4 inch, with respect to vertical, linear and transverse position within each segment.

Ducts internal to the concrete section shall be properly aligned when passing from segment to segment and from the segment to a cast-in-place closure.

After installation in the forms, the end of the ducts shall be sealed to prevent entry of water and debris in accordance with the SPECIAL PROVISION for Post-Tensioning Systems.

Lifting devices incorporated in cantilever segments shall be adequate to distribute the handling and erection stresses without damage to the segment.

Anchoring devices for transverse top slab post-tensioning shall be recessed so that the ends of the prestressing steel and all parts of anchoring devices shall be at least two inches inside the end surface of the segment. Following post-tensioning, the recesses shall be filled in accordance with the details noted on the AFC plans.

Transverse post-tensioning anchors shall be placed into the form before the concrete is cast. Temporary block-outs to allow for later installation of anchors shall not be allowed. Local anchorage bursting, spiral, grid or multiple U-bar reinforcement shall be accurately located and securely fixed in position.

E. Concrete Placement

Concrete placement shall be in accordance with FDOT Specification 452-6.6 Concrete Placement, Consolidation and Finishing, as modified by the following:

1. General

   The placement of concrete shall not proceed until adequate measures, and protection is available to prevent weather damage during conveying and placement; this includes shelter from rain. Do not place concrete until the Design-Builder's Engineer of Record is satisfied that all the above items have been properly inspected and checked, and that the following conditions have been met:

   a. The rate of production and placement of concrete will be sufficient for completion of casting and finishing operations within the scheduled time,

   b. experienced concrete finishers are available where required for finish work, and

   c. all necessary finishing tools and equipment are on hand at the site and are in satisfactory condition for use.

   Special care shall be taken to plan the sequence of placing concrete so as to assure that voids do not occur within the concrete in areas where air is likely to be entrapped within the forms or in areas where flow of the plastic concrete is constrained by embedded items.

2. Concrete Placement Equipment

   Placement equipment shall be of a size and design to permit placing of concrete within a workable time period to avoid cold joints or blemishes between successive lifts. Placing equipment shall be cleaned as necessary at the end of each operation or workday and, just prior to reuse, shall again be checked and cleaned of hardened concrete and foreign materials.

   Belt conveyors shall be horizontal or at a slope which shall not cause excessive segregation or loss of ingredients. Concrete shall be protected against undue drying or rise in temperature. An approved device shall be used at the discharge end of a belt conveyor to prevent aggregate segregation. Mortar shall not be allowed to adhere to the return length of the belt. Concrete shall be discharged into a hopper or through a baffle.

   Concrete shall not be dropped more than four feet, unless confined by closed chutes or pipes. Formwork shall not be considered as chutes. Care shall be taken to prevent segregation when discharging concrete into the forms.

   Care shall be taken to fill each part of the form by depositing the concrete as near to the final position as possible. After the discharge of individual concrete loads into the forms, concrete

shall not be bodily moved from place to place within the forms by mechanical vibrators or other similar equipment.

3. Concrete Placement Sequence

   Concrete placement sequence shall be in accordance with FDOT Specification 452-6.6.3 Concrete Placement Sequence, as modified by the following:

   Concrete shall be placed in horizontal layers not more than 18 inches thick except as hereinafter provided. Each layer shall be placed and consolidated before the preceding layer has taken initial set.

   Immediately after all the concrete has been placed and consolidated, all accumulations of mortar splashed upon the remaining exposed reinforcement and surfaces of forms shall be removed before the concrete takes its initial set. Care shall be taken when cleaning reinforcing steel to prevent damage to or breakage of the concrete-steel bond.

   No construction joints shall be permitted within a segment except as detailed on the AFC plans.

4. Concrete Consolidation

   All concrete shall be consolidated by means of approved vibrators together with any other equipment necessary to perform the work as specified. Vibration of concrete shall conform to the 2016 VDOT Road and Bridge Specifications with the following exceptions.

   Internal vibrators shall have a minimum frequency of 8,000 vibrations per minute and sufficient amplitude to consolidate the concrete effectively. At least two standby vibrators in working condition shall be provided for emergency use in case of malfunction. The use of external vibrators for consolidating concrete shall be permitted and may be required when the concrete is inaccessible for adequate consolidation. When external vibration is used, the forms shall be constructed sufficiently rigid to resist displacement or damage. Care shall be exercised when placing and consolidating concrete so that reinforcing, post-tensioning ducts, anchorages and any other embedded items are maintained in their proper positions and are not damaged.

5. Finishing Top Surface of Superstructure Box Girder Segments

   When the concrete has been placed and vibrated in a section of sufficient width to permit working, the surface shall be struck off level and with a screed such that a slight excess of concrete is carried ahead of the screed to insure filling of all low spots. The screed shall be designed rigid enough to hold true to shape. A hydraulically driven, bare steel tube rotating in the opposite direction of travel may be used if heavy enough to prevent undue distortion.

   Longitudinally, the screed shall be moved back and forth across the concrete while one end rests on the upper surface of the form (bulkhead) and the other end on the match- cast segment.

   The screed shall be used a sufficient number of times, and at such intervals to produce a uniform surface, true to grade and free of voids. Then, the surface shall be worked to a smooth finish with a long handled wood or metal float of the proper size, or hand floated from bridges over the top slab. A float finish shall be applied to the top slab to produce a uniform dense surface where the screed cannot be used because of projecting rebar.

   Surfaces directly under barriers or rail plinths shall be finished dense but rough to an amplitude of approximately 1/8”.

   After the water sheen has disappeared from the surface of the top slab, but while the concrete is still plastic, the final finish shall be applied to the top slab. A float finish shall be applied to the top slab in preparation for subsequent transverse saw groove cutting in accordance with Project Specifications. The finished bridge deck top surface shall meet the requirements of below specifications.

Only minimum hand finishing shall be permitted and there shall be no overworking of the top slab. Only minimal amounts of water shall be allowed to aid in the finishing process when evaporation rates affect the quality of the finish. A fog spray shall be used to help retard surface evaporation, but shall not change the water-cement ratio at the deck surface. During periods of excessive drying, a cover of wet burlap or plastic sheeting shall be maintained on the slab at all times until final cure cover is placed. Monomolecular film coatings applied as a uniform blanket over the entire surface of the slab to retain moisture may be used, provided they effectively retard surface evaporation and are adequately maintained throughout the finishing operation.

F. Curing

Curing of precast concrete segments shall be in accordance with FDOT Specification 452-6.7 Curing, as modified by the following:

It is the responsibility of the Precaster to determine the measures to be taken to protect and properly cure the concrete. The Design-Builder's Engineer of Record shall review for adequacy, the curing method proposed by the Precaster. If the method proposed by the Precaster fails to produce satisfactory results in the judgment of the Design-Builder's Engineer of Record, the Precaster shall use other methods or shall alter the method used, so as to provide acceptable segments.

The minimum curing period shall be five days, or until the concrete has achieved the required 28-day compressive strength as determined by test cylinders cured under the same conditions as the segment. When the ambient temperature is below 35˚F, concrete surface temperatures shall be maintained above 50˚F during the initial curing period. The initial curing period is defined as the period of time until the concrete has achieved the required compressive strength specified for removing or lowering forms, partial stressing of transverse tendons, or segment handling as determined by test cylinders cured under the same conditions as the precast segment.

Immediately after placing the fresh concrete, it shall be cured through the initial curing period by one of the following methods. However, membrane curing-compound shall not be considered an acceptable alternative for the initial curing period.

1. Forms-in-Place Method: For formed surfaces, leave the forms in place without loosening. Cover the wet concrete deck surface with a waterproof sheet material that prevents moisture loss from the concrete. Secure all moisture barriers so that wind shall not displace them. Immediately repair broken or damaged waterproof sheeting.

2. Water Method: All surfaces other than slabs shall be protected from the sun and the whole structure shall be kept wet for the initial curing period. The concrete surface shall be kept moist at all times by fogging with an atomizing nozzle until the covering is placed.

3. Blanket Method: Electrically heated curing blankets or insulation blankets may be used in cold weather to maintain specified curing temperature and to retain moisture in concrete. Blankets shall be lapped (8 inches minimum) and shall be free of holes. Blankets shall be secured at laps and edges to prevent moisture from escaping.

4. Steam Method: After placement of the concrete, members shall be held for a minimum four-hour pre-steaming period. If the ambient air temperature is below 50ºF, steam shall be applied during the pre-steaming period to hold the air surrounding the member at a temperature between 50ºF and 90ºF. When the ambient air temperature is above 50ºF, the member shall remain undisturbed in the ambient air for a four-hour pre-steaming period.

   To prevent moisture loss on exposed surfaces during the pre-steaming period, members shall be covered with a moisture-tight covering as soon as surface finishing is complete or the exposed surfaces shall be kept wet by an approved fog spray. The moisture tight covering shall be removed just prior to initiating the steam curing. Alternatively, the segment enclosure shall be fully closed and the relative humidity shall be maintained at 95% or higher. Curing period shall be a minimum of 12 hours.

Enclosures for steam curing shall allow free circulation of steam around all surfaces of the segment either formed or exposed and shall be constructed to contain the live steam with a minimum moisture loss. The use of tarpaulins or similar flexible covers shall be permitted, provided they are kept in good repair and secured in such a manner as to prevent the loss of steam and moisture. These enclosures may also provide the required weather protection during conveying, placement and curing of the concrete if they are substantial enough to prevent wind and rain damage during the casting operations.

Steam at the jets shall be low pressure and in a saturated condition. Live steam shall not be directed on the concrete, test cylinders, or forms such as to cause localized high temperature. During application of the steam the temperature rise within the enclosure shall not exceed 40ºF per hour. The curing temperature shall at no point within the enclosure exceed 150ºF and shall be maintained at a constant level for a sufficient time necessary to develop the required strength for handling at the time of form removal. The steam curing cycle shall include a gradual cooling period during which the rate of decrease in temperature shall not exceed 40ºF per hour. The steam curing cycle shall include the gradual cooling period until the temperature inside the enclosure is within ±20ºF of the outside ambient temperature.

The Precaster shall provide temperature recording devices to make an accurate, continuous and permanent record of the curing temperature. At least two continuous temperature records per casting machine are required

Control cylinders shall be covered to prevent moisture loss and shall be placed in a location where temperature is representative of the average temperature of the enclosure.

The match-cast segment shall be contained within the same curing environment (temperature and humidity) as the segment being steam-cured, throughout the initial curing process.

5. Radiant Heat Method. Enclosures for radiant heat curing shall allow free circulation of heat around all surfaces of the segment either formed or exposed. Measures shall be taken as soon as possible after casting to prevent moisture loss on all exposed surfaces.

   During application of heat, the temperature rise within the enclosure shall not exceed 40ºF per hour. The curing temperature shall at no point within the enclosure exceed 150ºF and shall be maintained at a constant level for the time necessary to develop the required strength for removal of forms. A gradual cooling period, during which the rate of decrease in temperature in the enclosure shall not exceed 40ºF per hour, shall be included in the curing cycle. This cycle shall include the gradual cooling period until the temperature inside the enclosure is within ±20ºF of the outside ambient temperature. Curing period shall be a minimum of 12 hours.

   The Precaster shall provide temperature recording devices to make an accurate, continuous and permanent record of the curing temperature. At least two continuous temperature records per casting machine are required

   Control cylinders shall be covered to prevent moisture loss and placed in a location where temperature is representative of the average temperature in the enclosure.

   The match segment shall be contained within the same curing environment (temperature and humidity) as the segment being radiant-heat cured, throughout the initial curing process.

G. Final Curing of Concrete Segments

Except for segments cured by the Steam or Radiant Heat Methods, minimum curing of a precast segment period shall continue after the initial curing period, by the application of a membrane curing compound (conforming to the requirements of AASHTO M 148) to all exposed surfaces - except the segment face against the bulkhead to be used as the next match-cast face.

A Type 2, white-pigmented compound shall be used on the top deck surface and a Type 1, clear compound shall be used on all other exterior surfaces. The membrane curing compound shall be

of a consistency suitable for spraying at temperatures prevalent at the time of construction operations, and which forms a continuous, uniform film. It shall be free from precipitated matter caused by conditions of storage or temperature. The compound shall be relatively nontoxic. Paraffin based curing compounds shall not be used. After separating a segment from the bulkhead, this face shall have an approved de-bonding compound applied to serve both as a bond breaker for the next match casting operation and as a curing compound.

The membrane curing compound shall remain intact through the minimum curing period of five days or until the required 28 day strength is achieved for the segment. Under no circumstances shall the concrete surfaces be allowed to dry prior to curing compound application. Upon completion of the curing period (attaining 28 day strength) the segments may be shipped for erection.

Curing compound delivered to the job in drums shall be in the manufacturer's original container, labeled with the manufacturer's name, plant location, grade designation of compound, lot number and quantity. Curing compound delivered in bulk shall be supplied from and delivered to storage tanks designed to provide thorough agitation by means of compressed air. Thorough agitation shall be performed prior to shipment from manufacturer's plant and prior to use at job site.

Membrane curing compound shall be mixed with a mechanically operated mixer immediately before each use to provide uniform consistency. Application shall be in accordance with the manufacturer's recommendations, subject to the rate of application specified herein. The rate of application for membrane curing compound shall be at least one gallon per 150 square feet. If a surface is dry after stripping forms, the concrete shall immediately be thoroughly wet with water and the curing compound applied just as the surface film of water disappears. If curing compound is to be applied by spraying, the sprayer shall be compressor driven and of sufficient size to provide an even uniformed mist coating.

Standby equipment shall be required in case of mechanical failure. Hand held, pump-up sprayers shall be permitted for standby equipment. However, the hand held pump-up sprayers shall not be used except in case of mechanical failure. The membrane curing compound covering shall be continuous, flexible and without defects. Failure to comply with these requirements shall result in suspension of further concrete placements until proper control is re-established.

Curing compound shall be applied to create a uniform appearance from one segment to the next. If it is determined by the Design-Builder's Engineer of Record that the curing compound creates a visual difference in the color of the segments the exterior surfaces shall be lightly sandblasted to remove the color variation. All surface treatment resulting from an inconsistency in concrete color, shall performed by the Design-Builder (and Precaster) with no additional compensation.

H. Removal of Forms

Weight supporting forms shall remain in-place until the concrete has reached the compressive strength specified for form removal. For precast segments, constructed as shown in the Contract Documents without design modifications, this strength shall be at least 2,500 psi, or as directed by the Design-Builder's Engineer of Record.

Test cylinders, made and cured in the same manner as the segment, to confirm the form release strength prior to removal of forms. With Design-Builder Engineer's approval, a strength curve chart may be established to determine the time necessary for achieving the required form release strength, in accordance with the specifications for form removal.

Prior to lowering or removal of the wing forms, top transverse prestressing tendons shall be partially or fully stressed as indicated in the AFC Plans or approved Shop Drawings. Otherwise, transverse tendons shall not be stressed until after the segment has been used for the match-cast.

Care shall be exercised in removing the forms, separating the new and match-cast segments and separating the new segment from the bulkhead in order to prevent spalling and chipping of the concrete. Notify the Design-Builder Engineer of Record of any damage which occurs and repair

in an approved manner.

Prior to moving a segment from its as-cast position, erection marks identifying its location in the structure and order in the erection sequence shall be affixed to the inside of the segment.

1. Finished Surfaces of Concrete Segments

   All surfaces of precast segments and components, except the roadway surface of superstructure segment, shall receive a Class 1, Ordinary Surface Finish as described in Section 404.07 of the VDOT Standard Specifications.

I. Test Samples

Test samples shall be in accordance with FDOT Specifications for 452-6.9 Test Samples, as modified by the following:

Test samples and testing for compressive strength of concrete on each precast segment and field closure joint, shall be made by the Precaster to ensure adequate strength of these components at various stages of their manufacture and assembly. Test cylinders shall be made from concrete representative of that used to cast the structural component, in accordance with the applicable portion of Section 217 of the 2016 VDOT Standard Specifications.

Test cylinders shall be made for the following conditions:

1. Prior to release of prestressing of components which are to be pre-tensioned.
2. Prior to form release and/or moving the components to storage
3. Prior to post-tensioning transverse tendons if the component is less than 28 days old.
4. Prior to placing a component into position in the structure and/or stressing of longitudinal post-tensioning tendons if the component is less than 28 days old.

The test specimens for precast segments shall be stored in or on the segment or on a rack, in a like condition representative of the curing conditions to which the segment is exposed. The Precaster shall provide sufficient specimens for the proposed method for casting, transporting, and erecting the various components to allow for additional tests as necessary and shall maintain complete records of all testing.

J. Age at Erection

Unless otherwise approved by the Design-Builder's Engineer of Record, precast components shall be at least 14 days old prior to incorporation into the structure.

K. Casting Tolerances

Casting tolerances shall be in accordance with FDOT Specification 452-6.11 Tolerances, as modified by the following:

Control dimensions from segment to segment, including cast-in-place segments, shall be adjusted so as to compensate for any deviations within a single segment or series of segments so that the overall dimensions of each completed span shall conform to the dimensions shown in the Contract Documents and allowed by this section. If a check of two segments of any span (selected at random by the Design-Builder's Engineer of Record) shows that these tolerances are exceeded, the Design-Builder shall implement appropriate corrective action to the satisfaction of the Design-Builder's Engineer of Record.

L. Bridge Deck Riding Surface Profile Requirements

Upon completion of the superstructure erection, the bridge deck riding surface shall be evaluated in accordance with the Special Provision for Bridge Deck Rideability. After the profile of the top deck riding surface has been accepted by the Design-Builder's Engineer of Record, the Design-Builder shall groove the deck according to Section 404.07f of the 2016 VDOT Road and Bridge Specifications. Installation of expansion joint devices shall not proceed until the deck surface profile requirements have been met and accepted by the Design-Builder's Engineer of Record.

Proposals for any temporary filling of expansion joint block-outs, to facilitate grinding of the deck, shall be submitted to the Design-Builder's Engineer of Record for review and approval.

M. Damaged or Defective Segments

1. General

Isolated defects are imperfections or damage that may occur randomly and infrequently. Recurring defects are imperfections or damages of the same general type and nature, which continue to be found in the same general location of the segments at an unacceptable frequency, as determined by the Design-Builder's Engineer of Record.

As a minimum, the first five segments cast shall be jointly inspected by the Design-Builder's Engineer of Record, the Precaster, the Design-Builder and the Design-Builder's Engineer of Record at the following hold points:

a. after casting,

b. after moving to storage from the casting machine,

c. before erection, and

d. after erection.

All segment defects shall be identified and categorized during these inspections. The Precaster, Design-Builder, and Design-Builder's Engineer of Record shall examine the defects and propose to the Design-Builder's Engineer of Record, in writing:

a. The measures to be taken to prevent recurring defects in future segments.

b. The method of repair of all defects discovered as a result of the inspection as required herein.

If recurring defects continue following implementation of preventive measures, or are detected at any time during the construction, the Design-Builder's Engineer of Record shall instruct the Design-Builder, in writing, to cease operations producing such defective segments.

The Precaster, Design-Builder and Design-Builder's Engineer of Record shall examine the defects and propose to the Design-Builder's Engineer of Record, in writing: (1) measures to be taken to prevent recurring defects in future segments, and (2) the method of repairing all defects discovered as a result of the inspection as required herein.

2. Classification of Damage or Defects:

The Design-Builder's Engineer of Record shall determine what constitutes damage or defect, whether the damage or defect is isolated or recurring, and shall categorize it according to the following:

a. Cosmetic: Cosmetic defects or damages are those which do not affect the ability of the segment to resist construction or service loads or reduce the life expectancy of the structure. This category includes superficial discontinuities such as non-structural cracks less than 0.024" wide, small spalls or honeycombed areas less than 1" deep, entrapped air pockets (bug holes) or any defect that does not extend beyond the centerline of any reinforcing steel, or to any elements of the post-tensioning system. However, cosmetic defects of other types and causes may also be designated by the Design-Builder's Engineer of Record.

   Repair of cosmetic or superficial defects shall be made in such a manner that the aesthetics and the structural integrity of the segments are restored in accordance with this specification.

b. Structural: This includes any defect which shall impair the ability of the segment to adequately resist construction or service loads or reduce the life expectancy of the

structure. Any defect or damage that extends beyond the centerline of any reinforcing steel or into any element of the post-tensioning system or occurs in the deck portion of the segment is considered a structural defect. Examples of such defects include cracks wider than 0.025", large spalls and honeycombed areas in excess of 1" deep, major segregation or breakage of concrete. However, structural defects of other types and causes may also be designated by the Design-Builder's Engineer of Record.

The Design-Builder's Engineer of Record shall be responsible for construction load analysis, service load analyses and life expectancy determinations.

Repair of structural defects shall be such that the aesthetics and structural integrity of the segment shall be completely restored to a condition to be expected had the defect or damage had not occurred.

c. Unsatisfactory/Cause for Rejection: These are any defects or damage, as determined by the Design-Builder's Engineer of Record, that shall impair the ability of the segment to adequately resist service loads or construction loads, or shall reduce the life expectancy of the structure and which cannot be successfully repaired such that the structural integrity is completely restored.

   Any segment with an unsatisfactory defect shall be removed from the work and replaced at no additional cost.

   Damaged or defective segments shall be rejected by the Design-Builder's Engineer of Record for the following reasons:

   1. Failure of the Design-Builder's Engineer of Record to approve proposed repair procedures.
   2. Failure of the Design-Builder to execute the repair according to the approved procedure.
   3. Rejection by the Design-Builder's Engineer of Record of the proposed repair procedure or repair.
   4. Failure of the Design-Builder to provide the required certification or demonstration that the repair was successful and that the defect no longer exists, as required below.
   5. Failure of the Design-Builder to eliminate recurring defects.
   6. Determination by the Design-Builder's Engineer of Record that the work or materials used in the work does not meet other requirements of the Contract Documents and is not acceptable.
   7. More than 40% of the total contact surface of all shear keys in any single web is broken, spalled or honeycombed.
   8. More than 50% of the total contact surface of all alignment keys in any element of the slab (wing overhang, central portion between webs, etc.) is broken, spalled or honeycombed.

   Remove and dispose of segments found to be unsatisfactory and not repairable after structural review; cast new segment at no additional expense to the Department.

3. Repairs:

   Cosmetic repairs shall only be made following procedures prepared by the Design-Builder, submitted in writing to and approved by the Design-Builder's Engineer of Record. The Design-Builder's repair procedure shall identify those areas required to be repaired prior to post-tensioning, and those that shall be repaired after post-tensioning.

   Structural repairs shall be made in accordance with this Specification or by following procedures prepared by the Design-Builder. The repair procedure shall be signed and sealed by the Design-Builder's Engineer of Record and shall be submitted to the Design-

Builder's Engineer of Record for review and approval. The proposal shall include the following minimum information:

a. A detailed description and sketch or picture of the defect.

b. The magnitude and type of the most critical construction loading condition to which the defective area shall be subjected.

c. Detailed reinforcement requirements, material types, surface treatments, curing methods and repair procedures proposed. The procedure shall clearly indicate those areas required to be repaired before erection, and those areas to be repaired after erection.

d. The non-destructive testing method and procedure by which the Design-Builder shall demonstrate that the defect no longer exists and the segment has been restored to a condition to be expected had the defect or damage not occurred. In lieu of physical demonstration, on a case-by-case basis, the Contractor may be allowed to substitute a written certification by the Design-Builder's Engineer of Record that the repair has been performed satisfactorily and that the defect no longer exists.

4. Repairs to Shear Keys: If more than 20 percent of the shear keys in a web have been damaged, the Precaster, Erector, and Design-Builder shall advise the Design-Builder's Engineer of Record. The Design-Builder's Engineer of Record shall make a structural assessment and shall advise on an appropriate course of action. When 20 percent, but less than 40 percent, of the shear keys in a web have been damaged (broken, spalled or honeycombed) such that they cannot effectively transfer the shear across the joint, as determined by the Design-Builder's Engineer of Record, then the damaged shear keys shall be repaired in the following manner:

   a. Grind the damaged areas to produce a cylindrical depression into sound concrete to a depth and width approximately equal to the shear key dimensions,

   b. Complete necessary repairs to shear keys damaged at the casting site prior to shipping the segment to the erection site.

   c. After erection of the segments adjacent to the damaged keys and prior to erection of additional segments, carefully pack the voids left by the depressions with an epoxy mortar as approved by the Design-Builder's Engineer of Record.

   d. After the repair has been completed and has obtained a minimum compressive strength of 2500 PSI, the final prestressing force may be applied across the joint.

   e. With the Design-Builder Engineer of Record's approval, an alternate method of repair may be used.

5. Procedures for Repair and Patching of Segments:

   a. Deep Voids in Webs, Slabs or Walls of the Segment: Void depths greater than 2" (but less than one-half of the local section thickness) and with a surface area greater than 6 square inches shall be categorized as "Structural Repairs" and the repair procedure shall be as follows.

      Saw cut (at 45 degrees creating a "key" type of repair) the perimeter of the affected area to a depth of at least ½". Overcuts are not allowed. Chip away all partially consolidated material until sound concrete is encountered. If reinforcement passes through the void, expose the full diameter plus ½". The exposed portions of rebar shall be cleaned until they are free of concrete. If dirt, oil or paint is present, it shall be removed by 3,000 psi water blasting or sand blasting. Remove all other debris with compressed air. Parent concrete shall be in a saturated surface dry condition without any standing water prior to placement of patching concrete.

      Attach wood or steel forms as necessary to contain the patching concrete. Coat all surfaces of the void with suitable material, as approved by the Design-Builder's Engineer of Record. Fill the void with concrete of the same mix design as the

segment, cover and allow to cure.

Finish the patched area to match the surrounding concrete.

b. Shallow Voids (less than the cover): Voids shallower than the cover depth and smaller than 6 square inches in surface area are categorized as “Cosmetic” Repairs. The repair procedure shall be as follows.

Saw cut (at 45 degrees creating a “key” type of repair) the perimeter of the affected area to a depth of at least ½”. Overcuts are not allowed. Chip away all partially consolidated material until sound concrete is encountered. If dirt, oil or paint is present, it shall be removed by 3,000 psi water blasting or sand blasting.

Remove all other debris with compressed air. Parent concrete shall be in a saturated surface dry condition without any standing water, or prepared as per the recommendations of the manufacturer of the patching material. Fill the void with no sag mortar (approved by the Design-Builder’s Engineer of Record) and as per the recommendations of the manufacturer.

Finish the patched area to match the existing concrete.

c. Voids on a Match Cast Face (or in Shear Keys): Depending upon the size of the void, either a. or b. above shall be used. However, if approved by the Design-Builder’s Engineer of Record and these repairs are performed at the casting yard, the patch shall be witnessed by a representative of the Design-Builder’s Engineer of Record and held back by ½” from the match cast face. After erection, the resulting void shall be patched in the field.

d. Cracks: Cracks are classified as Structural or Non-Structural. Structural cracks are those induced by external forces that produce internal stresses exceeding the tensile strength of the concrete. Nonstructural cracks are those that appear as a result of component material characteristics, atmospheric effects and local constraints or shrinkage. The Precaster and Design-Builder shall notify the Design-Builder’s Engineer of Record of any cracks and the Design-Builder’s Engineer of Record shall determine the classification. No sealing or repair of structural cracks shall be made without approval in advance by the Design-Builder’s Engineer of Record.

Non-structural cracks shall be treated as follows:

Cracks less than 0.006" wide shall be sealed with a penetrant sealer. Cracks from 0.006" to 0.024" wide shall be injected with epoxy according to the procedure below. Cracks wider than 0.025" shall be investigated further.

Procedure for Epoxy Injection:

#1. Drill holes and install plastic injection ports at approximately 8” on center.

#2. Seal crack between ports with Sikadur-32 epoxy or other similar material approved by the Design-Builder’s Engineer of Record.

#3. Inject crack with a hand pump using Dayton Superior, Sure Inject J-56 epoxy or other similar material approved by the Design-Builder’s Engineer of Record. Begin injection from the lowest port and continue until the epoxy runs out of the next highest port. Cap the port and then move to the next port and repeat the process until the entire crack is filled.

e. Entrapped Air Pockets (Bug Holes). These are considered “Cosmetic”. The exterior surface of the segment, except the top deck shall have all entrapped air pockets filled and the surface sack rubbed with burlap. No entrapped air pockets on the match cast faces or the inside (void) surfaces shall be filled or sacked.

f. Other Situations. Situations other than those mentioned above shall be analyzed on a case-by-case basis and repaired only after approval by the Design-Builder’s Engineer of

Record.

VIII. PRECAST SEGMENT HANDLING, STORAGE AND SHIPMENT

A. Precast Segment Handling, Storage, and Shipment shall be in accordance with FDOT Specification 452-7 Precast Segment Handling, Storage, and Shipment, as modified by the following:

1. General: It is the intent of this project that precast segments be cast and placed into the structure with zero defects.

   Lifting devices incorporated into any cantilever segment shall be adequate to distribute the handling and erection stresses so as not to damage the segment.

   The Precaster and Design-Builder shall inspect each segment visually for evidence of damage or defect before, during and after critical operations and as often as necessary to ensure adequate quality control. The Precaster and Design-Builder shall immediately bring all such evidence of damage or defect to the attention of the Design-Builder's Engineer of Record. The extent and frequency of inspection by the Engineer of Record for quality assurance is the Design-Builder's Engineer or Record's prerogative, except as otherwise outlined herein. Segments may be inspected at any time during construction as deemed necessary by the Design-Builder's Engineer of Record to monitor compliance with this specification.

2. Storage and Shipping: Superstructure segments shall be stored level in the deck upright position and shall be firmly supported on a symmetrical three point bearing system under the webs at approved locations unless otherwise noted in the Contract Documents. Such bearing system shall not introduce twist under self-weight of the segment. The storage area of the segments shall be sufficiently stable to prevent differential settlement of the segment supports.

   Superstructure segments have not been specifically designed to be stacked vertically in a system where forces are induced in the lower segment. The Precaster and Design-Builder may request to vertically stack segments in the deck upright position provided he submits complete details of the stacking procedure substantiating that the segments shall not be damaged or distressed by such stacking. The submittal shall be signed and sealed by the Design-Builder 's Engineer of Record, who shall hold a valid license to practice professional engineering in the Commonwealth of Virginia. Stacking segments one upon another shall not be permitted without approval of the Design-Builder's Engineer of Record; and in no case shall stacking segments more than two high in a system that induces forces in the lower segments be permitted. Any evidence of damage or distress, as determined by the Design-Builder's Engineer of Record, resulting from stacking of segments shall be cause to discontinue immediately.

   Prior to shipment from the precasting yard, each segment shall be inspected for any damage. The faces of all match cast joints shall be thoroughly cleaned of laitance, bond breaking compound and any other foreign material by wire brushing, light sandblasting or water blasting. During transport segments and particularly the post-tensioning ducts, shall be capped and protected from possible contaminants including road deicing chemicals; salt water; and others that might affect the long- term durability or affect the appearance of the segments. During transport, firm support at the bearing locations noted above for support during storage shall be provided and the segments shall be fully secured against shifting. Upon arrival at the erection site, each segment shall again be inspected. If any damage has occurred during shipment, the Design-Builder's Engineer of Record shall be immediately notified. Erection of such damaged segments into the structure shall not proceed without authorization from the Design-Builder's Engineer of Record. Any damaged segments that are unsatisfactory shall be cause for rejection, per this specification.

IX. ERECTION

Erection shall be in accordance with FDOT Specification 452-8 Erection, as modified by the following:

A. Erection Of Precast Segments

The Design-Builder shall be solely responsible for design, fabrication, assembly and operation of all equipment to be used for handling and erecting segments.

Erection of segments shall not begin until the required shop drawings calculations have been reviewed and approved by the Design-Builder's Engineer of Record.

Elevations and alignment of segments shall be carefully measured at each stage of erection with instruments capable of providing the degree of accuracy necessary to assure satisfying erection tolerances. Any deviation from the table of elevations and alignment prepared by the Design-Builder shall be corrected so as to prevent accumulation of deviations using a method approved by the Design-Builder's Engineer of Record.

B. Erection Geometry Control

Erection geometry control shall be in accordance with FDOT Specification 452-8.2 Erection Geometry Control.

C. Temperature of Precast Segments with Epoxy Joints

Erection of segments shall be permitted only when the substrate temperatures of the mating surfaces are between 40°F and 105°F. Upon approval of the Design-Builder's Engineer of Record, an artificial environment may be provided to maintain the substrate temperature within the permissible limits by creating an enclosure heated by circulating warm air or by radiant heaters. Localized heating shall be avoided and the heat shall be provided in a manner that prevents surface temperatures greater than 95°F during the epoxy hardening-period. Direct flame heating of concrete shall not be permitted. The requirements of the SPECIAL PROVISION for "Epoxy Jointing of Precast Concrete Segments" shall apply.

D. Erection Tolerances for Superstructure Segments

Erection tolerances of superstructure segments shall be in accordance with FDOT Specification 452-8.3 Erection Tolerances, as modified by the following:

1. The difference in roadway elevation at the connection of two adjacent segments (measured perpendicular to the deck surface) and across closure joints shall be no greater than 1/8 inch. If there is failure to meet the tolerance, it may be required by the Design-Builder's Engineer of Record to grind the deck surface to meet the tolerance. All corrective work shall be at the Design-Builder 's expense.

2. The horizontal and vertical position of a pier segment (superstructure segment which rests on a pier) shall be within 1/4 inch of the longitudinal alignment, grade and cross-slope required by the approved erection plans. The longitudinal slope shall not vary by more than 0.005 feet in 10 feet from that required by the approved erection plans. These tolerances are for relative location of control points, not absolute location.

3. Deviations exceeding erection tolerances listed in 452-8.3 and in this specification, discovered during the match-casting operation by after-cast surveys before the matched-cast segments are separated, shall be corrected in subsequent castings. The method of correcting for such deviations shall be addressed in the casting manual or shall be submitted to the Design-Builder's Engineer of Record prior to casting the next match- cast segment.

E. Special Requirements

1. Span-by-Span and Wet Joint Erection

a. Closure Joints:

(1) Concrete: Concrete for closure joints, closure segments and filling of block-outs shall comply with the same specifications, compressive strength and criteria as the concrete in the precast segments, or as approved by the Design-Builder's Engineer

of Record. It shall be carefully placed, consolidated and cured to provide dense, uniform concrete, free from blemish. Casting, curing and finishing shall be in accordance with the Project Specifications and procedures prepared by the Design-Builder and approved by the Design-Builder's Engineer of Record. Ensure that the closure joint forms provide tolerances in accordance with the Project Specifications.

(2) Strength at Transfer (Application of Prestress): The closure concrete shall reach a minimum required strength as shown on the Contract Documents and Project Specifications prior to stressing any longitudinal post-tensioning.

(3) Span-by-Span Closures: Closures in span-by-span construction are generally at or near to the piers. These closures may be cast at any time of day. Temporary concrete blocks may be used to space the joint and to carry temporary or a minor proportion of the permanent tendon post-tensioning force, until the closure concrete has been poured and attained the required minimum strength for full post-tensioning.

b. Wet Joints shall be in accordance with FDOT Specification 452-8.4.1.2 Wet Joints.

c. Formwork shall be in accordance with FDOT Specification 452-8.4.1.3 Formwork.

2. Balanced Cantilever and Progressive Cantilever Erection:

During erection by the cantilever method, the cantilever segments, except for the last two (2) cantilever segments, are supported on the truss as shown on the erection scheme in the AFC plans or in the approved Erection Manual.

Check the alignment and elevations of the cantilevers, using two independent surveys, within one hours of sunrise on each day that segments are to be erected. Check measurements made by each survey and ensure they agree to within ¼ inches. When measurements do not agree, discontinue erection of segments until discrepancies in measurements are resolved to the satisfaction of the Design-Builder's Engineer of Record.

Accurate positioning of the first segments adjacent to the pier table is most important as it establishes the line and grade for the cantilever in each direction. These segments shall be positioned according to the final longitudinal alignment, grade and cross-slope; ensure no further erection continues until and unless these segments are properly located on the piers by the means provided. The horizontal and vertical location of the geometry control points on these segments shall be within 1/8 in. of the position required by the approved erection AFC plans or Erection Manual. Likewise, the slopes across these segments shall not exceed .003 Radians of angular deviation from the theoretical values for horizontal and vertical grades.

During erection, the Erector shall check alignments and elevations. If measured elevations and alignments deviate by more than the allowed tolerances, from those given on the approved erection plans or in the Erection Manual, the Erector shall notify the Design-Builder's Engineer of Record. Reasons for any discrepancies shall be investigated and appropriate corrective action shall be taken by the Erector at no additional cost to the Department.

a. Deformations: Deformations shall be in accordance with FDOT Specifications 452-8.4.2.1 Deformations.

b. Temperature Restrictions: Temperature restrictions shall be in accordance with FDOT Specifications 452-8.4.2.2 Temperature Restrictions, as modified by the following:

Note that a temperature differential between the top slab and remainder of the box sections shall cause the superstructure to deflect, resulting in false elevation readings and leading to erroneous elevation adjustments. Even on overcast days it is possible for a temperature differential to develop within the superstructure. To guard against false readings due to temperature differentials, readings should only be taken when all portions of the box section are stabilized at the same temperature. The Design-Builder is

expected to take precautions in devising methods to guard against these possible false readings and corresponding adjustments due to temperature differentials. To prevent false measurements, an ideal time for taking readings is within one hour of sunrise.

c. Permissible Loads on Cantilever: Permissible loads on Cantilever shall be in accordance with FDOT Specifications 452-8.4.2.3 Permissible Loads on Cantilever.

d. Span Closure Joints: For closure joints in cantilever construction, the superstructure segments adjacent to each side of the closure segment shall be aligned vertically and laterally, and shall be restrained to each other by closure devices during the construction of the closure joint. Concrete shall be placed in the closure joint at an appropriate time of day to minimize the effects of daily differential temperature variations between the top and bottom of the superstructure. The Design-Builder shall submit a plan for determining the appropriate time for casting of the closure to the Design-Builder's Engineer of Record for approval at least 60 days in advance of the casting. This plan shall define how the Erector intends to monitor the bridge deflections, temperatures and gradients so that the concrete can be placed and the finishing completed near the time of minimal thermal gradient in the cantilevers.

e. Falsework and Formwork: Falsework and Formwork: Falsework and formwork for closures pours shall be in accordance with FDOT Specification 452-8.4.2.5 Falsework and Formwork, as modified by the following:

   The formwork and release agent shall be of a type to provide the required surface finish to match that of the precast segments.

f. Measured Elevations: If measured elevations deviate from the table of elevations, the Design-Builder's Engineer of Record has the right to suspend further erection of superstructure segments until the cause of the deviation is discovered and a corrective action plan, submitted by the Design-Builder, is approved by the Design-Builder's Engineer of Record.

g. No additional expense shall be incurred by the Department and no additional time shall be granted to the Design-Builder as a result of this suspension for unacceptable erection deviation.

F. Final Clean Up

   Before final acceptance, the Design-Builder shall clean the interior of the concrete box of all rubbish, excess materials, loose concrete, dirt and debris. The interior of the box girders shall then be swept out. The final clean up shall be performed after all work on the interior of the box girders, including grouting of all tendons and utility work included in the Contract, has been completed.

G. Epoxy Jointing of Precast Segments

H. Packed Mortar Joints for Joints or Bearings

X. EQUIPMENT

Design calculations prepared under the direction of, and signed and sealed by, a Professional Engineer of Record registered in the Commonwealth of Virginia shall be submitted for any erection equipment, falsework, and other temporary construction which may be required to accomplish the work. For engineering performed by others, the Design-Builder's Engineer of Record shall not be responsible for reviewing the calculations for temporary construction, which may be required to accomplish the work.

Prior to the use of special erection equipment, the equipment shall be personally inspected by the Design-Builder 's Engineer of Record who shall certify to the Design-Builder's Engineer of Record in writing that it has been fabricated in accordance with the submitted drawings and calculations. In addition, after assembly, the Design-Builder 's Engineer of Record shall observe the equipment in

use and shall certify to the Engineer of Record in writing that it is being utilized as intended and in accordance with the submitted drawings and calculations. In each case, the Design-Builder 's Engineer of Record shall also sign and seal the letter of certification.

After the erection or installation of falsework and shoring, which requires the submittal of design calculations and shop drawings, but prior to the application of any superimposed load, the falsework shall be personally inspected by the Design-Builder's Engineer of Record who shall certify to the Design-Builder's Engineer of Record in writing that the falsework has been constructed in accordance with the materials and details shown in the submitted drawings and calculations.

For construction that affects public safety and prior to placement of any concrete, the Design-Builder's 's Engineer of Record shall certify to the Design-Builder's Engineer of Record in writing that any such temporary works have been constructed to safely withstand the superimposed loads to which it will be subjected during construction.

Prior to use of any equipment that is fabricated for the specific purpose of erecting any portion of the work included in this Project, the Design-Builder shall demonstrate by a full-scale load test that this equipment is adequate for its intended use on this project.

Observation of load testing of erection equipment, review of drawings and calculations covering erection equipment by the Design-Builder's Engineer of Record shall not be construed as any assumption by the Design-Builder's Engineer of Record of responsibility for means, methods, techniques, sequences or procedures of construction, nor on safety precautions or to a safety program thereto.

A. Span-by-Span Erection Equipment and Load Testing.

1. Brackets Supporting Truss for Span-by-Span Erection. If an erection truss is to be supported by any part of a pier, in designing support brackets, a lateral force equal to not less than ten percent of the weight of the truss plus the weight of segments to be placed on the truss shall be applied longitudinally. Also, these brackets shall have a secondary means of vertical support that does not rely on friction between the support and the pier. This secondary means of support may be a shear key in the pier that provides a positive mechanism of load transfer.

2. Load Testing Truss for Span-by-Span Erection. Prior to using an erection truss on the project, the Design-Builder shall demonstrate the capability of the truss to perform as intended by a load test.

   The load test procedure shall include:

   a. Constructing two (2) temporary piers approximately the size and shape of the upper portion of the permanent piers which are to be constructed on the project. The elevation at the top of these temporary piers shall be such that a sufficient distance is provided between the ground and truss after placement of the truss on these supports. The temporary piers may be constructed on foundations for the permanent structure.

   b. Assembling the truss supported on the piers in the same manner and using the same supporting devices (beams, brackets, etc.) as will be used on the project.

   c. Loading the truss with the segments it will support during erection of the bridge plus an additional load equal to the 25 percent of the weight of the segments.

   d. Measurement of vertical displacement at mid-span and horizontal movement at support points.

      The Design-Builder shall give the Design-Builder's Engineer of Record written notice at least 72 hours in advance of the time at which test loading of the truss shall be applied to the erection equipment.

      The Design-Builder may elect to perform the load test on the permanent structure, however, he shall submit calculations signed and sealed by, a Professional Engineer

registered in the state of Virginia that prove that the existing structure can support the loads introduced by the test. If any damage is caused to the permanent structure during the load test, the Design-Builder shall be responsible to repair the permanent structure as directed by the Design-Builder's Engineer of Record and at no cost to the Department.

XI. BARRIER AND MEDIAN SETTING

A. Barrier and median setting shall be in accordance with FDOT Specification 452-9 Barrier and Median Setting.

XII. BRIDGE DECK SURFACE

A. Bridge deck surface shall be in accordance with IIM-S&B-91, the 2016 VDOT Road and Bridge Specifications, and the Special Provision for Bridge Deck Rideability.

XIII. WATERTIGHT DECKS

A. Prior to hydrodemolition for placement of overlay, check all segment joints, closure joints and deck hole repairs to assure every location is watertight; repair all crack locations in accordance with 2016 VDOT Road and Bridge Specification Section 412.

B. After hydrodemolition, re-check all segment joints, closure joints and deck hole repairs to assure every location is watertight; if there are any leaks, additional repairs shall be in accordance with 2016 VDOT Road and Bridge Specification Section 412. Repairs will be considered acceptable if there is no leakage after ponding of water for one hour.

C. After repairs, overlay shall be applied per IIM-S&B-91.

XIV. MEASUREMENT AND PAYMENT

All cost for precast superstructure concrete, including cast-in-place concrete for closure joints and closure segments shall be as necessary to complete the work as specified in the AFC Plans and in accordance with Section 109 of the VDOT Standard Specifications. Payment shall be full compensation for manufacturing and assembling the precast segments complete in place in the bridge, including filling all concrete block-outs, for supply and application of epoxy bonding agent as required, for embedded prestressing ducts and anchorage hardware, for segment access details, cast-in-place joints, dry packing, for sealing the match cast joints, and all other materials, testing, and all the equipment, tools, forms, labor and incidental items required to complete the work.

This work is integral to the relevant work package that is part of the lump sum contract price. There is no separate payment for this work. If an item does not satisfy the criteria stated herein, and in the event the Department accepts this item, the Quality Assurance Manager (QAM) will document the basis of acceptance. The Design Builder and the Department will negotiate an appropriate adjustment in the contract price, warranty, or other specific requirements or adjustments that are appropriate.

VIRGINIA DEPARTMENT OF TRANSPORTATION
SPECIAL PROVISION FOR
ACOUSTIC EMISSION MONITORING SYSTEM FOR DETECTING AND LOCATING WIRE BREAKS IN STRANDS IN TENDONS
for Design-Build and PPTA Contracts

December 9, 2016

I. DESCRIPTION

This work shall consist of furnishing and installing an Acoustic Emissions Bridge Monitoring System in accordance with the contract documents and as directed by the Design-Builder Engineer of Record. The system shall be sufficiently robust to be able to identify a single wire break in any span and locate the specific location along each element.

II. MATERIALS

A. Acoustic Emissions Bridge Monitoring System

The acoustic emissions system shall be digital with resolution that can distinguish between a wire-break and background noise. The system must be able to provide real-time acoustic emissions feature extraction at 5 Million samples per second (MSPS) or faster, waveform capture, and parametric channel acquisition simultaneously using on-board digital signal processing. The following features shall be extracted and recorded for wire break classification: amplitude, duration, rise time, absolute energy, average signal level (ASL), Peak Frequency, Frequency Centroid, and Partial Powers. The system shall have digital I/O ports for input control and alarm output. The system shall be able to define acoustic emission hit based on hit definition time and hit lockout time to further reduce background noise and enhance positive identification of wire breaks. System performance specifications should be published and commercially available on the vendor's website. Performance shall be equal to the DaisAE system.

Unless noted all metal parts of the installation shall be of corrosion-resistant material. The system housing shall have a National Electrical Manufacturers Association (NEMA) 4 rating, weighing less than twenty pounds, to be mounted inside the bridge, away from any sources of water, with an operating temperature range from -10° to 150° F. It shall have an independent not multiplexed) acoustic emissions channels for each sensor. The acoustic emissions system shall have additional parametric input channels built in for other 1-10 volt sensors such as temperature and corrosion. The system shall have at least 4 high-pass and 4 low-pass software selectable analog filters on each channel. Each channel shall auto test the sensor associated with it. The system shall be expandable up to 40 percent additional channels by means of daisy chaining the AE modules together, as to have a single cable system for ease of maintenance and installation.

The system's dynamic range shall be ≥70 dB to detect large amplitude wire breaks as well as small-localized concrete cracking and corrosion without changing gain settings. The background noise amplitude of the system shall be <24 dB for maximum sensitivity.

1. Software Features

The acoustic emission software shall be a Windows based data acquisition, graphing, and replay program that can employ all the functionality of the Windows Operating System. The software shall process and display acoustic emission features and waveforms in real-time, and have the capability to store and reply. The software shall be able to replay and analyze all previously saved acoustic emission data files.

The software shall allow the selection of bridge elements for setup, and viewing, and incorporate attenuation profiling in order to view a sensor coverage map and to provide source amplitude information. It shall have the capability to generate a linear location graph automatically and locate the acoustic emission in three dimensions.

The software shall send automatic alarm emails to VDOT District Structure & Bridge Office if a wire break occurs or if a sensor cable is cut or damaged, and shall grade the wire breaks. There shall be a web-based interface, and monitoring shall include storage/recording of all events.

(a) Acoustic Emissions Transducer Units Dynamic Requirements
Integral, Low Noise, Filtered 26 dB Preamplifier drives
Sufficient length of cable for operation
Dynamic Peak Sensitivity 106 dB
Operating Frequency Range 15-40 KHz
Resonant Frequency 28 KHz
Directionality ±1.5 dB

(b) Environmental Requirements
Temperature Range -10 to 150°F
Humidity Range 0 to 100 per cent
Shock Limit 500 g
Shielded Crystal

(c) Physical Requirements
Dimensions 0.812" Dia. x 1.06" h (not including coating)
Case Material Stainless Steel and coated
Face Material Ceramic

(d) Electrical Requirements
Gain >25 dB

(e) Power Requirements
4-7 volts DC at 5 mA
Operating/Max Current 5/35 mA
Noise (RMS RTI) < 3 µvolts

(f) Data Retrieval System

A Data Retrieval System shall include a 4G cellular modem, at least 4 USB connections, an output monitor, a remote monitoring website, at least a 500 GB internal hard drive, a system that can be run independently or remotely.

(g) Electrical Power Supply

Electrical Power Supply shall conform to these specifications: 85-260 volts AC or 9-28 volts DC, surge protected, power consumption-12Watt + 0.025W per sensor. The electrical system in the bridges should be used if it can supply power to the lights as well as the acoustic emission system.

Battery power shall last at least 48 hours. A watch-dog timer on the Modem shall be incorporated to remotely reset the system should power be discontinued; emails shall be sent to VDOT District Structure & Bridge Engineer, or designee, to alert of the power outage.

The monitoring system shall incorporate cellular notification for the District Structure & Bridge Engineer, or designee, at the time of an acoustic event.

(h) Spare Parts

The following spare parts will be provided to VDOT as part of this item: one modem, two acoustic emissions sensors, eight acoustic emissions channel modules and four sensor cables.

III. CONSTRUCTION DETAILS

A. Performance

This system shall be capable of post tensioning wire break monitoring. It shall provide e-mail alerts in real time when a post tension strand break is detected in any monitored bridge element. The system shall be able to detect which element experienced the wire break and display the approximate location on the bridge element. The system shall be constructed to emphasize monitoring of wire breaks within 10-ft of anchorage locations. Wire breaks and all other irregularities in the bridges' acoustic emissions shall be immediately reported to the designated VDOT location and personnel.

1. Pre-Installation Field Testing

   A field attenuation test to determine sensor coverage shall be performed in accordance with ASTM E2374, "Standard Guide for Acoustic Emission System Performance Verification".

2. Installation

   The acoustic emissions system shall be installed in accordance with the manufacturer's instructions and consent including: electronic equipment packages, acoustic emissions transducers and the acoustic emissions sensors including their housing, brackets, wireless cellular antenna, electrical wiring, materials for 110 volt AC power at the master station, and all other materials required to complete the work. A minimum of two (2) sensors in each span shall be placed near the diagonally opposite inside corners of tendon anchorage bulkheads. Additional sensors shall be installed, as needed, to detect potential wire breaks that would not be detected by installing two (2) sensors per span. The Design-Builder shall test the system, and add sensors until the system meets all requirements, to ensure initial and continued operability. The system shall meet all state and local electrical codes and the electrical power wiring shall be installed by a licensed electrician.

3. Training and Procedure Manuals

   The manufacturer shall conduct a one day on-site training to instruct VDOT personnel in operation of the system. A manual that illustrates and explains the acoustic emission system, provides the operating and troubleshooting procedures and provides a source for replacement parts shall be supplied as part of the training.

IV. MEASUREMENT AND PAYMENT

The lump sum price bid shall include the cost of furnishing all labor, materials, and equipment necessary to satisfactorily complete the work.

This work is integral to the relevant work package that is part of the lump sum contract price. There is no separate payment for this work. If an item does not satisfy the criteria stated herein, and in the event the Department accepts this item, the Quality Assurance Manager (QAM) will document the basis of acceptance. The Design Builder and the Department will negotiate an appropriate adjustment in the contract price, warranty, or other specific requirements or adjustments that are appropriate.

VIRGINIA DEPARTMENT OF TRANSPORTATION
SPECIAL PROVISION COPIED NOTE FOR
HIGH PERFORMANCE CONCRETE
for Design-Build and PPTA Contracts

December 9, 2016

SECTION 217 – HYDRAULIC CEMENT CONCRETE of the Specifications is amended as follows:

Section 217.06 – Classification of Concrete Mixtures Table II-17 is amended as follows for Class A5 concrete:

Post-tensioned Superstructure Concrete shall be a minimum 6,000 psi and a maximum 10,000 psi in accordance with the requirements of Class A5 concrete listed in Section 217.06, Table II-17, except that the permeability at 28 days (VTM 112) shall be less than 1000 coulombs.

Section 217.07 – Proportioning of Concrete Mixes is amended to add the following:

At least two trial batches (each a minimum 3 cubic yards) shall be made using VDOT approved materials under similar conditions as those to be experienced during production and with the production equipment to be used for the project. Preparation and testing of samples shall be performed by an AMRL/CCRL accredited laboratory for the following tests: ASTM C31, ASTM C39, ASTM C1202, ASTM C231 (and if lightweight concrete is specified ASTM C173), ASTM C138 (if specified) and ASTM C143. A report, including test results (ASTM C39, ASTM C231 (or ASTM C173 if lightweight concrete is specified), ASTM C138 (if specified), ASTM C143 and VTM 112) demonstrating that the concrete meets the specifications, shall be provided to the VDOT Project Manager for approval for each concrete mix design at least 45 days prior to the delivery of the specified concrete to the project.

Class A5 pre-packaged concrete shall be from the VDOT Materials Division's Approved List No. 31, Table III, except that the set time shall be at least one hour.

Formulated latex modifier shall not be used.

12-09-16 (SPCN)

VIRGINIA DEPARTMENT OF TRANSPORTATION
SPECIAL PROVISION FOR
EPOXY JOINTING OF PRECAST CONCRETE SEGMENTS
for Design-Build and PPTA Contracts

December 9, 2016

I. DESCRIPTION

The work consists of furnishing, mixing and applying a two component epoxy bonding system to the match cast faces of all joints between precast concrete superstructure segments in accordance with the Contract Documents.

The work covered by this section also includes temporary post-tensioning across a joint, if required, by provisions contained elsewhere in this SPECIAL PROVISION.

This SPECIAL PROVISION covers use of normal setting epoxy bonding agents and slow-setting epoxy bonding agents.

In its workable state, the epoxy bonding agent shall provide lubrication along the keys as the precast concrete segments are brought together. In its hardened state, the epoxy bonding agent shall provide a watertight seal between precast concrete segments.

This special provision incorporates by reference the:

- Florida Department of Transportation Standard Specifications for Road and Bridge Construction Specification Section 453, including its referenced specifications.

  http://www.fdot.gov/programmanagement/Implemented/SpecBooks/January2016/JANUARY2016BK.shtm

- PTI/ASBI M50.3-12: Guide Specification for Grouted Post-Tensioning

  http://www.post-tensioning.org/store/PTI_M50.3-12:_Guide_Specification_for_Grouted_PT_

In the event that a conflict(s) exists between this Special Provision and the above referenced specifications, the following order of precedence shall be followed:

- This Special Provision shall govern over the PTI/ASBI and FDOT specifications.
- The FDOT specification and its references shall govern over the PTI/ASBI specification.

II. ACCEPTANCE OF EPOXY BONDING SYSTEM

Use only epoxy systems that are on the FDOT Approved Product List (APL). Design-Builders seeking evaluation of products not found on the FDOT Approved Product List must submit independent lab data demonstrating conformance to this specification to the Department for review and approval prior to use on the project.

Provide a manufacturer's certification which confirms that each manufactured lot meets the requirements of this Specification and is the same as the material listed on the FDOT APL to the Engineer of Record.

III. QUALIFICATIONS OF DESIGN-BUILDER'S PERSONNEL

Qualifications of Design-Builder's personnel shall be in accordance with Special Provision for Supplemental Post Tensioning Personnel Qualifications.

IV. MATERIALS

Materials shall be in accordance with FDOT Specification 453-4 Materials, as modified by the following:

A. General

Epoxy-bonding agents shall comply with ASTM C 881-99, Types VI and VII, Grade 3.

B. Formulation for Temperature Range

Formulation for Temperature Range shall be in accordance with FDOT Specification 453-4, as modified by the following:

Identify each of these formulations as either normal-set or slow-set epoxies as defined by the Contact Time.

C. Samples for Testing and Certified Test Reports

For quality control purposes, for each manufactured lot, furnish to the Design-Builder's Engineer of Record certified test reports from an approved testing laboratory indicating that the epoxy bonding agent material has passed all required tests. Upon request, also furnish to the Design-Builder's Engineer of Record, samples of the epoxy bonding agent material for independent testing.

D. Physical Requirements and Qualification Tests

Epoxy bonding agents proportioned as designated by the Manufacturer and mixed in accordance with the manufacturer's recommendations shall meet the physical requirements given below. The components of the epoxy-bonding agent shall be conditioned to the temperature at which testing is to be done prior to mixing the test specimen.

1. Consistency (Sag-Flow). This property determines application workability of the epoxy-bonding agent. Mixed epoxy bonding agent shall be tested and shall conform to the prescribed consistency in accordance with ASTM C 881 at the maximum temperature of the temperature range for the formulation being tested. The average sag-flow cannot exceed 1/4 inch.

2. Gel Time. This property is the period of time during which the epoxy-bonding agent remains workable in the mixing container and during which it shall be applied to the match cast joint surfaces.

   The mixed epoxy bonding agent shall be tested and shall conform to the prescribed gel time in accordance with ASTM C 881 at the maximum temperature of the temperature range for the formulation being tested. The gel-time shall be at least 30 minutes.

3. Contact Time (open Time) and Contact Strength. This property is the workable period of time allowable between mixing of the components of the epoxy bonding agent, application of the epoxy to the joint face(s), and joining the segments under an approximately uniform pressure of 40 psi.

   The contact time (open time) of the mixed epoxy-bonding agent shall be:

Normal-Set Epoxy	60 Minutes, Minimum
Slow-Set Epoxy	8 Hours, Minimum

   The above contact time (open time) shall be deemed acceptable if a slant cylinder test specimen, prepared and tested in accordance with the conditions below, sustains the following stress (contact strength) on the slant plane calculated as the axial (vertical) load divided by the area of the slant ellipse:

Normal-Set Epoxy	1,000 psi at 48 hours after joining.
Slow-Set Epoxy	1,000 psi at 14 days after joining.

   The cement mortar / concrete material for the slant-cylinder test shall have a compressive strength of at least 4,500 psi at 28 days when tested to ASTM C 39. The slant-cylinder test procedure shall be in accordance with ASTM C 882 with the following modifications.

   (a) Prior to the application of the epoxy-bonding agent, soak the concrete specimens in water for 24 hours at the maximum temperature of the application temperature range for the formulation being tested.

(b) Bring the two components of the epoxy-bonding agent to the maximum of the application temperature for the formulation being tested before being mixed and applied to the specimens.

(c) Dry the sloped surfaces of the concrete specimens for ten minutes on an absorbent material. Immediately after drying, apply the epoxy-bonding agent to both sloped surfaces to a thickness of 1/16 inch.

(d) Delay joining of the sloped surfaces for the following period of time, measured from the time the epoxy was mixed:

Normal-Set Epoxy	60 Minutes
Slow-Set Epoxy	8 Hours

(e) During the period between mixing of the epoxy and joining of the sloped surfaces, uncover and maintain the specimens at the maximum temperature of the application range for the formulation tested.

(f) Assemble the specimens together and cure at the maximum temperature of the formulation range (viz. 48 hours for normal set and 14 days for slow set epoxies) prior to testing.

NOTE: For slow-set epoxy, make an additional test specimen and test to failure at 24 hours. The formulation of the slow set epoxy is acceptable only if the epoxy-bonding agent exhibits a brittle break.

4. Compressive Yield Strength: This property is the compressive yield strength of the epoxy- bonding agent at various ages. Comparison of this property between batches is an indication of the level of quality control achieved in manufacturing the material.

The required compressive yield strength of the epoxy-bonding agent shall be in accordance with ASTM C 881 when tested using ASTM Method D 695 with the following conditions:

(a) Pour epoxy bonding agent into the mold for forming specimens within ten minutes after starting mixing of the components.

(b) Cure the specimens at the minimum temperature of the formulation range for a period of 24 hours.

(c) The compressive yield strength shall be at least:

Normal-Set Epoxy	2,000 psi at 24 hours
	6,000 psi or specified design compressive strength of concrete at 48 Hours
Slow-Set Epoxy	1,000 psi at 36 Hours and
	2,000 psi at 72 Hours
	Greater of 6,000 psi or specified design compressive strength of concrete at 14 Days

5. Bond Strength: This property is the strength of epoxy bonding agent as it bonds with concrete. Bond strength shall be in accordance with ASTM C 881 and the test is conducted on a slant cylinder according to ASTM C 882 with the following modifications.

(a) The test cylinder of concrete shall have a compressive strength of at least 6,000 psi at seven days age.

(b) Prepare the specimens the same as for item 3 (contact time and contact strength) above.

The required bond strength of the epoxy-concrete interface - calculated as the axial (vertical) load divided by the area of the slant ellipse - shall be at least:

Normal-Set Epoxy	1,000 psi at 48 Hours

Slow-Set Epoxy 1,000 psi at 14 Days

6. Heat Deflection Temperature of Epoxy Bonding Agent: The heat deflection temperature shall be in accordance with ASTM C 881 - i.e. 120ºF at 14 days - when the specimen is tested using ASTM Method D 648.

7. Alternative Preparation of Slant Cylinder Specimens: Test specimens of concrete may be prepared in standard 6 by 12 inch cylinder molds to have a height at midpoint of 6 inches and an upper surface with a slope at 30 degrees (±1 degree) with the vertical. The upper and lower portions of the specimen with the slant surfaces may be formed through the use of an elliptical insert or by sawing a full sized 6 by 12 inch cylinder. If desired, 3 by 6 inch or 4 by 8 inch specimens may be used.

   The sloped surfaces shall be free from bumps, edges or high spots over 1/32 inch in magnitude and the sloped surfaces cannot deviate from plane by more than 1/8 inch. After moist curing and after the concrete attains the required compressive strength, prepare slant surfaces by light sandblasting or stoning and washing with clean water.

   After the concrete halves have been joined with epoxy bonding agent according to the required conditions for the property being tested, test the joined specimen in accordance with ASTM C 39 (Test method for Compressive Strength of Cylindrical Concrete Specimens).

E. Epoxy Bonding Material Qualification Tests, Quality Control, Quality Assurance and Certification of Supply

1. Qualification Tests: Provide the results of Qualification Tests for each formulation temperature range of the epoxy-bonding agent from an independent laboratory engaged by the Manufacturer and approved by the Quality Assurance Manager (QAM). Independent qualification tests are required for each Manufacturer and formulation temperature range of epoxy-bonding agent. An epoxy-bonding agent, or formulation, shall not be accepted unless it meets the Qualification Tests. Qualification Tests from previous applications of the same epoxy formulations may be accepted by the QAM. However, make and supply only new material for this project (i.e. old stock cannot be used.).

2. Quality Control: For Quality Control, provide the QAM with certified copies of reports of routine tests by the Manufacturer for each lot of epoxy bonding agent supplied to the project. Routine, quality control tests shall be made for consistency (sag-flow), gel-time, and compressive yield strength for each lot.

3. Quality Assurance: For Quality Assurance, provide the QAM with certified copies of reports of repeat Qualification Tests made by an independent laboratory engaged by the Manufacturer and approved by the QAM. Only one repeat Qualification Test shall be required for each formulation for each Manufacturer in addition to the initial Qualification Tests - providing that the material demonstrates good performance in use and application on site and that each lot meets the Quality Control requirements. If performance fails to satisfy job-site use, then the QAM may require additional Qualification Tests, or other approved action by the Contractor, to maintain the quality.

V. CONSTRUCTION REQUIREMENTS

Construction requirements shall be in accordance with FDOT Specification 453-5 Construction Requirements, as modified by the following:

A. General

Apply an epoxy bonding agent meeting the requirements of this SPECIAL PROVISION to joining surfaces of all precast concrete match-cast segments through which embedded post-tensioning ducts pass, unless otherwise specified in the Contract Documents.

Prior to the manufacture of epoxy for the project, a site meeting shall be held with representatives from the Design-Builder's Engineer of Record, Design-Builder and epoxy Manufacturer, to discuss selection of the proper formulations, the appropriate temperature ranges, storage and handling, mixing and application of the epoxy.

B. Qualifications of Design-Builder's Personnel

The work of mixing, handling and applying the epoxy-bonding agent shall be under the direct supervision of a person who has extensive knowledge of and experience in the use of this material. The Design-Builder's Engineer of Record may require the Design-Builder to arrange for a technical representative of the manufacturer to be at the site as an advisor at the beginning of this operation.

Ensure that all personnel who shall be working with the epoxy-bonding agent are thoroughly familiar with the safety precautions necessary when handling this material.

C. Shimming of Joints

Under normal circumstances shimming of joints with fiber-glass matting to correct alignment is not allowed. In extreme circumstances, and on a case-by-case basis, the Design-Builder's Engineer of Record may permit shimming. In such cases, submit proposals for and obtain the approval of the Design-Builder's Engineer of Record prior to any shimming.

D. Cleanliness of Surfaces to be Joined

The surfaces to which the epoxy bonding agent are to be applied shall be free from oil, form release agent, laitance or any other deleterious material that would prevent the epoxy-bonding agent from bonding to the concrete surface. Clean the surfaces by light sandblasting, wire brushing or light use of high-pressure water blasting (with a minimum pressure of 2,500 psi and a maximum of 6,000 psi) in a manner that does not destroy the surface shape and profile of the mating surfaces.

The mating faces shall be a dry and free of moisture at the time the epoxy- bonding agent is applied. Free moisture shall be considered to be present if a dry rag, after being wiped over the surface, becomes damp.

E. Substrate Temperatures And Epoxy Formulation

Substrate temperatures and epoxy formulation shall be in accordance with FDOT Specification 453-5.3 Substrate Temperatures and Epoxy Formulation, as modified by the following:

Plan the erection and post-tensioning operations such that the time lapse from the initial mixing of components for the first batch of epoxy-bonding agent, closing the joint and applying the minimum required contact pressure, does not exceed 70 percent of the contact time for the particular formulation.

F. Mixing Epoxy Bonding Agent

Mixing epoxy bonding agent shall be in accordance with FDOT Specification 453-5.4 Mixing Epoxy Bonding Agent.

G. Application and Amount of Epoxy

Apply the epoxy-bonding agent immediately after mixing. Apply the epoxy bonding agent uniformly to a nominal thickness of 1/16 inch in accordance with the manufacturer's recommendations with a spatula or by gloved hand. Apply the material to all areas of both faces to be joined, unless otherwise directed by the product Manufacturer. Do not place the epoxy bonding within ½ inch of a post-tensioning duct except, regardless of spacing, a bead of epoxy bonding agent shall be applied between all adjacent post-tensioning ducts. Apply additional epoxy thickness, equal to the shim thickness, to segment faces when shims are placed in a joint.

If a bead of epoxy is not extruded around the joint, then determine the reason why before proceeding.

Do not use epoxy-bonding agent material from a batch for which the time since combining components exceeds 20 minutes.

H. Contact Pressure

The purpose of the minimum (and as uniform as possible) contact pressure is to ensure proper mating of the surfaces and squeezing of the epoxy to completely fill and seal the joint with a finished thickness as even as possible.

Apply a minimum closing contact pressure of approximately 40 psi to each epoxy joint during the curing

period* for the epoxy. Use uniform pressure on the new joint, consistent with the Design-Builder's means and methods of erection. The Design-Builder's means and methods of erection shall ensure the minimum required contact pressure for the curing period. Contact pressure may be attained through combinations of weight and temporary and/or permanent post-tensioning.

The minimum contact pressure may be increased at any time after the epoxy has taken an initial set*. However, the minimum contact pressure may only be reduced after the epoxy in the joint has properly hardened and cured. If the minimum contact pressure is reduced, the joint cannot be subject to local tensile stress for a further 7 days or until the span, cantilever or pier column is complete, whichever is the earliest.

Prior to construction, submit details to the Design-Builder’s Engineer of Record for review addressing how the required contact pressure and duration shall be achieved for the erection of segments.

*Initial Set and Curing Period - in the context of the erection of the segments, the initial set and curing periods are as follows.

For a given temperature formulation the initial set is the point at which the epoxy in the joint has fully gelled. Without the use of artificial means to accelerate the process, this time, as a minimum, is the gel-time for the type of epoxy, application and conditions of use.

For a given temperature formulation the curing period is the time required for the epoxy to become fully hardened after application and closing of the joint under the contact pressure. Without the use of artificial means of heating or accelerating the cure, for a normal set epoxy, this period is usually 24 hours and for a slow set epoxy, usually at least 72 hours.

I. Mating of Segments

Mating of segments shall be in accordance with FDOT Specification 453-5.6 Mating of Segments.

J. Thermal Controls

Thermal controls shall be in accordance with FDOT Specification 453-5.7 Thermal Controls.

K. Failure to Comply with Time Limits or Incomplete Jointing

1. Time Limit. If the time limit between mixing of the epoxy-bonding agent and the application of the contact pressure is exceeded, or if the joint is incompletely filled and sealed, then separate the concrete segments. Remove all epoxy from the faces using spatulas and approved solvent. Have cleaning materials on-hand in the event of an aborted joining. Do not reapply the epoxy until the faces have been properly cleaned and solvents dispersed, for a period of 24 hours.

2. Failure to Provide Watertight Seal. In the event that water seepage through the deck slab at an epoxy precast segment joint becomes evident, take measures to seal the joint such as applying a gravity feed low viscosity concrete crack sealer or epoxy pressure injection. Submit proposed methods for sealing leaking segment joints to the Design-Builder’s Engineer of Record for approval.

L. Cleaning of Joints and Swabbing Ducts

Clean all excess epoxy-bonding agent from exterior surfaces of the concrete segment in such a way as to not damage or stain the concrete surface. Capture excess epoxy squeezed from the joint, and do not allow it to free fall from the structure.

Immediately after concrete segments are joined, pass a swab through each empty post-tensioning duct to smooth out any epoxy-bonding agent in the duct. When slow-set epoxy is used, pass the swab through all the segments adjacent to uncured epoxy after each new segment is erected.

M. Removal of Support to Segments

Removal of support to the segments shall be in accordance with FDOT Specification 453-6 Removal of Support to Segments.

N. Record of Segment Jointing

Records submitted for segment jointing shall be in accordance with FDOT Specification 453-7 Record of Jointing.

VI. MEASUREMENT AND PAYMENT

All cost for furnishing, mixing and applying a two component epoxy bonding system to the match cast faces of all joints between precast concrete superstructure segments in accordance with the Contract Documents, temporary post-tensioning across a joint and all labor, equipment and incidentals necessary to complete the work as specified above and in the AFC plans should be included in the lump sum contract price.

This work is integral to the relevant work package that is part of the lump sum contract price. There is no separate payment for this work. If an item does not satisfy the criteria stated herein, and in the event the Department accepts this item, the Quality Assurance Manager (QAM) will document the basis of acceptance. The Design Builder and the Department will negotiate an appropriate adjustment in the contract price, warranty, or other specific requirements or adjustments that are appropriate.

VIRGINIA DEPARTMENT OF TRANSPORTATION
SPECIAL PROVISION FOR
RIDEABILITY FOR CONCRETE BRIDGE DECKS
for Design-Build and PPTA Contracts

December 9, 2016

SECTION 404 – Hydraulic Cement Concrete Operations of the Specifications is amended as follows:

Section 404.04 Bridge Deck Construction is amended to include the following:

Rideability: The smoothness of the completed roadway surfaces of the bridge deck, approach slabs, and adjacent 50 feet of approach roadway pavement will be tested with an inertial road profiling device in accordance with VTM 106 and the requirements herein on the behalf of the Design-Builder's Engineer of Record; the Design Builder shall conduct all testing. A summary (encompasses entire testing limits) Mean Roughness Index (MRI) will be generated for the maximum number of ten foot wide travel lanes (2 - wheelpaths) possible on the structure without a median barrier; remaining width shall be distributed to shoulders along the fascia of equal width. A minimum of two test runs will be performed on each travel lane. The ride quality acceptance will be based on the test run that produces the lowest summary MRI for that travel lane. The longitudinal profiles that furnish the lowest summary MRI shall represent the approach roadway, approach slabs, and bridge deck when applying acceptance criteria (unless otherwise noted). MRI data attained for areas within 10 feet of Expansion Joints will be excluded from the assessment of incentive and/or disincentive adjustments. The longitudinal profiles shall include (as nearly as possible) one elevation sample every 6 inches. The Design-Builder's Engineer of Record shall conduct the testing after completion of bridge deck, approach slabs, and 300 feet of the final surface of approach roadway pavement. It shall be the Design-Builder's responsibility to notify the Design-Builder's Engineer of Record at least 30 days prior to the need of the testing. The Design-Builder shall have the entire area to be tested clean and cleared of all obstructions.

Rideability assessment and any corrective action required as a result of the assessment shall be performed prior to bridge deck grooving and shall be performed by Stage.

Acceptance: The longitudinal profiles representing 50 feet of adjacent approach roadway, approach slabs, and bridge decks shall be subjected to a 10 foot simulated rolling straightedge. This analysis will identify each instance in which the as-built surface profile deviates more than 1/8 inch from any two contacts with the simulated straightedge. Using the results of the simulation, the number of out-of-tolerance points identified in each 100-foot section of each travel lane shall be established and totaled. Only one violation per unit of longitudinal distance shall be counted (i.e. violation in the left and/or right wheelpath shall be considered a single violation).

Within each 100-foot section, deviations in excess of 1/4 inch in 10 feet or less shall be corrected as directed by the Design-Builder's Engineer of Record. Other areas excluded from profiler testing may be tested using a conventional 10 foot straightedge. The variation of the surface from the testing edge of the straightedge between any two contacts with the surface shall not be more than 1/8 inch in the longitudinal direction and 1/4 inch in the transverse direction. Humps and depressions exceeding the specified tolerance shall be subject to correction as directed by the Design-Builder's Engineer of Record, at no additional cost to the Department. Surfaces which fail to conform to the above-noted smoothness tolerances shall be ground until the above-noted tolerances are met. The Design-Builder's Engineer of Record may require correction of any or all adjoining traffic lanes and/or shoulders, at no additional expense to the Department, to assure uniform cross section.

Where corrections are made the bridge deck will be re-tested to verify that corrections have produced the acceptable ride surface. After initial corrections, any additional corrections and testing required by the Design-Builder's Engineer of Record to bring riding surface into conformance with specifications will be performed at Design-Builder's expense.

This rideability specification does not relieve the Design-Builder from responsibility concerning workmanship in accordance with the requirements of the Specifications or as defined by the Design-Builder's Engineer of Record.

12-09-16 (SPCN)

VIRGINIA DEPARTMENT OF TRANSPORTATION
SPECIAL PROVISION FOR
SUPPLEMENTAL OWNER QUALITY ASSURANCE DURING POST-TENSIONED STRUCTURE AND BRIDGE CONSTRUCTION
for Design-Build and PPTA Contracts

December 9, 2016

I. DESCRIPTION

A. General

A low maintenance Post-Tensioned Structure can only be achieved through the use of quality materials installed by conscientious trained personnel with appropriate experience working from well thought out error free plans. Minimum levels of training and experience for personnel performing critical roles are specified. Fabrication, installation and record keeping are all critical minimizing long term maintenance and inspection costs. Elements related to durability of the structure including anchorages, tendons, duct filler are hidden in almost all cases by large volumes of concrete and reinforcing steel making inspection a complicated and expensive endeavor.

II. OWNER WITNESS ACTIVITIES AND HOLD POINTS

A. Prior to Approval of Construction Plans

1. Design Supervisory Personnel Approval: In order to receive Stage I approval of a post-tensioned superstructure the Design-Builder shall submit for VDOT approval a resume(s) outlining the experience of the supervisory personnel responsible for final design, detailing and specification of post-tensioning elements (including but not limited to anchorage type and locations, ducts, tendon layout, erection sequence) shall be submitted for approval. Personnel with experience required by the Special Provision for Supplemental Post-Tensioning Personnel Qualifications for Design-Build and PPTA Contracts shall supervise the design, provide quality control and provide quality assurance for all work packages including post tension tendon components or elements in which there are internal or external ducts detailed.

2. Supplemental Stage I Plan Review: In addition to other Stage 1 report requirements, when post tensioning is anticipated as part of the final structure the following is required in the Stage 1 supplemental submission;

    a. concept level plans showing estimated number of tendons,

    b. tendon layout and geometry with sufficient detail to show the number of internal and external tendons

    c. concept level sequence of construction

    d. box access locations including conceptual level details

3. Inspectability Review: At least ninety (90) days prior to submitting plans to be approved for construction, the Design-Builder shall submit plans for conformance to inspectability criteria in IIM-S&B-93. Review comments shall be incorporated into the plans submitted for approval.

4. Plan and Computation Review: Each Construction Plan work package submitted for VDOT approval shall include supporting documentation (including computations) and specific supporting documentation demonstrating compliance with the QC and QA developed by the Design-Builder as part of the IIM 91 requirements. If revision of the submission is required, the revised submission shall include all elements requiring approval. Partial re-submissions shall be rejected and returned.

5. Construction of Post-Tensioned elements shall not begin until approval of the work package by the Department is received by the Design-Builder.

B. Pre-Production Reviews

1. Shop Drawing Review: Approved shop drawings based on plans approved during plan and computation review shall be submitted to VDOT for review.
2. Precast Segment Fabrication System; Documentation showing the Precast Segment Fabrication System based on plans approved during plan and computation review shall be submitted to VDOT for review. Documentation shall include all supporting computations, and quality review documents in addition to documents showing the System.
3. Post-Tensioning System: Documentation showing the approved Post-Tensioning System based on plans approved during plan and computation review shall be submitted to VDOT for review. Documentation shall include all supporting computations, and quality review documents in addition to documents showing the System
4. Casting Manual: Approved Casting Manual based on plans approved during plan and computation review shall be submitted to VDOT for review. Documentation shall include all supporting computations, and quality review documents in addition to documents making up the Manual
5. Handling, Storage and Transport of Segments: Approved documents Handling, Storage and Transport of Segments based on plans approved during plan and computation review shall be submitted to VDOT for review. Documentation shall include all supporting computations, and quality review documents in addition to documents describing Handling, Storage and Transport of Segments.
6. Erection Manual: Proposed Erection Manual based on Approved for Construction plans and Approved Shop Drawings shall be submitted to VDOT for review. Documentation shall include all supporting computations, and quality review documents in addition to documents making up the Manual. When appropriate, supplemental information including, but not limited to, Sequence of Construction, Maintenance of Traffic and Demolition shall be part of the submission for review. The Erection Manual shall include all proposed QC and QA activities related to erection as part of the Manual.
7. Field Survey and Erection Control: The approved Field Survey and Erection Control Plan review shall be submitted to VDOT for review. Documentation submitted shall include all supporting computations, and quality review documents in addition to documents making up the Plan
8. Construction Equipment and Load Testing: Approved Construction Equipment and Load Testing documentation shall be submitted to VDOT for review. Documentation shall include all supporting computations, and quality review documents in addition to documents describing Construction Equipment and Load Testing.
9. Other Approved Documents, Manuals, Systems as shall be identified in the Design-Builders QC/QA plan.

C. Pre-Production Approvals:

1. Grout Acceptance Testing Plan Approval: The Grout Acceptance Testing Plan shall be submitted for approval at least thirty (30) days before beginning testing. The Plan shall be revised and extended as necessary in accordance with the IIM-S&B-94 Requirements for Qualification, Job Site Testing and Acceptance of Grouts being used in Post-Tensioned Structures to include additional testing. Revisions to the approved plan shall be submitted for re-approval at least seven (7) working days before continuing testing under the revised Plan.
2. Grout Approval: After the approval of the Grout Testing Plan candidate grouts shall be tested. The Department shall be notified at least fourteen (14) days in advance of any testing which is intended to support approval of the candidate grout within the Commonwealth of Virginia and thirty (30) days for any testing outside of the Commonwealth of Virginia. The Department shall be provided the opportunity to witness all tests planned for supporting approval of any candidate grout.

3. Mock-Up Approval: At least sixty (60) days prior to any field Mock-Up tests, the Design Builder shall notify the Department and provide to VDOT a detailed Mock-Up plan for approval. Mock up testing shall take place at the project site or at the contractor's project office site. Mock-Up testing shall not take place sooner than fourteen (14) days after Grout Approval. At least seven (7) days prior to the Mock-Up test the Department shall be provided access to the Mock-Up to ensure compliance with the specifications. The Mock-Up shall not proceed until approval of the set up. The Mock-Up test shall be considered a Hold point. Production tendon filling shall not begin sooner than sixty (60) days after the approved Mock-Up test.

   Approval of any Mock-Up test, including grout, shall not occur until after all required testing on cured grout and any tendon forensic analysis is complete and passes and is submitted for review. Five (5) working days after receipt of submissions shall be allowed for review and approval by the Department.

   Approval of any Mock-Up test including flexible filler shall not occur until after all required testing on flexible filler and any tendon forensic analysis is complete and passes and is submitted for review. Five (5) working days after receipt of submissions shall be allowed for review and approval by the Department.

4. Tendon Installation and Stressing Plan Approval: Tendon installation and stressing plan shall be submitted to VDOT for approval at least 60 days prior to the first tendon installation. The installation of tendons shall not begin until after VDOT's approval of the tendon installation and stressing plan. The Tendon Installation and Stressing Plan shall include all proposed QC and QA activities as part of the Plan.

5. Duct Filling Plan Approval: At least sixty (60) days prior to beginning production filling, the Design Builder shall notify the Department and provide a detailed Filling Plan including both a Grouting Plan and a Flexible Filler Injection Plan for approval. Production filling shall not take place sooner than fourteen (14) days after Filling Plan approval. The Duct Filling Plan shall include all proposed QC and QA activities as part of the Plan.

6. Other Tests and Plans related to tendon stressing and duct filling as shall be identified in the Design-Builders QC/QA plan.

D. Production Reviews:

The Department shall have the opportunity to witness production post-tensioning activities. Department reserves the right to sample materials installed during production. Including, but not limited to:

1. Duct Installation Including Ducts, Couplers and Anchors and Concrete Placement
2. Segment Location Elevation and Grade
3. Duct Pressurization
4. Strand Placement
5. Stressing Operations
6. Filling Operations (Grouting and Flexible Filler)
7. Post-Filling Operations
8. Box Waterproofing
9. Overlay Construction

To facilitate the witness activities the Design Builder shall keep the Department informed using a two week look-ahead schedule and notifications of modifications to the schedule as needed to account for schedule changes.

E. Record Keeping and retention for Post-Tensioning Tendons:

Prior to final acceptance by the Department, the Design-Builder shall submit a “Birth Certicificate of Health” (BCH). The BCH shall be a relational database containing all material source documentation, acceptance documentation, material testing, installation documentation, quality control and quality assurance records for every tendon in the structure at the time of acceptance.

Information shall be collected and stored in such a way the information in the completed database shall be able completely relational and able to be searched by each piece of information. It shall also contain the approved Plans for each tendon, including Approved for Construction plan, approved shop drawing(s), approved stressing plan, approved filling plan and approved repair plan. The Design-Builder shall propose the specific structure and contents of the database as part of the Inspectability Review for the Departments approval. The information in the database shall include, but not be limited to items below and all CEI records as determined by the approved QC/QA plan developed to meet IIM 91 General Requirements for the Usage, Design and Specification of Post-Tensioned Bridge Superstructures for Design-Build and PPTA Contracts:

	Complete for each Post Tensioning Tendon	**Meets Project Req’ts**	**Crew Super.**	**Project Engr.**	**QC MGR**	**EOR**	**QAM**	**VDOT**
	Structure							
	Segment Number							
Shop Drawing Review And Approval	Tendon identified as required for serviceability?							
	Unique duct identifier							
	Orientation							
	PT system manufacturer							
	PT duct type							
	PT duct nominal diameter or size							
	Pt anchorage type							
	PT material correct for intended use							
	PT system approved?							
	Shop Drawing Approval							
Tendon Installation	duct begin geometry within tolerance							
	duct end geometry within tolerance							
	Diabolo geometry approval							
	Date cap removed to install strand							
	Min Duct Diameter							
	Unique Torpedo ID							
	torpedo Diameter							
	Torpedo length							
	Date of duct successful continuity check (torpedo)							
	Date of successful dryness check							

	Complete for each Post Tensioning Tendon	Meets Project Req'ts	Crew Super.	Project Engr.	QC MGR	EOR	QAM	VDOT
	Structure							
	Segment Number							
	Date of successful pre-strand installation airtightness check							
	Strand Manufacturer							
	Strand material							
	Number of Strands							
	Diameter of Strands							
	Strand lot number							
	unique strand/tendon Reel Number							
	Strand acceptance certification verified							
	Date of strand installation							
	Installation of water tight anchorage protection (exposed strands only)							
	Date of successful Post strand installation air tight check							
	Time and Date of beginning of tensioning							
	temp at start of tensioning							
	max temp during tensioning							
	unique jack identification number							
	Force at end of tensioning							
	Total elongation							
	elongation met required length extension within tolerance?							
	Time and Date of end of tensioning							
	temp at end of tensioning							
	Description of precipitation during tensioning							
	Installation of water tight anchorage protection after tensioning (exposed strands only)							

	Complete for each Post Tensioning Tendon	Meets Project Req'ts	Crew Super.	Project Engr.	QC MGR	EOR	QAM	VDOT
	Structure							
	Segment Number							
Pre-Filling Checks	Type of filler							
	Date of prefilling checks							
	Number of filler locations							
	filler manufacturer							
	filler Lot							
	Date of Bag weight testing							
	Avg Weight of bags							
	COV for bag weights							
	Date of approval for Pre-installation fillertesting							
	minimum 2% overfill capacity							
	top Vents functional							
	bottom vents functional							
Pre-Grout Air Tightness	Date of successful pre-filling air tight check							
	Date of successful pre-filling dryness check							
	Responsible filler							
	Valid filler Plan for materials and duct geometry							
	Unique Mixer ID							
	Valid filler Mock up for materials and duct geometry?							
	Qualification of filler personnel current							
Filler Testing	Time and Date of beginning of filling							
	ambient temp at start of filling							
	ambient max temp during filling							
	Ambient temp at end of filling							
	fill temp at outlet at near anchorage							
	fill temp at outlet near far anchorage							
	Time and Date of end of filling							

	Complete for each Post Tensioning Tendon	Meets Project Req'ts	Crew Super.	Project Engr.	QC MGR	EOR	QAM	VDOT
	Structure							
	Segment Number							
	grout solids between 60 and 75 degrees prior to mixing							
	water between 60 and 75 degrees prior to mixing							
	Flexible Filler temp after heating before pumping							
	Approval of temperature deviation from standard temp by Contractor Project Engineer							
	Approval of temperature deviation from standard temp by Contractor QC							
Post-Grouting Acceptance	28 day grout cube results meet requirements							
	void evaluation at anchorages							
	filler void evaluation at outlets							
	filler void evaluation at drains							
	grout hardness confirmed using GPR and UT							

The BCH shall include an electronic copy of each paper approval hold point required by the Design-Builder, including the formal approval by the responsible entity or person.

SECTION 450
PRECAST PRESTRESSED CONCRETE CONSTRUCTION

450-1 Description.

Fabricate, store, transport and erect precast/prestressed concrete members prestressed by the pretensioning method. Pretensioned precast prestressed concrete products are products prestressed by the pretensioning method. In this method, steel components are stressed and anchored; the concrete for the product is then cast and cured, and finally the stress in the steel components is released from the anchorages to the concrete through bond, after the concrete has attained its specified release strength.

A precast prestressed concrete plant, hereinafter called plant, is an independent operating facility capable of performing all the operations necessary to fabricate precast/prestressed concrete products.

Obtain precast/prestressed products from a plant that is currently on the Department's Production Facility Listing. Producers seeking inclusion on the list shall meet the requirements of Section 105.

When the plant's Quality Control Program is suspended, accept responsibility of either obtaining precast/prestressed products from a precast/prestressed concrete plant with an accepted Quality Control Program, or await re-approval of the Producer Quality Control Program. The Engineer will not allow changes in Contract Time or completion dates as a result of the concrete plant's Quality Control Program suspension. Accept responsibility for all delay costs or other costs associated with the plant's Quality Control Program suspension.

450-2 Quality Control Program.

450-2.1 General: Develop a Producer Quality Control Program as specified in Section 105.

Meet the requirements of the accepted Quality Control Program, Contract Documents, and Precast/Prestressed Concrete Institute (PCI) Manual for Quality Control for plants and production of structural precast concrete products. The requirements of the Contract Documents will govern, when there is a discrepancy between the PCI Manual and the Contract Documents.

Accept responsibility for performing daily Quality Control (QC) inspections of all phases of work ensuring all materials and workmanship incorporated into the product meet the requirements of the Contract Documents. Also, maintain a daily activity report detailing the results of the daily Quality Control Program activities. Ensure these daily reports and minutes of the weekly meetings with the Engineer and the plant's production personnel are maintained at the plant. During the weekly meetings, discuss the results of the QC inspections.

Inspect the product for conformance with the product dimension tolerances shown in Appendix B of PCI Manual MNL-116 (Manual for Quality Control for Plants and Production of Structural Precast Concrete Products), except as modified herein. Apply the tolerances with respect to the theoretical positions and dimensions shown in the Plans. Apply the same tolerances for U-Beams as those specified for I-girders, excluding sweep tolerance, when inspecting the product for conformance with dimension tolerances. For Florida U-Beam diaphragms, the tolerance for the thickness of the intermediate and end diaphragms is plus 1 inch and minus 1/2 inch, and the location of intermediate diaphragms, relative to design plan

positions, is plus or minus 3 inches. The tolerance of the thickness of end diaphragms shall be plus 3 inches and minus 1/2 inch.

Limit sweep to 1/2 inch for U-Beams and Inverted-T Beams. The maximum allowable sweep for I Beams is 1/8 inch per 10 foot length, but not to exceed 1.5 inch. The maximum allowable sweep for piling is 1/8 inch per 10 feet, but not to exceed 1.0 inch.

The tolerance for beam strand sheathing is plus or minus 2 inches.

Ensure the tolerance on all miscellaneous shaping including, but not limited to, chamfers, miters, bevels, keys, tapers, radii, holes, inserts, and block outs is within plus or minus 1/8 inch of the control dimension of the shape.

The tolerances represent the total allowable tolerance that will be accepted in the finished product. Do not apply tolerances shown for the overall dimensions of a member to violate the tolerances shown for positions of reinforcing and prestressing steel. Apply the tolerances during and after the fabrication of prestressed products. Do not reduce the concrete cover for reinforcing steel, prestressing steel or any other metallic objects specified in the Plans more than 1/4 inch. Do not reduce the concrete cover for reinforcing steel, prestressing steel or any other metallic objects when the cover specified in the Plans is minimum cover.

Ensure the QC inspector is present during concrete placements and performs inspection during all fabrication of precast prestressed concrete products, including the inspection of the operations before, during and after the placement of concrete.

Ensure the Plant QC Manager, or the QC inspectors under their direction, examine all precast prestressed concrete products within five working days of detensioning to ensure their dimensions conform to the specified tolerances and to determine if there are any deficiencies. This process control shall be listed on the Producer Quality Control Plan (QC Plan).

450-2.2 Plant: Ensure each plant has an onsite QC Manager meeting the requirements of Section 105.

450-2.3 Product Certification: Ensure the QC inspector inspects all completed products at the plant not less than 24 hours before shipment to verify that all Contract Documents requirements are met. Upon verification that all Contract Document requirements have been met and all necessary repairs have been satisfactorily completed, the product will be stamped with the approved QC Manager stamp identified in the Producer QC Plan.

Attach to each monthly request for payment, certification that the listed precast prestressed products have been produced under the Producer QC Plan and meet the Contract Document requirements. Ensure the certification is signed by a legally responsible person of the plant and is provided on the plant's letterhead.

450-2.4 Documentation: Ensure that a system of records is maintained in each plant which will provide all information regarding the certification and testing of prestressing steel, reinforcing steel, concrete materials and concrete, curing materials, embedded items, tensioning, concrete proportioning, pre-placement, placement, post-placement inspections, curing, and disposition of products. Include in the record keeping the deficiencies found as a result of the inspection and testing. Keep certified test reports for all materials incorporated into the production of precast prestressed concrete products.

Ensure that the printout or manual record of the tensioning operations is maintained and reflects the identification of the bed, type of fabricated products, the complete Financial Project Identification Number, jack identification number, date prestressing strands were stressed, temperature at the time of stressing, and signature of the qualified tensioning machine operator.

Ensure the proposed method and format for documenting required information is included in the Producer QC Plan.

Maintain records until all the precast prestressed products for a project have been fabricated then submit all the records to the Engineer. Ensure records are available at all times for the Engineer's inspection.

450-2.5 Quality Assurance Inspection and Testing: The Engineer will perform periodic inspections, sampling, and testing to ensure of the quality and acceptability of the materials, methods, techniques, procedures and processes being utilized by the Contractor in the fabrication of precast prestressed concrete products.

450-3 Materials.

450-3.1 General: Meet the following requirements:

Concrete .....Section 346
Steel Strands*.....Section 933
Steel Bars .....Section 933
Steel Accessories .....Section 933
Reinforcing Steel and Metal Welded Wire
Reinforcement**..... Sections 415 and 931
Embedded Duct Enclosures .....Section 462
Membrane Curing compounds***.....Section 925
Epoxy Resin Compounds.....Section 926
Burlap.....Section 925
Curing Blanket 400-16
Penetrant sealer*** .....Section 413
Methacrylate .....Section 413
Epoxy Injection of Cracks .....Section 411

* Do not use strands from more than one source in any individual prestressed element, with the exception of the partially tensioned strands (dormant strands).

** The steel spirals for reinforcing in concrete piling may be manufactured from stock meeting the requirements of any grade of reinforcing steel, as shown in ASTM A615 for steel bars, or ASTM A1064 for steel wire.

*** Use membrane curing compounds and sealers that are compatible with coating or other materials that are applied to concrete surface.

Use inserts in accordance with the recommendations of the manufacturers and within their certified capacities and application qualifications. Do not use aluminum inserts.

Use draped strand devices of sufficient rigidity having adequate support to retain the position of the strand unchanged under the induced load. Do not allow the devices to induce friction to the tendons such that the required jacking force and elongation cannot be attained.

450-3.2 Strand Chucks and Splice Chucks: For pretensioning, use strand chucks that are capable of anchoring the strands without slippage after seating and ensure against strand failure within the grips at loads less than 95% of ultimate strength.

Provide manufacturer's certification that splice chucks used to transmit the prestressing force from one prestressing tendon to another are capable to hold at least 95% of the ultimate tensile strength of the prestressing strand.

Do not use wedges that become worn, cracked, deformed, or that allow dead end seating in excess of 3/8 inch. Use components from the same manufacturer to make up chucks and to provide proper wedge fit.

Use chucks as complete units. Clean, inspect, and lubricate the chucks between each use. Use wedges and housing that are compatible and made for the specific type and size of prestressing strand that are being used, avoid improper fit and improper seating of wedges on the strands.

The Engineer will allow one splice per strand subject to the following:

1. Splices are located outside the concrete products (except for precast piling where up to two splices are permitted to be used in each pile, so long as they are not located in the same vertical cross section, perpendicular to longitudinal axis of the pile).

2. Strands which are being spliced have the "lay" or "twist" in the same direction.

450-4 Material Acceptance and Testing.

450-4.1 Concrete: Perform the QC sampling and testing of concrete in accordance with the requirements of Section 346.

450-4.2 Reinforcing Steel, Welded Wire Reinforcement and Prestressing Steel for Pretensioning:

450-4.2.1 General: Identify all reinforcing steel, welded wire reinforcement and prestressing steel for pretensioning by LOTs. A LOT of reinforcing steel or welded wire is a shipment of material from the same manufacturer and heat. A LOT of prestressing steel is a shipment of material of the same size, production grade and heat from the same manufacturer.

Acceptance of reinforcing steel, welded wire reinforcement and prestressing steel for pretensioning is based on manufacturer's certification and the Department's verification tests. The sampling for verification testing will be performed by the Department at each precast plant, on at least two LOTs per year, additional samples may be taken at the manufacturing source of reinforcing steel, welded wire reinforcement and prestressing strands.

When products contain the material that has failed to meet the requirements of 450-3, reject the unused material of the failed LOT. The Engineer may require the evaluation of the products, which contain the failed material, in accordance with 450-14.

450-4.2.2 Reinforcing Steel and Welded Wire Reinforcement: Obtain and maintain for each LOT a certified mill analysis, physical property test report and the manufacturer's assigned LOT number with the heat of the material represented. Verify that the report represents the steel received and that the steel meets the Contract Documents requirements. Reject all unidentified reinforcing steel or welded wire reinforcement received at the plant or job site.

Provide the manufacturer's certified mill analysis and three 7 foot long, randomly selected samples from the designated LOT of reinforcing steel and three randomly selected samples from the designated LOT of welded wire reinforcement when requested by Engineer. Ensure each sample of welded wire reinforcement covers an area of four intersections of transverse and longitudinal bars. Ensure the transverse wires of each piece of welded wire reinforcement extend approximately 6 inches to both sides.

450-4.2.3 Prestressing Steel for Pretensioning: Obtain and maintain for each LOT of material received, the manufacturer's assigned LOT number, certified test values for specified material properties together with a representative load-elongation curve and the modulus of elasticity value based upon strand nominal area. Provide and support by records maintained by the strand manufacturer, production tolerances applied in selection of the reported strand modulus. Verify that documents provided represent the shipment received and meets the Contract Documents requirements.

Reject all unidentified prestressing steel received at the plant or job site.

Provide the manufacturer's certified mill analysis and three 5 foot long randomly selected samples from the designated LOT of material when requested by the Engineer.

450-4.2.4 Strand Chucks and Splice Chucks: Obtain and maintain certified test results certifying that the material meets the requirements of 450-3.

450-4.2.5 Steel Accessories: Use only steel accessories meeting the requirements of 450-3.

450-4.2.6 Ducts: Obtain and maintain certified test results certifying that the material meets the requirements of 450-3.

450-5 Shop Drawings.

Submit shop drawings when the Contract Documents do not contain all the detailed information necessary to fabricate and erect the pretensioned prestressed concrete product. Ensure the submitted shop drawings meet the requirements of 5-1 and any additional Contract Document requirements.

Shop drawings are not required to depict supplemental reinforcing steel used to facilitate fabrication of products.

In lieu of shop drawings, furnish one copy of the following to the Engineer:

1. A copy of the Framing Plan with product designations for all superstructure components.
2. Strand detensioning schedule.
3. Tensioning and elongation calculations.
4. Details of supplemental steel that remains as part of the finished product.
5. Drawings, details and spacing for embedded items associated with fall protection systems used on beams.
6. When proposing to use materials and/or methods that differ from the requirements of the Contract Documents, submit full plan details and Specifications for the alternate materials and methods. Ensure the alternate materials and methods meet the following requirements:

a. The provisions of the Contract Documents.

b. The AASHTO LRFD Bridge Design Specifications, edition with interims as referenced in Plans.

c. The recommendations of the material manufacturer.

d. Any materials change proposed by the Contractor and approved by the Engineer.

e. Net compressive stress in the concrete due to prestressing acting alone, after all losses, is not less than that provided by the stranding shown in the Plans.

f. Ultimate strength of the structure with the proposed changes is not less than the ultimate strength of the original design.

g. The provisions of the Departments Structures Design Guidelines.

450-6 Forms.

450-6.1 General: Use metal side and bottom forms, unless otherwise specified in the Contract Documents. For members with special shapes such as corner sheet piles, wood forms are permitted. Slab units and sheet piles may be cast on concrete surfaces meeting the profile dimensional tolerances of 450-6.3. Apply release agents in accordance with the manufacturer's

recommendations. Liquid membrane curing compounds may be used to prevent bonding of slab products and sheet piles to the existing concrete surface, when applied in two or more coating. Ensure the last application of liquid membrane is applied immediately before placement of the slab or sheet pile.

For all beam members, use side forms designed to be removed without damaging the top flange of the beam. Remove the forms horizontally away from the beam by a method that prevents any contact of the form with the top flange after release of the form. Do not subject the top flange to any vertical force at any time. Include the form details and method of removal in the Producer QC Plan.

For all Florida-I Beams, use forms that do not have more than two horizontal joints.

Use void forms of a type for which service adequacy has been demonstrated, having sufficient strength to provide stability during handling and placing and to withstand hydrostatic pressures and other forces imposed upon them during concrete placement. Use form material that is neutral with respect to the generation of products harmful to the physical and structural properties of the concrete. Ensure that the presence of the form materials does not cause any detrimental effect to the concrete or other materials within the member. Positively vent all voids to the outside of the member. For end headers and inside forms, other materials capable of resisting the pressure from concrete are permitted.

Use end headers so designed that they can be placed and maintained in correct position between the side forms. Hold the headers in place with devices capable of being removed or loosened after the concrete has attained its initial set allowing free form expansion during curing methods that involve heat. Use end headers with openings conforming to the prestressing steel pattern to permit passage of the prestressing steel. Locate the openings accurately within 1/8 inch of planned location of prestressing steel elements.

Construct circular openings for strands a maximum of 1/4 inch larger than the nominal strand diameter. Construct square or rectangular openings a maximum of 1/4 inch larger, horizontally and vertically, than the nominal strand diameter. Ensure that all headers are mortar tight.

450-6.2 Supports: Use forms of sufficient thickness, with adequate external bracing and stiffeners, which are anchored to withstand the forces due to placement and vibration of concrete. Ensure that joints in forms are mortar tight. Support bottom forms on concrete pallets with metal stiffeners, wales or shims. Do not use timber elements between the bottom metal form and concrete pallets.

450-6.3 Alignment: Make and maintain during their use, forms and centering true to the shapes and dimensions for the product being produced. Plumb, align, and secure forms for each product in position before each reuse.

Apply the following tolerances to form alignment and pallets or beds used in prestressed construction:

1. Horizontal Alignment (horizontal deviation of side forms either side of a vertical plane within the length of a product) = 1/8 inch,
2. Vertical Alignment (vertical deviation of the bed or pallet from a horizontal plane within the length of a product) = 1/8 inch,
3. For vertical joints, Offset Between Adjacent Form Sections = 1/8 inch.
4. For horizontal joints, Offset Between Adjacent Form Sections = 1/16 inch.

450-6.4 End Header Locations:

450-6.4.1 General: Provide a minimum of 18 inches of exposed strands from the end header to the stressing anchorage and between adjacent ends of all products except 24 inches square and smaller piles. Provide a minimum of 6 inches of exposed strands between adjacent ends of 24 inches square and smaller piles.

450-6.4.2 Cold Weather: Provide a distance of at least 5 feet from the end header to the stressing anchorage, when the ambient temperature is expected to be below 55ºF between the time of tensioning and detensioning. When the ambient temperature is expected to be below 55ºF between the time of tensioning and detensioning and the product's exposed strands between the stressing anchorages are not protected, maintain a 25 foot minimum free length of stressed strands, between the end header and the stressing anchorage at each end of a bed line. When cold weather concrete conditions as specified in 450-10.1 are in effect, protect all exposed strands between stressing anchorages regardless of length. When the products and strands between stressing anchorages are protected, provide protection adequate to maintain the ambient temperature of the air around the strands at or greater than 55ºF until the products are detensioned or 24 hours after placing concrete, whichever is less.

450-6.5 Surface Conditions: Use clean, rust free form surfaces against which concrete is to be cast. Inspect forms and, if necessary, recondition them.

450-6.6 Form Ties: Ensure that no form wires or metal pieces are left within 2 inches of the surface of the finished concrete.

450-6.7 Corners, Angles and Joints: Ensure corners and angles are chamfered, mitered, or rounded with a radius of 3/4 inch, unless otherwise specified or shown in the Plans. Provide smooth mortar tight joints between panel forms within the alignment tolerances.

450-6.8 Form Release Agent: Before placing concrete, treat the facing of all forms with a form release agent in accordance with the manufacturer’s requirements. Ensure the application of form release agents does not contaminate prestressing strands and/or reinforcing steel.

450-7 Protection and Placement of Prestressing Steel.

450-7.1 Protection of Prestressing Steel: Maintain and store prestressing steel above the ground surface on platforms, skids, or other supports, to prevent contamination from below, and protect them from mechanical injury. Do not use any packaging or wrapping material that retains moisture at the bottom of the reel. Clean contaminated prestressing steel before use or otherwise reject it. Handle prestressing steel carefully to prevent nicks or kinks and do not expose it to temperatures greater than 200ºF at any time. Do not use arc welding equipment, including welding electrode lines, within 2 feet of prestressing steel. Do not perform any welding on forms that have been set in place after the prestressing steel is placed in the bed. Reject prestressing steel that has sustained any physical damage at any time.

450-7.2 Placing Prestressing Steel: Use care during placement of prestressing steel to avoid physical damage and contamination. Reject damaged strands. Do not use prestressing steel containing nicks, kinks, or former chuck grip marks. Do not use steel showing evidence of scale formation or which has become pitted. Remove and replace any damaged prestressing steel in the bed.

450-7.3 Cleanliness of Prestressing Steel: Inspect the prestressing steel for any evidence of contamination. Use steel that is free of deleterious materials such as grease, oil, wax, dirt, paint (except that used for marking identification) or other similar contaminants. Remove any contaminants detected from the steel before proceeding with fabrication activities. Rust on

prestressing steel that can be removed by light rubbing is acceptable. Streaks or spots which may remain after rust removal are acceptable if no pitting is present.

450-7.4 Debonded Strands: Extend the tubular debonding material (sheathing) through the header for debonded prestressing steel. Tie and tape the debonding material at the terminus located at the inside of the member. Seal openings between strand and sheathing for debonded strands with 100% silicone sealant within seven calendar days of detensioning. The sealing of openings between strand and sheathing is not required for beams with ends not be encased in permanent concrete diaphragms per 450-11.5 and strand protection per 450-11.6. Use sheathing that is tubular non-slit, high-density plastic with a minimum wall thickness of 0.025 inch, and an inside diameter exceeding the maximum outside diameter of the pretensioning strand by 0.025 inch to 0.14 inch, which does not react with concrete, coating, or steel and prevents the intrusion of water or cement paste during concrete placement.

Do not use strands debonded over the full length of a product.

450-8 Tensioning Equipment and Operations.

450-8.1 Equipment: Use a hydraulic jacking system that is adjustable to the automatic application and sustaining of a predetermined load, together with a pressure transducer or load cell built into the hydraulic system. Connect such pressure gage or transducer to a dial or digital readout and printer (manual recording of the tensioning operations is permitted) which will provide an instantaneous readout and record of the applied load in pounds. Use a jacking system with the capacity to induce the required load. Base the use of this system on demonstrated accuracy and repeatability of plus or minus 2% of anticipated load verified through comparison with loads indicated by an independent load cell.

Calibrate all jacking systems before using and repeat calibration at intervals not exceeding 12 months. Calibrate and recalibrate in accordance with the equipment manufacturer's recommendations, by qualified calibration agency or by plant personnel under the supervision of a Specialty Engineer.

Calibrate gages, jacks and pumps as a system in the same manner they are used in tensioning operations with the cylinder extension in the approximate position that it will be in actual use at final jacking force. In multi-strand tensioning systems, gages may be calibrated against a master gage of known accuracy, provided that the other units of the system are calibrated against the same master gage. Ensure calibrations cover the load ranges that will be used during production. Verify the accuracy setting of the automatic cutoff valves by running the desired cutoff load. Ensure a certified calibration curve accompanies each tensioning system. Load readings can be used directly if the calibration determines a reading is within plus or minus 2% tolerance of anticipated load. Ensure calibration of load cells or proving rings used to calibrate jacking systems are on compression force testing equipment that has been calibrated in accordance with ASTM E74.

When any jack or gage appears to be giving erratic results, or if the jack force and elongation do not compare within specified limits and differences cannot be justified while work is in progress, recalibrate the equipment. Also verify the accuracy of the equipment after internal jacking system repairs or when gage and jacking units are switched.

Calibrate or recalibrate in accordance with ASTM E4 using equipment that is calibrated in accordance with ASTM E74. After calibration or recalibration has been completed, prepare a certificate and have it signed by the person in responsible charge of the verifications as outlined in ASTM E4 and ASTM E74. Ensure that the calibration report includes, the serial number of the equipment that is calibrated, calibration chart in a graph or tabular form,

calibration date, temperature, full range of readings before and after calibration, National Institute of Standards and Technology's (NIST's) traceable number of calibration device, method of calibration, calibration agency, and laboratory or Engineer supervising the calibration.

Verify the accuracy of the jacking and recording system a minimum of once each week during tensioning operations by either an independently calibrated load cell, or by comparison with calculated strand elongation. When weekly verification is to be performed by comparison with calculated strand elongation, check a minimum of ten strands and the difference in the indicated load and the load determined from the elongation must agree within 5% of the computed theoretical load values. If the differences are greater than 5%, suspend the tensioning operation, evaluate the tensioning operation by qualified personnel and correct any deficiencies before proceeding.

When weekly verification is done by load cell, perform a minimum of five spot checks to the maximum anticipated load of strands. Use a load cell or proving ring that is calibrated in accordance with ASTM E74 and the accuracy of the force must be traceable to NIST. Maintain written records of readings obtained from the force recording system and verifying standard. Ensure the weekly verification record includes the serial number of the equipment, verification date, verification agency, NIST traceable number of calibration standard, and name of the person making the spot checks. The load reading from the recording system must agree within plus or minus 2% of the anticipated load indicated by the load cell or proving ring that are calibrated annually.

450-8.2 Operations:

450-8.2.1 General: The tensioning operations consist of the application of the final force or load which is the force required by the Plans and with the adjustments for abutment rotation, bed shortening, anchorage header movement, live end seating, dead end seating, splice chuck seating, friction in the jacking system and any other elements as applicable for the type of bed and anchorage being used. Also, adjust the force required by the Plans when the temperature differential between the ambient temperature at time of stressing and the expected concrete temperature at time of placement is greater than 25ºF. Increase the force at the rate of 1% for each 10ºF increment that the ambient temperature at time of stressing is below the expected concrete temperature at time of placing. Decrease the force at the rate of 1% for each 10ºF that the ambient temperature at time of stressing is above the expected concrete temperature at the time of placing. Do not allow the stress in the prestressing steel to exceed 80% of the specified tensile strength of the strand, after seating. During each tensioning operation, for the verification of the live and dead end seating, check the seating of at least 4 strands or a minimum of 10% of the total number of strands, whichever is greater. Maintain a printed or manual record of the tensioning operation.

Compensation for temperature differential and abutment rotation are not required for self-stressing beds. However, adjust the final load for the effects of bed shortening due to the load from all the strands.

If the placement of concrete is delayed for more than seven calendar days after the completion of the stressing operation, check and adjust the final strand load as necessary before placement of concrete and maintain a printed or manual record of the stressing operation.

Accomplish tensioning by either single strand tensioning or multiple strand tensioning, and ensure that it is symmetrical about the vertical axis of the product. Tensioning methods, in general, consist of tensioning to the required loads indicated by the

jacking system, or tensioning to the required load while monitoring the elongation of the prestressing steel.

450-8.2.2 Single Straight Strand Tensioning: Apply an initial force of 5% to 25% of the final force to eliminate slack in the system. When single straight strand tensioning is used, tension the prestressing steel until the required final force is attained. Measure and record the force and elongation.

450-8.2.3 Multiple Straight Strand Tensioning: Apply the initial uniform tensioning load to each individual strand before the application of full tensioning load to the group of strands. The amount of the initial load will be influenced by the length of the casting bed and the size of strands in the group to be tensioned. The minimum initial tensioning load will be 5% of the required final load. Increase the magnitude of this load if deemed necessary but do not allow it to exceed 25% of the required final load. Then tension the strands by multiple strand tensioning to final load by pulling to elongation and checking against the jack load. Allow the required elongation to control the tensioning. The actual jack load must agree within 5% of the required load.

For uniform application of load to strands, the face of anchorage at final load must be in a plane parallel to its position under initial load. Verify this by measurement of movement on opposite sides of the anchorage and check its plumb position before and after application of the final load. During tensioning, allow the anchorage to move without restraint.

450-8.2.4 Draped Strand Tensioning: Tension draped strands by either partial tensioning and subsequent strains or by final tensioning in draped position.

Partial stressing and subsequent strains applies when the strands are tensioned through a combination of applied jack loads and strand uplift. To verify the final force, place a load cell between the tensioning anchorage and anchor chucks at the dead end on at least two draped strands. Other methods as approved by the Engineer may be used to verify the final force in the dead end. Bring the partially draped strand to an initial tension using a force in the range of 5% to 25% of the required final tensioning force. After application of the initial force, establish reference marks for measuring elongation. Apply a pre-calculated jacking force and measure elongations on a minimum of four strands. The average measured elongation must agree within 5% of the theoretical elongation for strand force measured by jack load, or the factors contributing to the difference must be identified and corrected before proceeding. Allow the load indicated by the jacking system to control the tensioning for the pre-calculated load. Obtain the required final force by lifting or depressing the strand simultaneously at all pickup or hold down points or in an approved sequence as shown on the shop drawings. On each different bed setup, after lifting or depressing the strands to their final position, check the final force at the dead end of at least two strands on the bed. If the load is below the required tensioning force by more than 5%, adjust it to the final load.

When the final stressing is performed in the draped position, apply the tensioning load in two increments with the tendons being held in their draped positions. To verify the final force, place a load cell between the tensioning anchorage and anchor chucks at the dead end on at least two draped strands. Other methods as approved by the Engineer may be used to verify the final force in the dead end. Bring each strand to an initial tension of 5% to 25% of the final load before the application of the required final load. After application of the initial load, establish reference marks for measuring elongation. Then tension the strands to final load and measure the elongation. Allow the load indicated by the jacking system to control the tensioning for the initial and final loads. The measured elongation must agree within 5% of the

theoretical elongation for the strand force measured by jack load, or the factors contributing to the difference must be identified and corrected before proceeding. When the jacking is performed at one end of the bed, check the applied load on two draped strands at the other end of the bed. If the load on the end opposite the jacking end is below the required value by more than 5%, adjust the load to the required final load.

450-8.2.5 Wire Breakage: Limit wire breakage to 2% of the total area of the strands in any product and verify that breakage is not indicative of a more extensive distress condition, otherwise reject all stranding. Replace individual strands with more than one wire failure.

450-8.2.6 Position of Prestressing Steel: Position prestressing steel as shown in the Plans within the tolerances allowed in 450-2.1. Fix the required vertical and horizontal position of each prestressing strand at the ends of each product and at intervals within each product not exceeding 30 feet. Use the method of fixing the prestressing steel shown in the Producer QC Plan. When blocks are to be used for supporting prestressing steel, use those cast from concrete of the same mix design as used in the prestressed product. Stagger the location of blocks with an offset of 12 inches or greater and do not stack them.

450-9 Placement of Reinforcing Steel and Other Embedded Materials.

450-9.1 Reinforcing Steel: Tie and/or support in position all reinforcing steel in each product with other reinforcing steel in a manner that will accurately position the steel throughout the fabrication process. Use types of ties and methods of tying recommended by the CRSI, including lacing. Do not tie reinforcing steel to debonded prestressing steel within the limits of the sheathing material.

Tie or lace beam stirrup bars at a minimum of three points. Tie reinforcing steel, other than stirrup bars in beam ends, as a minimum, at every other intersection. Either tie or lace spiral wire in piling at all four corners in the 1 inch pitch area, at the top corners and bottom center in the 3 inch pitch area, and at the top corners in the center area. Tie the bottom center in the pile center area as necessary to maintain concrete cover. Bend all tie wires away from the form surface to provide maximum concrete cover.

When shown in the Plans, weld reinforcing steel in accordance with the requirements of AWS Structural Welding Code D 1.4. Do not weld in the prestressing bed.

450-9.2 Other Embedded Materials:

450-9.2.1 Inserts and Lifting Devices:

450-9.2.1.1 Placement: Locate inserts and lifting devices in accordance with the tolerances listed in 450-2.1.

450-9.2.1.2 Corrosion Protection: Provide corrosion protection for embedded metal lifting devices that would remain exposed after construction.

After lifting operations using recessed metal lifting devices are complete, backfill block-outs with a Type F epoxy compound meeting the requirements of Section 926 for a minimum distance of 2 inches beyond the perimeter of the metal device as measured parallel to the exposed concrete surface. If the block-out extends less than 2 inches beyond the perimeter of the metal device, extend the epoxy compound beyond the block-out along the concrete surface. If Type 304 or 316 stainless steel lifting devices are used, non-shrink grout meeting the requirements of Section 934 may be used to backfill the block-out within its limits.

After lifting operations using flush or protruding metal lifting devices are complete, cut the lifting devices back to a minimum depth of 1 inch below the

concrete surface and patch with a Type F epoxy compound meeting the requirements of Section 926. For all square prestressed piling, concrete sheet piling and concrete poles, cut and patch lifting devices before transporting from the casting yard.

450-9.2.2 Placement of Bearing Assemblies: Set bearing assemblies designed to transmit reaction forces to the concrete in the position shown in the Plans. Place bearing plate assemblies or shoes which are to be cast in a product within appropriate tolerances as provided in 450-2.1. Check the assemblies for position after stripping from the forms.

450-10 Concrete Operations.

450-10.1 Temperature Restrictions:

450-10.1.1 Cold Weather Concreting: When the temperature of the surrounding air is expected to be below 40ºF within 24 hours after placing concrete, the temperature of the plastic concrete as placed must be 55ºF or greater. Maintain the temperature of the concrete after placement at or above 55ºF for the first 24 hours or until detensioning, whichever occurs first. For piles and other members with a minimum section dimension of 12 inches or more, maintain the temperature of the concrete after placement at or above 50°F for the first 24 hours or until detensioning, whichever occurs first. Make arrangements for heating, covering, insulating or housing the concrete work in advance of placement and maintain the required temperature without injury due to concentration of heat. Do not use direct fired heaters during the first 24 hours after concrete placement, unless actions are taken to prevent exposure of the concrete to exhaust gases which contain carbon dioxide. Continuously monitor the temperature of the concrete or the ambient air around the product until the product is detensioned. Monitor by the use of thermocouples located in the product cross-section or temperature recording devices located under the enclosure. Provide one thermocouple or temperature recording device for each 200 feet of bed length or part thereof. Locate the thermocouples within the products cross-section as shown in the Producer QC Plan or as approved by the Engineer. Record the monitored temperatures determined by each thermocouple. Review the recorded temperatures to ensure that they are within the specified limits. Initially calibrate recording devices or thermocouples and recalibrate them at least annually in accordance with the manufacturer's recommendations.

450-10.1.2 Hot Weather Concreting: Meet the requirements of Section 346 for temperature requirements and special measures for mixing concrete in hot weather.

Apply fog mist spray of water to prestressing strands, reinforcing steel and steel forms just before placing the concrete when the hot weather concreting special measures are in effect and the temperature of steel forms or reinforcing steel is greater than 120ºF.

450-10.2 Protection of Concrete from Weather: Have protection materials available before the concrete placement begins to cover the products in the event of rain during the placement of concrete. Protection materials may be tarps, curing blankets, or other impervious material that will not puncture when placed over protruding reinforcing steel and/or form elements. Include the method and materials for protection in the Producer QC Plan.

450-10.3 Concrete Placement:

450-10.3.1 General: Check forms, reinforcing steel, prestressing steel, vent pipes, anchorages and other embedded items for compliance with the Contract Documents before placing concrete. Place concrete in accordance with 400-7, except as modified herein.

For concrete operations conducted at night, provide enough lighting to allow visual inspection of the interior of the forms during the complete concrete placement operation.

Convey concrete by the use of buckets, conveyors, pumps, troughs, or other equipment specifically designed for concrete conveyance, provided the placement method consistently produces quality concrete with no segregation or separation of the mix. Locate the concrete conveyance equipment within 12 inches of the top of the forms or surface of the concrete to minimize the free fall of the concrete.

Multiple placements may be used within a bedline, provided compliance with 450-11.1 is maintained.

450-10.3.2 Requirements for Successive Layers: Except for self-consolidating (self-compacting) concrete, place concrete as described in 450-10.3.2.1 through 450-10.3.2.5 as shown in the Producer QC Plan or as approved in writing by the Engineer.

In any progressive concrete placement operation, do not allow the time between successive placements onto previously placed concrete to exceed 20 minutes, unless the previously placed concrete has not yet stiffened, as evidenced by the continued effective use of vibration.

450-10.3.2.1 AASHTO Type II, Florida-I Beam 36 and Double-T Beams, Piling and Precast Slab Units (Except Voided Piling and Slabs): Place concrete in one or more layers or lifts. If more than one layer is used for Double-T Beams, end the first layer such that the top of the concrete is slightly below the bottom of the flange.

450-10.3.2.2 AASHTO Type III, Type IV and Florida-I Beams 45 and 54 and Voided Units (Slabs and Piling): Place concrete in a minimum of two horizontal layers. The thickness of the first layer will be such that the top of the concrete is just above the top of the bottom flange. In voided units, end the first layer slightly above the middle height of the void. Fill the form by the last layer.

450-10.3.2.3 All Beams 63 Inches or Deeper: Place concrete in a minimum of three horizontal layers. The thickness of the first layer will be such that the top of the concrete is slightly above the top of the bottom flange. The thickness of the second layer will be such that the top of the concrete is slightly above the bottom of the top flange. Fill the beam forms by the last layer.

450-10.3.2.4 Pretensioned I Beams Containing Longitudinal Post-tensioning Ducts: Place concrete in one continuous lift beginning in the end block zone and progressing to the other end. Do not allow the progression of the concrete placement to proceed until previously placed concrete has been properly consolidated, and the rate of advancement equals the ability to fill the forms. In progression of the placement, deposit concrete within the forms on the surface of previously placed concrete.

450-10.3.2.5 Florida U Beams: Place the concrete in Florida U Beams in a minimum of two horizontal layers. The thickness of the first layer shall be such that the top of the concrete is above the top of the bottom flange.

450-10.4 Vibration of Concrete: Except for self-consolidating concrete, consolidate concrete by internal or external vibration, or combination of these methods. Design external form vibrators for the specific use. Design forms used in conjunction with external vibration and build them to effectively transmit vibration to the concrete mass. Mount and operate form vibrators in compliance with the vibrator manufacturer's written recommendations, a copy of which must be on file at the prestressed concrete plant. Secure vibrators to the form mounts by positive locking devices so that maximum vibration is transmitted into the form. Modify or replace external form vibrator systems that are demonstrated to be ineffective. Operate vibrators at each mount location for the time necessary for complete concrete consolidation. Do not allow progressive points of

vibration to exceed twice the visually effective radius of vibration. Keep forms equipped with external vibrators clean, and free of any buildup of hardened concrete.

Ensure internal vibrators are available before concrete placement is started. Use an internal vibrator with a head of such size that proper vibration of the concrete will be secured without causing movement of the prestressing steel or reinforcing steel. The vibrating frequency range must be 8,000 to 15,000 impulses per minute. Have at least one standby vibrator available on-site. Insert the vibrator in the concrete at points spaced to ensure uniform vibration of the entire mass of the concrete. Do not allow points of insertions to be further apart than the radius over which the vibrator is visibly effective. Allow the vibrator to sink into the concrete by its own weight and allow it to penetrate into the underlying layers sufficiently so that the two layers are thoroughly consolidated together. After the concrete is thoroughly consolidated, slowly withdraw the vibrator to avoid formation of holes.

Revise the existing placement and consolidation procedure to improve the consolidation of the concrete, if the existing placement and consolidation procedure have produced unacceptable surface defects such as honeycombing, aggregate or mortar pockets, and excessive air bubbles.

450-10.5 Finishing:

450-10.5.1 General: When concrete incorporating silica fume is used, screed and finish with a continuous water fog mist maintained above the concrete. Do not apply the fog directly toward the concrete. The Contractor may apply a monomolecular finishing aid approved by the Engineer in accordance with the manufacturer's recommendation.

450-10.5.2 Beams: Rough float the top surface of the beam and then scrub it transversely with a coarse brush or metal tine to produce a roughened surface for bonding. For the other external surfaces of prestressed beams, unless otherwise specified, apply a General Surface Finish in accordance with 400-15.1. Remove mortar leakage and stains to produce beams with a uniform appearance.

450-10.5.3 Piling: Unless a Class 5 Applied Finish Coating is otherwise specified, apply a general surface finish as specified in Section 400 to pile surfaces, except that pointing with mortar will not be required for cosmetic chips and bug holes with a depth less than 1/4 inch and a diameter of less than 3/4 inch. All other general surface finish requirements will apply, including the pointing of material form tie cavities with mortar. Surface finish deficiencies that meet the definition of noncomplying prestressed products must be corrected in accordance with 450-12. Miter or round the top corners similar to the corner radius of the pile forms. Surfaces exposed during casting must have a steel trowel finish.

450-10.5.4 Slabs and Double-T Beams: When the Plans show the top surface of prestress slab or Double-T Beams units to be the riding surface, apply a Class 4 floor finish in accordance with Section 400. When the Plans show the surface to be overlaid with asphalt or concrete, rough float the top surface and then scrub it transversely with a coarse brush to remove all laitance and to produce a roughened surface for bonding. For the other external surfaces of slabs and double-T beams, unless otherwise specified, apply a General Surface Finish in accordance with 400-15.1.

450-10.6 Curing: Cure prestressed concrete as required for a minimum duration of 72 hours. If forms are loosened upon setting of concrete and/or removed before the 72 hour curing period is complete, expand the curing to cover the newly exposed surfaces by either coating with curing compound or extending the continuous moist cure area. Maintain concrete surface moisture at all times until curing is begun. If a water sheen is not present, apply

supplemental moisture by fog misting or prevent water sheen loss on flat work by use of an evaporation retarder.

After the finishing operations have been completed and as soon as the concrete has hardened sufficiently to permit the application of curing material without marring the exposed surface, cover the exposed surfaces of all prestressed concrete products by one of the following procedures or other alternate curing methods. Alternate curing methods and details proposed by the Contractor must be approved by the Engineer. Base alternate curing methods upon a demonstrated ability to retain surface moisture of the concrete and to control curing temperatures within acceptable limits. Discontinue use of any alternate curing method other than those included herein upon any indication of noncompliance with this Specification.

450-10.6.1 Continuous Moisture: Place burlap on the surface and keep it continuously saturated for the curing period by means of soil soakers, leaking pipes, or automatic sprinklers. Do not apply moisture manually. If side forms are removed during the curing period, extend the burlap to completely shield the sides of the product. Water flow may be metered to cycle repetitively for five minutes on and five minutes off during the 72 hour curing period. When it is not practical to apply moisture or curing compound inside the voided piles, cover their ends with wet burlap to prevent moisture loss.

450-10.6.2 Membrane Curing Compound: Apply a white Type 2 curing compound to all surfaces in a single-coat, continuous operation, at a uniform coverage as recommended by the manufacturer but not less than 1 gallon per 150 square feet. Apply the curing compound on the concrete surfaces that are still damp but no free standing water. Allow surfaces covered by the membrane curing compound to remain undisturbed for the curing period. Recoat any cracks, checks or other defects in the membrane seal which are detected during the curing period within one hour. If side forms are loosened during the curing period, remove them at that time and immediately coat the formed surfaces with a clear membrane curing compound and maintain the surface seal for the remainder of the curing period. Bottom surfaces must be similarly coated after removal of the forms. Remove membrane curing compound to applied surfaces of concrete products to which other concrete is to be bonded by sandblasting or water-blasting until all traces of membrane curing compound are removed.

When the curing compound is applied by spraying, use a compressor driven sprayer of sufficient size to provide uniform spray at the nozzle. Keep all nozzles clean to ensure a uniform application of compound. For compressor driven sprayers, provide a calibrated reservoir which will allow the quantity of applied materials to be accurately determined. Maintain standby equipment in case of mechanical failure. If a mechanical failure occurs, a hand held pump-up sprayer may be used to apply curing compound to the remainder of the products cast in the day's production. Suspend additional concrete placements until the mechanical sprayer is functioning properly.

450-10.6.3 Curing Blankets: Curing blankets may be used for curing the top surfaces of products. Do not use curing blankets which have been torn or punctured. Securely fasten edges to provide as tight a seal as practical. Allow curing blankets to remain in place for the curing period. Should the system fail to maintain a moist condition on the concrete surface, discontinue the use of curing blankets and take immediate corrective action to prevent further loss of concrete moisture.

450-10.7 Accelerated Curing:

450-10.7.1 General: Use low-pressure steam curing, radiant heat curing or continuous moisture and heat curing. If accelerated curing is completed before the curing period

has elapsed, continue curing for the remaining part of the curing period in accordance with one of the curing methods above.

If accelerated curing is used, furnish and use temperature recording devices that will provide accurate, continuous, and permanent records of the time and temperature relationship of the enclosure and concrete throughout the entire curing period. Place the temperature recording sensors at a minimum of two locations, spaced approximately at or near the third point of bed length, to measure the temperatures of the enclosure and concrete. Initially calibrate recording thermometers and recalibrate them at least annually in accordance with manufacturer's recommendations. Place the sensors at the center of gravity of the bottom flanges for beams. Place the sensors at the center of gravity of the cross sections normal to pile length for solid piles, and at the midpoint of the wall thickness of the pile for voided piles.

When the ambient air temperature is equal to or higher than 50ºF, start the accelerated curing by supplying or retaining moisture and the application of the heat, following the initial set period of concrete. Determine the initial set time in accordance with ASTM C403. During the application of heat, do not allow the temperature rise in the concrete product to exceed 36ºF per hour. The maximum curing temperature of the enclosure or concrete must not exceed 150ºF. Maintain the maximum curing temperature uniform throughout the enclosure, with variation of not more than 20ºF from the maximum peak temperature until concrete reaches the required release strength. Allow the concrete element to cool gradually at the maximum cooling rate of 50ºF per hour and continue the cooling at this rate until the concrete temperature is 40ºF or less above the ambient temperature outside the curing enclosure.

When the ambient air temperature is below 50ºF cure the concrete in two stages. Start the accelerated curing of the first stage during the preset period by applying heat to increase the temperature of concrete at the maximum rate of 10ºF per hour. The total temperature gain of concrete during the initial set period cannot exceed 40ºF higher than the placement temperature, or 104ºF, whichever is less. Upon obtaining the initial set, continue curing as stated above for ambient temperature of 50ºF or higher. To prevent moisture loss on exposed surfaces during the preheating period, cover products as soon as possible after casting or keep the exposed surfaces wet by fog spray or wet blankets. Use enclosures for heat curing that allow free circulation of heat about the product and that are constructed to contain the heat with a minimum moisture loss. The use of tarpaulins or similar flexible covers may be used provided they are kept in good repair and secured in such a manner to prevent the loss of heat and moisture. Use enclosures that cover the entire bed from stressing abutment to stressing abutment, including all exposed stranding.

450-10.7.2 Low-Pressure Steam: The steam must be in a saturated condition. Do not allow steam jets to impinge directly on the concrete, test cylinders, or forms. Cover control cylinders to prevent moisture loss and place them in a location where the temperature is representative of the average temperature of the enclosure.

450-10.7.3 Curing with Radiant Heat: Apply radiant heat by means of pipe circulating steam, hot oil or hot water, or by electric heating elements. To prevent moisture loss during curing, keep the exposed surfaces wet by fog spray or wet blankets.

450-10.7.4 Continuous Moisture and Heat: This method consists of heating the casting beds in combination with the continuous moisture method described above. Do not allow the heating elements to come in direct contact with the concrete or the forms. The initial covering of burlap and the continuous application of moisture will be as described in 450-10.6. An auxiliary cover in addition to the burlap for retention of the heat will be required over the

entire casting bed. Support this cover a sufficient distance above the product being cured to allow circulation of the heat.

450-10.8 Curing Requirements for Silica Fume Concrete: Use either a 72 hour continuous moisture curing or a (12-24) hour low-pressure steam curing in accordance with 450-10.7. Upon completion of the low-pressure steam curing, continue curing for the remaining part of the 72 hour curing period by application of the curing compound, continuous moisture curing, or use of the curing blankets.

If 72 hour continuous moisture is used, begin curing silica fume concrete immediately after the finishing operation is complete and keep a film of water on the surface by fogging until the curing blankets are in place. No substitution of alternative methods nor reduction in the time period is allowed. After completion of the 72 hour curing period, apply a membrane curing compound to all concrete surfaces. Apply curing compound according to 450-10.6.

450-10.9 Form Removal: Do not remove forms sooner than six hours after casting and not until the concrete strength is sufficient to avoid structural damage. For AASHTO Type V, Type VI, Florida-I Beams, and Bulb-T Beams, do not remove the forms supporting the top flange concrete sooner than 12 hours after casting unless the release strength has been reached.

450-11 Detensioning.

450-11.1 General: The required concrete strength at which the prestressing force may be transferred to the concrete in a product will be a minimum of 4,000 psi, unless specified otherwise in the Plans. Verify the release strength by compressive strength cylinder tests or other approved means, no later than 24 hours after casting and every 24 hours thereafter until release strength is developed. In lieu of every 24 hour testing, the contractor is permitted to estimate the strength development of concrete by the maturity method in accordance with ASTM C1074, the pulse velocity method in accordance with ASTM C597, or any other nondestructive test method acceptable to the Engineer, until the time of the detensioning. Before detensioning, verify the concrete release strength by testing the compressive strength test cylinders. Make a minimum of two compressive strength release test cylinders daily for each individual mix or for each LOT, or fraction thereof, of given concrete mix design where the daily consumption exceeds this volume or when non-continuous batching or dissimilar curing is used. The release strength test, representing the LOT, is the average compressive strength of two test cylinders, which are cured under conditions similar to the product or match-cured test specimens, which are match cured until the time of release. For products cured using accelerated curing, release the prestressing force immediately after terminating the accelerated curing process. After the detensioning operation is completed, continue to 72 hour curing period using one of the methods listed in 450-10.6. For products cured using methods other than accelerated curing, release the prestressing force within a detensioning time limit, not to exceed five calendar days after the verification of release strength by compressive strength cylinder test or other approved strength gain monitoring system. For all products in a casting line, use the same test method for determining their release strengths. Ensure the detensioning time limit is included in the Producer QC Plan. Cure concrete cylinders used for detensioning strength tests in the same manner and location as the prestressed concrete products.

For I-girders, where side forms are loosened upon setting of concrete or removed before the 72 hour curing period is complete, the top flange dormant strands may be released after the concrete reaches a compressive strength of 2,000 psi.

450-11.2 Method of Stress Transfer: In all detensioning operations, keep the prestressing forces nearly symmetrical about the vertical axis of the product and apply them in a manner that will minimize sudden shock or loading. Remove or loosen forms, ties, inserts, or other devices that would restrict longitudinal movement of the products along the bed. Release hold-downs for products with draped strands in a sequence as shown in the Plans or Producer QC Plan. Cut dormant strands (partially tensioned strands) in top of beams before releasing any fully tensioned strands. Release fully bonded strands next, beginning with the lowest row and moving upwards, followed progressively by strands having the minimum length of tubular sheathing through to those strands having the maximum length of tubular sheathing. The Contractor may propose alternative detensioning patterns to suit the plant's particular operation. Specify the method of the stress transfer to be used either in the Producer QC Plan or the construction submittal.

Transfer prestressing forces to the concrete by either single strand release or multiple strand release.

450-11.3 Single Strand Detensioning: Detension the strand by using a low-oxygen flame in accordance with a pattern and schedule provided in the approved shop drawings, or Producer QC Plan, or described in 450-5. Heat with a low-oxygen flame played along the strand for a minimum of 5 inches. Heat strands in such a manner that the failure of the first wire in each strand will occur after the torch has been applied for a minimum of five seconds. Release strands in all prestressed products simultaneously and symmetrically about the vertical axis at both ends of the bed and at all intermediate points between products to minimize sliding of products. As an alternate, strands in piles, sheet piles, slabs and AASHTO Type II girders may be released simultaneously and symmetrically about the vertical axis at both ends of the bed until all the strands are released, then proceeding in order to intermediate points nearest the bed ends, or to the single remaining point at the center and release strands at these points in the same manner until all strands are released.

450-11.4 Multiple Strand Detensioning: In this method, detension all strands simultaneously by hydraulic dejacking. The total force is taken from the header by the jack, then released gradually. Do not allow the overstress required to loosen the anchoring devices at the header to exceed the force in the strand by 5%. After detensioning, strands at all points may be cut progressively from one end of the bed to the other using equipment and methods described above.

450-11.5 Cutting Strands and Bars: Upon completion of the detensioning operation, cut strands to required length, using an oxygen flame or mechanical cutting device. Do not use electric arc welders to cut bars or strands.

450-11.5.1 Beams: For beam ends that will be permanently encased in concrete diaphragms, cut strands to 2.5 inches plus or minus 0.5 inch beyond the end of the product or as specified in the Plans. For beams with ends that will not be encased in permanent concrete diaphragms, mechanically cut strands a minimum of 1/8 inch below the concrete surface.

450-11.5.2 Piles: Mechanically cut strands flush with the concrete surface. For top (head) of fender piles and pile ends not embedded under final conditions, burn the strands a minimum of 1 inch below the concrete surface and clearly mark the pile to identify the top (head) end.

450-11.5.3 Poles: Mechanically cut strands to a minimum of 1/8 inch below the concrete surface.

450-11.6 Protecting Ends of Strands: Prepare the concrete surfaces and apply Type F-1 epoxy in accordance with the manufacturer's recommendations.

450-11.6.1 Beams: For beam ends that will not be permanently encased in concrete diaphragms, apply two layers of epoxy to the exposed beam ends (including clipped and chamfered surfaces) within seven calendar days of detensioning and prior to development of any corrosion at the ends of strands. The finished thickness of the epoxy coating must be a minimum of 1/16 inch and form a vertical flat plane without deviations or localized depressions from recessed strands or other defects.

450-11.6.2 Piles: Apply epoxy patches to all recessed strands.

450-11.6.3 Poles: Coat entire face of tip (top) and butt (bottom) ends with epoxy.

450-12 Noncomplying Prestressed Products.

450-12.1 General: When a precast prestressed concrete product does not comply with the requirements of this Section or is damaged, use the following provisions for evaluating and disposing of deficiencies. However, when precast prestressed concrete products have been installed, the disposition of concrete cracks shall be in accordance with 400-21. Apply these provisions in all cases that clearly fall under the circumstances described. Consider situations not covered by these specific circumstances on their individual merits. Consider and apply the following where practical.

The QC Manager, or QC inspectors under direction of the QC Manager, will examine all deficiencies within the time limit specified in 450-2.1 and 450-2.3, to determine the applicable provisions and requirements of this Article and which course of action is appropriate. If the QC Manager determines that a deficiency is a cosmetic or minor defect, appropriate repairs may be executed immediately in accordance with 450-13. Perform and complete cosmetic and minor defect repairs to the satisfaction of the QC Manager. If the QC Manager determines that a deficiency is a major deficiency, requiring an engineering evaluation, submit a repair proposal to the Engineer in accordance with 450-14. Make all repairs that require a repair proposal under the observation of and to the satisfaction of the QC Manager.

The disposition of deficiencies and repair methods provided herein must at no time, and under no circumstances, be used as an excuse for or applied in such a manner so as to relieve the Contractor of his responsibility for QC. The number and type of deficiencies evaluated under this Specification will, however, be used in evaluating the Contractor's QC.

The Engineer will require a credit on any product with deficiencies that require engineering evaluation and are attributable to the Contractor, accepted for use in the structure. Bear the costs of repairs and any actions taken to rectify deficiencies at no expense to the Department.

450-12.2 Surface Deficiencies: Surface deficiencies are defined below. Regardless of the types of deficiencies, when the total surface area of all deficiencies within a single product exceeds 2.0 % of the product's length times its depth, the product will require engineering evaluation and disposition in accordance with 450-14. Surface deficiencies include spalls, chips, bug holes, surface porosities, and honeycombs.

450-12.2.1 Bug Hole: A bug hole is a void caused by air that is entrapped against the form and that has an area up to 3.0 square inches and a depth up to 1.5 inches. Treat any bug hole with a dimension exceeding either of these dimensions as a honeycomb. The Engineer will not require the Contractor to repair any bug hole with a depth less than 0.25 inch and less than 0.75 inch in diameter, unless otherwise indicated in the Plans or Specifications. Consider all other bug holes cosmetic and repair them in accordance with 450-13.2.

450-12.2.2 Spall: A spall is a depression resulting when a fragment is detached from a larger mass by impact, action of weather, by pressure or by expansion within the larger mass.

A cosmetic spall is a circular or oval depression not greater than 1.0 inch in depth nor greater than 3.0 square inches in area, and must be repaired in accordance with 450-13.2.

With the exception of spalls in the bearing areas and edge of the top flange, a minor spall is defined as a spall not larger than 2.0 square feet and no deeper than one inch plus the sum of the concrete cover and the diameter of the bar in the first layer of reinforcing. Repair minor spalls in accordance with 450-13.4.

Spalls located at the edges of the top flange are considered minor spalls as follows:

1. A spall on one edge of the top flange, without a coincident spall on the other edge of the top flange, is considered a minor spall if the total longitudinal length of the defect does not exceed 10 feet and any lateral dimensions of the spall measured perpendicular to the longitudinal axis of the beam are not greater than 25% of the width of the top flange.

2. Coincident spalls on opposite edges of the top flange are considered minor spalls if the total length of the defects within both spalls does not exceed 10 feet and any lateral dimensions of the spalls at a given location measured perpendicular to the longitudinal axis of the beam are not greater than 25% of the width of the top flange.

Spalls located in the bearing area that extend back into the concrete within the limits above the bearing plate are considered major spalls.

A major spall is a spall that any of its dimensions exceeds the dimensions that are described for minor spalls. A major spall requires engineering evaluation and disposition in accordance with 450-14.

450-12.2.3 Chip: A chip is the local breaking of the corners or edges of the concrete with the resulting void containing angular surfaces.

Cosmetic chips are chips where the sum of the two lateral dimensions perpendicular to the length does not exceed 2.0 inches. Regardless of length, it is not necessary to repair cosmetic chips except for visually exposed reinforcing steel, prestressing strand, insert, or weldments surfaces, which may require repair in accordance with 450-13.5.

Minor chips are chips where the sum of the two lateral dimensions perpendicular to the length exceeds 2.0 inches, but does not exceed 4.0 inches, and with a length of no more than 12.0 inches. Repair minor chips in accordance with 450-13.5.

Major chips are any chips larger than minor chips. Major chips require engineering evaluation and disposition in accordance with 450-14.

450-12.2.4 Surface Porosity: Surface porosity is considered a minor defect and is the localized porosity of a formed surface due to medium scaling. Medium scaling is defined as the loss of surface mortar up to 3/8 inch in depth and exposure of concrete aggregate. Repair surface porosity in accordance with 450-13.3.

450-12.2.5 Honeycombing: Honeycombing is voids in the concrete, loss of fines or other material from between the aggregate particles, the inclusion of air pockets between aggregate particles, or larger volumes of lost material. Remove honeycombing in its entirety to sound concrete before establishing the classification of the defect.

Minor honeycombing is a void no deeper than concrete cover and no larger than 2.0 square feet in area that results after the removal of unsound material. Repair minor honeycombing in accordance with 450-13.6.

Major honeycombing is a void deeper than concrete cover regardless of the surface area, or shallower but with a surface area greater than 2.0 square feet that results after the removal of unsound material. Major honeycombing requires engineering evaluation and disposition in accordance with 450-14.

450-12.3 Formed Surface Misshaping: Formed surface misshaping is the visual and measurable deficiency or excess of material from the specified tolerance on any surface of a product.

450-12.3.1 Pile Ends: Make square pile ends which are outside this Section's tolerances by grinding in accordance with 450-13.7, or any other means of removal as approved by the Engineer. Reshape the chamfer if more than 0.25 inch from the cast pile end is removed and such removal affects the chamfer dimension.

450-12.3.2 Pile Chamfers: Reshape chamfers outside of this Section's tolerances to within the tolerances in accordance with 450-13.7.

450-12.3.3 Other Surfaces: Any deficiency exceeding the plan dimensions for size, length, squareness, designated skew, plumbness, and the like by up to twice the specified plus (+) tolerance may be corrected by grinding to within the allowable tolerance in accordance with 450-13.7. Any deficiency exceeding the specified minus (-) tolerance or twice the specified plus (+) tolerance requires an engineering evaluation and disposition in accordance with 450-14.

450-12.4 Bearing Areas: Consider the bearing area to extend from the end of the product to 3 inches beyond the edge of the bearing contact area for the full product width.

Do not allow the bearing plate or bearing area plane of precast prestressed concrete beam and slab units to deviate from a true plane by more than 1/8 inch when tested in all directions with a steel straightedge. In the event that a 100% true plane is not achieved, the Engineer will accept a surface having not less than 80% of its area in a true plane provided the deviations are evenly distributed. Remove minor convex projections by grinding with an abrasive stone. The Engineer will accept minor depressions, provided that they amount to not more than 20% of the bearing area, are evenly distributed over the entire bearing area, and are not deeper than 1/8 inch.

450-12.5 Cracks: A crack is the separation of a product or portion thereof which may appear before or after detensioning and may or may not cause separation throughout the product thickness or depth. Identify cracks by the classifications and locations described below and subject them to the disposition required by the identified crack. If the total surface length of all cracks within a single product, regardless of width, located between the end zones exceeds one-quarter of the product's length, an engineering evaluation and disposition in accordance with 450-14 is required. Establish crack sizes subsequent to release of all pretensioning forces.

The Engineer will reject any pile that is cracked to the point that a transverse or longitudinal crack extends through the pile, shows failure of the concrete as indicated by spalling of concrete on the main body of the pile adjacent to the crack, or which in the opinion of the Engineer will not withstand driving stresses. Occasional hairline surface cracking caused by shrinkage or tensile stress in the concrete from handling will not be cause for rejection.

450-12.5.1 Classification and Treatment of Cracks: Regardless of cause and for the purposes of Section 450, cracks in precast prestressed components, excluding piling, will

be identified according to their surface appearance in accordance with the following classifications:

Cosmetic cracks are any cracks which are less than 0.006 inch wide and are located in non-critical locations on the product. Based on the environmental classification of the site where the product will be located, treat cosmetic cracks as follows:

1. Slightly or moderately aggressive environment: Do not treat cracks.

2. Extremely aggressive environment: After detensioning, apply penetrant sealer in accordance with Section 413.

Minor cracks are any cracks which are between 0.006 and 0.012 inch wide, inclusive, and are located in non-critical locations on products. Based on the environmental classification of the site where the product will be located and the final elevation of the product on the site, treat minor cracks as follows:

1. Slightly aggressive environment: Do not treat the cracks.

2. Moderately aggressive environment:

a. For products that will be located at an elevation of more than 12 feet above the existing ground level or above mean high water elevation: Do not treat cracks.

b. For products that will be located at an elevation within 12 feet above the existing ground level or above mean high water elevation: Apply a penetrant sealer on the cracks after detensioning in accordance with Section 413.

3. Extremely aggressive environment:

a. For products that will be located at an elevation of more than 12 feet above the existing ground level or above mean high water elevation: Apply a penetrant sealer on the cracks after detensioning in accordance with Section 413.

b. For products that will be located at an elevation within 12 feet above the existing ground level or above mean high water elevation: Inject epoxy into the cracks after detensioning in accordance with Section 411.

Major cracks are any cracks of any width which are located in critical locations on products or cracks in non-critical locations of the product that are greater than 0.012 inch wide. Major cracks require an engineering evaluation, including crack depth measurement and disposition, in accordance with 450-14.

Cracks in the Riding Surface: Repair cracks in the top surface of components which will become the riding surface (with no overlays), once in service, regardless of the environmental classification as follows:

1. Epoxy inject cracks wider than 0.006 inch in accordance with Section 411, unless the Engineer approves the sealing of cracks with high molecular weight methacrylate in accordance with Section 413.

2. Seal cracks that are 0.006 inch wide or less by applying a penetrant sealer in accordance with Section 413.

450-12.5.2 Locations of Cracks: Regardless of cause and for the purposes of this Specification, cracks will be identified as occurring in either critical or non-critical locations of the product in accordance with the following criteria and conditions:

Critical locations of cracks are any locations in which a crack would tend to open under stresses occurring at any time during the service life of the structure, or which may reduce the ultimate capacity or fatigue life of the product. Specifically, critical locations of

cracks are any locations in a product not defined and not included in 450-12.5.3 as non-critical. Cracks in critical locations require engineering evaluation and disposition in accordance with 450-14.

Non-critical locations of cracks are defined by the position within a product's length, the position within a product's depth, and the orientation of the crack.

450-12.5.3 Non-critical Locations of Cracks by Product Type:

450-12.5.3.1 Piles: Surface cracks in any direction and of a length not exceeding twice the width of the pile.

450-12.5.3.2 All Types of Simple Span Pretensioned Concrete Beams:

End zones (within a distance of three times the depth of the product from the end):

1. Horizontal or diagonal cracks at either or both ends in the top flange and web of the product, not in the plane of nor intersecting any row of prestressing strands, and extending from the end of the product for a length not to exceed the product's depth.
2. Vertical cracks extending through the top flange not to exceed one-half of the product's depth after detensioning.

Mid-span region (between end zones): Vertical cracks extending through the top flange and web of the product.

Any Location: Horizontal crack at the interface of the web and top flange which is not longer than the product's depth.

Intermediate diaphragms of Florida U-Beams: cracks at any location.

450-12.5.3.3 Simple Span Double-T Beams:

End zones (within a distance of twice the depth of the product from the end): One horizontal crack at either or both ends and in the top flange of the product, not in the plane of nor intersecting any row of prestressing strands, and extending from the end of the product for a length not to exceed half the product's depth.

Mid-span Region (between end zones): Vertical cracks extending through the top flange and not exceeding half the web depth of the product.

Any Location: Horizontal crack at the interface of the web and top flange which is not longer than the product's depth.

450-12.5.3.4 Pretensioned I-Beams Containing Longitudinal Post-tensioning Ducts:

End zones (within a distance of twice the depth of the beam from the end): Vertical cracks in the bottom half of the beam within an end zone with no post-tensioning anchorages and where the post-tensioning ducts are located in the top of the beam at the location of a permanent substructure support. Horizontal or diagonal cracks at either or both ends in the top flange and web of the product where no post-tensioning anchorage zone is present.

Mid-span Region (between quarter points): Vertical cracks in the web and top flange of the beam provided the beam is to be supported at each end in its final position in the structure.

Any Location: Horizontal cracks not longer than the beam's depth and only at the interface of the web and top flange provided the beam is to be supported at each end in its final position in the structure.

450-12.5.3.5 Post-Tensioned Beams for Drop-In Spans:

Pier Sections: Horizontal or diagonal cracks at either or both ends in the top flange and web of the product.

Drop-In Sections: Same as simple span pretensioned concrete beams.

End Sections: At end of beam with post-tensioning anchorages: same as Pretensioned I-Beams Containing Longitudinal Post-tensioning Ducts. At end of beam adjacent to pier sections: same as for simple span pretensioned concrete beams.

450-12.5.3.6 Simple Span Prestressed Slab Units:

End Zones (within a distance of twice the depth of the product from the end): One horizontal crack at either or both ends in the top half of the product, which is not in the plane of nor intersecting any row of prestressing strands, and extending from the end of the product for a length not to exceed half the product's depth.

Any Location (after detensioning): Vertical cracks in the top half of the product's depth.

450-12.5.3.7: Pretensioned Concrete Poles:

Longitudinal cracks: The length of each crack must be less than twice the base width of the pole.

Transverse or diagonal cracks: Cracks perpendicular to or at an inclined angle to the longitudinal direction of the pole. The length of each crack must be less than two-thirds of the base width of the pole.

Edge cracks: Cracks exhibiting at the edge and extending across one or two adjacent planes of a square pole. The total length of each crack must be less than 2.0 inches.

450-13 Repair Methods and Materials.

450-13.1 General: Before beginning the repair of bug holes, spalls, chips, surface porosity, and honeycomb, remove all laitance, loose material, form oil, curing compound and any other deleterious matter from repair area. Repair cosmetic and minor deficiencies by methods specified herein. The Contractor is permitted to elect an alternate repair method. Submit the alternative repair methods in writing to the Engineer for approval prior to performing repairs. For each project maintain the record of deficiencies and their repair methods. Ensure the record includes information about product description, unit serial number, date cast, defect description including dimensions, repair method and materials, defect discovery date, and signature of producer's QC Manager indicating concurrence with the information.

Cure repaired surfaces for the full 72 hour curing time or for the curing time as recommended by written recommendations from the manufacturer of the repair material. Ensure the repaired surfaces have a surface texture, finish and color which matches the appearance of the unaffected surrounding area of the product.

450-13.1.1 Product Acceptance on the Project: Use only non-shrink grout that is listed on the Approved Product List (APL).

450-13.2 Cosmetic Surface Filling: Repair areas to be filled with an approved high-strength, non-metallic, non-shrink grout meeting the requirements of Section 934. Mix, apply and cure the grout in accordance with the manufacturer's recommendations. Coating of the prepared surface with epoxy bonding agent before grout placement is not required.

450-13.3 Surface Restoration: Maintain the surface continuously wet for a minimum of three hours before application of repair material. Repair areas to be restored with a mortar mix consisting by volume of one part cement, 2.5 parts sand that will pass a No. 16 sieve, and

sufficient water to produce a viscous slurry mix or repair areas to be restored with an approved high-strength, non-metallic, non-shrink grout meeting the requirements of Section 934. Mix, apply and cure the grout in accordance with the manufacturer's recommendations. Cure areas repaired with a mortar mix in accordance with 450-10.6. Coating of the prepared surface with epoxy bonding agent before grout placement is not required.

450-13.4 Cutting and Filling: Carefully cut all feathered edges of the area to be repaired back perpendicular to (or slightly undercut from) the surface to the depth of sound concrete or to a minimum depth of 1/2 inch, whichever is deeper. Coat the prepared surface with an approved epoxy bonding agent applied in accordance with the manufacturer's recommendations. Fill the cutout area with an approved high-strength, non-metallic, non-shrink grout mixed and applied in accordance with the manufacturer's recommendations. Firmly consolidate the grout mix in the cutout area.

450-13.5 Restoration of Surfaces and Edges: When reinforcing steel or prestressing strand is exposed, remove concrete from around the items to provide a 1 inch clearance all around. Form surfaces and edges to the original dimensions and shape of the product. Coat the prepared surface with an approved epoxy bonding agent applied in accordance with the manufacturer's recommendations. Restore surfaces and edges with an approved high-strength, non-metallic, non-shrink grout mixed and applied in accordance with the manufacturer's recommendations. Firmly consolidate the grout mix in the area to be repaired. Restore surfaces and edges to the original dimensions and shape of the product.

450-13.6 Removal and Restoration of Unsound Concrete: Carefully cut the area of unsound concrete to be repaired back perpendicular to (or slightly undercut from) the surface and to the depth of sound concrete or to a minimum depth of 1 inch, whichever is deeper. When reinforcing steel, prestressing strand, inserts or weldments are exposed, remove the concrete from around the items to provide a 1 inch clearance all around. Coat the prepared surface with an approved epoxy bonding agent applied in accordance with the manufacturer's recommendations and then filled with an approved high-strength, non-metallic, non-shrink grout mixed and applied in accordance with the manufacturer's recommendations. Firmly consolidate the grout mix in the area to be repaired. Restore surfaces and edges to the original dimensions and shape of the product.

450-13.7 Surface Grinding: Grind off misshaped formed surfaces with an abrasive stone. Apply two coats of penetrant sealer in accordance with the requirements of Section 413, to any surfaces which are not subsequently encased in concrete, immediately after grinding has been accepted. Do not apply a penetrant sealer to any surfaces to be subsequently encased in concrete.

450- 13.8 Treatment of Cracks: Treat cracks in accordance with 450-12.5.

450-14 Submittal of Proposal to Accept or Repair Deficiencies.

450-14.1 General: When a product has deficiencies unacceptable to the Engineer, the Contractor may propose repairs. Deficiencies discovered in the casting yard must be repaired before shipment. Do not ship products, which require repairs, from the casting yard to the project site until such repairs are complete and the Engineer has determined the product to be acceptable. Deficiencies discovered at the project site may be repaired at the site, subject to the Engineer's approval. All proposed repairs must be submitted for engineering evaluation and credit in accordance with 450-14.2, unless the specific repair methods have been submitted and approved. The plant may use the repair method that is previously approved in the Producer QC Plan, without submittal of the proposal for engineering evaluation or credit. The use of the previously

approved repair method is only applicable to the same type of single deficiency that is exhibited in a product.

450-14.2 Submittal of Repair Proposal:

The repair proposal must be completed by the Contractor's Engineer of Record and shall consist of the following:

1. A cover letter prepared on the Contractor's letterhead addressed to the Engineer describing the product.

2. Information in a format acceptable to the Engineer describing the details of the non-compliance and the proposed repairs.

3. An engineering evaluation: A structural performance and durability evaluation which explains why the performance and durability of the repaired deficient product is acceptable as compared to that of an undamaged comparable product. The evaluation must be supported by one or more of the following types of information:

a. Written evidence of a previously approved comparable deficiency and its repair.

b. Documented research that demonstrates the proposed repair to be effective.

c. If applicable, engineering calculations providing support for recommendations.

4. A proposed credit to the Contract proportionate to the product's deficiency. The credit is in addition to the cost for review and evaluation of the proposal.

5. Any other supportive information, pictures and drawings. For cracked elements, show on a drawing the location, average width, depth, length, and termination points of each crack along the surfaces. Provide the distance from each termination point to a fixed reference point on the component, such as beam end or edge of flange. The description of the proposed repair and the structural and durability evaluation of the product must be prepared by or under the direct supervision of the Contractor's Engineer of Record and must bear their signature and seal.

If the proposal is accepted by the Engineer, all Department costs associated with review of the proposal, including the cost of any and all engineering evaluation and testing services required, will be deducted from payment to the Contractor, but not to exceed 15% of the product value based on unit bid prices.

Include in the proposed credit consideration of the Department's added costs which may include but are not necessarily limited to re-inspection, testing, reduced durability, or increased maintenance cost. The Engineer will review and evaluate the Contractor's proposal and will notify the Contractor of its disposition. The Engineer's review of the Contractor's proposal does not amend or delete code requirements, unless such changes are specifically brought to the Engineer's attention and accepted by the Engineer. The Engineer's acceptance of a proposal does not relieve the Contractor of his responsibility to provide products that are structurally adequate to resist the loads specified in the Contract drawings and that maintain the intended aesthetic, durability and maintenance aspects of the product. The Engineer will not accept repaired products unless repairs are made as proposed or described, the resulting repairs are sound in all aspects, and the repairs are aesthetically acceptable. Replace a rejected product with a product meeting the requirements of the Contract Documents at no additional expense to the Department.

450-15 Repairs Before Approval.

If repairs to precast products are initiated in advance of the Engineer's approval, the affected product will only be considered for acceptability and use when the following conditions have been satisfied:

1. Before beginning the repairs, prepare and deliver to the Engineer a repair proposal in accordance with the requirements of 450-14.
2. All repair materials must meet the requirements of Section 930 and be selected from the APL or otherwise be subsequently evaluated, tested by the Contractor as required by the Department, and approved by the Department for the specific use made of the material.
3. Repairs have been performed under the observation of the QC Manager.

Accept responsibility for actions taken, and perform these actions at your own risk. It is intended that repairs be made only after the proposed methods have been accepted to ensure that the proposal will not be modified or rejected, and the work will be accepted if the repair proves to be adequate.

450-16 Handling, Storage, Shipping and Erection.

450-16.1 Handling: All products which are pretensioned may only be handled after transfer of the prestressing force. For products that are prestressed by a combination of pretensioning and post-tensioning do not handle before sufficient prestress has been applied to sustain all forces and bending moments due to handling. Exercise care in handling to prevent damage to products. Lift and move products so as to minimize stresses due to sudden changes in momentum. Calculate pick up and dunnage points. Pick up products only at points designated as pickup points as shown on the Contract Plans or shop drawings. Maintain all beams in an upright position at all times.

Evaluate the temporary stresses and stability of beams during their handling. The temporary stresses induced into the products during handling must be within the acceptable stresses at release listed in the Department's Structures Design Guidelines. Take appropriate action to increase the stability of products during handling when the factor of safety against lateral buckling instability is below 2.0. Include the expected fabrication tolerance for sweep in the analysis. The analysis procedure provided by the Precast/Prestressed Concrete Institute or similar procedures may be used for the stability evaluation.

Verify lifting devices for capacity in lifting and handling products, taking into account various positions during handling. Keep multiple component lifting devices matched to avoid non-compatible use. When a product has multiple lifting devices, use lifting equipment capable of distributing the load at each device uniformly to maintain the stability of the product. When the lifting devices are grouped in multiples at one location, align them for equal lifting.

Take appropriate steps to prevent the occurrence of cracking. When cracking occurs during handling and transportation, revise handling and transporting equipment and procedures as necessary to prevent cracking for subsequent products.

450-16.2 Storage: Store precast prestressed beams, Double-T Beams and slab units on only two points of support located within 18 inches of the end of the product or as calculated. Support skewed beams, Double-T Beams or slab units within 18 inches of the end of the full product section or as calculated. Support other products on an adequate number of supports so as to keep stresses in the products within the allowable stresses at release listed in the Department's Structures Design Guidelines. Locate multiple supports (more than two) within 1/2 inch of a

horizontal plane through the top surface of the supports. Adequately brace beams as necessary to maintain stability.

All supports must be level and on adequate foundation material that will prevent shifting or differential settlement which may cause twisting or rotation of products. Immediately pick up products in storage that have rotated or twisted and adjust the supports to provide level and uniform support for the product.

Support prestressed products that are stacked by dunnage placed across the full width of each bearing point and aligned vertically over lower supports. Do not use stored products as a storage area for either shorter or longer products or heavy equipment.

Where feasible, base the selection of storage sites, storage conditions and orientation upon consideration of minimizing the thermal and time-dependent creep and shrinkage effects on the camber and/or sweep of the precast pretensioned products.

Continuous application of water during the initial 72 hour moist curing period may be interrupted for a maximum of one hour to allow relocation of precast prestressed concrete elements within the manufacturing facility. Keep the moist burlap in place during relocation of the element.

Measure and record the sweep and camber of beams monthly. Keep the measurement records on file for review at any time by the Engineer, and upon request, transmit a copy of these measurements to the Engineer. If the camber exceeds by 1 inch the design camber shown in the Plans, take appropriate actions in accordance with 400-7.13.1 to accommodate the product in the structure.

If the sweep exceeds the tolerance specified, take immediate measures to bring the sweep of the product back to within tolerance.

Notify the Engineer immediately when the sweep or camber exceeds the specified tolerances. Special storage conditions for the purpose of removing excessive sweep will not be restricted by requirements of this Subarticle nor contained in 450-2.1. If the sweep of the product exceeds the tolerance specified and cannot be removed, the disposition of the product will be in accordance with 450-12.1 and 450-14.

450-16.3 Shipping: Do not ship precast prestressed concrete products to the project site prior to the completion of the 72 hour curing period and attainment of the required 28-day strength. The contractor is permitted to verify the shipping strength test, before 28 days, by testing compressive strength cylinders that are cured under the conditions similar to the product or by testing temperature match cured cylinders. The use of maturity method, ASTM C1074, pulse velocity method in accordance with ASTM C597, or any other nondestructive test method acceptable to Engineer, is permitted to estimate the strength before its verification by test cylinders. The shipping strength test is the average compressive strength of two test cylinders. Do not ship products until accepted and stamped by the QC Manager or the inspectors under the direct observation of the QC Manager. At the beginning of each project, provide a notarized statement to the Engineer from a responsible company representative certifying that the plant will manufacture the products in accordance with the requirements set forth in the Contract Documents and Producer QC Plan. The QC Manager's stamp on each product indicates certification that the product was fabricated in conformance with the Producer QC Plan, the Contract, and this Section. Ensure that each shipment of prestressed concrete products to the project site is accompanied with a signed or stamped delivery ticket providing the description and the list of the products.

Evaluate the temporary stresses and stability of all products during shipping and locate supports, generally within 18 inches from the beam end, in such a manner as to maintain stresses within acceptable levels. Include impact loadings in the evaluation.

450-16.4 Erection: Erect precast prestressed products without damage. Meet the handling and storage requirements of 450-16.1 and 450-16.2 for field operations. Before casting diaphragms and the deck slab, do not allow the horizontal alignment of prestressed concrete beams to deviate from a straight line connecting similar points of beam ends by more than the sweep tolerances specified in 450-2.1. Adequately brace beams as necessary to maintain stability.

450-17 Measurement and Payment.

450-17.1 General: The work specified in this Section will be measured and paid for as shown below for the particular item involved. Precast prestressed concrete members are acceptable to the Department for full payment when all requirements of the Contract Documents have been met. No partial payments will be made for precast prestressed concrete members until the 28-day strength requirement, along with other applicable Specification requirements, have been met.

450-17.2 Prestressed Concrete Piling: Payment will be made at the Contract unit price per foot for the particular type of piling, measured and paid for as specified in Section 455, including the provisions for cutoffs and splices.

450-17.3 Prestressed Concrete Beams: Payment will be made at the Contract unit price per foot for Prestressed Beams, complete in place and accepted. Final pay lengths will be plan quantity based on casting lengths, as detailed in the Plans, subject to the provisions of 9-3.2.

450-17.4 Prestressed Concrete Slab Units: Payment will be made at the Contract unit price per foot for the units, complete in place and accepted. Final pay lengths will be plan quantity based on casting lengths, as detailed in the Plans, subject to the provisions of 9-3.2.

450-18 Basis of Payment.

Price and payment will be full compensation for all work and materials specified in this Section, including steel reinforcement, pretensioning steel, embedded ducts, hardware, inserts and other materials as required, to fabricate, transport and place the product into its permanent position in the structure.

Payment for the items will be made under the following:

Item No. 450- 1-	Prestressed Beams - per foot.
Item No. 450- 2	Prestressed Beams: Florida-I Beams – per foot.
Item No. 450- 3-	Prestressed Slab Units - per foot.
Item No. 450- 4-	Prestressed Beam U-beams - per foot.
Item No. 450- 88-	Prestressed Slab Units Transversely Post-Tensioned - square foot.

SECTION 452
PRECAST SEGMENTAL BRIDGE CONSTRUCTION

452-1 Description.

Fabricate, store, transport and erect precast structural concrete superstructure and/or substructure segments on a prepared foundation, to the established lines and grades, in accordance with the design, dimensions and details shown on the Plans and in accordance with this Section.

Reinforcing steel, embedded items and all appurtenant items are included.

Base the bid on the design shown in the Plans.

The work in this Section does not include longitudinally post-tensioned beams upon which a concrete slab is cast-in-place.

452-2 Qualification Requirements for Supervisory Personnel.

Meet the requirements of Section 105.

452-3 Definitions.

The following definitions apply to segmental bridge construction:

452-3.1 Segment: A modular section of the superstructure and/or substructure consisting of a certain cross-section shape and length as detailed in the Plans.

452-3.2 Match Cast: A precast concrete fabrication process whereby a segment is cast against the preceding segment producing a matching interface which permits the re-establishment of the cast geometry at erection time. Match casting is accomplished by either the short line or long line casting method.

452-3.3 Short Line Casting: Casting segments one at a time in a casting cell between a bulkhead at one end and a previously cast segment at the other. The first segment is cast between the bulkhead and another, temporary bulkhead.

452-3.4 Long Line Casting: Casting segments on a casting bed of sufficient length to permit the cumulative casting of segments for the entire length of a span or cantilever between field closure pours without repositioning the segments on the casting bed. With this method, the first segment is cast between bulkheads and successive segments are cast between a movable bulkhead on one end and the previously cast segment on the other.

452-3.5 Casting Cell: A special formwork arrangement usually consisting of a fixed vertical bulkhead of the cross section shape at one end and adjustable soffit, side and core forms all designed and assembled into a machine for making a single superstructure segment. A casting cell for a substructure pier shaft segment consists of exterior and interior side forms and a soffit form of the cross section shape.

452-3.6 Wet Joint System: Where segments are made in a casting cell between two bulkheads and are not match cast. The segments are then erected in the superstructure with a narrow cast-in-place joint between each segment. (During erection, all the segments of a span or multiple spans are supported by falsework, truss or other technique until the joints have gained strength and the longitudinal post-tensioning installed to make them self supporting.)

452-3.7 Span By Span (Erection): Placing a specified number of segments on a temporary support system, aligned and post-tensioned longitudinally forming a completed span of the superstructure.

452-3.8 Balanced Cantilever (Erection): The segments are sequentially erected alternately on either side of the pier in cantilever to a point where a closure is cast-in-place.

452-3.9 Progressive Cantilever: (Erection): The segments are erected progressively in cantilever, in one direction, from one pier to the next, using temporary intermediate piers, or other systems as required to support the advancing cantilever between piers.

452-3.10 Casting Curve: The curve of casting geometry that has to be followed in the casting cell or bed for achieving the theoretical bridge profile and alignment after all the final structural and time dependent (creep and shrinkage) deformations have taken place. The casting curve is a combination of the theoretical bridge geometrical profile grade, alignment and the camber.

452-3.11 Camber: The amount by which the concrete profile at casting time must differ from the theoretical geometric profile grade to compensate for all structural dead load, post-tensioning, all long term and time dependent deformations (creep and shrinkage) including all the intermediate erection stages and effects. (The opposite of deflections).

452-3.12 Erection Elevation: The elevation at which a segment is set in the structure at the time it is erected. (This is profile grade corrected by the amount of deflection calculated to occur from that stage onwards.)

452-4 Shop Drawings, Calculations And Manuals.

452-4.1 General: Use methods and procedures providing adequate safety to the general public from construction/erection activities and/or falsework placed over or adjacent to traveled roadways, navigational or recreational waterways or any existing commercial, industrial or other facility.

452-4.2 Information Required: Submit detailed shop drawings, calculations, manuals and other information, including, but not limited to, the following:

452-4.2.1 Segment Shop Drawings:

1. A schedule of materials for segment fabrication including concrete, reinforcing steel, prestressing steel, duct filler, and other similar items.
2. Each segment number and the direction of erection.
3. Segment dimensions including widths, lengths, thicknesses, tapers, fillets, radii, working points, post-tensioning, clearances, rebar dimensions and spacing, embedded items, holes, anchorage positions, and other similar items.
4. Post-tensioning requirements as outlined in Section 462. Check post-tensioning for consistency with pre-approved post-tensioning hardware and provide part numbers for Department pre-approved systems on the shop drawings. Substitution of parts or materials is not allowed.
5. The volume of concrete, weight of reinforcement and weight of post-tensioning in each precast segment and the total weight for reinforcement and post-tensioning for both the superstructure and substructure summarized and tabulated on the shop drawings.
6. Details and calculations for any localized strengthening for concentrated supports and loads or reactions from any special erection equipment placed in locations not already allowed for in the Plans.
7. Details and supporting calculations for any modifications to segment geometry, cross section dimensions, or segment length including any required changes to reinforcing and post-tensioning.

8. Details of permanent and temporary embedded items including inserts, blockouts, temporary openings, holes, and other similar items; and any localized required strengthening and the materials and methods to fill and finish the holes.

452-4.2.2 Casting Yard:

1. Procedures for segment fabrication including layout of the casting yard, set up and operation of the casting cells, movable rain and sun shades, geometry control stations, the storage and handling of rebar cages. the preparation of as built geometry data, placing and finishing concrete, curing of concrete, form stripping, bond breaking, and other similar items.

2. Calculations and details for lifting, storage and stacking of segments. Additional strengthening of the segments to accommodate stacking will be at no expense to the Department.

3. Equipment for segments fabrication, including details of the forms and casting cells for the manufacture of the segments, surveying the segment, lifting and transportation of the segment in the yard, and other similar items.

4. Segment storage including layout of the storage area, method of supporting the segments, single or double stacking, placing erection marks and segment identification, and other similar items.

5. Segment transportation from the casting yard to the site.

452-4.2.3 Erection Manual: Meet the requirements in 452-8.

452-4.2.4 Manual for Geometry Control and Casting Curves: Meet the requirements in 452-6.3.

452-5 Materials.

452-5.1 General: Use materials which conform to this Section and the requirements prescribed in Division III, Materials, for the particular kind and type of material specified.

452-5.2 Concrete: Use concrete as specified in Section 346 except as specifically modified herein. Use No. 67 coarse aggregate in the concrete for segments.

Screenings are not allowed as a substitute for silica sand for use in concrete for Precast Superstructure Segments.

452-5.3 Reinforcing Steel: Use ASTM A615, Grade 60 reinforcing steel which meets the requirements of Section 415. When welding reinforcing steel, meet the requirements of the American Welding Society's Structural Welding Code D1.4. The Engineer may allow shop prepared welded reinforcing grillages. Field welding of reinforcing steel is not allowed.

452-5.4 Post-Tensioning Systems: Use post-tensioning hardware components meeting the requirements of Section 462. Components are not interchangeable and must comply with the details of the approved shop drawings.

452-6 Casting Requirements.

452-6.1 General: Ensure that all materials, details, and procedures are as specified herein, as noted in the Plans, or as directed by the Engineer.

Do not begin casting segments until the Engineer approves the relevant shop drawings, calculations, casting manuals, concrete forms and concreting operations and the post-tensioning system components and layout if different from that on the Contract Plans. (Approval of post-tensioning stressing elongations and forces for field erection operations is not required at this stage but is required prior to erection.)

To use wet joints to join cantilevers or for corrective measures, obtain the Engineer's written approval.

Give each segment an erection mark indicating its location, orientation and order in the erection sequence. Match mark abutting edges of adjacent segments. Show erection marks on the erection plans or in the erection manual.

452-6.2 Forms: Take responsibility for the design and engineering of the forms as well as their construction. Form all exposed formed surfaces of each element of the structure with the same material to produce similar concrete surface textures, color, and appearance. Obtain the Engineer's approval of forms prior to initiating casting operations. Build the details shown on the Contract Plans or as amended by approved shop drawings into the forms.

Repair worn, damaged, or otherwise unacceptable forms and obtain the Engineer's approval before casting any segment.

Where sections of forms are joined, ensure that offsets in flat surfaces do not exceed 1/16 inches and that offsets with corners and bends do not exceed 1/8 inches.

Ensure that all joints in the forms and contact points with bulkheads and existing segments have good fitting seals to prevent loss of fine material and cement grout.

Check and inspect forms on a regular weekly basis to ensure proper alignment and geometric accuracy. Do not use forms which fail to meet the specified casting tolerances until such corrections are made to produce segments within the specified tolerances.

Use a small blockout at all locations where an external tendon enters or exits the face of the concrete at deviation blocks and diaphragms except at anchorage locations. The blockout will be approximately 2 inches larger in diameter or overall dimensions than the tendon duct and have a depth equal to at least the minimum prescribed concrete cover dimension shown in the Plans.

452-6.3 Casting Control (Geometry): Before commencing the casting operation, submit the proposed method of geometry control for all segment casting operations to the Engineer for approval. This submittal must be in the form of a "Casting Manual" and include but not necessarily be limited to:

1. All measuring equipment, procedures and the location of control points to be established on each segment.
2. The location and values of all permanent benchmarks and reference points in the precasting yard.
3. A geometry control procedure for the vertical and horizontal alignment control for the precasting of segments; including survey controls and procedures, observations, checks, computational and/or graphical methods and correction techniques.
4. The casting curves which include the theoretical geometric horizontal alignment, profile grade and superelevation appropriately combined with the camber.

Ensure that the casting manual covers all geometry control operations necessary and is compatible with the chosen methods of casting and erection, including erection survey, elevation and alignment control. Prepare the manual in accordance with submittal requirements of this Section.

Do not begin casting without the Engineer's approval of the geometry control method.

In the precasting yard, use instruments for the geometry control which are mounted on a permanent platform of sufficient height to sight on all control points. In addition, establish and maintain permanent benchmarks and reference points throughout the casting operations.

During casting, make all corrections required in the geometry of the segments from the control points established on each segment.

With a match cast system, after casting and before bond breaking to separate the segments, check the position of the new cast and match cast segments again. If positions are not as desired, make corrections in the next segment. In general, and unless otherwise approved by the Engineer, make observations on the geometry control reference hardware cast into the segments (i.e. elevation bolts, alignment offsets and lengths) to a precision of plus or minus 0.001 foot.

During casting operations, produce and maintain on a daily basis a graphical plot of the vertical and horizontal "as cast" alignments along each vertical and horizontal control line to an exaggerated scale in order to clearly highlight variations. Depict these against both the theoretical geometric vertical and horizontal alignment casting curves on a continuous layout of an entire unit of the bridge between expansion joints. Maintain this plot in good condition so that it may be used and referenced during erection.

Keep all geometry control hardware cast into any segments, such as elevation bolts and alignment hairpins, in place during erection for reference and checking purposes. Remove the hardware after completion of erection of the unit in the bridge between expansion joints.

Use experienced personnel to operate the instruments and supervise the casting operation. Prior to the commencement of casting, obtain the Engineer's approval of the experience and/or qualifications of the supervisory and instrument operating personnel, particularly with regard to the observational precision required.

452-6.4 Preparation For Match Casting: When match casting is used, take great care in positioning of the match cast (previously cast) segment in relation to the segment to be cast. Ensure that the match cast segment is not twisted.

Ensure that all materials to be embedded in the concrete of the new cast segment are properly positioned and supported in order to maintain their position and withstand concrete placement and consolidation without damage. Make provisions for all projections, recesses, notches, openings, blockouts and the like in accordance with the Plans and approved shop drawings.

Cover the abutting surface of the match cast segment with a thin film of a bond breaker consisting of flax soap and talc, or other material approved by the Engineer. Use a soap and talc mixture consisting of five parts flax soap to one part talc. The Engineer will base acceptance of a material other than soap and talc prior to casting any segments by demonstration on a large specimen consisting of a precast piece and a new cast piece with a contact facial area of at least 4 square feet.

452-6.5 Embedded Items:

452-6.5.1 General: Embedded items must be in accordance with specifications for prestressed and post-tensioned construction and the requirements herein.

452-6.5.2 Embedded Post-Tensioning Ducts: Ensure that embedded ducts for post-tensioning tendons and bars are positioned accurately to their required alignment. Properly fabricate and identify all ducts so that proper positioning is assured and can be verified after casting.

Utilize positive methods to ensure that ducts will not be displaced or damaged during concrete placement and consolidation. Adequately secure all embedded post-tensioning ducts to the reinforcement cage at intervals not exceeding 30 inches for steel pipes

and 24 inches for plastic ducts, (Small ducts and very flexible ducts may require closer supports). Any auxiliary ties and support bars needed for these purposes will be considered incidental and at no extra cost to the project. Prevent the concrete cover requirements from being violated by any auxiliary ties and support bars.

After installation in the forms, ensure that the ends of the ducts are sealed at all times to prevent entry of water, debris and fine material. Following each pour of concrete, demonstrate that all empty ducts are free of water and are unobstructed and undamaged.

Immediately prior to installation of the prestressing steel, again demonstrate to the satisfaction of the Engineer that all ducts are unobstructed and free of water and debris.

452-6.5.3 Anchorage Plates and Castings: Prior to placing concrete in the forms, fix all tendon anchorage plates and anchorage castings in their respective position in the forms, connected to their duct and sealed to prevent mortar intrusion. Ensure that anchorage plates and castings are rigidly fixed in the forms to maintain their correct alignment and position during concrete placement and consolidation.

452-6.5.4 Reinforcing Steel: Fabricate and place reinforcing steel in accordance with the Contract Plans or as superseded by the approved shop drawings and as required herein.

Do not cut out or remove reinforcing steel to permit proper alignment of post-tensioning ducts. Replace any bar that cannot be fabricated to clear the ducts by additional bars with adequate lap lengths and submit the details to the Engineer for approval.

In the plane of the reinforcement parallel to the nearest surface of the concrete, ensure that bars do not vary from plan placement by more than 1 inch, nor by more than one-eighth of the spacing between bars, whichever is less. In the direction perpendicular to this plane of reinforcement, ensure that bars do not vary from plan placement by more than 1/4 inches. The top and bottom cover of reinforcing steel must be within 1/4 inches of the cover dimensioned in the Plans. The edge cover of the reinforcing steel must be within 1 inch of the cover dimensioned in the Plans.

452-6.6 Concrete Placement, Consolidation and Finishing:

452-6.6.1 General: Do not deposit concrete into the forms until the entire set-up of the forms, reinforcement, ducts, anchorages and embedded items have been thoroughly inspected and checked. Do not place concrete until the Engineer is satisfied that all the above items have been properly inspected and checked, and the rate of producing and placing the concrete will be sufficient to complete the casting and finishing operations within the scheduled time, that experienced concrete finishers are available where required for finish work and that all necessary finishing tools and equipment are on hand at the site of the work and are in satisfactory condition for use.

During conveying and placement, protect concrete against undue drying or rise in temperature and inclement weather.

452-6.6.2 Concrete Placement Equipment: Use concrete placement equipment of a size and design which permits placing concrete within the specified time. Clean all equipment at the end of each operation or workday and, just prior to reuse, check the equipment again and clean off hardened concrete and foreign materials.

Place concrete by belt conveyors and by pumping in accordance with 400-7.6 and 400-7.7, respectively.

452-6.6.3 Concrete Placement Sequence:

1. Superstructure box segments: First place concrete in the central portion of the bottom slab between the inside edges of the internal web forms, leaving a narrow gap of 6 inches to 12 inches for inspection and consolidation of the bottom corners when the next load is placed in the webs. Then place the concrete in the bottom corners of each web to connect and consolidate with that already placed in the bottom slab. Then place concrete in the remainder of the webs in lifts not exceeding 24 inches at a time up to the top of the webs but not into the slab over the webs. Place concrete in the top slab in the outer wing and mid slab regions between webs before placing, completing and consolidating zones over the top of the webs.

2. Substructure and Pier Shaft Segments: Cast precast pier shaft segments vertically. Place the concrete in uniform lifts of approximately 24 inches to 36 inches and consolidate well.

3. Obtain the Engineer's approval on any alternative sequences to the above, or for any other precast components.

452-6.6.4 Concrete Placement and Consolidation: Discharge individual loads of concrete into the forms, and place and consolidate in the required locations. After discharge into the forms, do not bodily move concrete from place to place within the forms by mechanical vibrators or other similar equipment.

Place and consolidate concrete with care so that post-tensioning ducts, anchorages and any other embedded items are maintained in their proper positions and are not damaged.

Consolidate all concrete using approved vibrators together with any other equipment necessary to perform the work as specified. Use internal vibrators having a minimum frequency of 8,000 vibrations per minute and sufficient amplitude to consolidate the concrete effectively. Provide at least two stand-by vibrators in working condition for emergency use in case of malfunction.

Use of external vibrators for consolidating concrete when the concrete is inaccessible for adequate consolidation by internal means. When external vibration is used, construct the forms sufficiently rigid to resist displacement or damage.

Vibrate concrete in a manner which avoids displacement or damage to reinforcement, post-tensioning ducts, anchorages and other embedded items.

No construction joints are allowed within a segment, except as detailed in the Plans.

452-6.6.5 Finishing: Strike off the roadway surface of the segment with an approved mechanical screed operated by a self contained power source.

Furnish and use a straightedge at least 24 inches longer than the segment while finishing the concrete deck surface of superstructure box girder segments. Use the straightedge approximately parallel to the centerline of the segment to strike an accurate surface between the bulkhead and the top of the match cast segment at all positions across the segment width.

Give all other surfaces of segments and precast components a Class 3 Finish at the precast site in accordance with 400-15.

452-6.7 Curing:

452-6.7.1 General: Where casting cells are intended to operate on a short (daily) cycle and it can be demonstrated to the satisfaction of the Engineer that the required initial concrete strengths for the removal of the forms, application of prestress, moving and handling of the segments and that the final concrete strength can be achieved in a timely and consistent

manner, then steam curing will not be required. However, take precautions to promote proper curing by methods approved by the Engineer and in accordance with Section 400. Such precautions must meet or exceed the following:

1. To prevent moisture loss, cover all exposed surfaces (those not in contact with a form or match cast segment) as soon as possible after casting with a moisture tight covering (wet curing blankets or other approved equal systems). Avoid spoiling the deck surface finish. Keep the cover on or within 12 inches of the deck surface.

2. Keep the moisture-tight covering substantially in place throughout succeeding operations such as geometry control survey, stripping of internal forms, wing forms and shifting of and working with a segment in a match cast position. Keep the concrete surface wet throughout these operations.

3. After stripping of the side and core forms, continue curing of the precast concrete by the application of a Type 2 (white pigmented) membrane curing compound as specified in 925-2 to all exposed surfaces (including segment exterior once exposed by removal from the form). Apply an approved debonding compound to match cast surfaces to serve both as a bond breaker and seal for curing.

4. Maintain the moisture tight covering for at least 72 hours.

As an alternative, steam curing may be used.

5. While the new cast segment is in contact with the match cast segment, cover the match cast segment with curing blankets, or other approved equal system, to minimize the effects of differential temperature between the segments.

452-6.7.2 Steam Curing: Meet the requirements of Section 400 modified by the following requirements when steam curing is used.

1. Provide a device or devices for simultaneously recording the temperature of three widely separated locations per casting cell. Locate the three temperature sensors near the top, middle and bottom of the enclosure or as otherwise approved by the Engineer. Identify the charts with the hours, dates and segment number and deliver to the Engineer immediately after steam curing is completed unless otherwise approved.

2. Apply an approved debonding compound to match cast surfaces to serve both as a bond breaker and seal for curing.

3. Expose match cast segments to the same curing environment (temperature and humidity) as the new cast segment until the new segment reaches the required strength to allow the removal of the forms.

452-6.8 Removal of Forms: Prior to removing the forms, protect the plastic concrete from adverse weather effects.

Keep supporting forms in place until the concrete has reached the required strength for form removal as specified in the Plans, in this Section, or as approved by the Engineer.

Test cylinders, made and cured in the same manner as the segment, to confirm the form release strength prior to removing form. With the Engineer's approval, a strength curve chart may be established to determine the time necessary for achieving the required form release strength, in accordance with the specifications for form removal.

Avoid cracking or damaging the segment when removing the forms, especially match cast surfaces and shear keys. Notify the Engineer of any damage which occurs and repair in an approved manner.

452-6.9 Test Samples: Provide additional test samples and testing for compressive strength on precast segments and field closure joints to control the construction activities and to ensure adequate strength of these components at various stages of their manufacture and assembly.

Make test cylinders, in accordance with Section 346, cured in the same manner as the structural components to ensure adequate compressive strength has been achieved in accordance with the plan requirements for the following conditions:

1. Prior to release of prestressing for components which are to be pretensioned.
2. Prior to form release and/or moving the components to storage.
3. Prior to post-tensioning transverse tendons if the component is less than 28 days old.
4. Prior to placing a component into position in the structure and/or stressing of longitudinal post-tensioning tendons if the component is less than 28 days old.

Determine the number of cylinders in accordance with the proposed method for casting, transporting and erecting the various components.

Provide the results of the compression testing of one or more test cylinders for controlling the time of execution of the various construction operations. Obtain the Engineer's approval for meeting the Specification requirements on casting, curing and testing of concrete test cylinders.

No direct payment will be made for the concrete testing. All costs for such testing will be included in the bid items for the various precast structural components.

452-6.10 Age at Erection: Unless otherwise approved by the Engineer, precast components must be at least 14 days old prior to incorporating into the structure.

452-6.11 Tolerances:

452-6.11.1 General: The following tolerances apply to the fabrication of precast components:

(1) Superstructure Box Segments:	
Width of Web	±1/4 inch
Depth of bottom slab	±3/16 inch
Depth of top slab	±3/16 inch
Overall depth of segment	±3/16 inch
Overall width of segment	±1/4 inch
Length of segment	±3/8 inch
Diaphragm dimensions	±3/8 inch

(2) Precast Box Pier Segments	
Height (Individual Element)	±1/4 inch
Width and Breadth (Individual Element)	±1/4 inch
Thickness (wall)	±1/4 inch

(3) All Fabricated Segments:	
Ends (deviation from a plane per 20 ft width or depth	±1/4 inch per 20 ft not to exceed 1/2 inch.
Flat Surface (deviation from a plane at any	±0.025 in/ft not to exceed a total of 1/4 in.

location)	

452-6.11.2 Corrections: Control dimensions from segment to segment, including cast-in-place segments, and compensate for any deviations within a single segment or series of segments so that the overall dimensions of the completed structure meet the dimensions and overall erection tolerances shown in the Plans and allowed by this Section.

452-6.11.3 Repairs: Repair minor breakage, spalling, or honeycomb (not over 1 inch deep) by a method approved by the Engineer. Major breakage, spalling, or honeycomb in excess of 1 inch deep is subject to the Engineer's structural review. If found to be satisfactory, repair these areas using a method approved by the Engineer. Do not perform surface finishing or repairs on the matching joint surfaces of precast segments until after final erection of the segment, except as herein noted. If more than 20%, but less than 40% of the total contact surface of all shear keys in any single web is broken, spalled or honeycombed, grind the damaged areas to produce a cylindrical depression into sound concrete to a depth and width approximately equal to the shear key dimensions. Complete necessary repairs to shear keys damaged at the casting site prior to shipping the segment to the erection site. After erection of the segments adjacent to the damaged keys and prior to erection of additional segments, carefully pack the voids left by the depressions with an epoxy mortar as approved by the Engineer. With the Engineer's approval, an alternate method of repair may be used. The Engineer will consider the segment unsatisfactory for use if more than 40% of the total contact surface of all shear keys in any single web is broken, spalled or honeycombed. Use an Engineer approved method for repairing damaged alignment keys located in the top and bottom slabs. The Engineer will consider a segment unsatisfactory for use if more than 50% of the total contact surface of all alignment keys in any element of the slab (wing overhang, central portion between webs, etc.) is broken, spalled or honeycombed. Remove and dispose segments found to be unsatisfactory and not repairable after structural review and cast a new segment at no expense to the Department.

452-7 Precast Segment Handling, Storage and Shipment.

Handle segments with care to prevent damage. Handle segments using only the devices shown on the shop drawings for this purpose. Store all precast segments level in the upright position. Firmly support all precast segments for storage and shipment on an approved three point bearing system which does not introduce a twist under self weight. Do not stack superstructure segments one upon another unless approved by the Engineer.

Prior to shipment the Engineer will thoroughly inspect each segment for damage. Thoroughly clean the faces of all joints of laitance, bond breaking compound and any other foreign material by light sand blasting prior to shipment. Make no repairs of minor spalls or chipped areas on the joint surfaces until after erection of the segment. Upon arrival at the bridge site the Engineer will inspect each segment again. If in the Engineer's opinion, any damage has occurred during shipment that will impair the function of the segment (structurally, aesthetically, etc.), the segment will be rejected. Replace any rejected segment with an approved segment at no cost to the Department. Provide firm support at bearing locations noted above. Fully secure the segments against shifting during transport. Provide a storage area of suitable stability for the segments to prevent differential settlement of the segment supports during the entire period of storage.

452-8 Erection.

452-8.1 Erection Manual: Before commencing erection operations, submit proposals for all segment erection operations to the Engineer for approval. This submittal must be in the form of an "Erection Manual" and include but not necessarily be limited to:

1. A detailed step-by-step sequence for the erection of each segment including all intermediate procedures relating to erection equipment, temporary and permanent post-tensioning and making of closures between spans and/or cantilevers and other required sequencing.
2. Positioning, use and sequencing of falsework, jacking and/or releasing of falsework, temporary towers, supports, tie-downs, counterweights, closure devices and the like.
3. Positioning, use and sequencing of erection equipment such as cranes, beam and winch devices, gantries, trusses and the like, both on and off the structure, including the movement, introduction and/or removal of any supports onto or connections with the structure. Include drawings and calculations for the structural effects of erection equipment on the structure.
4. Detailed scheduling of all temporary and permanent post-tensioning operations and sequences in accordance with the segment erection and closure operations and other required scheduling.
5. Stressing forces and elongations for post-tensioning.
6. Sequencing of filler injection operations.
7. A method for the field survey control for establishing and checking the erected geometry (elevations and alignments) with particular attention to the setting of critical segments such as, for example, pier segments for balanced cantilever erection. This information may be included in the Erection Manual or may be provided later as a supplementary or separate document.
8. Any other relevant operations as required and applicable to the structure type and construction method.

Do not start erection without the Engineer's approval of the erection manual.

452-8.2 Erection Geometry Control:

452-8.2.1 General: Numerical or graphical methods may be used for alignment control and checking during erection. Establish the key stages for checking of the erection in the erection manual and obtain the Engineer's review and approval. Key stages would include, for example, setting a pier segment during cantilever erection and various intermediate points during subsequent segment erection, at span closure and upon completion.

Prepare a table of elevations and alignments required at each key stage of erection in accordance with the Plans, as cast geometry, camber and erection elevations for establishing erection controls and submit to the Engineer for approval.

Carefully check elevations and alignments at each stage of erection and correct as required to avoid any possible accumulation of errors.

If geometric corrective measures are necessary, the Engineer will require the Specialty Engineer to develop the means and methods to ensure the epoxy joint remains watertight and free from localized stress concentrations. The Specialty Engineer will be required to submit the corrective measures to the Engineer for approval. Use shims made of ASTM A240 Type 304 wire cloth (roving) with a maximum of 1/8 inch thickness.

452-8.2.2 Span-by-Span and Wet Joint Erection: Position each span segment according to the final longitudinal alignment, grade, camber and cross-slope. Keep the horizontal

and vertical alignment of the pier segment within 1/16 inches of that required by the approved erection plans.

Correct any deviation more than the tolerance allowed above using a method approved by the Engineer.

452-8.2.3 Balanced Cantilever and Progressive Cantilever Erection: Check the alignment and elevations of the cantilevers, using two independent surveys, within one hour of sunrise on each day that segments are to be erected. Check the measurements made by each survey and ensure they agree to within 1/4 inches. When measurements do not agree, discontinue erection of segments until discrepancies in measurements are resolved to the satisfaction of the Engineer.

Accurate positioning of the pier segments is very important as it will establish the line and grade for cantilevers in each direction. Position each pier segment according to the final longitudinal alignment, grade and cross-slope and ensure no further erection continues until and unless these segments are properly located on the piers by the means provided. Keep the horizontal and vertical alignments of the pier segment within 1/16 inch of the alignment values required to control points as established by the approved erection plans.

Check at each key stage of erection, in accordance with approved erection procedures, the ends of cantilevers for required elevations and alignment. Correct any deviation from the required alignment by a method approved by the Engineer.

452-8.3 Erection Tolerances:

1. Ensure that maximum differential between outside faces of adjacent segments in the erected position does not exceed 3/16 inches.
2. Ensure that transversely, the angular deviation from the theoretical slope difference between two successive segment joints not exceed 0.001 rad.
3. Ensure that longitudinally, the angular deviation from the theoretical slope change between two successive segments does not exceed 0.003 rad.
4. Dimensions from segment to segment will compensate for any deviations within a single segment so that the overall dimensions of the completed structure meets the dimensions shown in the Plans such that the accumulated maximum error does not exceed 1/1000 of the span length for either vertical profile and/or horizontal alignment.

Carefully check elevations and alignments at each stage of erection and correct as required to avoid any possible accumulation of errors.

452-8.4 Other Miscellaneous Erection Requirements:

452-8.4.1 Span-by-Span and Wet Joint Erection:

452-8 .4.1.1 Closure Joints: Use concrete meeting the same specifications and criteria as the concrete in the segments. Ensure that concrete reaches the minimum required strength as shown in the Plans or in the Specifications prior to stressing the continuity post-tensioning. Ensure that the closure joint forms provide tolerances as specified under 452-6.11 Tolerances.

452-8.4.1.2 Wet Joints: Where forming joints between segments using cast-in-place concrete, the above conditions for closure joints also apply to wet joints. In addition, the cast-in-place “Wet Joints” cannot be less than 3 inches wide, nor greater than 9 inches wide unless otherwise approved by the Engineer.

452-8.4.1.3 Formwork: Adequately support formwork at all wet joints and closure joints to take all loads applied and do not remove them until the concrete in the joints has reached its required strength and the longitudinal tendons have been tensioned.

452-8.4.2 Balanced Cantilever and Progressive Cantilever Erection:

452-8.4.2.1 Deformations: For computing deformations due to time dependent stress variations, the erection time assumptions are shown in the Plans.

Deformations due to creep and shrinkage and the concrete modulus of elasticity have been computed using the FDOT's Structures Manual edition noted in the Plans. Obtain the Engineer's approval for method of calculating the above parameters.

452-8.4.2.2 Temperature Restrictions: Meet the requirements of 453-4 for substrate temperatures, epoxy formulation and thermal controls where precast segments are jointed with epoxy. Measure the substrate temperature at the mid-depth of the top slab for box girder sections or 4 inches from the top surface for slabs and other sections.

452-8.4.2.3 Permissible Loads on Cantilever: During balanced cantilever erection, unbalance the cantilever by only one segment at any time. In addition to the unbalanced load due to one segment, the cantilevers are designed for loads applied by the erection equipment as listed in the Plans. Use alternate erection methods which comply with the assumptions in the Plans or otherwise approved by the Engineer.

452-8.4.2.4 Span Closure Joints: Use concrete for closure joints which comply with the same specifications and criteria as the concrete in the segments. Ensure that concrete reaches the minimum required strength as shown in the Plans or in the Specifications prior to stressing the transverse or continuity post-tensioning. Ensure that the closure joint forms provide tolerances as specified for precast segments.

452-8.4.2.5 Falsework and Formwork: Support falsework and formwork at closure pours by the cantilever ends or terminating segments of each series of segments to be joined. Secure cantilever together vertically, longitudinally, and transversely so that the applied loads will yield equal deflections to both cantilevers. Do not remove securing devices until the closure pour concrete has reached its required strength and longitudinal continuity tendons are tensioned. Submit calculations and details to verify that the devices and methods have adequate rigidity and do not impose excessive loads and stresses on the structure.

452-8.4.3 Precast Box Pier Construction - Erection Tolerances:

1. Ensure that maximum differential between outside faces of adjacent segments in the erected position does not exceed 3/16 inches.
2. Ensure that the rotational angular deviation, measured about a vertical line, between two successive segment joints does not exceed 0.001 rad.
3. Ensure that the maximum angular deviation of a segment from a vertical line does not exceed 0.003 rad. and that the maximum overall deviation from the vertical, measured in any direction, does not exceed 0.01 inches per foot of height.
4. Ensure the base precast segment is within 1/2 inch of the Plan location.

452-8.5 Epoxy Jointing of Precast Segments: Meet the requirements of Section 453 for epoxy jointing precast segments. Select the appropriate epoxy material based on the job requirements as either normal or slow set epoxy within the formulation temperature range based on the substrate temperature.

452-8.6 Packed Mortar Joints for Joints or Bearings: Where designated on the Plans, place packed mortar after the joint or bearing has been set at the proper final elevation.

Pressure grouting may be allowed with the Engineer's approval of the materials and method to be used.

Mortar for packing consists of one part cement and one part fine aggregate, by volume, mixed with a non-shrink admixture as recommended by the manufacturer. Mix the dry

elements thoroughly to a uniform mixture. Add water to produce a mealy, slightly adhesive mixture. Pack the mortar until a water sheen is produced on the surface of the mortar.

Build a form around the joint leaving one side open. Secure the form to withstand the required packing forces. Insert a small amount of mortar into the open joint to form a 2 inches thick bead on the opposite side of the form. Pack this bead by striking a special tool made of 1/2 inch by 2 inch steel having a length approximately 10 inches longer than the largest dimension of the joint being packed with a 2 pound hammer. Continue compaction until water begins to bleed out of the mortar. When bleeding has occurred, insert another bead of mortar and pack as described above. Continue this process until the joint is filled to the limits shown in the Plans.

452-9 Barrier And Median Setting.

Prior to forming the barriers, accurately establish the as-constructed gutter line elevations at intervals not exceeding 10 feet. Then form the base of the barrier and median to provide an inside vertical face which extends from the surface of the concrete structure to an elevation located 3 inches (or as shown in the Plans) above the theoretical gutter line elevations. Maintain the plan vertical height of the barriers as a minimum when variations exist between the plan profile and the actual profile of the gutter.

452-10 Bridge Deck Surface.

Provide a Class 4 Floor Finish in accordance with Section 400 for Long Bridges upon completion of superstructure segment erection and prior to opening to traffic. Install expansion joints in accordance with Section 400.

452-11 Watertight Decks.

Check all segment joints, closure joints and deck hole repairs to assure every location is watertight, upon completion of all milling and grinding activities on the riding surface. Repair all locations showing evidence of leaks by cutting a 3/8 inches wide x 5/8 inches deep groove along the leak interface. Clean and completely fill the groove with epoxy meeting the requirements of Section 453. Dispense the epoxy into the groove using a pneumatic gun and epoxy cartridges. Clean all excess epoxy bonding agent from external visible surfaces in a way not to damage or stain the concrete surface. Do not smear epoxy over areas located more than 1 inch from each side of the groove.

452-12 Method of Measurement.

Precast superstructure and substructure segment concrete, including cast-in-place concrete for closure and wet joint pours, will be measured by volume according to the quantities represented by the dimensions of the segments and cast-in-place pours on the Contract Plans or approved shop drawings; whichever is the lesser.

All reinforcement in precast superstructure and substructure segments, cast-in-place closures and wet-joints will be measured by weight according to the quantities represented by the reinforcement details in the Plans or approved shop drawings; whichever is the lesser.

All permanent post-tensioning in the superstructure and substructure will be measured by weight according to the quantities represented by the details in the Plans or approved shop drawings; whichever is the lesser.

452-13 Basis of Payment.

452-13.1 General: Payment will be in accordance with the following:

452-13.2 Precast Segments-Concrete: Payment for precast superstructure and substructure segment concrete will be at the Contract bid prices per cubic yard for the various classes of concrete called for.

Such prices and payments will be full compensation for manufacture, storage, transport, assembly and erection of the segments complete and in place, including filling all concrete blockouts and similar miscellaneous details. These prices and payments will also include the furnishing and the application of epoxy bonding agent and Class 5 applied finish coating when specified in the Plans, providing temporary and permanent segment access details, material testing, special erection equipment, temporary post-tensioning, tools, labor and incidental items necessary for completing the work in accordance with the Plans, Specifications and approved shop drawings.

Cast-in-place concrete for closure and wet joint pours will be paid for under these items which also include the cost of all formwork, closure devices and other temporary construction needed to make these closures and joints and cast-in-place segments or portions thereof as designated in the Plans.

Include the cost of providing a Class 4 floor finish on the bridge deck and approach slab surfaces in the cost of superstructure and approach slab concrete.

The Bridge floor grooving will be measured and paid for separately.

No additional payment will be made for extra concrete necessitated by approved modifications to the segments or structure needed to accommodate the Contractor's construction methods.

452-13.3 Precast Segments-Reinforcement: Payment for reinforcement in precast segments, closure pours, wet joints and other cast-in-place concrete joints and details will be at the Contract bid price per pound for reinforcing steel (superstructure) and for reinforcing steel (substructure).

No additional payment will be made for extra reinforcement necessitated by approved modifications to the segments or structure for the purposes of the Contractor's construction methods.

452-13.4 Precast Segments-Post-Tensioning: Payment for permanent post-tensioning will be in accordance with Section 462.

No additional payment will be made for extra permanent or temporary post-tensioning necessitated by approved modifications to the segments or structure for the purposes of the Contractor's construction methods, nor will payment be made for temporary tendons which are approved to be left in the structure, either stressed or unstressed, for the convenience of the Contractor's operations.

452-13.5 Precast Segments-Partial Payment: Partial payment for precast segments will be made at 65% of the bid price per cubic yard of concrete and per pound of reinforcement when the segment has been cast and accepted. Remaining payment will be made when the segment has been erected and accepted for incorporation into the structure. Payment for post-tensioning will be in accordance with Section 462.

452-13.6 Precast Segment-Non-Compliance: Any penalties or deductions for non-compliance with regard to concrete, reinforcement or post-tensioning will be applied to the work affected in accordance with the requirements of the respective specifications.

452-13.7 Precast Segment Production: Preparatory operations for superstructure segment casting will be paid for separately at the Contract Lump Sum price for precast segment production. This item consists of the work necessary for establishing and putting into operation segment casting facilities. It includes preparatory work, operations, acquisition or lease of real property, acquisition or lease of segment manufacturing equipment, acquisition or lease of equipment for the handling, transport and storage of the segments, and all other work or operations which must be performed or costs incurred prior to the manufacture of the concrete segments, including engineering services such as shop drawings.

Partial payments will be made as indicated below:

1. Upon production of documentary evidence, such as paid invoices, canceled checks or similar executed financial instruments, the cost for the acquisition of the casting forms for the precast segments by purchase, lease or manufacture will be paid up to a limit of 25% of the Lump Sum Price bid.

2. When the first precast superstructure segment has been cast out of the first operable casting form and the segment is approved and accepted by the Engineer, 25% of the Lump Sum Price bid will be paid.

3. Thereafter, when each succeeding superstructure segment has been cast out of any operable casting form and approved and accepted by the Engineer, 5% of the Lump Sum Price bid will be paid for each segment up to a limit of 50% of the Lump Sum Price bid (i.e., 5% for each of the next ten acceptable segments).

The total Lump Sum Price bid under this item will not exceed the least of:

1. 12% of the sum of the amounts paid for the concrete in the precast segments only (i.e., excluding any cast-in-place concrete in joints, closures or designated cast-in-place segments) or

2. 5% of the Contract amount excluding mobilization and this item.

The balance of the Lump Sum Price not paid after completion of casting the first eleven satisfactory superstructure segments will be paid after completion of the erection of the first span or closure of the first pair of cantilevers, whichever occurs first.

452-13.8 Payment Items:

Payment will be made under:

Item No. 400- 4- 39-Class IV Concrete (Precast Superstructure Segments)-per cubic yard.

Item No. 400- 4- 40-Class IV Concrete (Precast Substructure Segments)-per cubic yard.

Item No. 400- 8- 40-Class V Concrete (Precast Substructure Segments)-per cubic yard.

Item No. 415- 1-4-Reinforcing Steel (Superstructure)-per pound.

Item No. 415- 1-5-Reinforcing steel (Substructure)-per pound.

Item No. 452- 70-Precast Segment Production-lump sum.

SECTION 453
EPOXY JOINTING OF PRECAST SEGMENTS

453-1 Description.

Furnish, mix and apply a two-component epoxy bonding system to the match cast faces of joints between precast concrete superstructure and/or substructure segments in accordance with the Contract Documents.

In its workable state, or open time, the epoxy bonding agent must function as a lubricant for joining the segments. In its hardened state, the epoxy bonding agent must provide a watertight seal between the precast concrete segments. The hardened epoxy bonding agent must provide intimate contact for stress transfer by completely filling all interstitial space between the match cast segment faces.

This Section applies to precast segmental structures with multiple shear joints in webs and joints with suitable shear keys in precast substructure segments.

453-2 Acceptance of Epoxy Bonding System.

Use only epoxy systems that are on the Department's Approved Product List (APL). Manufacturers seeking evaluation of their products must submit an application conforming to the requirements of Section 6.

Provide to the Engineer a manufacturer's certification conforming to the requirements of Section 6, which confirms that each manufactured lot meets the requirements of this Section and is the same as the material listed on the APL.

453-3 Qualifications of Contractor's Personnel.

For mixing, handling and applying the epoxy bonding agent, provide direct supervision by a person with knowledge and experience, or trained by a technical representative of the manufacturer in the use of this material. Arrange for a technical representative of the manufacturer to be at the site as an advisor at the beginning of this work.

Ensure that all personnel who will be working with the epoxy bonding agent are thoroughly familiar with the safety precautions necessary for use of this material.

453-4 Material.

453-4.1 General: Use only epoxy bonding agents for match-cast joints between precast segments which are thermosetting 100% solid compositions that do not contain solvent or any non-reactive organic ingredient except for pigment required for coloring and meet the requirements of ASTM C881, Type VI Grade 3 as modified below. Use epoxy bonding agents composed of two components, a resin and a hardener, with each component distinctly pigmented so that mixing produces a third color similar to the concrete in the segments.

Epoxy bonding agents must be insensitive to damp conditions during application and, after curing, must exhibit high bonding strength to cured concrete, good water resistivity, low creep characteristics and tensile strength greater than the concrete.

453-4.2 Packaging, Identification and Use: Use only components packaged in two parts, in sealed containers, proportioned in the proper reacting ratio, ready for combining and mixing in accordance with the manufacturer's instructions. Each container must bear a label and/or stamp designating the manufacturer's name, brand name, the component type (resin or hardener), the range of substrate (surface of concrete) temperature over which the application is

suitable, material classification, the date of formulation, the shelf life of the material, and the manufacturer's lot number.

Provide instructions, furnished by the manufacturer, for the safe storage, handling, mixing and application of the material.

Do not use any material from containers which are damaged or have been previously opened. Combining of epoxy bonding components from bulk supplies will not be permitted. Only full packets of components will be mixed.

453-4.3 Classification of Epoxy Material: Epoxy bonding agents which remain workable for a short open time (about one hour) are referred to herein as "normal set epoxy". Epoxy bonding agents which remain workable over an extended open time (about eight hours) are referred to herein as "slow set epoxy".

453-4.4 Formulation for Temperature Range: Epoxy bonding agents must be formulated to provide application temperature ranges which are suitable for the erection of match cast segments with substrate temperatures between 40°F and 115°F with a minimum of at least two, but preferably three, formulations dividing the range into approximately equal subranges which overlap by at least 5ºF.

453-4.5 Physical Requirements:

453-4.5.1 General: Epoxy bonding agents proportioned as designated by the manufacturer and mixed in accordance with the manufacturer's recommendations shall meet the requirements of ASTM C881. For the properties listed below, modify the ASTM test procedures as noted. The components of the epoxy-bonding agent shall be conditioned to the temperature at which testing is to be done prior to mixing the test specimen.

453-4.5.2 Contact Time (Open Time) and Contact Strength: The contact time (open time) of the mixed epoxy-bonding agent shall be:

Normal-Set Epoxy ..... 60 minutes, minimum
Slow-Set Epoxy ..... 6 hours, minimum

The above contact time (open time) will be deemed acceptable if a slant cylinder test specimen, prepared and tested in accordance with the conditions below, sustains the following stress (contact strength) on the slant plane calculated as the axial (vertical) load divided by the area of the slant ellipse:

Normal-Set Epoxy ..... 1,000 psi at 48 hours after joining
Slow-Set Epoxy .....1,000 psi at 14 days after joining

The cement mortar/concrete material for the slant-cylinder test shall have a compressive strength of at least 4,500 psi at 28 days when tested to ASTM C39. The slant-cylinder test procedure must be in accordance with ASTM C882 with the following modifications:

1. Delay joining of the sloped surfaces for the following period of time, measured from the time the epoxy was mixed:

Normal-Set Epoxy .....60 minutes
Slow-Set Epoxy .....6 hours

2. During the period between mixing of the epoxy and joining of the sloped surfaces, the specimens will be uncovered and maintained at the maximum temperature of the application range for the formulation tested.

3. After joining, cure at the maximum temperature of the formulation range at the time periods specified above prior to testing.

For slow-set epoxy, prepare an additional test specimen and test it to failure at 36 hours. The formulation of the slow-set epoxy is acceptable only if the epoxy-bonding agent exhibits a brittle break.

453-4.5.3 Compressive Yield Strength: The compressive yield strength of the epoxy-bonding agent shall be:

Normal-Set Epoxy .....2,000 psi at 24 hours
.....6,000 psi at 48 hours

Slow-Set Epoxy .....2,000 psi at 7 days
.....6,000 psi at 14 days

Determine compressive yield strength in accordance with ASTM D695 with the following conditions:

1. Pour the epoxy-bonding agent into the mold for forming specimens within ten minutes after starting mixing of the components.
2. Prior to testing, cure the specimens at the minimum temperature of the formulation range for the time periods specified above.

453-4.5.4 Bond Strength: Bond strength shall be:

Normal-Set Epoxy ..... 1,000 psi at 48 hours after joining
Slow-Set Epoxy .....1,000 psi at 14 days after joining

Determine the bond strength in accordance with ASTM C882 with the following modifications:

1. The test cylinder of concrete shall have a compressive strength of at least 6,000 psi at seven days age.
2. Delay joining of the sloped surfaces for the following period of time, measured from the time the epoxy was mixed:

Normal-Set Epoxy .....60 minutes
Slow-Set Epoxy .....6 hours

3. During the period between mixing of the epoxy and joining of the sloped surfaces, the specimens will be uncovered and maintained at the minimum temperature of the application range for the formulation tested.
4. After joining, cure at the minimum temperature of the formulation range for the time periods specified above prior to testing.

453-5 Construction Requirements.

453-5.1 General: Apply an epoxy bonding agent meeting the requirements of this Section to mating surfaces of all match-cast precast concrete segments.

Prior to the manufacture of epoxy for the project, a site meeting will be held with representatives from the Engineer, Contractor and epoxy manufacturer, to discuss the selection of the proper formulations, storage and handling, mixing and application of the epoxy.

Have the necessary cleaning materials immediately available at the location of the segment joining, in the event that the segments must be separated and cleaned or epoxy reapplied.

Include in the erection manual required by Section 452, details of erection and post-tensioning operations which assure that the time elapsing between mixing components of the first batch of epoxy bonding agent applied to the joining surfaces of precast concrete segments and the application of a compressive contact pressure across the joint does not exceed

70% of the open time for the particular formulation of epoxy bonding agent used. Also, include details of how the minimum, closing, contact pressure of approximately 40 psi will be applied uniformly to each joint to which epoxy is applied during the epoxy curing period. Contact pressure may be attained through combinations of weight and temporary and/or permanent post-tensioning.

453-5.2 Cleanliness of Surfaces to be Joined: Ensure that the application surfaces are free from oil, form release agent, laitance or any other deleterious material that would prevent the epoxy bonding agent from bonding to the concrete surface. Remove laitance by light sandblasting, wire brushing. Do not destroy the surface shape and profile of the mating surfaces.

Ensure that the surfaces have no free moisture on them at the time the epoxy bonding agent is applied. Free moisture will be considered present if a dry rag, after being wiped over the surface, becomes damp.

453-5.3 Substrate Temperatures and Epoxy Formulation: Apply the epoxy bonding agent only when the substrate temperature of both surfaces to be joined is between 40°F and115°F. The formulation of the epoxy bonding agent must have an application temperature range that conforms to the substrate temperature of the surfaces being joined. If the mating surfaces have different substrate temperatures, then use the formulation for the higher temperature in hot weather periods. In cold weather periods, use the formulation for the lower temperature. Thermal control precautions may be taken in accordance with 453-5.7 below.

453-5.4 Mixing of Epoxy Bonding Agent: Mix the two components of the epoxy bonding agent in strict accordance with the manufacturer's instructions, using only full and undamaged containers. Only open the containers immediately before being combined and do not use any which have an expired shelf life. Thoroughly stir each container of component before combining the components. Combine the two components and thoroughly mix until a uniform color is achieved. Mix with a properly sized mechanical mixer operating at no more than 600 rpm and/or in accordance with the recommendations of the epoxy manufacturer.

Do not mix until the segments to be joined are within approximately 18 inches of their final position. Schedule mixing of the epoxy bonding agent so that the material in a batch is applied to the face of a joint within a maximum of 20 minutes after combining the components.

The Engineer, at his discretion, may require a dry run to check the fit of two surfaces before applying the epoxy.

453-5.5 Application and Amount of Epoxy: Begin application immediately after a batch has been mixed. Uniformly apply the epoxy bonding agent in accordance with the manufacturer's recommendations by spatula or gloved hand a nominal thickness of 1/16 inches. Apply the epoxy to all areas of both faces to be joined. Do not exclude epoxy from around holes formed by ducts. Apply additional epoxy thickness, equal to the shim thickness, to segment faces when shims are placed in a joint.

The amount of epoxy may be adjusted provided that a sufficient amount is applied to completely fill all interstitial space in the joint and to extrude a small bead from the joint after application of the compressive contact pressure.

If a bead of epoxy is not extruded all around the joint, then determine the reason why before proceeding.

Do not use an epoxy bonding agent from a batch for which the time since combining the components has exceeded 20 minutes.

453-5.6 Mating of Segments: Immediately after each mating surface is covered with epoxy bonding agent, bring the segments together and apply the specified compressive contact

pressure in accordance with the approved erection procedures. The contact pressure may be increased at any time after the epoxy has taken an initial set. Do not reduce the contact pressure until the epoxy in the joint has properly hardened and cured. If the contact pressure is reduced, do not subject the joint to tensile stress.

A discernable bead line of extruded epoxy bonding agent must be apparent along the exposed edges of the joint. Fill all areas of the joint which do not show a bead of epoxy by dispensing additional epoxy, meeting the requirements of this specification, into the joint using a pneumatic gun with epoxy cartridges. Inject epoxy to a minimum depth of 1 inch.

Catch and retain epoxy which is squeezed out of the joint in areas over waterways, roadways, buildings, etc.

Clean all extruded epoxy bonding agent from external visible surfaces in a way not to damage or stain the concrete surface. Do not smear surplus extruded epoxy bonding agent over large areas (areas more than 1 inch from each side of the joint), visible surfaces or surfaces to which a cover coat, Class 5 applied finish coat or similar or texturing is to be applied later.

Immediately after the segments are joined, swab all embedded (internal) post-tensioning ducts or conduits passing through the joints to smooth out any extruded epoxy bonding agent.

If the time between combining the components of the epoxy bonding agent and applying the compressive contact pressure exceeds 70% of the minimum open time, immediately separate the segments and clean in accordance with 453-5.8.

453-5.7 Thermal Controls:

453-5.7.1 Cooling in Hot Weather: If the substrate temperature exceeds 115°F, do not proceed with epoxy jointing. The Contractor may take precautions to keep the mating substrate surfaces cool by shading and/or wetting with clean water except that the above requirements for no moisture at the time of application must be strictly adhered to.

453-5.7.2 Artificial Heating in Cold Weather: If electing to erect segments in cold weather when the substrate temperature of the mating concrete surfaces is below 40°F, an artificial environment may be used to increase the substrate temperature subject to the following:

1. Make the artificial environment by an enclosure surrounding the joint through which warm air is circulated, or heating is provided by radiant heaters.
2. Raise the temperature of the concrete substrate across the entire joint surface to at least 40°F.
3. Prevent localized heating and the temperature of the substrate exceeding 95°F at any point on the surface. Direct flame heating of the concrete is not allowed.
4. Maintain the temperature of the substrate surfaces between 40°F and 95°F for at least 24 hours after joining the surfaces.
5. The Contractor may propose, for review by the Engineer, an optional method of raising and maintaining the substrate temperature of the mating surfaces. Any optional method must meet the thermal restrictions above.

Epoxy jointing operations may proceed if the air temperature is above 45°F and rising and the limitations above are met.

453-5.8 Failure to comply with Time Limits or Incomplete Jointing: If the time limit between mixing of the epoxy-bonding agent and the application of the contact pressure is exceeded, or if the joint is incompletely filled and sealed, separate the segments and remove all epoxy from the faces using spatulas and approved solvent. Do not re-apply epoxy until the faces have been properly cleaned and solvents dispersed, for a period of 24 hours.

453-6 Removal of Support to Segments.

453-6.1 Span-by-Span Erection: Ensure that precast concrete segments remain fully supported by the erection truss or system until at least 20 hours after mixing of the last batch of epoxy bonding agent applied to any joint in the span.

453-6.2 Cantilever Erection: Independent support to a newly erected cantilever segment may be removed when the epoxy bonding agent in the third previous mating joint has set. It is not necessary for the epoxy bonding agent in the new joint or the immediately previous joint to be set prior to removing the independent support of the new segment provided that the temporary and/or permanent post-tensioning has been installed to carry the load of the new and previous segment along with any applied construction loading as per the requirements of the erection system.

453-7 Record of Jointing.

Record and submit to the Engineer on a weekly basis the following information:

1. General:
    a. Date and time of jointing,
    b. Segment numbers or spans jointed,
    c. Weather conditions
2. For each joint (identified by location or segment numbers):
    a. manufacturer's lot number of epoxy bonding agent components.
    b. Temperature of the concrete on the joint surface at the middle of each segment when application of the epoxy bonding agent began.
    c. Time of mixing first batch of epoxy bonding agent applied to the joint and completion of application.
    d. Time of applying the required compressive contact pressure.
3. Details of any repairs performed including reason for repair, joint location, volume of epoxy used, method of application, etc.

453-8 Basis of Payment.

No separate payment will be made for the work of epoxy jointing of precast concrete segments. The cost of this work will be included in payment for the various precast concrete items.

SECTION 462
POST-TENSIONING

462-1 Description.

1. Furnish, transport, store, handle, and install all components of Post-Tensioning (PT) systems, in accordance with the requirements of this Section and the component manufacturer's recommendations. Constituent components of PT systems include, but are not limited to, anchorage assemblies, filler containment assemblies, filler material, and related steel reinforcement. Use the most stringent requirements, as determined by the Engineer, of those specified in this Section or the component manufacturer's recommendations for protecting components from damage due to environmental exposure, improper handling, or improper installation.

2. With the exception of mild reinforcing and prestressing steel, furnish all PT system components from a single supplier.

a. Use only approved PT systems meeting the requirements of Section 960 and selected from the Structures Design Office (SDO) website for Approved Post-Tensioning Systems.

b. Use only PT systems of appropriate type and size required to construct tendons shown in the Contract Documents.

c. With the exception of local zone reinforcement, do not substitute, modify, or delete any components of an approved PT system. Inclusion of all possible subcomponents is required for PT system and component testing; however, subcomponents of approved systems may be eliminated from final installations based on project-specific requirements, provided all component-to-component interface hardware are included as necessary to maintain connections and PT system integrity.

3. Install the PT tendon (e.g., strands, wires, or bars) in ducts. Stress the PT tendon to a predetermined load and anchor ends directly against hardened concrete. After anchoring the PT tendon, install permanent anchorage caps, inject ducts with filler to completely fill voids, and install protection at anchorages.

4. Submit all required documents in accordance with this Section and Section 5 to the Engineer for review and written approval.

5. Cable stays are not covered by this Specification.

6. Install duct filler in accordance with the requirements of this Section. Provide fully filled duct and anchorage assemblies free from leaks, blockages, and voids. Provide sufficient test data to the Engineer to verify that the work meets the requirements of this Section. Perform filler injection operations in accordance with 462-4.

462-2 Materials.

462-2.1 General:

Approval of any material by the Engineer will not preclude subsequent rejection if material is damaged or otherwise found to not meet the requirements of this Section or Section 960.

462-2.2 Steel Reinforcing:

462-2.2.1 Mild:

1. Provide reinforcing steel per Section 931.

2. Final design and details of local zone reinforcement are project specific and are the responsibility of PT system supplier. Design project specific local zone reinforcement for the number of strands or wires a particular approved PT system can accommodate at maximum allowable strand or wire force; do not design project specific local zone reinforcement for a reduced system capacity.

3. Submit signed and sealed project specific local zone reinforcement details to the Engineer for review and written approval.

462-2.2.2 Prestressing:

462-2.2.2.1 Strand:

1. Provide prestressing strands per Section 960.
2. Strand couplers are not permitted.

462-2.2.2.2 Bar:

1. Provide prestressing bars per Section 960.
2. For permanent applications, use and location of bar couplers is subject to written approval by the Engineer.

462-2.2.2.3 Parallel Wire:

1. Provide prestressing parallel wire assemblies per Section 960.
2. Wire couplers are not permitted.

462-2.3 Duct Filler: Use only grout and flexible filler meeting the requirements of Section 938 and are listed on the Department's Approved Product List (APL).

462-2.3.1 Grout:

1. Select grout for use in PT system by application: repair, horizontal, or vertical.

2. Mix grout per manufacturer's instructions with potable water meeting requirements of Section 923.

462-2.3.2 Flexible Filler: Prepare filler for installation in accordance with the manufacturer's instructions.

462-2.4 Other Material References:

Meet the requirements of this Section, as well as the following:

Class 5 Applied Coating* .....Section 975
Elastomeric Coating System* .....Section 975
Epoxy Compound* .....Section 926
Magnesium Ammonium Phosphate Concrete* .....Section 930
Methacrylate* .....Section 413
Water Section 923

*Use products listed on the Department's Approved Product List (APL).

462-2.5 Component Samples:

462-2.5.1 Prestressing Steel:

1. Furnish samples per Section 933 from each manufacturer of prestressing strand, wire, and bar to be used on project.

2. The Engineer will collect sample materials from prestressing steel used for PT operations on the Project.

3. Samples, properly identified and tagged per 462-6, will be stored by the Engineer.

462-2.5.2 Grout:

1. The Engineer may sample grout packages at random, not to exceed a total quantity of one bag per LOT or shipment.

2. Grout sample may be virgin package mix, liquefied state, or solid state; Engineer will determine at what frequency, interval, sample phase (powder, liquid or solid) and location those samples will be recovered from the project.

3. Sample, properly identified and tagged per 462-6, will be stored by the Engineer.

462-2.5.3 Flexible Filler:

1. The Engineer may sample flexible filler at random, not to exceed a total quantity of one gallon per LOT. A LOT is defined as a single production batch or shipment not to exceed 1,000 gallons.

2. Sample may be virgin product in liquefied state or solid state. The Engineer will determine at what frequency, interval, sample phase (liquid or solid) and location those samples will be recovered from the project.

3. Sample, properly identified and tagged per 462-6, will be stored by the Engineer.

462-3 Alternate PT System Designs.

Designs using a PT scheme different from that shown in the Contract Documents may be submitted for the Engineer's approval provided proposed scheme fulfills, and the Contractor demonstrates, compliance with these requirements:

1. PT system type and size meets all requirements of this Section.

2. Net compressive stress in the concrete after all prestress losses is equivalent to or greater than that provided by the PT scheme shown in original Contract Documents.

3. Distribution of individual tendons at each cross section generally conform to the distribution shown in original Contract Documents.

4. Proposed PT scheme meets the ultimate strength requirements of the American Association of State Highway and Transportation Officials Load and Resistance Factor Design, AASHTO LRFD Bridge Design Specifications Section 5, and is equivalent to or greater than service and strength limit states provided in original Contract Documents.

5. Stresses in concrete and PT steel at all sections and at all stages of construction meet requirements of the Design Criteria shown in original Contract Documents.

6. All Design Criteria provisions noted in original Contract Documents are satisfied.

7. Show complete design and detail of all elements for proposed locations of alternate PT scheme.

8. Submit the following for the Engineer's approval:

a. design calculations including short and long term prestress losses

b. complete shop drawings including PT scheme and system, reinforcing steel, and concrete cover

9. Any alternate PT system approved by the Engineer resulting in a change in quantity from that shown in the Contract Documents is paid based on comparison of the following:

a. quantity actually used and accepted or original plan quantity, whichever is less, and

b. unit bid price.

If approved alternate PT scheme or system is under a Cost Savings Initiative Proposal (CSIP), method of payment will be in compliance with CSIP agreement.

10. Submit alternate PT scheme signed and sealed by the Contractor's Engineer of Record.

462-4 Qualifications.

Provide all project personnel and crew foreman in accordance with Section 105.

462-5 Submittals.

462-5.1 Shop and Working Drawings:

1. Submit to the Engineer all necessary information, Plans, shop and working drawings, and manuals in accordance with this Section and Section 5. Submit to the Engineer signed and sealed PT related shop drawings designed by the Contractor's Engineer of Record.

2. Prepare shop drawings addressing all requirements stated in the Contract Documents and requirements of this Section. Indicate pre-approved PT systems to be used as shown on the SDO website for Approved Post-Tensioning Systems. Show details of tendon geometry and locations complying with the Contract Documents and limitations of selected PT system. Include all inlets, outlets, high point outlet inspection details, anchorage inspection details, permanent anchorage caps, protection system materials, and application limits.

462-6 Transport, Handling and Storage.

462-6.1 General:

Store all materials in a weatherproof building, shed, covering, or container until time of use.

462-6.2 LOT Identification:

1. Assign an individual LOT number and tag items shipped to project in a manner that allows each LOT to be clearly identified at project site for all PT system components, filler, bars of each size from each mill heat of steel, and all strands from each manufactured reel.

2. Submit records to the Engineer identifying assigned LOT numbers with heat or reel of material represented if applicable.

3. All unidentified prestressing components, strands, wires, bars, or filler received at the site will be rejected.

4. Loss of positive identification of these items at any time will be cause for rejection.

5. Provide a copy of filler Quality Control Data Sheet received from the manufacturer, to the Engineer for each LOT on the project.

6. Material with a total time from manufacture in excess of six months must be retested and certified by supplier before use or be removed from project and replaced with new material.

462-6.3 Prestressing Steel:

1. Protect all prestressing steel against physical damage and corrosion at all times.

a. Package prestressing steel in containers for protection against physical damage and corrosion during shipping and storage.

b. Place a corrosion inhibitor, which prevents rust, in package or incorporate it into a corrosion inhibitor carrier type packaging material.

c. Corrosion inhibitor must have no deleterious effect on steel, filler, concrete, or bond strength of steel to concrete.

d. Inhibitor carrier type packaging material must conform to provisions of Federal Specification MIL-P-3420.

e. Immediately replace or restore damaged packaging to original condition.

f. Clearly mark shipping package with a statement that package contains high-strength prestressing steel, care to be used in handling, include type, kind, and amount of corrosion inhibitor used, date when placed, safety orders, and instructions for use.

2. The Engineer will reject prestressing steel that has sustained physical damage.

3. Remove and discard lengths of strand found to contain broken wires.

4. Wire must be bright and uniformly colored, with no foreign matter or pitting on its surface.

462-6.4 Filler:

1. Maintain filler in environmental exposure conditions (e.g., temperature, humidity) in strict conformance with manufacturer's recommendations at all times from manufacture to installation.

2. Storage in the open must be on a raised platform and with adequate waterproof covering to protect the filler.

3. On site storage is limited to a maximum period of one month.

4. Do not use stored filler that has exceeded the manufacturer's recommended usage date. Remove all such filler from the jobsite.

462-6.5 Duct and Pipe:

1. Protect ducts against ultraviolet degradation, crushing, excessive bending, dirt contamination, corrosive elements, or any other damage or contamination during transport, storage, and handling.

2. Furnish ducts with end caps to prevent contamination inside duct. Do not remove duct end caps until duct is incorporated into the bridge component.

3. Ship capped duct in bundles that are covered during transport and storage.

4. Store on a raised platform and completely covered to prevent contamination.

5. If contamination is discovered, immediately flush duct with potable water per 462-7.2.4 before use.

462-7 Construction.

462-7.1 General:

1. Furnish the Engineer with written certification from PT supplier (vendor) that PT system chosen for the project meets requirement of this Section, Section 960, and is a Department approved PT system prior to installing any PT hardware.

2. Provide a list of PT system components and reference drawings to the Engineer.

3. Use methods to place and consolidate concrete that will not displace or damage any PT ducts, anchorage assemblies, splices and connections, reinforcement, or other embedded items.

4. Conduct all stressing and filler injection operations in the presence of the Engineer.

462-7.2 System Installation:

Accurately and securely fasten all PT anchorages, ducts, inlet and outlet pipes, miscellaneous hardware, reinforcing bars, and other embedded items at locations shown in the

Contract Documents or on approved shop or working drawings or as otherwise approved by the Engineer in writing.

462-7.2.1 Ducts:

1. Construct tendon ducts using the minimum number of splices as practical.

2. Accurately position and align ducts at locations shown in the Contract Documents, or according to approved shop or working drawings, or as approved in writing by the Engineer.

3. Securely fasten all internal ducts at regular intervals not exceeding 30 inches for steel pipes, 24 inches for round plastic ducts, and 12 inches for flat ducts to prevent movement, displacement, or damage from concrete placement and consolidation operations.

4. Show method and spacing of duct supports on appropriate shop drawings.

5. Ensure external tendon ducts are straight between connections to internal ducts at anchorages, diaphragms, and deviation saddles and are supported at intermediate locations according to the Contract Documents including approved shop drawings.

6. Ensure all alignments, including curves and straight portions, are smooth and continuous with no lips, kinks, or dents. This also applies to curves in pre-bent steel pipe.

7. Check and repair all ducts in accordance with 462-7.5 as necessary before placing any concrete.

8. Ensure ducts at end connections to anchorages, splices, inlets, outlets, drains, and all other duct openings are sealed at all times after installing ducts and until tendon installation is complete. Briefly open low point drains just prior to tendon installation and again just prior to filler injection to allow for drainage of any water that may be present within the duct.

9. Provide an absolute seal of anchorage and duct termination locations per the pre-approved system drawings.

10. Use of tape is not permitted to make connections for any reason.

11. Use heat welding techniques, in accordance with duct manufacturer's instructions, to make splices between sections of smooth plastic duct or make connection with electrofusion duct coupler meeting the material requirements of Section 960 and approved system drawings.

12. When connecting steel pipe to plastic pipe with a boot, use a 3/8 inches wide power seated band and clamps in accordance with 960-2.2 on each end of a duct boot to seal against filler leakage. Install band per manufacturer's instructions.

13. Ducts for prestressing used exclusively for temporary erection where PT will be removed from structure are not required to be coupled across segment joints.

462-7.2.1.1 Installation Tolerances:

1. Ensure final position of PT ducts is within the tolerances in the following table:

Table 7.2.1.1-1 Duct Installation Tolerances

Type	Vertical Position (inches)	Horizontal Position (inches)
Horizontal tendons in slabs or in slab regions	±1/4	±1/2

of larger members		
Longitudinal draped superstructure tendons in webs: Tendon over supports or in middle third of span	±1/4	±1/4
Tendon in middle half of web depth	±1/2	±1/4
Longitudinal, generally horizontal, superstructure tendons usually in top or bottom of member	±1/4	±1/4
Horizontal tendons in substructures and foundations	±1/2	±1/2
Vertical tendons in web	Longitudinal Position ±1	Transverse Position ±1/4
Vertical tendons in pier shafts	±1/2	±1/4
All other cases	±1/4	±1/4

2. Ensure entrance and exit angles of tendon paths at anchorages, duct joints, and/or at faces of concrete are within plus or minus 3 degrees of desired angle measured in any direction.

3. Accomplish any deviations in alignment with smooth unkinked transitions.

4. Locate anchorages within plus or minus 1/4 inches of desired position laterally and plus or minus 1 inch along tendon except that minimum cover requirements must be maintained.

5. Position anchorage confinement reinforcement in the form of spirals, multiple U-shaped bars, or links centered around duct and starting within 1/2 inches of the back of the main anchorage plate.

6. If conflicts exist between reinforcement and a PT duct, position of duct prevails. Adjust local reinforcement with the Engineer's written approval.

462-7.2.2 Splices and Joints:

1. All splices, joints, couplings, connections (inlet and outlet), and valves are part of approved PT system.

2. Fabricate all duct splices to prevent duct kinks during concrete placement.

3. Use mandrels as needed to maintain duct alignment and shape.

462-7.2.3 Inlets, Outlets, and Drains:

1. Place filler inlets/outlets and drains at locations shown in the Contract Documents including approved shop drawings.

2. Equip all filler inlets/outlets and drains with approved positive shut-off devices (e.g., valves).

3. At a minimum, place filler inlets/outlets in the following positions and those shown in Design Standards, Index No. 21801:

a. Top of tendon anchorage;

b. Top of anchorage cap;

c. At high points of duct profile when vertical distance between highest and lowest point is more than 20 inches;

d. At major change in duct cross section; and,

e. At other locations required by the Engineer.

4. For all tendons other than grouted top slab transverse tendons in box girders, place drains at the geometric low points of all duct profiles, or as close as is practical to the geometric low points of all duct profiles, except where an inlet, outlet or anchorage that can serve as a drain is located at a low point. Locate drains, and inlets and outlets serving as drains, at the bottom of the duct cross section.

5. Extend filler and drain tubes a sufficient distance out of concrete member to allow for proper closing of valves.

6. Direct inlets, outlets and drains exiting on vertical or predominantly vertical surfaces of box and I-girders toward the inside face of exterior I-girders or toward the interior of box girders.

462-7.2.4 Tendons:

1. Do not exceed 14 calendar days between first installation of prestressing steel within duct and completion of the stressing and filler injection operation for PT bars located in superstructure and all strands and wires regardless of location.

2. Do not exceed 21 calendar days between the first installation of prestressing steel within duct and completion of the stressing and filler injection operations for PT bars located in substructure.

3. Any light surface corrosion forming during the period of time described in (1) or (2) will not be cause for rejection of prestressing steel.

4. Failure to inject filler into duct within the number of calendar days specified, will result in stoppage of work, except when waived by the Engineer in writing.

5. Flushing of filler is not permitted without written approval of the Engineer and is only permitted as defined in this Article.

6. Vacuum injection is required to repair all voids and blockages as subject to provisions of 462-8.3.2.

7. For tendon ducts subjected to contamination with chlorides (e.g., uncapped ducts that have been subjected to salt spray), flush duct with potable water containing slack lime (i.e., calcium hydroxide) or quicklime (i.e., calcium oxide) in the amount of 0.17 pounds per gallon.

a. Test for presence of chlorides and oils in discharged water before placing tendon.

b. If chloride levels in flush water outflow exceed 300 ppm, continue to flush duct until chloride level in flush water outflow is below 250 ppm.

c. Dry duct interior by blowing oil-free compressed air, by vacuuming, or by other means deemed acceptable to the Engineer. Remove excess water trapped in duct corrugations. The Engineer may require use of a borescope or other visual inspection means, at no additional cost to the Department, to ensure duct interior is water free.

8. Push or pull strands and wires through ducts to make up a tendon using methods that will not snag on any lips or joints in ducts.

9. Round off end of strands and wires that are pushed or fit advancing end with smooth protective cap.

10. Do not intentionally rotate strands or wires by any mechanical means during installation of PT strand into duct.

11. For superstructure tendons, provide sufficient strand and wire length beyond dead end anchorages to allow for second end stressing as needed for reconciliation of jacking force versus measured elongation.

12. Alternatively, tendons may be pulled through duct using a special steel wire sock or other device attached to advancing end. Strands may be brazed together for pulling as long as one foot of strand from the brazed end is removed by cutting after installation. Do not electric arc weld strand ends together for this purpose.

13. Cut tendons in accordance with 462-7.3.2.7.

14. Strand installation aids (i.e. wire/nylon ties around strand bundle, strand spacers, etc.) must be removed prior to stressing

15. Do not install permanent tendons before completion of testing as required by this Section or the Contract Documents. The only two exceptions are:

a. Tendon to be tested by "Theoretical Elongation Verification" may be installed for test; and,

b. Transverse tendons may be pre-installed in precast segmental boxes prior to concrete casting such that they meet 462-8.3.1.

462-7.3 Post-Tensioning Operations:

1. Do not apply PT forces until concrete has attained compressive strength specified in the Contract Documents.

2. Conduct all stressing operations in presence of the Engineer.

3. With the written approval of the Engineer, revise PT operations so final tendon force is in agreement with the Contract Documents.

462-7.3.1 Stressing Equipment:

Only use equipment furnished by supplier of PT system.

462-7.3.1.1 Jacks and Gauges:

Equip each jack with pressure gauge for determining jacking pressure that has a minimum dial diameter of six inches.

462-7.3.1.2 Calibration:

1. Calibrate each jack and its gauges as a unit.

2. Calibration must consist of three test cycles with cylinder extension of jack in various positions (e.g., two-inch, four-inch, eight-inch stroke).

3. At each pressure increment, average forces from each test cycle to obtain an average force.

4. Perform calibration with equipment (e.g., jack, pump, hoses, etc.) setup in same configuration intended for use on Project.

5. Jack and gauge calibration is to be initially performed by PT supplier or an independent laboratory.

6. Use load cells calibrated within the past 12 months to calibrate stressing equipment.

7. Supply documentation denoting the load cells calibration date and tractability to National Institute of Standards and Technology (NIST) along with jack/gauge calibration.

8. Provide the Engineer with certified calibration charts and curves for each jack and gauge unit used on the project prior to start of work and every six months thereafter or as requested by the Engineer.

9. Calibrations subsequent to initial calibration with a load cell may be accomplished with use of a master gauge. Supply master gauge to the Engineer in a protective waterproof container capable of protecting calibration of gauge during shipment to a laboratory. Provide a quick-attach hydraulic manifold to enable quick and easy installation of master gauge to verify permanent readings. Master gauge will remain in the possession of the Engineer for duration of project and will be returned to the Contractor after final acceptance of project by the Engineer.

10. Any jack repair, such as replacing seals or changing length of hydraulic lines, requires recalibration using a load cell.

11. No extra compensation will be allowed for initial or any subsequent calibrations or use of master gauge required by the Engineer.

462-7.3.2 Stressing Tendons:

1. Tension all PT steel so PT force is not less than that required by the Contract Documents or as otherwise approved by the Engineer in writing.

2. Do not use monostrand jacks to stress tendons with five or more strands or wires.

3. Use of curved stressing noses or chairs is not permitted.

462-7.3.2.1 Jacking Maximum Stress:

Maximum temporary stress (i.e., jacking stress) in PT steel must not exceed 80% of Guaranteed Ultimate Tensile Strength (GUTS).

462-7.3.2.2 Initial and Permanent Stresses:

1. PT steel must be anchored at initial stresses resulting in long term retention of permanent stresses or forces of no less than those shown in the Contract Documents.

2. Unless otherwise approved by the Engineer in writing, initial stress after anchor set must not exceed 70% of GUTS.

3. Permanent stress and permanent force are stress and force remaining in PT steel after all losses, including long term creep and shrinkage of concrete, elastic shortening of concrete, relaxation of steel, losses in PT steel from sequence of stressing, friction, and unintended wobble of ducts, anchor set, friction in anchorages, and all other losses particular to the specific PT system.

462-7.3.2.3 Stressing Sequence:

1. Permanent PT tendons must be stressed from both ends, except as noted in the Contract Documents.

2. Required force may be applied at one end and subsequently at other end or simultaneously at both ends.

462-7.3.2.4 Elongation:

1. Ensure forces being applied to tendon and resulting elongation of tendon can be measured at all times.

2. Measure elongations to nearest 1/16 inch.

3. For required tendon force, observed elongation must agree within 7% of theoretical elongation or entire operation must be halted, checked, and source of error determined and remedied to satisfaction of the Engineer before proceeding.

4. Do not overstress tendon to achieve theoretical elongation.

5. In event that agreement between observed and theoretical elongations at required force falls outside acceptable tolerances, the Engineer may, at his

discretion and without additional compensation to the Contractor, require additional tests for Tendon Modulus of Elasticity and/or In Place Wobble and Friction Test.

462-7.3.2.5 Friction:

1. Provide actual expected friction and wobble coefficients and anchor set in the shop drawings; submit calculations and show a typical tendon force diagram on shop drawings based upon expected actual coefficients and values for the PT system to be used.

2. Graphite may be used as a lubricant when friction must be reduced, subject to written approval of the Engineer.

462-7.3.2.6 Tendon Wire Failure:

1. Multi-strand PT tendons with wires which fail by breaking or slipping during stressing may be accepted provided these conditions are met:

a. Completed structure has a final PT force of at least 98% of original total design PT force;

b. PT force across a mating joint is at least 98% of PT force required by the Contract Documents for that mating joint for that stage of construction for precast or cast-in-place segmental construction. This 98% minimum PT force requirement applies to segmental construction, or any similar construction, that has members post-tensioned together across a common joint face at any stage of construction; and,

c. Any single tendon must have no more than a 5% reduction in cross-sectional area of PT steel due to wire failure.

2. When conditions permit the Contractor to propose acceptable alternative means of restoring PT force lost due to wire failure, any of the above conditions may be waived at discretion of and with approval of the Engineer in writing.

462-7.3.2.7 Cutting of PT Steel:

1. Cut PT steel using an abrasive saw or plasma torch within 3/4 inches to 1-1/2 inches away from the anchorage.

2. Flame cutting of PT steel is not permitted.

3. Do not cut tendon to final length prior to acceptance.

462-7.3.2.8 Post-Tensioning Operations Record:

1. Keep a record of these PT operations for each tendon installed:

a. Project name, Financial Project ID (FPID);

b. Contractor and/or subcontractor;

c. Tendon location, size, and type;

d. Date tendon was first installed in duct;

e. Reel number for strands and wires and heat number for bars;

f. Tendon cross-sectional area;

g. Modulus of elasticity;

h. Date stressed;

i. Jack and Gauge numbers per tendon end;

j. Required jacking force;

k. Gauge pressures;

l. Elongations (theoretical and actual);

m. Anchor sets (anticipated and actual);

n. Stressing sequence (i.e., sequential order of tendon stressing by number);

o. Stressing mode (single-end, dual-end, simultaneous);

p. Witnesses to stressing operations (Contractor and Inspector);

q. Any other relevant information.

2. Provide the Engineer with a complete copy of all stressing operation records within five days of completed tendon installation.

462-7.3.3 System Protection:

462-7.3.3.1 Tendon:

1. Install anchorage caps and seal all other duct openings within four hours after stressing.

2. Seal all openings and temporarily weatherproof open ends of anchorage if acceptance of tendon is delayed.

3. If tendon contamination occurs and if directed by the Engineer, remove tendon, flush duct with potable water per 462-7.2.4, and replace with new tendon.

462-7.3.3.2 Anchorage:

1. Protect PT strand, wire, and bar anchorages as indicated in the Contract Documents within seven days of completing filler injection operations (see 462-7.4 for filler injection operations).

2. Cap all filler inlets/outlets with plugs meeting the requirements of Section 960.

3. Construct anchorage pour-backs with a Type Q epoxy grout per Section 926 within 28 days of permanently affixing all anchorage caps within each individual pour-back.

a. Remove all laitance, grease, curing compounds, surface treatments, coatings, and oils by grit blasting or water blasting. Flush surface with water and blow dry. Surfaces must be clean, sound, and without any standing water. Test substrate at all pour-back locations using ACI 503 and develop a minimum of 175 psi tension (e.g., pull-off value). Testing frequency may be reduced, as determined by the Engineer, after the Contractor has demonstrated an ability to prepare substrate surfaces for bonding as indicated by the result of the ACI 503 test.

b. Mix and apply epoxy grout in accordance with the manufacturer's current standard technical guidelines. Construct all pour-backs in leak proof forms creating neat lines. Epoxy grout may require pumping for proper installation. Construct forms to maintain a liquid head to ensure intimate contact with concrete surface. Use vents as needed to provide for escape of air to ensure complete filling of forms.

4. Coat exposed surfaces of all pour-backs and anchorage caps with an elastomeric coating system meeting requirements of Section 975 and having a thickness of 30 mils to 45 mils. Assure concrete, anchorage caps, or other substrates are structurally sound, clean, and dry. Concrete must be a minimum of 28 days old. Remove all laitance, grease, curing compounds, surface treatments, coatings, and oils by grit blasting or water blasting using a minimum 10,000 psi nozzle pressure. Blow surface with compressed air to remove dust or water. Apply the elastomeric coating within 90 days of filler injection. Apply a manufacturer's approved primer over the elastomeric coating before applying Class 5 coating, if required.

5. Prior to application of elastomeric coating, construct a 2 foot x 4 foot concrete test block with a similar surface texture to surfaces to be coated. Coat a vertical face with chosen elastomeric coating system. Determine number of coats required to achieve the

specified thickness without runs and drips. Mix and apply elastomeric coating as per manufacturer's current standard technical specifications. Spray application is preferred; roller application is permitted. Have coating manufacturer representative on site to supervise and comment on application of elastomeric coating onto test block. Apply coating using approved and experienced personnel with a minimum of three years experience applying similar polyurethane systems. Submit credentials of these persons to the Engineer for review and consideration for approval.

462-7.4 Filler Injection Operations:

462-7.4.1 Grouting Operations: Conduct all grouting operations in the presence of the Engineer.

462-7.4.1.1 Plan:

1. Submit a Grouting Operations Plan to the Engineer for approval at least six weeks in advance of any scheduled grouting operation.

2. Written approval of Grouting Operations Plan by the Engineer is required before any grouting of permanent structure takes place.

3. At minimum, Grouting Operations Plan will address and provide:

a. Names and proof of training for grouting crew and crew supervisor in conformance with this Specification;

b. Type, quantity, and brand of materials to be used in grouting, including all required certifications;

c. Type of equipment to be used, including capacity in relation to demand and working conditions, as well as, standby equipment and spare parts;

d. General grouting procedure;

e. Duct pressure test and repair procedures;

f. Method to be used to control rate of flow within ducts;

g. Theoretical grout volume calculations;

h. Mixing and pumping procedures in accordance with the manufacturer's recommendations;

i. Direction of grouting accounting for grade and/or slope of tendon;

j. Sequence of inlet and outlet pipes use;

k. Procedures for handling blockages;

l. Procedures for possible post grouting repair.

4. Conduct a joint meeting of the Contractor, grouting crew, and the Engineer before grouting operations begin. Discuss Grouting Operations Plan, required testing, corrective procedures, and any other relevant issues at the meeting.

5. Demonstrate, to the Engineer's satisfaction, grouting of a longitudinal tendon by constructing a full-scale mockup with all associated PT system components of a typical longitudinal tendon profile on the project. Utilize 'clear' duct for the mockup to facilitate visual inspection and verification that no voids or bleed are present in the tendon mockup after grouting. Place a non-stressed PT strand equivalent to the typical longitudinal tendon size inside the duct to simulate in-place PT strand.

462-7.4.1.2 Inlets and Outlets:

1. Ensure connections from grout pump hose to inlets are free of dirt and are air-tight.

2. Inspect valves to ensure they can open and close properly.

462-7.4.1.3 Supplies:

Provide an adequate supply of water and compressed air for clearing and testing ducts, as well as, mixing and pumping grout before grouting operations start.

462-7.4.1.4 Equipment:

1. Provide grouting equipment consisting of measuring devices for water, a high-speed shear colloidal mixer, a storage hopper (e.g., holding reservoir) and pump with all necessary connecting hoses, valves, and pressure gauge.

2. Provide pumping equipment with sufficient capacity to ensure PT ducts can be filled and vented in not more than 30 minutes without interruption.

3. Provide an air compressor and hoses with sufficient output to perform required functions.

4. Have vacuum grouting equipment (i.e., volumetric measuring type) and experienced operators available not less than 48 hours prior to the maximum number of calendar days allowed in 462-7.2.4, between first installation of prestressing steel within the duct and completion of the stressing and grouting operation for PT. If the maximum number of days in 462-7.2.4 have been exceeded, have available vacuum grouting equipment and experienced operators available within 48 hours notice.

462-7.4.1.4.1 Mixer and Storage Hopper:

1. Provide colloidal grout machinery with a charging tank for blending and a holding tank. Blending tank must be equipped with a high speed shear colloidal mixer capable of continuous mechanical mixing producing a homogeneous and stable grout free of lumps and un-dispersed cement. Holding tank must be kept agitated and at least 10% full at all times during pumping operations to prevent air from being drawn into duct.

2. Add water during primary mixing phase in the colloidal mixer by use of a flow meter or calibrated water reservoir with measuring accuracy equal to 1% of total water volume.

462-7.4.1.4.2 Pumps:

1. Provide pumping equipment capable of:

a. continuous operation which includes a system for circulating and agitating grout when actual grouting is not in progress,

b. maintaining pressure on grouted ducts,

c. fitted with a valve that can be closed off without loss of pressure in duct.

2. Grout pumps will:

a. be positive displacement type,

b. provide a continuous grout flow

c. be able to maintain a discharge pressure of at least 145 psi.

3. Use pumps constructed with seals to prevent oil, air, or other foreign substances from contaminating grout and prevent loss of grout or water.

4. Specify pump capacity adequate to maintain the specified grouting rate.

5. Place pressure gauge with full scale reading of no more than 300 psi at duct inlet. If long hoses (in excess of 100 feet) are used, provide two gauges: one at pump and one at inlet.

6. Grout hoses to be compatible with pump output (diameter and pressure rating).

462-7.4.1.4.3 Vacuum Grouting: Provide vacuum grouting equipment meeting these minimum requirements:

1. Volumeter for measurement of void volume;
2. Vacuum pump with a minimum capacity of ten cubic feet per minute and equipped with a flow-meter, graduated hopper, or other acceptable means approved by the Engineer capable of measuring the amount of grout being injected.
3. Manual colloidal mixers, manual high speed shear mixers, or other mixing methods recommended and approved by the grout manufacturer, in writing, for the specific project covered by this Section for voids less than 5.5 gallons in volume. However, mix a minimum of one full bag of grout regardless of the size void to be grouted.
4. Standard colloidal mixers for voids 5.5 gallons and greater in volume.

462-7.4.1.4.4 Standby Equipment: Provide a standby colloidal grout mixer and pump during grouting operations.

462-7.4.1.5 Grouting:

1. Maintain grout fluidity in strict compliance with grout manufacturer's recommendations.
2. In the presence of the Engineer, perform a test to confirm accuracy of grouting equipment volume-measuring components each day of use before performing any grouting operations. Testing in a warehouse or similar condition is acceptable. Use either water or grout for testing using standard testing devices with volumes of 0.5 gallon and 6.5 gallon and an accuracy of equal to or less than four ounces. Perform one test with each device. Results must verify accuracy of grouting equipment void volume-measuring component within 5% of test device volume and must verify accuracy of grouting equipment grout volume component within 10% of test device volume for the 0.5 gallon test device. When testing the 6.5 gallon device, ensure an accuracy of 3% (test device volume) and 6% (grout volume).
3. Do not use grout that tests outside allowable flow rates.
4. Perform grouting in accordance with procedures set forth in approved Grouting Operations Plan.
5. Grout all ducts.

462-7.4.1.5.1 Temperature:

1. At inlet end of grout hose, the maximum limit for grout temperature is 90°F for normal grouting procedures and 85°F when performing repair operations with vacuum grouting.
2. Condition grout material to maintain mixed grout temperature below maximum limit.
3. Grouting operations are not permitted when ambient temperature is below 40°F or is expected to fall below 40°F within one day subsequent to grouting.
4. Postpone grouting operations if freezing temperatures are forecasted within two days subsequent to grouting.

462-7.4.1.5.2 Mixing and Pumping:

1. Mix grout with a metered amount of water.
2. Mix materials to produce a homogeneous grout.

3. Continuously agitate grout until grouting operations are complete.

4. Reject bags of grout containing clumps.

462-7.4.1.5.3 Production Test:

1. Test grout fluidity to verify it is within limits established by grout manufacturer during grouting operations. Target fluidity rate is established by manufacturer's representative based on ambient weather conditions.

2. Determine grout fluidity in accordance with Section 938.

a. Perform a fluidity test using flow cone on grout discharged from anchorage cap outlet immediately after uncontaminated uniform consistency discharge begins for each tendon greater than 50 feet in length. For tendons 50 feet or less, perform a fluidity test on a per batch basis. For fluidity tests done on a per batch basis, perform test after new batch has been transferred from mixing tank to holding tank and thoroughly mixed with remains of the previous batch to produce a new homogenous mixture. During mixing process, continually re-circulate grout from hose into holding tank. Ensure measured grout efflux time is not less than efflux time measured at injection end of grout hose.

b. Alternately, check grout fluidity using Wet Density method contained in Section 938. Density at discharge outlet must not be less than grout density at inlet. Continuously discharge grout until density requirements are met. Discard grout used for testing fluidity.

3. Perform fluidity test for each tendon to be grouted without modifying water-cement ratio.

4. Check temperature of grout at inlet end of grout hose hourly to verify conformance to this Section.

5. Obtain a sample from first production batch of grout and perform a wick induced bleed test on this sample in accordance with Section 938 at beginning of each day's grouting operation. Begin grouting operations after sample is obtained.

6. Once grouting has begun, if zero bleed requirement is found to not have been achieved in the wick induced bleed test at any time during required test time period, complete grouting of any partially grouted tendons currently being grouted but do not begin grouting any new or additional tendons. Immediately inform the Engineer when grouting operations have ceased due to non-compliance of the wick induced bleed test.

7. Do not re-start grouting operations until such time that testing shows grout meets specified requirements.

462-7.4.1.5.4 Operations:

1. Open all grout outlets before starting grouting operation.

2. Inject grout into duct in accordance with approved Grouting Operations Plan.

3. Pump grout at the lowest possible pressure practical.

4. Conduct normal grouting operations at a pressure range of 10 psi to 50 psi measured at grout inlet.

5. Do not exceed maximum pumping pressure of 145 psi at grout inlet for round ducts and 75 psi for flat ducts.

6. Use grout pumping methods that ensure complete filling of ducts and complete encasement of steel.

7. Grout must flow from first and subsequent outlets until any residual water or entrapped air has been removed prior to closing outlet.

8. Pump grout through duct and continuously discharge it at anchorage and anchorage cap outlets until all free water and air are discharged and consistency of grout is equivalent to that of grout being pumped into inlet. Close anchorage outlet and discharge a minimum of two gallons of grout from anchorage cap into a clean receptacle. Close anchorage cap outlet.

9. Elevate grout pressure to the equivalent realized pumping pressure while grouting the duct, seal inlet valve, and wait two minutes to determine if any leaks exist after all outlets have been bled and sealed. If leaks are present repair all identified leaks using methods pre-approved by the Engineer and repeat steps until no leaks are present. Bleed pressure to 5 psi and wait a minimum of ten minutes for any entrapped air to flow to high points if no leaks are present. Increase pumping pressure not to exceed actual realized pumping pressure of duct and discharge grout at each high point outlet to eliminate any entrapped air or water after specified ten minute period has expired. Complete process by locking a pressure of 30 psi into tendon duct.

10. If actual grouting pressure exceeds maximum allowed, close inlet and pump grout at next outlet which has just been closed or is ready to be closed as long as a one-way flow is maintained. Do not pump grout into a succeeding outlet from which grout has not yet flowed. Fit outlet/inlet to be used for pumping with a positive shut-off valve as shown in the approved system drawings and pressure gauge if this procedure is used.

11. Stop grouting operation if complete grouting of tendon cannot be achieved by the steps stated and in compliance with the approved Grouting Operations Plan. After waiting 48 hours, vacuum grout duct in accordance with this Section.

462-7.4.1.5.5 Vertical Grouting:

1. Provide a reservoir, equivalent to a minimum of 2% of the total anticipated grout volume used on a particular tendon, at upper end of tendon to store bleed water and grout; maintain grout level above level of prestressing plate and anchorage for all vertical tendons. Design and size this device to maintain level grout at an elevation that ensures potential bleed will not drop below the highest point of upper anchorage device. Design reservoir to allow all bleed water, if any, to rise into reservoir.

2. Discharge grout and check grout fluidity as described in this Section. Immediately add grout if level of grout begins to drop, potentially allowing bleed water into the upper anchorage device and tendon duct. Remove reservoir after grout has hardened. Visually inspect for voids using a borescope or probe in presence of the Engineer. Fill all voids found in duct using volumetric measuring vacuum grouting process in accordance with this Section.

3. Allow grout to flow from each outlet until all air and water have been purged prior to using a higher elevation outlet for pumping. Pump grout at increasingly higher outlets which have been or are ready to be closed, as long as one-way grout flow is maintained for vertical tendons within allowable grouting pressures.

462-7.4.1.5.6 Grouting Operations Report:

1. Provide grouting report signed by the grouting Contractor within five days of each grouting operation for review by the Engineer.

2. Record theoretical quantity of grout anticipated as compared to actual quantity of grout used to fill duct. Notify the Engineer immediately of shortages or overages.

3. Information to be noted in this report must include at a minimum, but not necessarily be limited to:

a. identification of tendon;
b. date grouted;
c. number of days from tendon installation to grouting;
d. type of grout;
e. injection end and applied grouting pressure;
f. ratio of actual to theoretical grout quantity;
g. number of grout bags mixed;
h. total quantity of water used to mix grout;
i. summary of any problems encountered; and,
j. corrective action taken,
k. description and results of the post grouting operations and inspection.

462-7.4.2 Flexible Filler Operations:

462-7.4.2.1 Microcrystalline Wax: Conduct all wax injection operations, repairs, and inspections in the presence of the Wax Injection Foreman, Wax Injection QC Inspector and the Engineer.

462-7.4.2.1.1 Wax Injection Operations Plan:

1. Prepare a Wax Injection Operations Plan in cooperation with the PT system vendor and the PT wax manufacturer.

2. Submit the Wax Injection Operations Plan to the Engineer for approval at least six weeks in advance of any scheduled injection operation.

3. Written approval of the Wax Injection Operations Plan by the Engineer is required before any injection of permanent structure can begin.

4. At a minimum, the Wax Injection Operations Plan will address and provide the following:

a. .Names and qualifications for wax injection crew and crew supervisor in conformance with this Specification;
b. Type, quantity, and brand of materials to be used in wax injection including all required certifications;
c. Type of equipment to be used, including capacity in relation to demand and working conditions, as well as, standby equipment and spare parts;
d. General wax injection procedure for all duct geometries and types;
e. Duct pressure test and repair procedures;
f. Method to be used to control rate of flow within ducts and anchorage assembly;
g. Theoretical wax volume calculations;
h. Injection rate;
i. Maximum injection pressure during injection and locking pressure;

j. Vacuum (gauge) pressure requirements, vacuum tests and repair procedures;

k. Heating, mixing and pumping procedures in accordance with the manufacturer's recommendations;

l. Direction of wax injection accounting for grade and/or slope of tendon;

m. Location of all high points and all low points accounting for grade and/or slope of tendon;

n. Sequence of valve operations at PT system inlets and outlets, including minimum wax discharge quantities;

o. Procedures for handling blockages;

p. Procedure for sealing duct after wax injection;

q. Procedure for inspecting the PT system after wax injection, filling voids created by inspection procedures, and sealing duct after PT system inspection;

r. Procedures for possible post injection repair;

s. Method(s) and material(s) that will be used to protect concrete surfaces from wax spills, leaks, etc. during wax injection, post injection inspection and post injection repair;

t. Safety and clean-up procedures;

5. Conduct a joint meeting of the Contractor, wax injection crew, and the Engineer before wax injection operations begin. Discuss Wax Injection Operations Plan, required testing, corrective procedures, and any other relevant issues at the meeting.

6. Demonstrate, to the Engineer's satisfaction, wax injection of a duct by constructing a full-scale mockup with all associated PT system components of a typical duct profile on the project. Utilize the same type of duct and wax injection equipment as used on project. Place a non-stressed PT strand equivalent to the typical longitudinal tendon size inside the duct to simulate in-place PT strand. Assist the Engineer in the inspection and disassembly of the PT system after wax has congealed.

462-7.4.2.1.2 Inlets and Outlets:

1. Ensure connections from wax pump hose to inlets are free of dirt and are air-tight.

2. Inspect valves to ensure they can open and close properly.

3. Provide clear hose and connections to outlet valves compatible with heated wax injection for discharging excess wax. Kinks and clogs in the vent hoses are not permitted during pumping operations.

462-7.4.2.1.3 Supplies:

1. Provide an adequate supply of compressed air for clearing and testing ducts before wax injection operations start.

2. Provide clean receptacles for collecting excess wax at outlet locations.

3. Provide supplies for stopping wax leaks.

462-7.4.2.1.4 Equipment:

1. Provide equipment consisting of measuring devices for wax, wax melting unit(s), wax mixer for maintaining uniform temperature, a storage holding

reservoir, pump, and volumetric flow rate and displacement volumetric meters with all necessary connecting hoses, valves, pressure gauges, timer, and temperature gauge.

2. Provide pumping equipment with sufficient capacity to ensure PT ducts can be filled and vented in not more than time specified by the wax manufacturer and this Specification.

3. Provide an air compressor and hoses with sufficient output to perform required functions.

4. For filling of air voids in an incomplete wax injection, have vacuum wax injection equipment (i.e., volumetric measuring type) and experienced operators available not less than 48 hours prior to the maximum number of calendar days allowed in 462-7.2.4, between first installation of prestressing steel within the duct and completion of the stressing and wax injection operation for PT. If the maximum number of days in 462-7.2.4 have been exceeded, have available vacuum wax injection equipment and experienced operators available within 48 hours notice.

5. For vacuum assisted injection, provide vacuum pump equipment able to measure and have sufficient capacity to ensure a minimum of 90% vacuum in the PT system prior to filler injection. Provide continuously running vacuum pump or vacuum reservoir capable of maintaining vacuum during the wax injection process.

6. Ensure that all injection and inspection equipment is maintained in accordance with equipment manufacturer's instructions and is calibrated and in good working condition.

7. Provide equipment for dislodging congealed wax blockages.

462-7.4.2.1.4.1 Storage Reservoir and Mixing:

1. Provide heated holding tanks for wax injection.

a. Holding tanks must be equipped with a heating system capable of producing a melted wax free of lumps within the temperature limits specified by the manufacturer.

b. Holding tanks must be kept at least 10% full at all times during pumping operations to prevent clogs and air from being drawn into duct

c. Holding tanks must have at time of injection a quantity of heated wax required to inject the PT system. The quantity of heated wax required to inject the PT system is calculated as 25% more than the total quantity to fill the duct and anchorages, to discharge wax at outlets, to fill pumping equipment and hoses, and to maintain the minimum amount of wax in the holding tanks during pumping operations.

2. Provide equipment to ensure uniform temperature of heated wax, either by mixing or other methods.

462-7.4.2.1.4.2 Pumps:

1. Provide pumping equipment capable of the following:

a. continuous operation which includes a system for heating pump components when wax injection is not in progress;

b. maintaining pressure on wax injected ducts;

c. fitted with a valve that can be closed off without loss of pressure in duct.

2. Wax pumps will:

a. be positive displacement type;

b. provide a continuous wax flow;

c. be able to maintain a discharge pressure of at least 75 psi;

d. provide an injection of filler into duct in a velocity range of 40-70 ft/min.

3. Use pumps constructed with seals to prevent oil, air, or other foreign substances from contaminating wax and prevent loss of wax.

4. Pumps with hoppers are not permitted.

5. Specify pump capacity adequate to maintain the wax injection rate.

6. Place pressure gauge with full scale reading of no more than 150 psi at duct inlet. If long hoses (in excess of 100 feet) are used, or if the duct injection port is more than 50 feet above the pump, provide two gauges: one at pump and one at inlet.

7. Wax injection hoses to be compatible with pump output (diameter, pressure rating and temperature).

462-7.4.2.1.4.3 Vacuum Wax Injection:

1. For filling voids in incomplete wax filling operations, provide vacuum wax injection equipment meeting these minimum requirements:

a. Volumeter for measurement of void volume;

b. Vacuum pump with a minimum capacity of ten cubic feet of air per minute and equipped with a flow-meter, graduated reservoir, or other acceptable means approved by the Engineer capable of measuring the amount of wax being injected.

c. Mixers and heaters, or other mixing and heating methods recommended and approved by the wax manufacturer, in writing, for the specific project covered by this Section.

2. For vacuum assisted injection, provide vacuum wax injection equipment meeting these minimum requirements:

a. Vacuum pump with a minimum capacity of ten cubic feet of air per minute with the capability of removing 90% of standard atmospheric pressure within the PT system and equipped with a vacuum pressure gauge;

b. Hoses, vacuum reservoirs, and connections required for attachment to the PT system.

462-7.4.2.1.4.4 Heaters: Use a heater and temperature monitoring system capable of liquefying the entire mass of PT wax to be used for a given injection operation within the temperature limits specified by the PT wax manufacturer. The heater systems must apply a uniform heat to the PT wax and avoid locally high temperatures that may damage the PT wax or container. Use a heater and temperature monitoring system which complies with the recommendations of the PT wax manufacturer.

462-7.4.2.1.5 Wax Injection:

1. Maintain wax temperature in strict compliance with the wax manufacturer's published product data sheet.

2. Perform wax injection in accordance with procedures set forth in approved Wax Injection Operations Plan.

3. Inject duct.

462-7.4.2.1.5.1 Temperature:

1. Condition wax to maintain its temperature during injection between 212°F and 240°F unless proven acceptable otherwise.

2. Wax injection operations are not permitted when ambient temperature is below minimum temperatures specified by the wax manufacturer.

462-7.4.2.1.5.2 Production Test:

1. Check wax temperature to verify it is within established limits during operations.

2. Do not start operations until such time that testing shows wax meets specified requirements.

462-7.4.2.1.5.3 Operations:

1. Open all inlets, outlets and drains before beginning wax injection operation to remove standing water from duct.

2. Protect concrete surfaces from wax spills, leaks, etc.

3. Inject wax in accordance with approved Wax Injection Operations Plan.

4. Use pumping methods that ensure complete filling of ducts and anchorage assembly with wax.

5. Ensure the entire mass of wax is fully liquefied prior to and throughout injection operations. Establish a non-turbulent, laminar system circulation by continuously recirculating the wax between the pump and the storage container prior to injecting the wax into the duct. Pump components must be at wax injection temperature prior to wax injection into duct. Do not allow wax to free fall during recirculation or injection operations. Maintain a positive head of liquid wax above all withdrawal and recirculation ports and do not allow air intrusion into the pumping system. Do not pour liquid wax into an open pump or hopper.

6. Inject PT wax at a continuous and steady rate in accordance with the approved Wax Injection Operations Plan at a flow rate through duct at a velocity between 40 and 70 feet per minute and pressures limited to 75 psi. If pressure gauges are utilized at the pump and at the injection port, ensure that pressures at both locations are within the limits put forth in this Section.

7. For vacuum assisted injection, provide a minimum of 90% vacuum in the duct prior to injection. Injection of filler may occur at an anchorage port. Vacuum through anchorage cap outlet at opposite end of duct from the injection anchorage port. If injection location does not occur at anchorage port, provide required vacuum through both anchorage caps. All outlets, inlets, and vents other than vacuum locations and injection location must be closed during injection procedure. Pump filler into inlet and continuously vacuum air until duct is fully injected with filler. Close outlet valve at anchorage cap when filled with filler. Close inlet valve with locking pressure between 30 psi and 45 psi.

8. For vented filler injection, allow wax to flow from duct and anchorage discharge points until a steady flow of wax free from air is continuously discharged. Collect a minimum of two gallons of continuously flowing wax free

from air at discharge point before closing outlet valve. Do not reuse discharged wax. After all outlets are closed, close the inlet valve at locking pressure between 30 and 45 psi. For tendon profiles with high point vents as labeled in Design Standards, Index No. 21801, continue with the following procedure:

a. Wait 30 to 60 seconds after outlet valves and inlet valve are closed.

b. Open high point outlet valves and inlet valve, and inject wax through duct.

c. Close each high point valve after wax flows through outlet continuously free from air. After all high point valves are closed, increase pressure to locking pressure between 30 and 45 psi and close inlet valve.

9. Record the total volume of wax injected into the system.

10. Upon completion of wax injection, seal the duct in accordance with the approved PT system drawings. Remove all excess wax from exposed surfaces.

462-7.4.2.1.5.4 Wax Injection Operations Report:

1. Provide wax injection report signed by the wax injection Contractor within five days of each wax injection operation for review by the Engineer.

2. Record theoretical quantity of wax anticipated as compared to actual quantity of wax used to fill duct. Notify the Engineer immediately of shortages or overages.

3. Information to be noted in this report must include at a minimum, but not necessarily be limited to:

a. Identification of duct;

b. Date of duct pressure test;

c. Date wax injected;

d. Number of days from tendon installation to wax injection;

e. Wax product identification;

f. Final locking pressure of wax in PT system;

g. Reservoir temperature at time of initiation of wax injection;

h. Theoretical volume of wax required to completely fill the duct;

i. Volume of wax injected into duct;

j. Volume of wax collected at discharge points;

k. Injection rate including timing of duct inlet opening and closing;

l. Ambient temperature;

m. Summary of any problems encountered and any deviations from the Wax Injection Operations Plan;

n. Corrective action taken;

o. Description and results of the post wax injection operations and inspection;

p. Vacuum gauge pressure and percent vacuum in duct prior to injection;

4. Maintain daily wax injection operations reports at the job site for review by the Engineer. Provide all daily reports to the Engineer on a weekly basis or more frequently as directed by the Engineer.

462-7.4.2.1.6 Manufacturer's Installation Technician: Provide for a PT system vendor installation technician, certified by the vendor as having sufficient knowledge and expertise to oversee the wax injection personnel. The vendor's technician shall be under the direct employ of the vendor and shall be present for all wax injection activities for a minimum of the first two days of wax injection for each of the Contractor's wax injection crews. The vendor's technician shall provide written certification to the Engineer that the Contractor's installation process is in conformance with the approved Wax Injection Operations Plan.

462-7.5 Repair: Perform no remedial or repair work without the Engineer's approval in writing.

462-7.5.1 Lifting and Access Holes:

1. Repair all holes with magnesium ammonium phosphate concrete meeting requirements of Section 930 or Type Q epoxy grout meeting requirements of Section 926. Immediately before casting concrete (i.e., within 24 hours), mechanically clean and roughen the mating concrete surfaces to remove any laitance and expose small aggregate. Use grit blasting or water blasting using a minimum 10,000 psi nozzle pressure. Flush surface with water and blow dry. Form, mix, place, and cure material in strict compliance with manufacturer's recommendations.

2. Coat repaired holes, block-outs, and an area extending six inches outside perimeter of repair with a high molecular weight methacrylate (HMWM) listed on the APL upon completion of deck grooving. Prepare surface to be coated and apply HMWM in accordance with Section 413. Friction (skid) tests per Section 413 are not required.

462-7.5.2 Inlets and Outlets:

1. Place threaded plastic plugs in all inlet/outlet locations required in the Contract Documents.

2. Fill inlet/outlet recesses as shown in the Contract Documents using a Type Q epoxy compound, Type E epoxy compound, or Type F-1 epoxy compound meeting requirements of Section 926.

3. Prepare surface to receive epoxy compounds in compliance with manufacturer's recommendations.

462-7.5.3 Duct:

1. Heat-shrink wrap material designed for duct repair may be used with approval of the Engineer in writing.

2. Use approved heat-shrink sleeve material to repair ducts. Install in accordance with manufacturer's instructions.

462-8 Acceptance and Testing.

462-8.1 Contractor Material Testing:

1. The following tests are not required on post-tensioned, precast flat slab bridges, and double-tee bridges, but are required on all other PT applications.

2. Include cost for Contractor Tendon Modulus of Elasticity Test and In-Place Wobble and Friction Test in price of PT system.

462-8.1.1 Tendon Modulus of Elasticity Test:

Perform a tendon modulus of elasticity test in accordance with the following procedure if required in the Contract Documents or ordered by the Engineer.

1. Bench test two samples of each size tendon prior to stressing tendons to determine modulus of elasticity for purpose of accurately determining tendon elongations while stressing.

2. Bench length between anchorages must be at least 40 feet and tendon duct at least two inches clear of tendon all around for purpose of this test.

3. Test procedure must consist of stressing tendon at an anchorage assembly with a load cell at dead end.

4. Tension test specimen 80% of GUTS in ten increments and then detention from 80% of GUTS to zero in ten decrements.

5. Record gauge pressure, elongations, and load cell forces for each increment and decrement.

6. Note elongations of tendon for both ends and the central 30 feet, measured to an accuracy of plus or minus 1/32 inches.

7. Correct elongations for actual anchor set of dead end.

8. Calculate modulus of elasticity as follows:

$$E = PL/Adl$$

where,

P = force in tendon

L = distance between pulling wedges and dead end wedges or exact length in the center 30 feet of tendon

A = cross sectional area of tendon

dl = tendon elongation within length, L, for load, P

9. Submit revisions to theoretical elongations to the Engineer for approval if bench test varies from modulus of elasticity used for shop or working drawings by more than 1%.

10. Additional Tendon Modulus of Elasticity Tests may be required when observed tendon elongations in erected structure fall outside acceptable tolerances or to otherwise settle disputes to the satisfaction of the Engineer.

11. Additional test series of substantiation from previous projects, not to exceed two per source, will be required if source of prestressing steel changes during project.

12. Apparatus and methods used to perform the test must be submitted to the Engineer for approval in writing.

13. Tests must be conducted in the Engineer's presence.

462-8.1.2 In-Place Wobble and Friction Test:

1. Test in-place a minimum of one tendon per tendon group performing the same function for tendons in excess of 100 feet long.

2. Functional tendon groups are cantilever tendons, continuity tendons, draped external tendons, or continuous profiled tendons passing through one or more spans.

3. Selected tendon will represent the size and length of tendon group being tested.

4. In-place test is not required on projects with straight tendons used in flat slabs or precast voided slabs.

5. Test procedure consists of stressing tendon at an anchorage assembly with a load cell or a second certified jack at dead end.

6. Stress test specimen to 80% of GUTS in eight equal increments.

7. For each increment, record gauge pressure, elongations, and load cell force (if a load cell is used).

8. Take into account any wedge seating in both live end (i.e., back of jack) and dead end (i.e., back of load cell) and any friction within anchorages, wedge plates, and jack as a result of slight deviations of strands or wires through these assemblies.

9. Keep an accurate account of elongation at jacking end allowing for intermediate wedge seating and slip of the jack's wedges for long tendons requiring multiple jack pulls with intermediate temporary anchoring.

10. If elongations fall outside the plus or minus 7% range compared to anticipated elongations, investigate reason and make detailed calculations confirming final tendon forces are in agreement with requirements of the approved Contract Documents.

11. Do not vary value of expected friction and wobble coefficients by more than plus or minus 10% in reconciling theoretical and actual elongations.

12. Submit for written approval by the Engineer a plan to correct or compensate for elongation discrepancies if necessary.

13. The Engineer will require one successful test for each tendon group for the project.

14. The Engineer may require additional in-place tests if there are irreconcilable differences between forces and elongations or other difficulties during the course of routine stressing operations.

15. Submit apparatus and methods used to perform test to the Engineer for approval in writing.

16. Conduct all in-place tests in the Engineer's presence.

462-8.1.3 Required Reports:

1. Submit two copies of the test report for "Tendon Modulus of Elasticity Test" to the Engineer at least 30 days before installing tendon.

2. Submit two copies of the test report for "In-Place Wobble and Friction Test" to the Engineer within two weeks after successful installation of tested tendon.

462-8.1.4 Test Results Application:

1. Reevaluate theoretical elongations shown on PT shop or working drawings using results of "Tendon Modulus of Elasticity Test" and "In-Place Wobble and Friction Test," as appropriate, and correct calculations as necessary.

2. Submit revisions to theoretical elongations to the Engineer for approval in writing.

462-8.2 Contractor Field Tests:

462-8.2.1 Prior to Concrete Placement:

1. Types of systems to be tested include all PT system components utilized on the project for, but not limited to, transversely post-tensioned slabs, longitudinally post-tensioned girders, transverse post-tensioning in box girder segments, pier and bent caps, and

columns. Longitudinal tendons in box-girder segments (internal tendons) are exempt from this testing.

2. In the formwork, pressure test each different type and size of duct assemblies with all assemblies used in a single structural component (e.g. segment, beam, etc.) constructed for first time on project.

3. One system per group, but not less than a total of two per project, will be randomly chosen by the Engineer for testing.

4. When required by the Engineer, test assemblies in their final position just prior to concrete placement by sealing them at their anchorages or construction joint termini and then applying compressed air in accordance with this Section to determine if assembly connections are pressure tight.

a. In presence of the Engineer, pressurize duct to 1.5 psi and lock-off outside air source.

b. Record pressure loss for one minute.

c. If pressure loss exceeds 0.15 psi, or 10%, find and repair leaks in duct assembly using repair methods approved by the Engineer and retest.

462-8.2.2 Post Concrete Placement:

1. After stressing and before injecting filler into duct, install all anchorage caps, inlets and outlets and test the duct with compressed air in accordance with this Section to determine if duct connections require repair.

2. In the presence of the Engineer, pressurize duct to 50 psi and lock-off outside air source. Record pressure loss for one minute. A pressure loss less than 25 psi, or 50%, is acceptable for ducts with a length of equal to or less than 150 feet and a pressure loss less than 15 psi is acceptable for ducts longer than 150 feet.

3. If the pressure loss exceeds allowable, repair leaking connections using methods approved by the Engineer and retest.

462-8.3 Contractor Inspections:

462-8.3.1 Post Concrete Placement/Prior to Filler Injection Operations:

1. Upon completion of concrete placement and except as otherwise described, prove PT ducts are free and clear of any obstructions or damage and are able to accept intended PT tendons by passing a torpedo through ducts.

2. Use a torpedo having same cross-sectional shape as duct that is 1/4 inches smaller all around than clear, nominal inside dimensions of duct. Make no deductions to torpedo section dimensions for tolerances allowed in manufacture or fixing of ducts. For straight ducts, use a torpedo at least two feet long. For curved ducts, determine length so that when both ends touch outermost wall of duct, torpedo is 1/4 inches clear of innermost wall. The Engineer will reject member if torpedo will not travel completely through duct and workable repair cannot be made to clear duct. Torpedo must pass through duct easily when pushed through by hand, without resorting to excessive effort or mechanical assistance.

3. Alternatively, four strand tendons in flat ducts used for transverse PT of segmental box-girders may be preplaced prior to concrete casting. Prove PT ducts are free and clear of any obstructions or damage by moving the group of strands back and forth in duct for a minimum distance of one foot in each direction. Move strands easily, by hand, without resorting to excessive effort or mechanical assistance.

462-8.3.2 Post Filler Injection Operations:

462-8.3.2.1 Post Grouting Operations:

1. Inspect all tendons.

2. Do not open or remove inlets and outlets until grout has cured for a minimum of 24 hours and complete tendon inspections within 96 hours.

3. Perform inspections within one hour after removal of all inlets/outlets located at anchorages and high points along the tendon.

4. Drill into existing grout ports at all high points along tendon as well as inlets or outlets located at anchorages for inspection. Drill through hardened grout to penetrate full-length of grout port access piping to top of trumpet or duct. If drilling of inlets or outlets is not feasible with conventional equipment, propose an alternative method of tendon inspection for approval by the Engineer in writing. Use drilling equipment that will automatically shut-off when steel is encountered. Do not drill into anchorage cap unless anchorage caps are determined to have voids by sounding.

5. Perform all inspections using borescopes or probes and in presence of the Engineer.

6. Fill voids using volumetric measuring vacuum grouting process not less than 48 hours prior to the maximum number of calendar days in 462-7.2.4 allowed between first installation of prestressing steel within duct and completion of the stressing and grouting operation for PT. If the maximum number of days in 462-7.2.4 have been exceeded, have vacuum grouting equipment and experienced operators available within 48 hours notice.

7. Seal and repair all anchorage and inlet/outlet voids that are produced by drilling for inspection purposes as specified within four hours of completion of inspections if no additional voids are detected in tendon ducts or anchorages.

8. Remove inlet/outlet to a minimum depth of two inches below face of concrete and seal the surface as specified within 4 hours of inlet/outlet removal. Use an injection tube to extend to bottom of holes for backfilling with epoxy grout.

9. Drill into duct and explore voided areas with a borescope if grouting operations were prematurely terminated prior to completely filling duct. Probing is not allowed. Determine location and extent of all voided areas. Fill voids using volumetric measuring vacuum grouting equipment in accordance with this Section.

462-8.3.2.2 Post Flexible Filler Injection Operations:

462-8.3.2.2.1 Microcrystalline Wax:

1. Inspect PT system.

2. Do not open or remove inlets and outlets until wax has cooled for a minimum of 24 hours and complete tendon inspections within 96 hours.

3. Perform inspections within one hour after removal of all inlets/outlets located at anchorages and high points along the tendon.

4. Visually inspect existing ports at all high points along tendon as well as inlets or outlets located at anchorages. Repair wax leaks according to the Wax Injection Operations Plan.

5. Between 24 and 48 hours following wax injection, perform the following inspection operations for each tendon:

a. Sound external ducts with a rubber mallet to ensure the system is free from voids,

b. Remove all inspection port caps and visually inspect to ensure the system is free from voids,

c. If voids greater than 12 cubic inches are detected, address voids using this section and methods described in the approved Wax Injection Operations Plan;

d. Fill voids created by inspection procedures and replace all inspection port caps and seal in accordance with the approved Wax Injection Operations Plan.

6. Fill voids greater than 12 cubic inches using volumetric measuring vacuum wax injection process not less than 48 hours prior to the maximum number of calendar days in 462-7.2.4 allowed between first installation of prestressing steel within duct and completion of the stressing and wax injection operation for PT. If the maximum number of days in 462-7.2.4 have been exceeded, have vacuum wax injection equipment and experienced operators available within 48 hours notice.

7. Seal and repair all anchorage and inlet/outlet voids that are produced for inspection purposes as described in the approved Wax Injection Operations Plan within four hours of completion of inspections if no additional voids are detected in tendon ducts or anchorages.

8. Inspect duct and explore voided areas with a borescope if wax injection operation was prematurely terminated prior to completely filling duct. Determine location and extent of all voided areas. Fill voids using volumetric measuring vacuum wax injection equipment in accordance with this Section.

462-9 Method of Measurement.

1. Quantity of PT tendons to be paid for under this Section will be computed weight, in pounds, of permanent PT steel tendons installed in the completed structure and accepted.

2. Quantity is determined by theoretical plan length measured from anchorage to anchorage (measured from front face of bearing plate) with no allowance made for waste or extension past bearing faces.

3. No measurement will be made for temporary PT which is considered incidental to Pay Item 462-2, Post Tensioning Tendons.

4. Use these unit weights for quantity determination:

Table 9-1 PT Strand and Bar Weight per Unit Length	
Prestressing System	Weight per Unit Length, Lb/Ft
1/2 inch diameter 7-wire strand	0.52
0.6 inch diameter 7-wire strand	0.74
1 inch high strength deformed bar	3.01
1-1/4 inch high strength deformed bar	4.39
1-3/8 inch high strength deformed bar	5.56
1-3/4 inch high strength deformed bar	9.23

462-10 Basis of Payment.

462-10.1 General:

1. PT tendons will be paid for at the Contract unit price per pound of steel tendon, completed and accepted.

2. Payment will be full compensation for furnishing, installing, stressing, and filler injection of all temporary and permanent, internal and external ducts. Payment also includes anchorage assemblies and associated supplemental reinforcing steel required by supplier, PT system hardware not embedded in concrete, ducts, grout and grouting operations, flexible filler and filler injection operations, all testing, including Tendon Modulus of Elasticity Test and In-Place Wobble and Friction Test, protection of PT anchorages, vents, inlets, outlets, and all labor, materials, tools, equipment, and incidentals necessary for completing the work in accordance with the Contract Documents. This payment also includes lubricants in tendon ducts for friction control and flushing lubricants or contaminants from ducts.

3. Anchorage components, ducts, and similar items of PT system hardware embedded within precast components or cast-in-place concrete will be deemed to be included in cost of precast component or cast-in-place concrete in which it is embedded.

4. Payment is based on unit price bid extended by either quantities shown in the Contract Documents or actual quantities used and accepted, whichever is less, if the Contractor constructs structure with an accepted alternate not detailed in the Contract Documents.

5. Permanent PT strand, wire, or bar tendons which are an integral part of individual precast concrete segments or units will be measured and paid for under this item and will not be considered incidental to cost of those precast concrete segments or units.

6. Payment for PT will be made following successful placement, stressing, filler injection, inspection, repair, protection, and written approval by the Engineer.

7. Full payment for PT tendons within precast segmental concrete structure units may occur prior to erection of segments into final position when ducts have been injected and anchorage protection system applied and the segmental unit otherwise approved in writing for placement by the Engineer.

462-10.2 Pay Items:

Payment will be made under:

Item No. 462- 2 Post-tensioning Tendons - Per Pound

SECTION 926
EPOXY COMPOUNDS

926-1 Types of Compounds.

Epoxy resin based compounds for application to portland cement concrete, bituminous cement concrete, metals and other type surfaces shall be applicable for the following types as designated.

Type	Description
A*	An epoxy resin, for bonding fresh concrete to hardened concrete.
B*	An epoxy resin adhesive, for bonding hardened concrete to hardened concrete and constructing doweled splices in precast prestressed concrete piles.
E*	A fluid epoxy for crack injection in the repair of old structures.
F F-1* F-2**	An epoxy for repairing spalled areas on concrete bridge structures with these subtypes: A non sagging gel type for vertical surfaces. A pourable type for repairs where forms are to be used.
H**	An epoxy for structural bonding where asphalt overlays are to be in contact with the hardened compound.
K*	An epoxy for underwater sealing of the bottom of the jacket of an integral pile jacket system.
M***	A coal tar epoxy coating for steel sheet piles and H piles (water immersion) and hot applied coal tar epoxy tape.
Q*	An epoxy for use in post tensioning anchorage protection systems.
*Accepted by APL **Accepted by certified test report ***Accepted by certification	

926-2 Epoxy Design Requirements.

926-2.1 General: All types of compounds except M shall contain no volatile solvent.

All types of compounds except F, M, and N shall be basically pure reactive material with a maximum ash content of 2%.

When product materials are required to be mixed, all types shall have simple mix ratios of one to one or two to one or shall be supplied in pre-measured containers in which all of the contents of all packages are to be mixed.

Certain terms used in this specification shall have these meanings:

low modulus - the stress-strain property for which ultimate tensile strength is attained at over 10% elongation.

high modulus - the stress-strain property for which ultimate tensile strength is attained at under 6% elongation.

non-sagging gel - grades of mixed compounds which will not perceptibly flow under their own weight on a vertical surface in the unhardened state.

pourable - grades of mixed compound sufficiently fluid that they (either neat or filled) can be cast into and will take the shape of a mold.

926-2.2 Approved Product List (APL): All epoxy materials shall be one of the products listed on the Department's Approved Product List (APL) unless alternative acceptance is identified in this Specification. Manufacturers seeking evaluation of their products shall submit

product data sheets, performance test reports from an independent laboratory showing the product meets the requirements of this Section, an infrared identification curve (2.5 to 15 µm) and a APL application in accordance with Section 6. Information on the APL application must identify the epoxy type.

Products may only be used for applications recommended by the manufacturer.

926-2.3 Certification: The Contractor shall provide the Engineer with certification from the manufacturer of the epoxy, confirming that the requirements of this Section are met. The certification shall conform to the requirements of Section 6. Each certification shall cover only one batch of epoxy materials.

926-3 Specific Requirements for Types A and B Compounds.

926-3.1 Mixing and Application: Types A and B epoxy compounds (for bonding fresh concrete to hardened concrete or bonding precast concrete parts) shall be listed on the APL and be mixed, applied, and cured in accordance with the manufacturer's directions, or as might be directed otherwise by the Engineer.

Epoxy compounds shall be used only under conditions which are compatible with the material being applied in accordance with the specific directions of the manufacturer.

926-3.2 Performance Tests:

1. Epoxy Bonding Compounds: Epoxy Bonding Compounds shall be prepared and tested in accordance with FM 3-C882. The ratio of the compressive strength of the composite cylinder to the compressive strength of the weaker concrete shall not be less than 0.90

2. Epoxy Mortars: Epoxy mortar shall be prepared and tested in accordance with FM 3-C882. The average compressive strength of the three test specimens shall be at least 5,000 psi.

926-4 Specific Requirements for Type E Compounds.

Epoxies for crack injection shall meet the Specification for Type B compound with these additional requirements:

Viscosity five minutes after mixing	300 to 600 cps at 77°F by ASTM D 2393
Wet bond strength to concrete, minimum	250 psi at seven days by FM 5-518

926-5 Specific Requirements for Type F Compounds.

926-5.1: Repairing Spalled Areas: Epoxies for repairing spalled areas shall meet the requirements in this Section.

926-5.2: Subtype F-1: Subtype F-1 is used for repairing vertical and other surfaces and shall be a trowelable low modulus, non-sagging gel epoxy compound capable of bonding to wet surfaces with these properties:

Color	Shall match gray color No. 36622 of FED-STD-595
Viscosity	Gel
Maximum sand loading	2.25 parts sand to one part mixed epoxy by volume
Elongation in tension minimum	10% by ASTM D 638, seven day cure
Wet bond to Steel and Concrete minimum	250 psi by Florida Test Method FM 5-518

Subtype F-1 shall be listed on the APL.

926-5.3: Subtype F-2: Subtype F-2 is used for filling larger spalls where a form is required to build back to the original surface. Materials shall be a pourable low modulus type compound capable of bonding to wet surfaces with these properties:

Color	Shall match gray color No. 36622 of FED-STD-595-
Maximum sand loading	2.25 parts sand to one part mixed epoxy by volume
Elongation in tension, minimum	10% by ASTM D 638, seven day cure
Exotherm	110°F by ASTM D 2471, 1 pint sample
Wet bond strength	250 psi at seven days by FM 5-518

Type F-2 products will be accepted on the job. Furnish to the Engineer testing from the manufacturer of the product for each LOT of material to be incorporated in the project. The test results will indicate that the material is in conformance with the Specifications, and will include actual values from the required tests. Obtain approval from the Engineer before incorporating material into the project.

926-6 Specific Requirements for Type H Compounds.

Epoxies for structural bonding where bituminous pavement overlays will come in contact with the hardened compound shall meet the requirements for Types A and B compounds above and the manufacturer shall provide test data showing that cutback and emulsified asphalts, asphalt cement, and bituminous mixes shall bond to but not soften or otherwise damage the epoxy after a curing period of four days.

Type H products will be accepted on the job. Furnish to the Engineer testing from the manufacturer of the product for each LOT of material to be incorporated in the project. The test results will indicate that the material is in conformance with the Specifications and will include actual values from the required tests. Obtain approval from the Engineer before incorporating material into the project.

926-7 Specific Requirements for Type K Compounds.

Epoxies for sealing the bottom of integral pile jackets in the repair of concrete piles shall be listed on the APL. These epoxies will be extended with the aggregate supplied by the manufacturer. The epoxy shall be factory pre-proportioned including factory supplied aggregate and meet the following requirements:

Compressive strength at seven days, minimum by the method described in 926-3.2(b)	4,500 psi
Bond Strength by FM 5-518	
to wet concrete, minimum	250 psi
to wet pile jacket, minimum	150 psi
Viscosity of mixed epoxy component at 77°F, five minutes by ASTM D 2393	1,000-2,000 cps

The epoxy shall be capable of flowing through water in the void area of the jacket and hardening under water so as to provide a water tight seal of the depth indicated in the Plans or approved shop drawings and to maintain this seal during subsequent construction steps.

926-8 Specific Requirements for Type M Compounds.

Coal Tar epoxy coatings for steel sheet and H piles used in bridges, fender systems and other structures subject to immersion in water shall comply with the requirements of SSPC Paint 16 with Type 1 pitch. Application of the epoxy coating shall meet the requirements of Section 560 for a coal tar epoxy coating.

Hot applied coal tar epoxy tape used to protect tie back rods on sheet pile walls and bulkheads shall comply with the requirements of American Water Works Association standard C203. Application shall be according to the manufacturers published recommendations.

Provide the Engineer a certification conforming to the requirements of Section 6 from the manufacturer, confirming that the penetrant sealer meets the requirements of this Section. Do not incorporate these materials into the project until the Engineer has accepted and approved the certification for the material. Submit such certification for each LOT of material delivered to the project. In each certification, identify the serial or LOT numbers of the containers certified.

926-9 Specific Requirements for Type Q Compounds.

These epoxy materials shall be listed on the APL and are to be used to protect the anchorages of post-tensioning tendons or bars and other uses indicated in the Plans. The material shall produce a low exothermic reaction and have flow and fill characteristics suitable for machine base plate applications. The material will be extended with the aggregate supplied by the manufacturer. Mix with the full aggregate loading unless the use of less aggregate is approved by the Engineer.

The material shall be factory pre-proportioned including factory supplied aggregate. Deliver products in original containers with manufacturer's name, date of manufacture, product identification label and batch numbers. Materials must be within the manufacturer's recommended shelf life. Store and condition the product in full compliance with manufacturer's recommendations.

The epoxy grout plus aggregate mix shall meet or exceed the specified physical properties stated herein as determined by the following standard ASTM test methods.

Property	Test Value	Test Method
Compressive Strength Cubes 7 day Cure at 77°F	> 10,000 psi	ASTM C 579B
Tensile Strength at 7 days	> 2,100 psi	ASTM C 307

Flexural Strength at 7day Cure at 77ºF	> 3,600 psi	ASTM C 580
Modulus of Elasticity 7 day Cure at 77ºF	< 2,100,000 psi	ASTM C 580
Coefficient of Thermal Expansion at 74 to 210°F	< 20 x 10^{-6} in/in/ºF	ASTM C 531

Peak Exotherm, Specimen 12 x 12 x 3 in.	< 150ºF	ASTM D 2471
Slant Shear at 7 days (Bond Strength to Concrete)	> 3000 psi	FM 5-587
Thermal Compatibility	5 Cycles Passed	ASTM C 884
Linear Shrinkage at 7 days	0.025%	ASTM C 531
Flowability and Bearing Area	90% Contact area	ASTM C 1339
Gel Time, Specimen 12 x 12 x 3 in.	< 4:00 (hr.)	ASTM D 2471

926-10 Packaging, Labeling, and Safety.

All containers shall show the type, mixing directions, batch numbers, manufacturer's name, date of packaging, shelf life expiration date and quantity in pounds or gallons. Containers with components shall clearly be identified with Component A-epoxy resin or Component B-hardener. Mix ratios shall be prominently shown on labels.

Potential hazards shall be stated on each package in accordance with the Federal Hazardous Products Labeling Act.

926-11 Storage.

Epoxy materials, which have been in storage for more than twelve months, will not be accepted for use.

926-12 Fillers.

Fillers for mixing mortars and grouts may be as recommended by the manufacturer of the particular epoxy compound and may be supplied as packages accompanying the epoxy or premixed in accordance with approved properties.

If a manufacturer recommends only the gradation of filler, it must be a silica sand commercially available in Florida and shall be a gradation listed in Table I or a specified blend of these gradations.

The silica sands specified in Table I shall be clean, kiln dried, packaged in strong moisture proof bags, contain no more than 0.2% organic trash, and be chloride free.

Fillers shall not be used with these compounds: Types E and M.

When the fillers specified in Table I are used, the maximum amount shall be 2.25 volumes to one volume of mixed compound.

TABLE I GRADATION REQUIREMENTS FOR FILLERS FOR USE WITH EPOXY COMPOUNDS				
GRADE				
	A	B	C*	D**
Sieve Opening Size	Required % Passing			
No. 4			95-100	95-100
No. 6		90-100		
No. 8			0-15	85-100
No. 16				65-97
No. 20	80-100	0-20		
No. 30	0-40			25-70
No. 50	0-10			5-35
No. 100				0-7

*For use only in sections 1 1/2 inches or greater in thickness.
**Same as quartz sand fine aggregate for cement concrete (902-1.3.1).

SECTION 930
MATERIALS FOR CONCRETE REPAIR

930-1 Description.

This Section covers cementitious materials used to repair concrete including defects or purposely placed openings in concrete elements. Materials containing organic compounds, such as bitumens and epoxy resin as the principal binder are not included. The requirements for epoxy resin materials are covered in Section 926. Any depth larger than the manufacturer's recommendation for the specific material shall be repaired with portland cement concrete meeting the requirements of Section 346.

930-2 Product Acceptance on the Project.

930-2.1 Product Acceptance: Use only products listed on the Department's Approved Product List (APL). Manufacturers seeking evaluation of products must submit an application in accordance with Section 6 and include independently certified test reports that the material meets the requirements of this Section. The application package must describe detailed quality control requirements for installation including, but not limited to: maximum water to cementitious material ratio, formulation for two or more component systems, special materials and/or equipment, recommendations for all surface preparation, and curing requirements.

Provide the Engineer certification conforming to the requirements of Section 6 from the manufacturer confirming that the materials used meets the requirements of this Section and is the appropriate product for the intended use.

When specified in the Contract Documents, furnish a report of test results from an independent laboratory on samples taken from material shipped. Ensure the test was performed within 45 days prior to the shipping date of the material.

930-2.2 Material Supply, Storage, and Marking: The material shall be pre-proportioned including aggregate. Deliver products in original, unopened containers with manufacturer's name, date of manufacture, and clearly marked with all information described below. Store the material in an elevated dry and weather protected enclosure in full compliance with the manufacturer's recommendations. Material must be used within manufacturer's recommended shelf life.

The material from which the containers are made shall have water vapor transmission not greater than 100 g/m^2 in 24 hours as determined in accordance with Procedure B of ASTM E96.

All containers shall be marked with the following information:

1. LOT identification number and material expiration date
2. Directions for use shall include but are not limited to the following:
   a. The type and kind of adhesive recommended (if any) to bond fresh repair material to the concrete or mortar being repaired.
   b. The recommended amount of resin, other liquid component, or both, to be mixed with the package contents.
   c. The recommended length of mixing time or sequence of mixing and resting times in minutes.
3. Date the material was packaged.
4. The yield in cubic feet or yield in ft^2/in thickness when mixed with the recommended amount of liquid.
5. The net weight in each container. The contents of any container shall not vary by more than 2% from the weight stated in the declarations. The average weight of filled containers in a LOT shall be not less than the individual weight stated in the declarations.

6. Instructions for the maximum and minimum water (or solutions) to cementitious material ratio.

7. State the approximate working time.

930-2.3 Sampling, Mixing, and Additional Testing: A LOT is the packaged repair material normally placed on a pallet. A unit sample is a single container or package of material randomly selected from the LOT. Mix and install the materials in accordance with the manufacturer's recommendations. Manufacturers will be required to provide field representation upon request by the Engineer. The Department reserves the right to conduct further field testing on any approved material.

930-2.4 Rejection: All broken containers will be rejected. Material that fails to meet any of the requirements of this Specification will be rejected. Report all materials failing to meet this specification and state the reasons for rejection in writing to the Engineer and the producer or supplier. Material in local storage in the hands of a vendor for more than six months after testing will be retested before use, except for the scaling resistance test and length change immersed in sulfate solution test for magnesium ammonium phosphate concrete. Retested material will be rejected if it fails to conform to any of the requirements of this Specification.

930-3 Laboratory Specimen Preparation:

930-3.1 Mixing and Fabrication: Mechanically mix the dry packaged materials with liquid components in accordance with the manufacturer's recommendations.

930-3.2 Length Change: Make and cure the test specimens in accordance with ASTM C157, except omit the curing period in Section 10.3; however both 11.1.1 and 11.1.2 shall apply for 28 day curing period.

930-3.3 Manifestly Faulty Specimens: Visually examine each group of specimens representing a given test or a given age of test, including tests of freshly mixed concrete, before or during the test, or both, whichever is appropriate. Discard any specimen found to be manifestly faulty by such examination without testing. Visually examine all specimens representing a given test at a given age after testing, and should any specimen be found to be manifestly faulty the test results thereof shall be disregarded. Should more than one specimen representing a given test at a given age be found manifestly faulty either before or after testing, the entire test shall be disregarded and repeated. The test result reported shall be the average of the individual test results of the specimens tested or, in the event that one specimen or one result has been discarded, it shall be the average of the test results of the remaining specimens.

930-4 Materials for Repair of Predominately Horizontal Surfaces.

930-4.1 General: This material is intended to be used to repair concrete where the area to be treated will be on a horizontal surface. Examples of the type of locations for these materials are bridge decks, portland cement concrete pavements and other locations required by the Contract Documents. Follow the manufacturer's recommendations for preparing the surfaces, mixing, placing, and curing the repair material unless otherwise directed in the Contract Documents.

930-4.2 Classification: The materials to be considered under this classification shall meet the following requirements:

930-4.2.1 Rapid Hardening: Moderate compressive strength for repairing concrete with an in-place compressive strength less than or equal to 4,000 psi.

930-4.2.2 Very Rapid Hardening: High compressive strength for repairing concrete with an in-place compressive strength greater than 4,000 psi. This material may be used in lieu of Rapid Hardening materials.

930-4.3 Physical Properties: The repair material shall meet or exceed the physical properties stated in Table 1 as determined by the specified test methods.

Table 1 - Physical Properties of Repair Materials for Horizontal Surfaces			
Requirement	Test Method	Rapid Hardening	Very Rapid Hardening
Minimum Compressive Strength, psi			
3 hours	ASTM C39* or ASTM C109*	N/A	2,000
24 hours		2,000	4,000
7 days		4,000	6,000
28 days		Greater than or equal to strength at 7 days.	
Maximum Length Change, %			
Allowable expansion at 28 days when water cured compared to length at one day	ASTM C157**	0.12	0.12
Allowable shrinkage at 28 days when air cured compared to length at one day		-0.12	-0.12
Allowable difference between increase in water and decrease in air		0.20	0.20
Minimum Slump (Concrete), inches	ASTM C143***	3	3
Minimum Flow (Mortar), %	ASTM C1437***	100	80
Time of Setting (Initial), minutes	ASTM C191* or ASTM C403*	Minimum 30	10 to 29
Coefficient of Thermal Expansion, in/in/°F	ASTM C531* or AASHTO T336	5.0×10^{-6} to 9.0×10^{-6}	5.0×10^{-6} to 9.0×10^{-6}
Minimum Bond Strength by Slant Shear, psi			
24 hours	FM 5-587	400	450
7 days		Greater than or equal to strength at 24 hours.	
Maximum Allowable Total Chlorides lbs/yd^3	FM 5-516	0.40	

* as applicable
** Make and cure the test specimens in accordance with ASTM C-157, except omit the curing period in Section 10.3; however both 11.1.1 and 11.1.2 shall apply for 28 day curing period.
*** Testing for flow/slump will be completed in 5 plus or minus 1/2 minutes after the start of mixing liquid with the Rapid Hardening materials or 15 plus or minus 1/2 minutes after mixing the liquid with the Very Rapid Hardening materials.

930-4.4 Specimen Preparation:

930-4.4.1 Flow/Slump: Testing for flow/slump will be completed in 5 minutes, plus or minus 1/2 minutes, after the start of mixing liquid with the Rapid Hardening materials or 15 minutes, plus or minus 1/2 minutes, after mixing the liquid with the very rapid hardening materials.

930-5 Materials for Repair of Predominately Vertical Surfaces.

930-5.1 General: This material is intended to be used to repair concrete where the area exposed in the field to be treated will be on a vertical surface. If an element has both horizontal and vertical surfaces, then the repair used will be for vertical surfaces. If it is not apparent which material is to be used, the vertical application will prevail. Examples of the type of locations for these materials are columns, caps, beams, piles, incidental concrete products, drainage structures and other locations required by the Contract Documents. Follow the manufacturer's recommendations for preparing the surfaces and for mixing, placing and curing the repair material.

930-5.2 Classification: The materials to be considered under this classification shall meet the following requirements:

930-5.2.1 High Performance: Moderate compressive strength for repairing concrete with a designed compressive strength greater than or equal to 5,000 psi.

930-5.2.2 Ultra-high Performance: High compressive strength for repairing concrete with a designed compressive strength greater than 5,000 psi. These materials may be used in lieu of high performance vertical materials.

930-5.3 Physical Properties: The repair material shall meet or exceed the physical properties stated in Table 2 as determined by the specified test methods.

Table 2 - Physical Properties of Repair Materials for Vertical Surfaces*			
Requirement	Test Method	High Performance	Ultra-high Performance
Minimum Compressive Strength, psi			
24 hours	ASTM C39** or ASTM C109**	1,000	2,000
7 days		N/A	5,000
28 days		5,000	Greater than or equal to strength at 7 days
Maximum Length Change, %			
Allowable expansion at 28 days when water cured compared to length at one day	ASTM C157**	0.12	0.12
Allowable shrinkage at 28 days when air cured compared to length at one day		-0.08	-0.08
Maximum Slump (Concrete), inches	ASTM C143	3****	3****
Maximum Flow (Mortar), %	ASTM C1437	100****	100****
Time of Setting (Initial), minutes	ASTM C191** or ASTM C403**	10 to 180****	10 to 180****
Coefficient of Thermal Expansion, in/in/°F	ASTM C531*** or AASHTO T336***	5.0×10^{-6} to 9.0×10^{-6}	
Minimum Bond Strength by Slant Shear, psi,			
24 hours	FM 5-587	450	750
7 days		750.	750
Minimum Flexural Strength (at	ASTM C580	500	700

7 days), psi			
Maximum Absorption (Mortar at 7 days), %	ASTM C413	4	4
Minimum Surface Resistivity (Concrete at 28 days), KOhm-cm	FM 5-578	N/A	22
Maximum Allowable Total Chlorides lbs/yd^3	FM 5-516	0.40	

* Use cement based materials modified with polymers and silica fume for extremely aggressive environments
** Make and cure the test specimens in accordance with ASTM C157, except omit the curing period in Section 10.3; however both 11.1.1 and 11.1.2 shall apply for 28 day curing period.
*** As applicable
**** For pump and pour applications, the maximum flow, slump and time of setting can be adjusted according to the manufacturer's recommendation.

930-6 Material for Repair of Concrete in High Stress Concentration Areas.

930-6.1 General: This material is intended to be used to repair block-outs and voids in post-tensioned elements, load bearing area of a beam, and other locations required by the Contract Documents. This material may be used for the repair of horizontal or vertical surfaces. Follow the manufacturer's recommendations for preparing the surfaces and for mixing, placing and curing the concrete. This material shall be a magnesium ammonium phosphate based concrete (MAPC).

930-6.2 Physical Properties: The MAPC material shall meet or exceed physical properties stated in Table 3 as determined by the specified standard test methods.

Table 3 - Physical Properties of Repair Material in High Stress Areas

Requirement	Test Method	Test Value
Minimum Compressive Strength (at 28 days), psi	ASTM C109*	8,500
Minimum Flexural Strength (at 28 days), psi	ASTM C348*	600
Minimum Slant Shear Bond (at 14 days), psi	FM 5-587*	2,500
Time of Setting (Initial), minutes	ASTM C191**	15 to 60
Maximum Scaling Resistance	ASTM C672	No scaling
Maximum Length Change, %		
Allowable expansion at 28 days when water cured compared to length at one day	ASTM C157***	0.03
Allowable shrinkage at 28 days when air cured compared to length at one day		-0.03
Maximum Allowable Total Chlorides lbs/yd^3	FM 5-516	0.40

* The test methods for compressive strength (ASTM C109), flexural strength (ASTM C348), and Slant Shear Bond (FM 5-587) shall be modified so that the specimens are air cured instead of moist cured. All of these samples shall be air cured until the time of testing..
** Initial time of set for MAPC will be tested in accordance with ASTM C191 with the following modification. The initial time of set shall be tested at 95° plus or minus 5°F.
*** Make and cure the test specimens in accordance with ASTM C-157, except omit the curing period in Section 10.3; however both 11.1.1 and 11.1.2 shall apply for 28 day curing period.

930-6.3 Specimen Requirements:

930-6.3.1 Curing of Compressive Strength, Flexural Strength and Slant Shear Bond Specimens: The test methods for compressive strength (ASTM C109), flexural strength (ASTM C348), and Slant Shear Bond (FM 5-587) shall be modified so that the specimens are air cured instead of moist cured. All of these samples shall be air cured until the time of testing.

930-6.3.2 Time of Setting: Initial time of set for MAPC will be tested in accordance with ASTM C191 with the following modification. The initial time of set shall be tested at 95°F, plus or minus 5°F.

930-7 Special Fillers.

930-7.1 General: This material is intended to be used as filler material and for rapid repairs to pile jacket structures and other locations specified in the Plans when no design mix concrete is available or a special filler is specified in the Contract Documents. Meet the requirements of Section 457 for preparing the surfaces, placing, testing and curing the concrete. Mix the material in accordance with the manufacturer's recommendations.

930-7.2 Classification: The materials to be considered under this classification shall meet the following requirements:

930-7.2.1 Cathodic Protection (CP) Filler: Provide cementitious based materials with a minimum cement content of 900 pounds of cement per cubic yard of mix. Material formulation must not contain fly ash, slag, silica fume or other mineral admixtures which may produce increased electrical resistance. The material shall not contain any substances corrosive to metals.

930-7.2.2 Non-Cathodic Protection (Non-CP) Filler: Provide cementitious based materials with a minimum cement content of 650 pounds of cement per cubic yard of mix. The material shall not contain any substances corrosive to metals.

930-7.2.3 Extended Materials: Where concrete filler materials are specified, approved mortar materials may be extended using size number 89 gradation aggregates from a certified FDOT approved source.

930-7.3 Physical Properties: The repair material shall meet or exceed the physical properties stated in Table 4 as determined by the specified standard test methods. If extended, materials shall meet the minimum requirements of Table 4.

Table 4 - Physical Properties of Special Fillers			
Requirement	Test Method	Cathodic Protection	Non-Cathodic Protection
Minimum Compressive Strength, psi			
24 hours	ASTM C39* or ASTM C109*	1,500	2,000
28 days		5,000	5,000
Maximum Length Change, %			
Allowable expansion at 28 days when water cured compared to length at one day	ASTM C157**	0.12	0.12

Allowable shrinkage at 28 days when air cured compared to length at one day		-0.12	-0.12
Allowable difference between increase in water and decrease in air		0.20	0.20
Slump (Concrete), inches	ASTM C143	7-9	7-9
Minimum Flow (Mortar), %	ASTM C1437	100	100
Time of Setting (Initial), minutes	ASTM C191* or ASTM C403*	200 to 400	200 to 400
Minimum Bond Strength by Slant Shear (at 7 days), psi	FM 5-587	450	450
Minimum Flexural Strength (at 7 days), psi	ASTM C580	700	700
Minimum Tensile Strength (at 7 days), psi	ASTM C307	200	200
Surface Resistivity (at 28 days), KOhm-cm	FM 5-578	15 or less	22 or greater
Maximum Allowable Total Chlorides lbs/yd^3	FM 5-516	0.40	

* as applicable
** Make and cure the test specimens in accordance with ASTM C157, except omit the curing period in Section 10.3; however both 11.1.1 and 11.1.2 shall apply for 28 day curing period.

930-7.4 Constructability: Furnish to the Engineer for approval shop drawing as may be required to complete repairs in compliance with the design shown in the Plans and the manufacturer's recommended repair system.

SECTION 938
DUCT FILLER FOR POST-TENSIONED STRUCTURES

938-1 Description.

This Section covers filler materials used to fill voided areas within ducts to protect post-tensioning steel. Grout applications are differentiated into three applications: horizontal, vertical and repair.

938-2 Approved Product List.

Only post-tensioning grouts and flexible filler material listed on the Department's Approved Product List (APL) shall be used. Manufacturers seeking evaluation of their product shall submit an application in accordance with Section 6 and include certified test reports from an independent laboratory, audited by and meeting the requirements of ISO 9001, showing the material meets all the requirements specified herein. A written certification from the manufacturer that the product meets the requirements of this Section must be provided.

Any change of materials or material sources requires new testing and certification of the conformance of the grout with this Specification.

Grout products will be qualified by application (horizontal, vertical or repair).

938-3 General Requirements.

938-3.1 Grout: Grouts shall be prepackaged in clearly labeled moisture proof containers. Grout bags shall indicate application type, date of manufacture, LOT number and mixing instructions. A copy of the Quality Control Data Sheet for each lot number and shipment sent to the job site shall be provided to the Contractor by the grout supplier and furnished to the Engineer. Materials with a total time from manufacture to usage in excess of six months shall be tested and certified by the supplier that the product meets the quality control specifications before use or the material shall be removed and replaced.

938-3.2 Flexible Filler Microcrystalline Wax: Flexible filler shall be delivered to the project site in clearly labeled prepackaged containers and stored in accordance with the manufacturer's recommendations and as applicable for the particular project. A copy of the manufacturer's Quality Control Data Sheet indicating compliance with Table 938-2 for each shipment sent to the job site shall be provided to the Contractor and furnished to the Engineer.

938-4 Grout.

938-4.1 Mixing: The material shall be mixed in accordance with the manufacturer's recommendations.

938-4.2 Grout Physical Properties:

938-4.2.1 Gas Generation: The grout shall not contain aluminum or other components which produce hydrogen, carbon dioxide or oxygen gas.

938-4.2.2 Laboratory Testing: The grout shall meet or exceed the specified physical properties stated herein as determined by the following standard and modified ASTM and FM test methods conducted at normal laboratory temperature (65°F-90°F) and conditions. Use the midrange of the water content indicated in the manufacturer's technical data sheet to produce the time of efflux shown in Table 938-1.

Table 938-1

Property	Test Value	Test Method
Total Chloride Ions	Max. 1.0 lbs/yd^3	FM 5-516
Gradation	99% passing the No. 50 95% passing the No. 100 90% passing the No. 170	ASTM C136*
Hardened Height Change @ 24 hours and 28 days	0.0% to + 0.2%	ASTM C1090**
Expansion	≤ 2.0% for up to 3 hours	ASTM C940
Wet Density - Laboratory	Report maximum and minimum obtained test value lb/ft^3	ASTM C138
Wet Density - Field	Report maximum and minimum obtained test value lb/ft^3	ASTM C138 or ASTM D4380
Compressive Strength 28 day (Average of 3 cubes)	≥7,000psi	ASTM C942
Initial Set of Grout	Min. 3 hours Max. 12 hours	ASTM C953
Time of Efflux immediately after mixing	Max. 12 seconds	ASTM C939
Bleeding @ 3 hours	0.0 percent	ASTM C940***
Pressure Induced Bleeding	0.0 percent	ASTM C1741
Surface Resistivity@ 28 days	16 KOhms-cm	FM 5-578
Relative Viscosity, RV_f, determined from Dynamic Sheer Rheometry	< 1.15	FM 5-605

*Use ASTM C117 procedure to determine the percent passing after washing the sieve.
**The time of efflux is the time to fill a one liter container placed directly under the flow cone. Modify the ASTM C939 test by filling the cone to the top instead of to the standard level.
***Modify ASTM C940 to conform with the wick induced bleed test as follows:

(a) Use a wick made of a 20 inch length of ASTM A416 seven wire 0.5 inch diameter strand. Wrap the strand with 2 inch wide duct or electrical tape at each end prior to cutting to avoid splaying of the wires when it is cut. Degrease (with acetone or hexane solvent) and wire brush to remove any surface rust on the strand before temperature conditioning.

(b) Mix the conditioned dry ingredients with the conditioned mixing water and place 800 ml of the resulting grout into the 1,000 ml graduate cylinder. Measure and record the volume of the grout.

(c) Completely insert the strand into the graduated cylinder. Center and fasten the strand so it remains essentially parallel to the vertical axis of the cylinder. Measure and record the level of the top of the grout.

(d) Calculate the bleed water, if any, at the end of the 3 hour test period and the resulting expansion per the procedures outlined in ASTM C940, with the quantity of bleed water expressed as a percent of the initial grout volume. Note if the bleed water remains above or below the top of the original grout height. Note if any bleed water is absorbed into the specimen during the test.

938-4.3 Accelerated Corrosion Test Method (ACTM): Perform the ACTM as outlined in Appendix B of the Specification for Grouting of Post-Tensioning Structures published by the Post-Tensioning Institute. Report the time to corrosion for both the grout being tested and the control sample using a 0.45 water-cement ratio neat grout.

A grout that shows a longer average time to corrosion in the ACTM than the control sample and the time to corrosion exceed 1,000 hours is considered satisfactory.

938-4.4 Variation in Testing for Specific Applications.

938-4.4.1 Horizontal Applications: Horizontal grout applications are defined as grouting of all superstructure tendons and transverse substructure tendons in caps, struts, etc. All physical requirements defined in 938-4.2 and 938-4.3 are applicable for grouts used in horizontal applications.

938-4.4.2 Vertical Applications: Vertical grout applications are defined as grouting of substructure column tendons. All physical requirements defined in 938-4.2 and 938-4.3 are applicable for grouts used in vertical applications.

938-4.5 Repair Applications: Repair applications are used to augment grouting operations which did not completely fill the duct or anchorage. For new construction, repairs may be made with the same filler approved for use in the tendon as long as the volume of the void is less 0.5 gal. In all other cases, use a non-sanded grout meeting the requirements of 938-4.2 and 938-4.3 that meets or exceeds 16 KOhm-cm at 28 days when tested in accordance with FM 5-578. Each sieve may be washed and dried before weighing in accordance with the procedure in ASTM C117 modified for sieve size.

938-5 Flexible Filler - Microcrystalline Wax.

938-5.1 Storage and Preparation: Store and prepare wax according to the manufacturer's product data sheet. Reject wax that shows any sign of segregation prior to application even though it conforms to these Specifications. Use equipment designed for pumping the wax in a fluid state to fill the tendon ducts.

938-5.2 Laboratory Testing: The wax shall meet or exceed the specified physical properties stated herein as determined by the following standard and modified ASTM and FM test methods conducted at normal laboratory temperature (65°F-78°F) and conditions.

Table 938-2

Property	Test Value	Test Method
Salt Fog – 168 hours@35°C	No corrosion	ASTM B117*
Corrosive Constituent Concentration Chlorides, Sulfides, and Nitrates Sulfate	 ≤ 50 ppm (total) ≤ 100 ppm	 ASTM D512 & ASTM D3867** ASTM D516**
Congealing Point	≥ 65°C	ASTM D938
Cone Penetration at 25°C	≤ 260 d-mm	ASTM D937
Bleeding at 40°C	≤ 0.5%	ASTM D6184
Resistance to Oxidation 100 hours at 100°C	≤ 0.03 MPa	ASTM D942
Kinematic Viscosity at 100°C	10 – 30mm^2/s	ASTM D445

*Test sample consists of a 4 inch x 6 inch steel panel blast cleaned to a NACE surface preparation SP5 or equivalent, with a 2 to 2.5 mil surface profile. The plate is covered with a layer of wax equivalent to 0.5 grams wax per square inch of panel.

**Prepare sample in accordance with NF M07-023, sections 6a through 6c or equivalent. Other analytical methods are acceptable as long as equivalency to the above methods has been established by the Department.

SECTION 960
POST-TENSIONING COMPONENTS

960-1 Description.

This Section covers all post-tensioning (PT) components remaining in a completed structure, including temporary erection PT left in-place and permanent PT for design capacity.

Manufacturers seeking approval of PT systems for inclusion on the Structures Design Office (SDO) list of Approved Post-Tensioning Systems must use materials and components meeting requirements of this Section and Section 462. Submit a complete PT System Application Package including component drawings, system drawings, and test reports from a certified laboratory (or laboratories), as defined in 960-3.1, to the SDO for review, acceptance and inclusion on the list of Approved Post-Tensioning Systems.

Any marked variations from original test values or any evidence of inadequate field performance of a PT system, will result in the PT System being removed from the list of Approved Post-Tensioning Systems.

960-1.1 Material References:

Meet the requirements of this Section and the following:

Epoxy Compounds*.....Section 926
Bar (post-tensioning) .....Section 933
Duct Filler for Post Tensioned Structures*.....Section 938
Reinforcing Steel (mild) .....Section 415
Parallel Wire (post-tensioning).....Section 933
Strand (post-tensioning).....Section 933
*Use products listed on the Department's Approved Product List (APL).

960-2 Component Standards.

All PT system components must be materials compatible with the filler material and installation process used to encapsulate the tendons. The component materials must not chemically degrade during the design life of the structure.

Substitution, modification, or deletion of components of PT systems as shown on the SDO website for Approved Post-Tensioning Systems, excluding local zone reinforcement, is not permitted. Inclusion of all possible subcomponents is required for PT system and component testing; however, subcomponents of approved systems may be eliminated from final installations based on project specific requirements, provided all component-to-component interface hardware are included as necessary to maintain connections and PT system integrity.

Provide only PT systems utilizing tendons completely encapsulated in grout or flexible filler filled anchorages and ducts. Do not use systems transferring prestress force by bonding prestress steel strand directly to concrete. Embedded anchorages for bars are permitted. Strand or strand-tendon couplers are not permitted.

Stamp all components of a PT system with the suppliers name, trademark, model number, and size corresponding to catalog designation.

All miscellaneous hardware components, including but not limited to splices, joints, duct couplers, connections, inlets, outlets, drains, valves, and plugs, are part of approved PT systems.

960-2.1 Anchorage Assembly:

1. Construct anchorages from ferrous metal.

2. Anchorages shall develop at least 96% of PT steel actual ultimate strength when tested in an unbonded state, without exceeding anticipated anchor set.

3. Average concrete bearing stress shall be in compliance with AASHTO LRFD Bridge Design Specifications and AASHTO LRFD Bridge Construction Specifications.

4. Test anchorages with typical local zone reinforcement shown in system drawings.

5. Test anchorages in accordance with AASHTO LRFD Bridge Construction Specifications, or the Guideline for European Technical Approval of Post-Tensioning Kits for Prestressing of Structures (ETAG-013, June 2002 edition) with the exception that the design concrete strength used in the testing will be 6,500 psi. For anchorages that will be used for tendons with flexible filler, test anchorages in accordance with ETAG-013 Section 6.1.2-I, with the exception that the design concrete strength used in the testing will be 6,500 psi.

6. Anchorages with grout or flexible filler outlets shall be suitable for inspection from either top or front of anchorage. Anchorages may be fabricated to facilitate both inspection locations or may be two separate anchorages of the same type, each providing singular inspection entry locations.

7. Geometry of grout and flexible filler outlets must facilitate access for borescope inspection directly behind wedge plate using a straight 3/8 inch diameter drill bit.

8. Ferrous metal components of an anchorage that are to be embedded in concrete shall be galvanized in accordance with Section 962. Other anchorage assembly components, including wedges, wedge plates, and local zone reinforcement need not be galvanized.

9. All anchorages shall have a permanent vented anchorage cap bolted to the anchorage.

960-2.1.1 Trumpets:

1. Trumpets associated with anchorages shall be constructed from ferrous metal galvanized per ASTM A123, polypropylene plastic, or polyolefin.

2. Trumpet thickness at transition location shall be the thickness of the duct or greater.

960-2.1.2 Wedges and Wedge Plates:

1. Wedge plate shall be ferrous metal.

2. Wedge plates must have centering lugs or shoulders to facilitate alignment with bearing plate.

3. For longitudinal tendons greater than four strands, design system with separate wedge plate and anchorage plate.

960-2.2 Filler Containment Assembly:

960-2.2.1 Duct and Pipe:

1. Use plastic duct, steel pipe, or a combination of plastic duct and steel pipe in accordance with this Section.

2. Ducts shall be manufactured by a seamless fabrication method. Fabricate all duct splices to prevent kinks during all phases of construction.

3. Do not alter the natural duct color that results from UV protected polymer.

4. Corrugated ferrous metal ducts are prohibited.

960-2.2.1.1 Corrugated Plastic Duct:

1. PT systems with duct injected with grout shall use corrugated polypropylene plastic material except where steel pipe is required.

2. Furnish ducts with minimum wall thickness as follows:

Table 2.2.1.1-1: Corrugated Plastic Duct Minimum Wall Thicknesses

Table 2.2.1.1-1: Corrugated Plastic Duct Minimum Wall Thicknesses		
Duct Shape	Duct Diameter	Duct Thickness
Flat	Any Size	0.08 inch
Round	0.9 inch	0.08 inch
Round	2.375 inch	0.08 inch
Round	3.0 inch	0.10 inch
Round	3.35 inch	0.10 inch
Round	4.0 inch	0.12 inch
Round	4.5 inch	0.14 inch
Round	5.125 inch	0.16 inch
Round	5.71 inch	0.16 inch

960-2.2.1.2 Smooth Plastic Duct:

1. PT systems with duct injected with flexible filler shall use smooth plastic duct.

2. Duct shall be polyethylene resin material.

3. Duct shall have a maximum dimension ratio (DR) of 17 as established by either ASTM D3035 or ASTM F714, as appropriate for manufacturing process used.

4. Duct shall have a minimum pressure rating of 125 psi.

960-2.2.1.3 Steel Pipe:

Where specified in the Contract Documents, steel pipes shall be Schedule 40 and galvanized in accordance with Section 962.

960-2.2.1.4 Minimum Internal Diameter:

1. For prestressing bars, duct shall have a minimum internal diameter of 1/2 inches larger than bar outside diameter, measured across deformations.

2. For prestressing bars with couplers, duct shall have a minimum internal diameter of 1/2 inches larger than largest dimension of the largest enclosed element.

3. For multi-strand tendons, ducts must have a minimum cross-sectional area 2-1/2 times PT steel cross-sectional area.

960-2.2.1.5 Connections, Fittings, and Tolerance:

1. Devices or methods for all duct connections (e.g., splices, joints, couplers, connection to anchorages), shall produce smooth interior alignment with no lips or kinks.

2. Use of tape is not permitted to join or repair duct, to make connections, or for any other purpose.

3. Use a reducer when adjacent sections of duct are directly connected to each other and the outside diameters vary more than plus or minus 0.08 inch.

4. Provide all connections that are external to the concrete with a minimum pressure rating of 100 psi.

5. Use heat shrink sleeves and circular sleeve couplers made from polyolefin or polypropylene material, or duct couplers made from polyolefin or polypropylene material with O-rings or seals to make connections between sections of corrugated plastic duct or between corrugated plastic duct and trumpets.

6. Use heat shrink sleeves and circular sleeve couplers made from polyolefin or polypropylene material to make connections between corrugated plastic duct and steel pipe.

7. Use heat shrink sleeves with or without circular sleeve couplers made from polyolefin or polypropylene material to make connections between corrugated plastic duct and anchorages with integral trumpets.

8. Use heat welding techniques, electrofusion duct couplers, or elastomer sleeves and stainless steel band clamps to make connections between sections of smooth plastic duct.

9. Use elastomer sleeves and stainless steel band clamps to make connections between smooth plastic duct and steel pipe.

10. Use welding or elastomer sleeves and stainless steel band clamps to make connections between sections of steel pipe that are external to the concrete.

11. Use welding, elastomer sleeves and stainless steel band clamps or heat shrink sleeves and circular sleeve couplers made from polyolefin or polypropylene material to make connections between steel pipe and trumpets that are internal to the concrete.

12. Use elastomer sleeves with a minimum wall thickness of 3/8 inches and reinforced with a minimum of four ply polyester reinforcement. Use a 3/8 inch wide stainless steel power seated band and clamps on each end of the elastomer sleeves to secure the sleeves to plastic ducts or steel pipes. Seat the bands with a 120 pound force prior to clamping them in place.

960-2.2.1.6 Segmental Duct Couplers:

1. Include segmental duct couplers for permanent internal PT systems at joints between match cast precast segments.

2. Use “O”- rings or compression seals between adjoining sections of segmental duct couplers.

3. Plastic duct couplers shall be polyolefin or polypropylene material.

4. Metallic components shall be stainless steel per 960-2.4.3.

5. Segmental duct couplers shall mount perpendicular to the bulkhead at segment joints and provide for duct alignment.

6. Segmental duct couplers shall be able to receive duct at an angle of 6 degree deviation from perpendicular.

7. Segmental duct couplers must be able to accommodate angular deviation of duct without tendon strands touching duct or coupler on either side of segment joint.

8. Ducts for prestressing, used exclusively for temporary erection PT that is to be removed from structure, are not required to be coupled across segment joints.

960-2.2.1.7 “O”-Rings:

1. “O”-rings with cross section diameters less than or equal to 0.25 inches and compression seals with thicknesses less than or equal to 0.25 inches for use with segmental duct couplers, anchorage caps and other similar components shall conform to the requirements of Table 2.2.1.7-1.

Table 2.2.1.7-1 "O"-Ring and Compression Seal Material Properties (cross section diameter or thickness ≤ 0.25 in)	
Mechanical Properties	
Shore hardness, ASTM D2240	50-75
Ultimate elongation %, ASTM D412	250% min.
Tensile strength, ASTM D412	1400 psi min.
Accelerated Testing	
Thermal Deterioration 70 hours @ 257° F, ASTM D573	
Change in tensile strength	± 30%
Change of elongation	-50%
Change of hardness	± 15 points
Compression Set Method B 22 hours @ 257° F, ASTM D395	50%
Volume change due to absorption of H_2O, Method D, for 70 hours @ 212°F, ASTM D 471	+ 10%
Environmental Resistance	
Ozone Resistance Exposure Method B, ASTM D1171	Pass
Low Temp. Non-brittle after 3 Min. @ -40°F, ASTM D2137	Pass

2. "O"-rings with cross section diameters greater than 0.25 inches and compression seals with thicknesses greater than 0.25 inches for use with segmental duct couplers, anchorage caps and other similar components, shall conform to the requirements in Table 2.2.1.7-1 with the additions and modifications in Table 2.2.1.7-2.

Table 2.2.1.7-2 "O"-Rings and Compression Seal Material Properties (cross section diameter or thickness > 0.25 in)	
Mechanical Properties	
Shore hardness, ASTM D2240	30-60
Tensile strength, ASTM D412	600 psi min.
Compression Set Method B 22 hours @ 257° F, ASTM D395	60%

3. **Compression Force** - Maximum force to compress an "O"-ring or compression seal to its final compressed position shall not be greater than 25 psi times the area encircled by "O"-ring or seal.

4. **Voided Area** - Compression seals must accommodate material flow within its own cross sectional area by using a hollow or voided design.

960-2.2.1.8 Heat Shrink Sleeves:

1. Heat shrink sleeves shall have unidirectional circumferential recovery and be sized specifically for duct size being coupled.

2. Use irradiated and cross linked high density polyethylene backing for external applications and linear-density polyethylene for internal applications.

3. Use adhesive with the same bond value to steel and polyolefin plastic materials.

4. Heat shrink sleeves shall have an adhesive layer that meets the requirements of the following table:

Table 2.2.1.8-1 Heat Shrink Sleeve Adhesive Layer Minimum Requirements			
Property	Test Method	Minimum Requirements	
		Internal Application	External Application
Minimum Fully Recovered Thickness		92 to 126 mils	111 mils
Peel Strength	ASTM D 1000	29 pli	46 pli
Softening Point	ASTM E 28	162ºF	216ºF
Lap Shear	DIN 30 672M	87 psi	58 psi
Tensile Strength	ASTM D 638	2,900 to 3,480 psi	3,480 psi
Hardness	ASTM D 2240	46 to 48 Shore D	52 Shore D
Water Absorption	ASTM D 570	Less than 0.05%	Less than 0.05%
Color		Yellow or Black	Black
Minimum Recovery	Heat Recovery Test	33% to 58%	23%
Operating Temperature		125°F	150°F

5. Install heat shrink sleeves using procedures and methods specified in the manufacturer's instructions.

960-2.2.2 Attachments:

960-2.2.2.1 Anchorage Caps:

1. Provide permanent anchorage caps made of stainless steel, nylon, polyester, or Acrylonitrile Butadiene Styrene (ABS).

2. Seal Anchorage cap with "O"-ring seals or precision fitted flat gaskets placed against the bearing plate.

3. Place a vent hole of 3/8 inch minimum diameter suitable for filler venting and inspection of the content inside the anchorage cap from the top or front of the anchorage cap as appropriate (e.g. anchorage caps not accessible after filler injection must have a vent at the top of the cap). Anchorage caps may be fabricated to facilitate both inspection locations.

4. Anchorage caps shall have a minimum pressure rating of 150 psi.

5. Stainless steel bolts shall be used to attach cap to anchorage.

6. Certified test reports documenting steel chemical analysis shall be provided when stainless steel anchorage caps are used.

960-2.2.2.2 Inlets, Outlets, Drains, Valves, and Plugs:

1. Provide permanent inlets, outlets, drains, valves, and threaded plugs made of nylon, polyolefin materials, or stainless steel.

2. All inlets, outlets, and drains shall have pressure rated mechanical shut-off valves or plugs. Mechanical shut-off valves must be 1/4 turn ball valves.

3. Inlets, outlets, drains, valves, and plugs shall have a minimum pressure rating of 150 psi.

4. Inlets and outlets shall have a minimum inside diameter of 3/4 inches for strand and 3/8 inches for single bar tendons and four-strand ducts.

5. Drains shall have a minimum inside diameter of 3/8 inches. Locate drains, and inlets and outlets serving as drains, at the bottom of the duct cross section.

6. Dual in-line mechanical shutoff valves are required for vertical PT systems.

7. Specifically designate temporary items, not part of the permanent structure, on PT system drawings.

960-2.3 Steel Reinforcing:

960-2.3.1 Mild:

1. Reinforcing steel shall conform to Section 415 and Section 462.

2. Test typical local zone reinforcement for compliance with AASHTO LRFD Bridge Design Specifications and AASHTO LRFD Bridge Construction Specifications, as applicable. Include reinforcement details in system drawings submitted for system approval.

960-2.3.2 Prestressing:

960-2.3.2.1 Strand:

Prestressing strands shall be in accordance with Section 933.

960-2.3.2.2 Bar:

1. Prestressing bars shall be in accordance with Section 933.

2. Bar couplers shall be in compliance with AASHTO LRFD Bridge Design Specifications and AASHTO LRFD Bridge Construction Specifications.

3. Test bar couplers in accordance with AASHTO LRFD Bridge Construction Specifications or the Guideline for European Technical Approval of Post-Tensioning Kits for Prestressing of Structures (ETAG-013, June 2002 edition). For bar couplers that will be used for tendons with flexible filler, test bar couplers in accordance with ETAG-013 Section 6.1.2-I.

4. Use only spherical nuts to anchor bars at bearing plates.

960-2.4 PT System Materials:

1. Use material specifications in this Section for all PT system components and subcomponents.

2. Use only virgin material for all non-ferrous components. Do not use any components manufactured from recycled material unless the manufacturer provides data supporting the material performance and oxidation properties meet or exceed that of virgin material.

3. Test only samples taken from finished product as applicable.

960-2.4.1 Nylon:

Use one of the following cell classes according to ASTM D5989:

1. S-PA0141 – weather resistant.

2. S-PA0231 – heat stabilized.

3. S-PA0401 – ultimate strength not less than 10,000 psi with UV stabilizer added.

960-2.4.2 Polyolefin:

Conforms to both of the following:

1. Contains antioxidants with a minimum Oxidation Induction Time (OIT) according to ASTM D3895 of not less than 20 minutes.

2. Remolded finished material has a minimum failure time of three hours when tested for stress crack resistance using ASTM F2136 at an applied stress of 348 psi.

960-2.4.3 Stainless Steel:

Conforms to the following:

1. ASTM A240 Type 316 - for metallic components other than bolts.

2. ASTM F593 Type 316 - for bolts.

960-2.4.4 Polypropylene:

Conforms to all of the following:

1. Non-colored, unfilled polypropylene according to ASTM D4101 with a cell class range of PP0340B44541 to PP0340B67884.

2. Contains antioxidants with a minimum Oxidation Induction Time (OIT) according to ASTM D3895 of not less than 20 minutes.

3. Contains a non-yellowing light stabilizer.

960-2.4.5 Polyethylene Resin:

Conforms to all of the following:

1. Meets requirements of ASTM D3350 with a minimum cell class of 445574C.

2. Contains antioxidants with a minimum Oxidation Induction Time (OIT) according to ASTM D3895 of 40 minutes.

960-2.4.6 Elastomer Sleeves:

1. Meet requirements of ASTM D1171 using Ozone Chamber Exposure Method B (no cracks permitted under 2X magnification).

2. Constructed of an elastic polymeric material that is compatible with the in-situ conditions and PT system components including the filler material and filler material installation process.

960-3 System Pre-Approval Requirements.

960-3.1 Independent Testing:

Use independent laboratories meeting the credentials described in this Section to perform all testing and to provide certified test reports for materials and components. Certification may be performed by a qualified independent laboratory outside of the United States, only if the facility is pre-approved by the State Materials Office.

Conform all testing procedures used for materials or components to applicable American Society of Testing and Materials (ASTM) and International Federation of Structural Concrete (fib) Specifications or as modified in this Section.

960-3.1.1 Material Laboratory:

Test plastic components in a certified independent laboratory accredited through the laboratory accreditation program of the Geosynthetic Accreditation Institute (GAI) or the American Association for Laboratory Accreditation (A2LA).

960-3.1.2 Component and System Laboratory:

Test individual components and the PT system as a whole witnessed by and/or in a certified independent laboratory audited by the AASHTO Materials Reference Laboratory (AMRL).

960-3.2 Testing Requirements:

960-3.2.1 System Pressure Test:

1. For each Family of PT systems, assemble system as detailed on the system drawings and perform pressure tests defined in this Article. A family of PT systems is a group of PT tendon/bar assemblies of various sizes using common anchorage devices and design.

2. Perform tests on the largest assembly and the smallest assembly for each family of PT systems.

3. Include in system test at least one of each component required to install a tendon from anchorage cap to anchorage cap.

4. Include plastic duct to steel pipe connections and segment duct couplers, if applicable.

960-3.2.1.1 Filler Containment Assembly Pressure Test:

1. Assemble anchorage and anchorage cap with all required filler injection attachments (e.g., grout tube, valves, plugs, etc.).

2. Seal opening in anchorage where duct connects.

3. Condition assembly by maintaining a pressure of 150 psi in system for three hours.

4. After conditioning, assembly must sustain 150 psi internal pressure for five minutes with no more than 15 psi, or 10%, reduction in pressure.

5. Filler Containment Assembly Pressure Test requirement will be considered satisfied for systems using same anchorages, anchorage caps, and filler injection attachments as a previously approved system as long as appropriate documentation from the previous submittal and written certification is provided by system Supplier stating that identical components are used in both assemblies.

960-3.2.1.2 External Duct Systems:

System testing for external duct assemblies requires two additional tests beyond the Filler Containment Assembly Pressure Test requirements:

1. Anchorage and its connection to duct/pipe assembly must be tested in accordance with and satisfy requirements for the Internal Duct Systems, where duct/pipe assembly consists of all components internal to concrete. Test assembly at 1.5 psi.

2. Duct/pipe assembly consisting of all external duct connections (e.g., welded duct splices, duct-to-pipe connections, etc.) and vent must meet the following:

a. Use 15 feet of pipe length for test pipe assembly.

b. Condition assembly by maintaining a pressure of 150 psi in system for three hours.

c. After conditioning, assembly must sustain 150 psi internal pressure for five minutes with no more than 15 psi, or 10%, reduction in pressure.

960-3.2.1.3 Internal Duct Systems:

1. Perform system test of assembly for compliance with requirements of Chapter 4, Article 4.2, Stage 1 and Stage 2 Testing contained in fib Technical Report, Bulletin 7 titled, “Corrugated Plastic Duct for Internal Bonded Post-Tensioning”.

2. For bar systems, modify system test length to 15 feet.

3. For systems being tested for use in precast segmental construction, modify this test to include one duct coupler or “O”-ring assembly intended for use at segment joint:

a. Test duct coupler for proper function by casting it into a two part concrete test block using match cast techniques. Use blocks that are at least 12 inches x 12 inches x 12 inches.

b. After concrete has hardened, pull blocks apart and clean surface of any bond breaker materials.

c. Using an external apparatus, clamp blocks together and maintain 40 psi pressure on block cross-section during pressure test. Do not apply epoxy compound between blocks.

d. Pressurize duct within test block to 5 psi and lock off outside air source.

e. Assembly must sustain a 5 psi internal pressure for five minutes with no more than a 0.5 psi, or 10%, reduction in pressure.

4. Remove clamping device, separate duct coupler blocks from duct system, and place a 1/16 inch layer of epoxy compound (Type B per Section 926) on face of both blocks, clamp blocks together, and maintain a pressure of 40 psi on block cross-section for 24 hours. Upon removal of clamping force, demolish blocks. Duct coupler and attached ducts should be intact and free of epoxy compound and properly attached without crushing, tearing, or other signs of failure.

960-3.2.1.4 Systems for use with Vacuum-Assisted Flexible Filler Injection: In addition to the testing specified in this Section, all PT systems that will be used in conjunction with vacuum-assisted flexible filler injection must meet the following requirements:

1. Prepare a system assembly consisting of at least one of the each component required to install a tendon from anchorage cap to anchorage cap using 15 feet of duct.

2. Condition the assembly by maintaining a 90% vacuum in it for 1 hour.

3. After conditioning, the assembly must sustain a 90% vacuum for 5 minutes with no more than a 10% loss of vacuum.

960-3.2.2 Minimum Bending Radius:

Establish bending radius for duct through testing. Test consists of a modified duct wear test as described in Chapter 4, Article 4.1.7 of fib Technical Report, Bulletin 7 titled, “Corrugated Plastic Duct for Internal Bonded Post-Tensioning”. Use identical test apparatus as that used for wear test with same clamping force as a function of number of strands in a duct.

1. Modify procedure as follows: After the specimen has reached its final position, remove the specimen and confirm that the residual thickness is adequate. With confirmation that the residual thickness is acceptable, immediately (within 30 minutes) reapply the original clamping force for 14 days.

2. Upon completion of test, remove duct and measure wall thickness along strand path. Wall thickness must not be less than 0.03 inches for duct up to 3.35 inches diameter and not less than 0.04 inches for duct greater than 3.35 inches diameter.

960-3.2.3 Additional Material Tests:

Ensure internal duct system components and accessories meet requirements of Chapter 4, Articles 4.1.1 through 4.1.8 of International Federation of Structural Concrete (fib) Technical Report, Bulletin 7 titled, “Corrugated Plastic Duct for Internal Bonded Post-Tensioning” as modified below:

1. Conduct lateral load resistance test (fib 4.1.4) without use of a duct stiffener plate using a 150 pound load for all sizes.

2. Wear resistance of duct (fib 4.1.7) as modified in this Section.

3. Bond length test (fib 4.1.8) must achieve 40% of GUTS in a maximum length of 16 duct diameters.

4. For smooth duct injected with flexible filler, fib 4.1.1 through 4.1.8 does not apply.

960-3.3 Required Sizes:

Develop and test PT systems for both internal and external applications for the following:

1. Department standard tendon sizes for designing and detailing consist of 0.6 inch diameter strand in anchorages containing 4, 7, 12, 15, 19, 27, and 31 strands.

2. Standard bar sizes range from 5/8 inches to 2-1/2 inches diameter.

3. Systems using alternate anchorage sizes and/or strands utilizing 1/2 inch strand and providing equivalent force to these standard sizes may be submitted for approval.

960-3.4 System Modifications:

Contact the SDO for direction before attempting to change pre-approved PT system materials or components. Repeat all appropriate material, component, and entire system tests if any component of a pre-approved PT system is modified or replaced, excluding local zone reinforcement. Submit an updated application to the SDO containing test reports and revised system drawings for proposed modified systems.

960-3.5 Component Samples:

Furnish all required material samples to laboratories for testing and to the Department as requested, at no cost to the Department.

960-3.6 Calculations, Drawings, and Certification:

Show fully detailed drawings of all component configurations, connections, anchorages, inlets, outlets, drains, high point outlet inspection details, anchorage inspection details, permanent anchorage caps and application limits of the PT system for approval and posting on the SDO's website for Approved Post-Tensioning Systems. Submit details of typical local zone reinforcement in system drawings signed and sealed by a Specialty Engineer. Indicate that all PT system components are stamped with

1. manufacturer's name
2. trademark model number
3. size corresponding to catalog description on PT system drawings.

Provide an application package cover letter signed by an officer of the PT system vendor certifying that the submitted PT system, as a whole and all of its individual components, meet or exceed all material and component/system requirements of this Section, as demonstrated by the submittal. Indicate in this certification that all testing required by this Section was performed by a certified independent laboratory (or laboratories), as defined in 960-3.1, and that all tests were performed to applicable ASTM and fib Specifications. Provide proof of current laboratory accreditation specifically indicating applicable accreditation categories related to PT systems. Provide all material and component certifications required throughout this Section.

SECTION 975
STRUCTURAL COATING MATERIALS

975-1 General Requirements.

975-1.1 General: Upon curing, all coatings and/or coating systems must produce an adherent coating that is visually uniform. The composition of the coating is left to the discretion of the manufacturer but the finished product shall meet all requirements of this Section. All coats of multi-coat systems shall be supplied by the same manufacturer. Multi-component coatings shall be prepackaged in the required ratios.

975-1.2 Environmental Requirements: Coating materials and their waste shall be characterized as non-hazardous as defined by Resource Conservation and Recovery Act (RCRA) Subarticle C rules, Table 1 of 40 CFR 261.24 Toxicity Characteristic.

Volatile Organic Compounds (VOC) shall be less than 3.5 lb/gal when tested in accordance with ASTM D3960.

975-1.3 Approved Product List (APL): All polymeric coating materials except the materials in 975-4 shall be listed on the Department's Approved Product List (APL). Manufacturers seeking evaluation of their products shall submit the product data sheets, performance test reports from an independent laboratory showing the product meets the requirements of this Section, a Product SDS or performance test reports showing percent weight compositional analysis including Chemical Abstract Number, ACGIH time weighted average and ceiling exposure limits for all components, lower and upper explosive limits, flash point, boiling point, amount of volatile organic compounds by weight, and specific gravity for each component of the coating system, and a APL application in accordance with Section 6.

975-1.4 Packaging and Labeling: Materials shall be shipped in containers legibly marked with application instructions, lot number, batch number, date of manufacture, shelf life, and Department APL number. Each lot or batch manufactured must have a unique number.

975-2 Structural Steel Coating Systems.

975-2.1 General: Structural steel coatings shall meet the application requirements of Section 560.

975-2.2 Performance Requirements: Outdoor exposure testing will be performed by the Department. Prepare four composite and four flat-scribed test panels in accordance with AASHTO R-31 (FED-STD-595, Shade X6134 or X4062) and submit to the State Materials Office. Also submit 1-quart wet samples of each component of each coating incorporated in the system being evaluated. Panels will be exposed at the Department's outdoor test site in accordance with ASTM G7. All coatings, regardless of color, shall meet the requirements below.

Laboratory Testing		
Property	Test Method	Requirement
Slip Coefficient	AASHTO R31	Min. Class B (primer only)
Salt Fog Resistance	AASHTO R31	Blister Size = 10 Average Rust Creep at the Scribe ≤ 0.1 inches
Cyclic Weathering Resistance	AASHTO R31	Blister Size = 10 Average Rust Creep at the Scribe ≤ 0.2 inches,

		Color Retention ΔE ≤ 8, Gloss loss less than 30 units
Abrasion Resistance	AASHTO R31	Wear Index ≤ 2.7 mg/cycle
Adhesion	AASHTO R31	Avg. system tensile strength ≥ 800 psi
Freeze Thaw Stability	AASHTO R31	Avg. tensile strength ≥ 800 psi
Coatings Identification	Fourier Transform Infrared Spectroscopy	IR scan (2.5 to 15 um) for each base, catalyst, and mixed coating.
Impact Resistance	ASTM D2794	Greater than 25 inch/lbs, 1/2" impact, intrusion
Flexibility	AASHTO R31, ASTM D522, 1 inch cylindrical mandrel	No cracking
Outdoor Testing		
Property	Test Method	Requirement
Rusting	ASTM D610 ASTM D1654 (scribed) ASTM D1654 (un-scribed)	≥ 9 after 5 years ≥ 9 after 5 years ≥ 9 after 5 years
Blistering	ASTM D714	10 after 5 years
Adhesion	ASTM D4541;annex A4	≥ 800 psi (un-scribed area) after 5 years
Color Retention	ASTM D2244	ΔE ≤ 8 after 2 years
Gloss	ASTM D523	≤ 30 gloss units after 2 years

975-2.3 Structural Steel Coating Systems for New Structures.

975-2.3.1 High Performance Coating Systems (Color Pigmented):

975-2.3.1.1 Prime Coat: Zinc dust pigment shall be a minimum of Type II in accordance with ASTM D520. Inorganic zinc rich primers shall meet the requirements of the Society for Protective Coatings (SSPC) Paint 20, Type I, Level 2.

975-2.3.1.2 Intermediate Coat: Intermediate coatings, when required by the manufacturer, shall be a component of the full coating system.

975-2.3.1.3 Finish Coat: The finish coat shall provide the color and gloss required for the completed coating system. A finish coat may be comprised of a single pigmented coat or a pigmented coat with a clear coat. The clear coat shall contain a dissipating colorant. The dissipating colorant shall be visible for a minimum of 12 hours after application and shall completely dissipate within 96 hours after application.

975-2.3.2 Inorganic Zinc Coating System: Zinc dust pigment shall be a minimum of Type II in accordance with ASTM D 20. Inorganic zinc rich primers shall meet the requirements of SSPC Paint 20, Type I, Level 2. The performance requirements for gloss and color retention are not applicable.

975-2.3.3 Interior Box Girder Coating System:

975-2.3.3.1 Prime Coat: Inorganic zinc dust pigment shall be a minimum of Type II in accordance with ASTM D520. Inorganic zinc rich primers shall meet the requirements of SSPC Paint 20, Type I, Level 2.

975-2.3.3.2 Finish Coat: The finish coat shall be one coat of white polyamide or cycloaliphatic amine epoxy coating. The performance requirements for gloss and color retention are not applicable.

975-2.4 Structural Steel Coating Systems for Existing Structures.

975-2.4.1 Prime Coat: Zinc dust pigment shall be a minimum of Type II in accordance with ASTM D520. Organic zinc rich primers shall meet the requirements SSPC Paint 20, Type II, Level 2.

Zinc primers shall be used as galvanizing repair compounds for areas greater than 100 square inches.

975-2.4.2 Intermediate Coat: Intermediate coatings, when required by the manufacturer, shall be a component of the full coating system.

975-2.4.3 Finish Coat: Finish coating shall provide the color and gloss required for the completed coating system. A finish coat may be comprised of a single pigmented coating or a pigmented coating with a clear coat. The clear coat shall contain a dissipating colorant. The dissipating colorant shall be visible for a minimum of 12 hours after application and shall completely dissipate within 96 hours after application.

975-3 Galvanized Steel Coating System.

Coatings applied over galvanized steel shall meet the outdoor exposure requirements of 975-2.2 with the exception that test panels shall be galvanized in accordance with ASTM A123 prior to application of subsequent coatings.

Coatings applied over galvanized steel strain poles, mast arms, and monotube assemblies shall meet the requirements of Section 649 and 975-4.

975-4 Painting Strain Poles, Mast Arms and Monotube Assemblies.

Paint systems used on galvanized steel strain poles, galvanized steel mast arms and galvanized steel monotube assemblies shall meet the color requirements as specified in the Contract Documents and shall exhibit no loss of adhesion or loss of color greater than 8ΔEs for five years after final acceptance as specified in 5-11. A galvanized steel strain pole, mast arm or monotube assembly that exhibits a cumulative surface area of delamination in excess of 100 square inches will constitute an adhesion failure. Delamination shall be defined as any area of exposed metal surface subsequent to hand tool cleaning in accordance with SSPC-SP2. A change in the coating color in excess of 8ΔEs per the CIE L*a*b* 1976 will constitute a color retention failure. The Department will measure the CIE 1976 color chromaticity coordinates for the color of the top coat of the two sample coupons provided with a BYK-Gardner Handicolor colorimeter using D65 illuminant and 2 degree geometry settings. The Department-measured L*a*b* chromaticity coordinates shall define the initial color and will be used for resolution of color retention failures and the resolution of color retention disputes. All paint systems shall possess physical properties and handling characteristics that are compatible with the application

requirements of Section 649. Materials shall be specifically intended for use over galvanized steel.

975-5 Elastomeric Coatings.

975-5.1 General: Use an elastomeric coating system to provide a waterproof barrier over post-tensioning anchorages or other areas designated in the Plans. The components of the coating system shall be supplied by a single manufacturer and sold as a waterproof coating system. The surface preparation and application of the coating system shall be performed in strict accordance with the manufacturer's specifications.

975-5.2 Physical Properties: The use of an epoxy prime coat is dependent upon the requirements of the manufacturer's waterproofing system. The polyurethane chemistry may be either waterborne aromatic (moisture-curing) or aromatic (moisture-sensitive). The minimum thickness of the system shall not be less than 30 mils. The elastomeric coating shall meet the following requirements:

Property	Test Method	Requirement
Hardness, Shore A	ASTM D2240	Between 60 and 90
Tensile Strength	ASTM D412	≥750 psi
Elongation	ASTM D412	≥400%
Tear Strength	ASTM C957	>70 pli
Abrasion Resistance H-18 wheels 1,000 gm/wheel	ASTM C957	≤350 mg loss / 1,000 revs.
Crack Bridging 1,000 Cycles	ASTM C957	System Passes
Elongation Recovery	ASTM C957	≥94%

975-5.3 System Modifications for Use on Bridge Substructure: Supply the elastomeric coating system with a 100% acrylic aliphatic polyurethane top coating.

975-6 Class 5 Applied Finish Coatings.

975-6.1 General: All coatings shall possess physical properties and handling characteristics compatible with the application requirements of Section 400. Unless otherwise specified, the color of the finish coat shall meet FED-STD-595, Table VIII, Shade No. 36622, or No. 36642 for uncoated weathering steel bridges.

975-6.2 Coating Requirements: Use 4 inch by 8 inch (except as required below) fiber cement test panels with a mass of 7 to 9 pounds per square foot of surface area to perform the laboratory tests. Coating performance shall meet the following requirements:

Laboratory Testing		
Property	Test Method	Requirement
Resistance to Wind Driven Rain	ASTM D6904	No visible water leaks, and if the rear face of the block is damp, the average gain in weight of the three 8"x16"x2" blocks must be less than 0.2 lb.
Freeze thaw resistance	AASHTO R31	No disbondment

Laboratory Testing		
Property	Test Method	Requirement
Water Vapor Transmission	ASTM D1653; Method B, Condition C	WVT≥10 perms
Abrasion Resistance	ASTM D968, 3,000 liters of sand	No loss of coating thickness ASTM D6132
Salt Spray (fog) resistance	ASTM B117, 2,000 hours	No disbondment
Fluorescent UV-Condensation Exposure	ASTM D4587, 2000 hours, 4 hours UV, 4 hours condensation	No blistering (ASTM D714), cracking (visual), or delamination (visual). chalking (ASTM D4214Method D) rating no less than 8.
Fungal Resistance	ASTM D3273	Rating of 10, ASTM D3274

Submit four fiber cement test panels and a 1 quart wet sample of each component of each coating incorporated in the total system being evaluated. Prepare test panels by applying the finished coating at a rate of 50 plus or minus 10 square feet per gallon. In addition, completely seal the corners of all test panels with a high build epoxy or equivalent to prevent moisture ingress at corners and cut edges.

975-7 Anti-Graffiti Coating Materials.

975-7.1 General Requirements: Anti-graffiti coatings intended for use under this specification shall be of a composition capable of preventing the adhesion of and facilitating the removal of acrylic, polyurethane, and alkyd spray paint. All anti-graffiti coatings shall possess the physical and handling characteristics that are compatible with the requirements of Section 563. The manufacturer shall designate the non-sacrificial product as water cleanable or solvent cleanable in accordance with this Section.

Anti-graffiti coatings shall contain less than 5.0 lb per gallon volatile organic compounds (VOC) as defined by 40 CFR Part 59, Subpart D, evaluated as per ASTM D3960.

The manufacturer shall supply the following additional information:

1. Technical data sheet that includes installation instructions and graffiti removal instructions, including any solvents or other materials, as necessary. Graffiti removal must be accomplished with nonproprietary cleaners as defined in ASTM D6578.
2. Sacrificial Coating Removal instructions, as applicable.
3. Certification that non-sacrificial anti-graffiti coating shall not blister, crack, check, chalk, delaminate, or exhibit a color change of more than 8 dE94 (or dE76) CIE LAB units for a period of one year after installation.

975-7.2 Performance Requirements: For laboratory testing, use flat test panels prepared in accordance with AASHTO R31. Outdoor exposure testing will be performed by the Department. Submit four, 4 inch by 8 inch fiber cement test panels to the State Materials Office. Panels will be exposed at the Department's outdoor test site in accordance with ASTM G7. Coating performance shall meet the following requirements:

Laboratory Testing - Non-Sacrificial		
Property	Test Method	Requirement

Laboratory Testing - Non-Sacrificial		
Property	Test Method	Requirement
Graffiti Resistance (solvent cleanable)	ASTM D6578. Complete removal of solvent-based acrylic, polyurethane, and alkyd spray paint; after exposure; and recleanability	Cleanability Level 8, 9, or 10, Accelerated or outdoor exposure is not required. Cure per the spray paint manufacturer's requirements and assess cleanability per Section 10 of ASTM D 6578.
Fluid Resistance (solvent cleanable)	ASTM D1308 – Spot Test, Paint Thinner, Gasoline	No blistering, discoloration, softening or adhesion loss.
Outdoor Exposure Testing – Non-Sacrificial		
Property	Test Method	Requirement
Graffiti Resistance (water cleanable)	ASTM G7: 6 months exposure at FDOT test site 2500 psi using pressure washer	Complete removal of solvent based acrylic, polyurethane, and alkyd based spray paint. No delamination or visual defects.

Laboratory Testing - Sacrificial		
Property	Test Method	Requirement
Cyclic Weather Testing	AASHTO R31: no salt fog, 95°F, 0%- 90% Relative Humidity, 500 hours, alternating RH every 100 hours	No melting or disbondment
Outdoor Exposure Testing - Sacrificial		
Property	Test Method	Requirement
Sacrificial Coating removability	ASTM G7: 6 months exposure at FDOT test site	Complete removal of solvent based acrylic, polyurethane, and alkyd based spray paint from substrate

VIRGINIA DEPARTMENT OF TRANSPORTATION

STRUCTURE AND BRIDGE DIVISION

INSTRUCTIONAL AND INFORMATIONAL MEMORANDUM

GENERAL SUBJECT: Post-Tensioned Bridge Structures	NUMBER: IIM-S&B-92
SPECIFIC SUBJECT: General Requirements for the Usage, Design and Specification of Substructures Supporting Post-Tensioned Bridge Superstructures	Date: December 13, 2016 SUPERSEDES: None
DIVISION ADMINISTRATOR APPROVAL: /original signed/ Kendal R. Walus, P.E. State Structure and Bridge Engineer Approved: December 13, 2016	

New IIM

EFFECTIVE DATE:

This Memorandum is effective on December 13, 2016.

REFERENCES:

IIM-S&B-93 Minimum Inspectability Requirements for Post-Tensioned Bridges

IIM-S&B-80 for additional load requirements for post-tensioned elements

GENERAL:

This IIM is <u>not</u> intended to replace AASHTO LRFD Bridge Design Specifications, 7th ed., VDOT 2016 Road and Bridge Specifications, FHWA, Post-Tensioning Institute (PTI), American Segmental Bridge Institute (ASBI) or other VDOT requirements. It is to clarify issues related to post-tensioning, supplement existing requirements, and provide guidance toward designing, and detailing a structure.

DESIGN AND DETAILING:

The bridge substructure and layout shall be developed to minimize long term maintenance and inspection costs for VDOT. Bridge elements shall be designed and detailed to ensure the easiest access for inspection, evaluation, repair and retrofit consistent with ensuring long-term maintenance, inspection and repair of the structure.

SUBSTRUCTURE ELEMENTS:

Post-tensioning shall not be used in substructures, with the exception of post-tensioning in cylinder piles. Concrete cylinder piles shall conform to the Special Provision for Concrete Cylinder Piles for Design-Build and PPTA Contracts.

Substructures supporting post-tensioned superstructures shall comply with the following requirements:

Multi-column piers:

Conventionally reinforced concrete pier columns shall each have a minimum cross sectional area of 19.5 square feet and least dimension of 3'-0" for rectangular column.

Single column piers (hammerhead or flared piers):

The cross sectional area of hammerhead pier columns shall have a minimum dimension of 5'-0" and shall not be less than 50 square foot.

Wall piers (including paired wall piers):

- The minimum wall thickness shall be 3'-0".
- The wall slenderness ratio (b/t)* shall not exceed 15.

H-shaped piers:

- The minimum wall thickness shall be 3'-0".
- The wall slenderness ratio (b/t)* for each wall shall not exceed 15.

Hollow column pier:

- Hollow columns shall be solid from the foundation to either 10'-0" above ground or 10'-0" above Mean Higher High Water, whichever is higher.
- Cross sections above the solid section shall conform to the following in addition to requirements of AASHTO:
    - Wall thickness shall be not less than 1'-3"
    - Wall thickness shall be uniform except that fillets, not less than ½ the thickness of the wall shall be provided in all corners
- Hollow columns shall conform to the inspectability requirements of IIM-S&B-93.

Abutments supporting Post-Tensioned Superstructures:

- Abutments supporting post-tensioned superstructures shall not include post-tensioning.

* Refer to AASHTO LRFD Bridge Design Specifications, 7th ed., Section 5.3 for definitions of b and t.

SPECIAL PROVISIONS and SUPPLEMENTAL (SPECIFICATIONS)

See: Appendix A

CC: Chief Engineer
Division Administrators
District Administrators
District Construction Engineers
District Maintenance Engineers
Assistant State Structure and Bridge Engineers
District Structure and Bridge Engineers
Residency Administrators/Engineers
Structure and Bridge Program Managers
FHWA: Bridge Section

APPENDIX A

Special Provision for Concrete Cylinder Piles for Design-Build and PPTA Contracts

Special Provision for Carbon Fiber Reinforced Prestressed Concrete Piles for Design-Build and PPTA Contracts

Special Provision Copied Note for Stainless Steel Strand for Design-Build and PPTA Contracts

VIRGINIA DEPARTMENT OF TRANSPORTATION
SPECIAL PROVISION FOR
CONCRETE CYLINDER PILES
for Design-Build and PPTA Contracts

December 9, 2016

I. DESCRIPTION

The work covered under this section includes the furnishing of plant, labor equipment, appliances and materials and the performance of operations in connection with the installation of prestressed pre-tensioned concrete cylinder piles or prestressed post-tensioned concrete cylinder piles.

The work includes, but is not limited to, furnishing equipment and supporting structure for driving prestressed concrete cylinder piles, of either type, including all material, labor, equipment, and all else necessary to construct any temporary supporting structure necessary or pre-boring necessary for driving prestressed concrete cylinder piles.

II. REFERENCES

2016 VDOT Road and Bridge Specifications

AASHTO LRFD Bridge Design Specifications, 7th Ed. and VDOT Modifications

III. MATERIALS AND FABRICATION

A. General

1. The required overall length of pile shall be achieved either by casting a pre-tensioned pile in one piece to the required length or by post-tensioning short segments into a single pile at the manufacturing plant.
2. Materials shall comply with the latest revisions of the Specifications and tests of ASTM, ACI, and PCI, PTI and the additional requirements shown on the Approved for Construction (AFC) Plans, Specifications, the Supplemental Specifications, and these Special Provisions.

B. Cement

Cement in cylinder piles and buildups shall conform to Section 217 Class A5.

C. Concrete

1. Concrete in cylinder piles and buildups shall conform to Section 217 Class A5.
2. Concrete shall contain either 5.4 gallons per cubic yard of calcium nitrite conforming to Section 215, or 2 gallons per cubic yard of calcium nitrite with granulated iron blast-furnace slag (minimum 40 percent by weight) or silica fume (minimum 7 percent by weight) conforming to Section 215.

D. Post-Tensioning Grout

Cement grout where used in prestressed piles shall be of materials which conform to the requirements stipulated herein for cement, sand, admixtures, and water. Admixtures shall conform to Section 215 of the Specifications. Neat cement grouts used in bonding post-tensioned tendons shall conform to Class B in PTI M55-1.12(13) Table 3.1 PILE JOINTS.

The bonding agent for the pile joints shall conform to Specifications Section 403.03 (b) 5.

E. Prestressing Reinforcement

Prestressing use for either pre tensioning or post-tensioning piles shall conform to one of the following based on the pile exposure:

1. If top of pile is 3'-0" or more below the mudline after 100 year scour event or the prevailing ground elevation after scour is above MHHW + 5'-0", carbon steel strands for prestressing shall be in accordance with the Special Provision for Prestressing Steel in Post-Tensioned Structures for Design-Build and PPTA Contracts.
2. If the top of pile is between 3'-0" below the mudline after the 100 year scour event or the top of pile is below MHHW + 5'-0" then prestressing strands shall conform to one of the following
   a. Stainless steel strands meeting the Special Provision Copied Note for Stainless Steel Strand.
   b. Carbon fiber reinforced polymer (CFRP) strands meeting the Special Provision for Carbon Fiber Reinforced Prestressed Concrete Piles for Design-Build and PPTA Contracts..

F. Spiral Reinforcement

Spiral reinforcement shall meet the requirements detailed in the special provision related to the applicable strand type.

G. Anchorage

Anchorage fittings for post-tensioned assemblies, if required, shall conform to the latest ACI 318, Building Code Requirements.

H. Protective Coating in Tidal Zone

When stainless steel or CFRP prestressing strands and spirals are used for cylinder piles protective coatings shall not be required. In all other cases, protective coatings shall be applied to the piles in accordance with Section 404.03(i) of the Specifications.

I. Backfill

Materials for backfill shall conform to the requirements of the Specifications Section 202.03 for fine aggregate Grade B.

IV. MANUFACTURE

A. Experience

Prestressed concrete cylinder piles shall be manufactured by a fabricator with at least 5 years of experience in the manufacturing of large diameter cylinder piles.

B. Casting Full Length Piles

1. Pre-tensioned cylinder piles shall be manufactured by the static-casting process.

C. Casting Sections of Piles to be Post-Tensioned

1. Concrete used in Spun Cast piles shall be deemed to meet the requirement for SCC in the Special Provision for Carbon Fiber Reinforced Prestressed Concrete Piles for Design-Build and PPTA Contracts if it meets the paragraphs 2 and 3 below.
2. Post-tensioned cylindrical piles shall be manufactured by the centrifugal casting process. Concrete piles manufactured by the centrifugal process shall be formed and compacted by centrifugal force in a machine of suitable type so designed that the pile molds may be rotated at sufficient speed to ensure even distribution and dense packing of the concrete without the creation of voids behind the reinforcing steel.
3. Filling the mold and spinning shall be a continuous operation and the spinning shall take place before any of the concrete in the mold has taken an initial set. Excess water forced to the center shall be drained or expelled in a suitable manner. The concrete pile shall not be removed from the mold until the concrete has attained sufficient strength to prevent deformation.

D. Tolerances

1. Section 405.06 shall apply except as modified herein:

   a. Voids in cylinder piles shall be located within 1/8" of their detailed position for each 4 feet of inside diameter. Center of gravity of strand group location shall be located within +/- ¼" of its design location. Assimilated deviation from straightness of the pile shall not exceed 1/8" per 10 feet of length.

   b. The ends of the forms used to cast the piles shall be a true plane perpendicular to the axis of the sections with the following tolerances:

      Maximum allowable deviation for abutting end surface: 1/8 inch

      Maximum allowable deviation for head end surface (top of the pile): 1/2 inch

      Maximum allowable deviation for the butt end surface (bottom of the pile): 1 inch

E. Spiral Reinforcing

Spiral reinforcing sections shall have a spiral reinforcement cage, arranged and dimensioned as shown on the Approved for Construction (AFC) Plans. This reinforcing cage shall be securely held in position during the casting or casting and spinning of the concrete.

F. Post-Tensioned Pile Longitudinal Holes

Longitudinal holes for the post-tensioning strands shall be formed during casting of the walls of the pile sections. The holes shall be 1-3/8 inch (nominal diameter) and positioned as shown on the AFC Plans. The spiral steel reinforcing shall be outside the tendon holes and shall have a minimum concrete cover as shown on the AFC Plans to the outside surface of the pile section.

G. Arrangement of Strand

The arrangement of the prestressing strand shall be in accordance with the details shown on the AFC Plans.

H. Weep Holes

One tapered weep hole shall be provided at a maximum spacing of 16'-0" or at least one per 16 feet section.. The holes shall be included during the forming of the pile. The tapered diameter shall vary from 1 to 1.5 inches. Drilling of weep holes shall not be allowed.

I. Handling

The method of handling the pile sections shall be such that no permanent damage to the concrete will occur. Care must be taken in handling to insure a minimum of spalling on the section end surface. Any section which has a greater than 10 percent of the end surfaces spalled to a depth greater than 0.12 inches will be rejected. The Department and the Design-Builder's Engineer of Record retain the right to reject any section that is unsatisfactory.

J. Post-Tensioned Pile Assembly

1. Pile sections shall not be assembled until the concrete has attained a strength of 4,000 pounds per square inch. The abutting joint surface shall be covered with a bonding agent, as specified in Section 403.03 (b) 5 of the Specifications.

2. After the bonding agent is applied, the pile sections shall be brought into contact and held together by compression while the bonding agent sets. Each post-tensioning strand shall be tensioned in accordance with the applicable Special Provision according to the prestressing strand material used. Measurement of strand tension shall be as specified in Sections 405 of the Specifications.

3. After completion of post-tensioning, the tendons shall be held by temporary anchors or mechanical end locks. Post-Tensioning shall be performed in accordance with the Special Provision for Post-Tensioning System for Design-Build and PPTA Contracts. The piles shall not be handled or moved in any manner detrimental to the pile during this period. Upon transfer of the load from jack to the temporary anchorage, the aggregate stress loss shall not

exceed an average of 10 percent in one strand or an average 5 percent of all strands in a pile.

4. The grout curing period must be sufficient to permit the removal of the temporary wire anchors without slippage of the wires in the grout.
5. Prior to the start of manufacture of any piles, the Design-Builder shall submit for approval by the Design-Builder's Engineer of Record, complete shop drawings showing the proposed yard layout, type of equipment and sequence of manufacture to be used.
6. The transfer of the prestressing force from temporary end-locks to grouted cables shall not be done until the grout has reached a compressive strength of not less than 4000 pounds per square inch. The prestressing cables shall be considered to be without slippage with the removal of the end-locks when, upon cutting the wires between the end of the pile and the anchor, with a burning torch, the wires do not part under stress with a "cup and cone" fracture but are burned through with the torch.

K. Extensions and Splices.

1. Splices of prestressed concrete cylinder piles will not be permitted.

L. Cut-Offs and Build-Ups.

1. Piles shall not be driven when the head is underwater without written approval of the Department.
2. Tops of foundation piles shall be embedded in the concrete footing at least the penetration shown on the AFC Plans. Piles shall be cut off at the designated elevation. The length of pile cut-off shall be sufficient to permit the removal of all damaged material.
3. The distance from the side of any pile to the nearest edge of the footing shall not be less than the minimum shown on the AFC Plans.
4. When the cut-off elevation is below the elevation of the bottom of the footing concrete or cap, the pile shall be built-up from the head of the pile to the planned cut-off elevation by means of reinforced concrete extensions as shown on the AFC Plans.
5. Cut-offs shall be made at right angles to the axis of the pile. The cuts shall be made in clean, straight lines.
6. Rejected and withdrawn piles and excess pile material resulting from cut-offs or other reasons, shall be removed from the project site by the Design-Builder.

M. Pile Markings

The Design-Builder shall mark each pile, prior to driving, with painted horizontal lines at 1 foot intervals, and painted numbers indicating the number of feet from the pile tip at 5 feet intervals. Markings shall be painted around the entire circumference of the pile and the number of feet from the tip of the piles shall be painted so that they are visible from any vantage point regardless of the manner in which the pile may be oriented during field operations.

V. DESIGN AND DETAILING

A. General

1. No square piles with voids shall be permitted.
2. The wall thickness of cylinder piles shall be not less than 1/10 of the external pile diameter measured in inches, nor 5".
3. Effective Prestressing after losses shall not be less than 1ksi.
4. Net tension stress along the axis during driving shall not be allowed.

B. Reinforcement

1. Build-ups shall be constructed using corrosion resistant reinforcing Class III where prestressing accomplished using either stainless strands or CFRP strands. Where conventional strand is used reinforcing in Build-up shall match the pile or pier cap reinforcing.
2. Under no circumstances shall stainless steel bars come into contact with carbon fiber reinforced polymer (CFRP) prestressing strands or reinforcement.

C. Capacity

1. For cylinder piles designed to resist loads other than axial compression, design shall provide sufficient moment, shear and tension connection capacity between buildup and pile and between build up and cap to meet the design demand(s).

VI. CONSTRUCTION EQUIPMENT

A. General

1. Piles in water shall be driven from a jack-up barge, platform, or floating derrick barge of sufficient size, capacity and stability to handle and install piles of the specified lengths, sizes, and dimensions shown on the AFC Plans. Jetting with the use of external jets to remove soil from outside the surface of the pile in order to facilitate pile penetration shall not be allowed. Pile shall driven using the pile-driving hammer, which meets the requirements given in this provision. In case the pile cannot driven through any hard strata with the use of a hammer meeting requirements given in Special Provisions, the soil from inside of the pile can be cleaned by use of internal jets or bailed out or air lifting or dredging methods or any other method approved by the Design-Builder Engineer of Record. Spudding from inside of the pile can also be used to aid in driving through the hard stratum. The driving equipment shall be of the type generally used in standard marine pile driving practice and operated in accordance with the manufacturer's recommendations. The Design Builder shall verify the stability of the pile driving system, for example, consider the weight ratio of the hammer and pile to the barge carrying it when lifting and transferring the hammer weight to the pile.
2. The Design Builder's pile driving equipment shall be capable of driving the piles to the required tip elevation and required ultimate resistance without damaging or overstressing the pile. All pile driving equipment shall be of an approved type and shall not be transported to the site without approval by the Design-Builder's Engineer of Record.
3. Jetting with the use of external jets to remove soil from outside the surface of the pile in order to facilitate pile penetration shall not be allowed.

B. Selection of Equipment for Driving Piles

1. Thirty working days prior to delivery of the equipment to the worksite, a pile and driving equipment data form shall be submitted for approval to the Design-Builder's Engineer of Record. At this time, for each pile supported substructure unit and hammer combination, a full initial pre-construction pile drivability wave equation analysis prepared, signed and sealed by a licensed Professional Engineer registered in the Commonwealth of Virginia shall be submitted showing that the proposed hammer will satisfactorily meet all pile installation requirements and all requirements given in special provisions. The initial pre-construction pile drivability wave equation analysis shall specifically consider all phase of pile installation, including allowance such as for spudding or removing inside soil plug as stated above.
2. Approval of the proposed driving system by the Engineer shall be based upon the pile drivability wave equation analysis predictions indicating that the proposed driving system can drive the piles to at least ten feet beyond the estimated pile tip elevation shown on the AFC Plans, and to develop at least the required nominal resistance shown on the AFC Plans at driving resistances no less than 3 blows per one inch nor greater than 10 blows per one inch, while at all times maintaining maximum compressive and tensile stresses in the piles within allowable driving stress limits. The analysis shall also indicate that the pile driving system will not damage the piles should practical refusal (as defined elsewhere herein) be encountered.

3. Approval by the Design-Builder's Engineer of Record of the Design-Builder's proposed pile driving system on the basis of the Design Builder's pile drivability wave equation analysis predictions of pile driving system performance shall not relieve the Design-Builder of the responsibility to mobilize, operate, and maintain equipment that will actually perform satisfactorily in the field and meet all contract requirements for installation of the piles. Approval of the Design-Builder's proposed pile driving system shall not relieve the Design-Builder of the responsibility for piles damaged because of misalignment of leads, failure of the cap-block or cushion material, failure of splices, malfunctioning of the pile hammer, or other improper construction methods.

4. A new pile driving system, modifications to an existing system, or new pile installation procedures shall be proposed by the Design-Builder if the pile installation stresses predicted by wave equation analysis or measured by the pile driving analyzer exceed the following maximum values:

   Compression stresses .....0.85 f'c – fpe

   Axial Tension stresses .....fpe

   Hoop Tension Stresses (during driving)……$3*(f'c)^{0.5}$

   Where f'c = compressive strength of concrete, fpe = effective prestress.

5. A pile installation plan shall be submitted by the Design-Builder, this plan shall include pile driving equipment, pile hammer size, type and energy, proposed driving criteria, methods of removing the inside plug, when necessary, and other details described herein.

C. Hammers

1. The pile driving hammer shall be of the size and type able to consistently deliver an effective dynamic energy sufficient to drive the piles to the estimated tip elevations and to the required nominal resistance shown on the AFC Plans.

2. For hydraulic hammers, the ram weight of the hammer shall be greater than 65 kips; the maximum stroke of the hammer shall not be greater than 5 feet; and rated energy of the pile driving hammer shall be greater than 260,000 ft-lbs. The thickness of timber cushion for the piles shall be at least 9 inches. For other hammers, such as air/steam hammers, the requirement for ram weight of the hammer and rated energy shall be increased in proportion of the efficiency of hydraulic hammer to that of the other type of hammer. However, the requirement of maximum hammer stroke of 5 feet shall remain the same. The hammer should have a variable stroke feature, so that if lower height of stroke is needed to limit the driving stresses, the hammer can be adjusted. All fuel and or stroke settings must be precisely and readily adjustable at all times during hammer operation. Diesel hammers will not be allowed to drive cylinder piles.

3. Hammers shall be provided with proper driving helmets suited for the piles. The hammers shall be maintained in good operational condition and shall be operated according to the manufacturer's recommendations. The driving equipment shall conform to the approved driving system. Approval shall be in accordance with the Contract Documents. The manufacturer's representative shall confirm the efficiency of the hammer in writing.

4. All necessary gages required to monitor performance of the hammer, as suggested by the manufacturer, shall be installed prior to any pile driving.

5. All piles must penetrate to the minimum tip penetrations shown on the AFC Plans and to any additional penetration necessary to develop the nominal resistance shown on the AFC Plans, unless modified by the Engineer of Record.

6. When necessary, reduce hammer energy and/or use a thicker pile cushions to prevent pile cracking during pile driving. Protection against cracking of the piles shall be the Design-Builder's responsibility. Repair or replacement of damaged piles shall be at the Design-

Builder's expense. When the point of the pile is being driven into firm ground, the full capacity of the hammer shall be used to develop the final driving resistance.

7. The cost of proof-load testing, repairing, or removing and replacing any defective pile shall be borne by the Design-Builder with no additional expense to the Department.

8. When an air/steam or hydraulic hammer is used, provide calibrated pressure gauges, complete with calibration certificates, positioned on the hammer side of all valves, located and graduated so as to be conveniently and safely monitored by the Design-Builder's Engineer of Record at all times during pile driving.

D. Hammer Cap Block

Cap block material shall be made of a stable and predictable material such as aluminum, nylon, or other suitable material as approved by the Design-Builder's Engineer of Record.

E. Helmet

The helmet shall be seated onto the pile and bear evenly and concentrically with minimum play upon the pile. The driving head (helmet) shall be sufficiently large and shallow so as not to bind the head of the pile if it twists slightly during driving. The pile head shall be free to rotate about the long axis of the pile, unrestrained by the helmet.

F. Pile Cushion

1. The helmet shall contain a ring shaped cushion pad consisting of laminated wood (plywood) placed in the pile driving helmet. The cushion shall conform to the cross sectional shape of the pile. The minimum thickness of the cushion shall be 9 inches. A new, unused pile cushion shall be placed in the helmet at the start of driving of each pile.

2. The pile cushion shall be inspected periodically during driving. The cushion shall be replaced as soon as it has reached 50 percent of its original thickness or it is evident that it has begun to smoke, burn, or otherwise deteriorate..

3. If necessary, the cushion thickness shall be increased to reduce tension or compressive stresses as determined by the pile driving analyzer.

4. Under no circumstances will the use of small wood blocks, wood chips, rope or other material be permitted for use as a pile cushion.

G. Removal of Soil Plug Inside the Pile

If, at any time, hammer blow count exceeds 120 blows per foot, stop driving and measure the depth of soil plug from top of the pile. Remove the soil plug in the pile to 3 feet from the toe and resume pile driving. Design Builder shall use one of the methods stated in the Pile Installation Plan to remove the soil plug from inside the pile. The last five (5) feet shall be driven with no disturbance to the plug.

The materials removed from inside the cylinder piles shall be contained within the turbidity curtain or removed to an upland location, designated by the Design-Builder's Engineer of Record.

H. Spudding

1. As an alternative or in addition to removing the soil plug from inside the pile, spudding from inside the pile can be performed. The spud shall have a diameter less than the inside diameter of cylinder pile. The last five (5) feet shall be driven with no disturbance to the plug.

2. Spud shall consist of a closed ended steel pipe pile having a minimum wall thickness of 1 inch.

VII. CONSTRUCTION PROCEDURES

A. Preparations for Driving

1. Pile Installation Plan

a. At least 30 days prior to the proposed start of the pile installation, the Design-Builder shall submit to the Design-Builder's Engineer of Record for approval, a written work plan for the installation of the piles. The work plan, which shall include the aforementioned data and the following, shall adhere to all applicable provisions of this Section.

b. *The Proposed Method of Operation.* A narrative step by step description of the complete pile installation process from beginning to end by numbered paragraph. The narrative shall include, but not be limited to transportation, storage, setting of the pile, jetting and driving and any other method or variation of advancing the pile and removal of the driving frame. The number and type of personnel, including the foreman and supervision, as well as job task shall be set forth.

c. *Experience.* The experience of the firm driving the piles and the key personnel, who will be in charge of the pile installation, shall be identified. Resumes of both the firm and the key personnel showing experience with large diameter prestressed concrete cylindrical piles on 5 projects or similar size and scope with in the last 10 years shall be submitted for approval to the QAM. At least one person in the approved qualifications submission shall be present on site during all pile operations. The name(s) of such person(s) shall be given by the Design Builder in the pile installation plan

d. Proposed mode of transportation from the supplier of piles to the site, together with a list of incidental permits that may be required for the transportation, shall be provided. When applicable, computations regarding stability of the piles during transportation and installation shall be submitted in accordance with the Special Provision for Stability to the Department for review.The proposed schedule of delivery to the site shall also be provided. The pile installation plan shall also indicate the intended location for storage of the piles at the site.

e. The proposed methods and equipment to move, lift and install the piles: This description shall include barges, access roads, temporary trestles, crane locations and type, and all relevant details essential to demonstrate the feasibility of the proposed scheme and support the proposed schedule of installation. Placement of fill or embankment in the water will not be permitted. The Design-Builder shall take into consideration that the channel water currents could impact the stability of the construction equipment.

f. A schedule of installation of all the piles, indicating the time allocated for manufacturing, transporting and installing the piles. The schedule shall indicate the proposed order of installation of the piles and the estimated time required to install each pile.

g. Contingency Plan: A plan for any interruption to the advancement of the pile resulting from equipment breakdowns or failures, accidents, resistance, need to change or improve method of advancing the pile, encountering of rocks, boulders, debris, or other buried objects and other unanticipated events.

h. Discontinuance Plan: A plan for discontinuing the pile driving due to damage to the pile, or inability to reach acceptance criteria or should the criteria set forth in the Project Specific Technical Specifications (PSTS) for Instrumentation and Monitoring of Adjacent Structures and Facilities be exceeded.

(1) The pile manufacturer's structural details for the piling, section and assembly descriptions, in the form of shop drawings and working drawings, shall be adhered to in every respect for the work to be performed under this Contract.

(2) Production piles shall be installed by the same methods and equipment as those used for installation of driving test piles.

B. Order List of Piles

Production piles shall be furnished in accordance with the provisions of Section 403.05.

C. Handling, Storage and Erection

1. The Design-Builder shall comply with Section 403.03(b)4 of the Specifications except that the lifting and support points for the piles shall be determined by the Design-Builder and submitted to the Design-Builder's Engineer of Record for approval.
2. The pile driving hammer shall be in good condition and be capable of delivering the maximum blows per minute required by the manufacturer's specifications.
3. The Design-Builder shall reduce the ram velocity or stroke during early driving when light soil resistance is encountered. At the first sign of soft driving, the Design-Builder shall reduce the ram velocity or stroke to avoid critical tensile stresses. The pile point shall be well seated with moderate soil resistance at the point before full driving energy is used.
4. Prior to lifting and driving, the Design-Builder shall inspect the full length of the pile to ensure that the top of the pile is perpendicular to the longitudinal axis of the pile, that no damage to the concrete is present, and that no strands or reinforcing is protruding from the head, sides, or corners of pile head. No piles shall be used that show any cracks prior to installation.
5. Piles shall be driven to the depths and at the locations indicated on the AFC Plans, or as directed by the Design-Builder's Engineer of Record. Piles shall be accurately spaced in true alignment, unless otherwise indicated on the AFC Plans. Fixed leads shall be used during driving. Fixed leads shall form a track in which the hammer is engaged for the full length of the travel. The pile driving leads shall be of such type and height that they hold the pile firmly in position and alignment, and in axial alignment with the hammer. The leads shall not be suspended from a line, swinging or hanging, except as specified herein. The requirement for fixed leads will only be waived when the physical conditions of the construction site make the use of such equipment impractical. In such cases the piles shall be rigidly braced and held in alignment by suitable guide frames. The intent of these special provisions is that the leads supporting the hammer control the path of the pile throughout the entire length of driving.
6. Approved temporary fixed pile positioning templates shall be constructed whenever necessary to maintain the piles in proper position and alignment during installation. Templates shall maintain the pile in proper position and alignment during driving or any jetting operations to remove soil plug from inside the pile or during spudding. The top of the template shall be located within 5 feet of cut-off elevation. Floating templates or templates attached to the pile driving operations barge will not be allowed. Where practical, the template shall be placed so that the pile can be driven to cut-off elevation before the template is removed. Wherever necessary the Design-Builder shall provide a rigid double-level template which will independently support the pile. When driving piles with a follower using floating equipment, a double template or other approved equipment shall be provided to maintain alignment of the hammer, follower and pile. A double template shall consist of a pile template within 5 feet of cut-off elevation and a second level positioned above or below that level as necessary to provide rigid, stable pile positioning and alignment. Where practical, the template shall be placed so that the pile positions of the second upper template shall be adjustable in size to serve as a guide for both the pile and any follower equipment. Templates shall not restrict the vertical movement of the pile, pile hammer, followers, or jetting equipment.
7. During driving and re-striking, the Design-Builder shall maintain and operate the driving equipment in accordance with the manufacturer's recommendations and maintain the hammer concentric with the driving train in axial alignment on the pile. The hammer shall not be used to limit deviation of the pile during driving by exerting lateral forces or striking at an angle. If damage to the pile head (as determined by the Design-Builder's Engineer of Record) occurs during driving and the hammer can no longer strike the pile uniformly and axially, then driving shall cease and the top of the pile shall be checked for proper fit and alignment within the helmet cap.
8. Each pile shall be driven continuously from the start of driving, until the required minimum penetration is attained within the designed bearing stratum. Intermittent driving will not be permitted unless otherwise authorized by the Design-Builder's Engineer of Record.

9. High internal pressures may occur inside hollow cylindrical piles during driving as soils and/or water enter the pile interior. The piles shall be checked periodically during driving to ascertain if this condition is occurring and to relieve the pressure by lowering water and/or soil levels as required. Piles damaged by such pressures shall be replaced at the expense of the Design-Builder. At the end of driving, the soil plug inside the pile shall be measured from top of the pile and recorded in the pile driving log.
10. Heads of piles shall not be pulled into position after final driving.
11. Piles shall be protected against excessive bending and accidental impact.
12. Piles shall be installed in an approved sequence that shall be based upon driving piles from the center of the pier group outward, or from one side of the pier group toward the opposite side. The driving sequence shall avoid driving any pile between two previously driven adjacent piles.

D. Post-Driving Inspection

1. For all driving test piles and production piles when pile damage due to high internal pressures or any other cause is suspected, when directed by the Design-Builder's Engineer of Record, the Design-Builder shall bail, drill, or airlift soil from inside the pile to the original mudline or lower, as directed by the Design-Builder's Engineer of Record, and shall provide full visual and camera inspection of the inside of the pile for damage.
2. The Design-Builder shall provide all required equipment to allow the Design-Builder's Engineer of Record to observe the inspection including; hoisting equipment, power, flashing, work platforms, push board, motorized skiff, lights, boatswain's chair, lift, oxygen, etc. The Design-Builder is hereby reminded that he shall comply with all applicable OSHA, federal, and local safety and environmental requirements while performing this work.
3. During the inspection, all cracking shall be noted as to length, width and depth, and recorded. If any of the crack criteria listed below is exceeded, the Design-Builder shall modify the installation procedure such that an accepted driving procedure and equipment are established.
4. Allowable cracks shall be limited to longitudinal cracks not exceeding five per 16'-0" length of pile; the crack shall be tight, allowing virtually no penetration of a penknife point; and shall show no indication of seepage.

E. Concrete Placement of Precast Concrete Piles

1. After the piles are driven to the required depth, the top of each pile shall be filled with Class A5 concrete. The depth of the concrete from the pile top shall equal or exceed the 130 percent of development length of the strands. The Engineer of Record shall show plug length the Approved For Construction Plans. Backfill materials conforming to the requirements of this Special Provision shall be added to fill the pile interior below the plug level. Reinforcing detailed in any build up shall extend to within 3 inches of the bottom of the plug.
2. Concrete placed inside cylinder piles for the pile to cap connection or any other reason must be protected from excess heat generated from hydration. Type III cement shall not be used. Low heat of hydration concrete mix designs shall be used, including concrete mixes containing granulated blast furnace slag cement or fly ash, to minimize heat from hydration.

F. Location Tolerance

1. Pile head tolerance at the conclusion of driving shall be in accordance with Section 403.06(f).
2. Axial alignment, as shown on AFC Plans: +/- 1/8 inch any direction per linear foot.

G. Driving Precautions and Pile Obstructions

1. Any sudden decrease in driving resistance shall be investigated with regard to the possibility of breakage of the pile. If such sudden decrease in driving resistance cannot be correlated to boring data and if the pile cannot be removed without damage for inspection, the pile will be

rejected.. Rejected piles shall be pulled and replaced at no additional expense to the Department.

2. If conditions during driving indicate that the pile is hitting an obstruction, the following shall apply:

   a. If the elevation of the top of the obstruction is less than five (5) feet below the elevation of the ground surface or river bottom existing at the location of the pile, the Design-Builder shall use whatever means are necessary to remove or circumvent the obstruction. If the obstruction is removed by methods other than coring, the resulting excavation up to the original elevation shall be filled with suitable granular material, or bank-run gravel as directed by the Design-Builder's Engineer of Record.

   b. If the elevation at the top of the obstruction is five (5) feet or more below the elevation of the ground surface or river bottom, the Design-Builder shall use a combination of water jet applied inside the pile and hammer to drive through the obstruction without any additional compensation.

   c. If the use of the combination water jet and hammer does not allow the pile to be driven through the obstruction, the Design-Builder shall drive adjacent piles to determine the approximate size of the obstruction.

   d. After the approximate size of the obstruction is obtained, the Design-Builder Engineer of Record will determine whether the obstruction is to be removed, or if the foundation needs to be redesigned leaving the obstruction in place.

   e. If it is determined by the Design-Builder's Engineer of Record that the obstruction is to be removed, the Design-Builder shall have the option of either coring through the obstruction to permit the driving of the piles, or of requesting permission to excavate and remove the obstruction. Extra work for coring through the obstruction or excavation and removal of the obstruction shall conform to Section 104.03.

H. Dynamic Pile Monitoring

1. For dynamic pile testing requirements, refer to the Specifications and the (AFC) Plans.

I. Defects and Breakage

Damage to piling due to faulty materials or construction methods may be cause for rejection. No defects, cracking, or breakage will be permitted within 12 feet above MHHW for piles in water at MHHW or 5 feet below MLLW for piles in water. No defects, cracking, or breakage will be permitted within 12 feet above ground for piles on land. Arrange piling segments such that any minor damage deemed acceptable as defined below will occur outside the region specified above associated with the MLW after repair and driving. Piling cracked in the process of fabrication, handling, storing, hauling, or driving is subject to the following provisions:

1. Piling shall be examined for cracks prior to detensioning, transverse cracks 1/16 in. or wider which extend to the level of reinforcing shall be reported to the Engineer of Record for evaluation before detensioning. When narrow transverse cracks extending to the level of reinforcing within any 10'-0" length add up to more than 1/16 in., the cracks shall be reported to the Engineer of Record for evaluation before detensioning. Effects of the summation of crack width over the entire length of the pile shall be evaluated and considered as contributing to the prestressing loss when determining the effective prestress in the pile. If the effective prestress, fpe, is reduced below 1.0ksi the pile shall be rejected.

2. Piling with 1 or more cracks transverse to the longitudinal reinforcement or strand, 1/16 in. or wider after detensioning, will be rejected if the crack occurs in a region of the pile that will be below ground or 5 feet below MLLW water level after driving. If the crack will be located at least 12 feet above MHHW (or ground elevation) when driving is complete, the piling may be used if it is cut back to the crack and rebuilt with a splice buildup.

3. Piling with 1 or more cracks transverse to the longitudinal reinforcement or strand that is less than 1/16 in. wide after detensioning may be used if the crack is repaired in accordance with 2016 VDOT Road and Bridge Specification Section 412.03(b) for Epoxy Injection. If cracks develop during driving in the portion that will be 5 feet below MLLW, stop driving and repair the cracks before continuing.

4. Piling with one or more cracks parallel or diagonal to the longitudinal reinforcing steel or strand and extending to the determined plane of reinforcement may be rejected. If cracks are found acceptable, repair them in accordance with 2016 VDOT Road and Bridge Specification Section 412.03(b) for Epoxy Injection.

   Fine hairline cracks or surface checks that do not extend to the plane of the nearest reinforcing steel, as determined by the Design-Builder‘s Engineer of Record, will not require repair and will not be cause for rejection

J. Rejection of Piles

1. Any pile which has been subjected to tensile forces under conditions of low penetration resistance or abuse resulting in spalling or crushing of the concrete sufficient in the opinion of the Design-Builder’s Engineer of Record to damage the pile; or which has been damaged, which develops excessive cracking, for which dynamic monitoring indicates pile damage, or which is driven sufficiently far out of location to impair its value to the structure, shall be repaired or removed and replaced with a suitable pile at the Design-Builder’s own expense.

2. Detail sketches of the proposed repair plus a complete description of the proposed repair materials shall be included. All repair work shall be at the Design-Builder’s own expense, with no additional cost to the Department. If during or following or the repair, the pile is subjected to forces great enough to impair its value as described above, or the completed repair is found to be unsatisfactory by the Design-Builder’s Engineer of Record, the pile shall be removed and replaced at the Design-Builder’s own expense.

VIII. CONSTRUCTION PROCEDURES

A. General

1. Piles shall be driven to the tip elevations shown on the Plans plus any additional penetration necessary to achieve the required ultimate resistance, or as determined during driving test pile installation.

2. The Engineer shall be the sole judge as to when the tip of the piles has reached the necessary tip elevation and the required ultimate resistance.

B. Pile Hammering Resistance Criteria

3. Pile hammering resistance criteria consisting of the minimum required penetration resistance blows per inch will be determined by the Engineer based on the Contractor’s pile drivability wave equation analysis for the approved pile driving equipment for the driving test piles.

4. Pile hammering resistance criteria established on the basis of the Contractor’s pile drivability wave equation analysis will later be verified by the Engineer or revised as necessary on the basis of subsequent Pile Driving Analyzer (PDA) measurements during dynamic monitoring of driving test piles and load test piles, including "CAPWAP" analysis of the PDA measurements, along with static load test results.

5. Bearing piles shall be driven until a pile hammering resistance no less the resistance determined to produce the required ultimate resistance has been continuously maintained for three consecutive feet of driving or to practical or absolute refusal, whichever occurs first, in all cases with the hammer operating at no less than the designated hammer stroke and blow rate that the that pile hammering criteria are based upon.

6. Practical refusal is defined as two times the pile hammering resistance required to produce the required ultimate resistance when maintained for one foot of continuous driving with the

hammer operating at no less than the designated hammer stroke and blow rate that the that pile hammering criteria are based upon.

7. Absolute refusal is defined as four times the pile hammering resistance required to produce the required ultimate resistance when maintained for one inch of driving with the hammer operating at no less than the designated hammer stroke and blow rate that the pile hammering criteria are based upon.

C. Driving Test Piles

1. Installation and evaluation of driving test piles shall conform to Section 403.04.
2. Driving test piles shall be driven prior to driving of any production piles at any given pier location.
3. Driving Test Piles requiring Dynamic Pile Testing (DPT) shall be driven, restrike and results provided to the Engineer for approval before any Driving Test Piles not requiring DPT are driven.

IX. MEASUREMENT AND PAYMENT

All cost for furnishing of plant, labor equipment, appliances and materials and the performance of operations in connection with the installation of prestressed pre-tensioned concrete cylinder piles or prestressed post-tensioned concrete cylinder piles should be included in the lump sum contract price. Such work includes, but is not limited to, furnishing equipment and supporting structure for driving prestressed concrete cylinder piles, of either type, including all material, labor, equipment, and all else necessary to construct any temporary supporting structure necessary or pre-boring necessary for driving prestressed concrete cylinder piles.

This work is integral to the relevant work package that is part of the lump sum contract price. There is no separate payment for this work. If an item does not satisfy the criteria stated herein, and in the event the Department accepts this item, the Quality Assurance Manager (QAM) will document the basis of acceptance. The Design Builder and the Department will negotiate an appropriate adjustment in the contract price, warranty, or other specific requirements or adjustments that are appropriate.

VIRGINIA DEPARTMENT OF TRANSPORTATION
SPECIAL PROVISION FOR
CARBON FIBER REINFORCED PRESTRESSED CONCRETE PILES
for Design-Build and PPTA Contracts

December 8, 2016

SECTION 105 – CONTROL OF WORK of the Specifications is amended as follows:

Section 105.10(c)3 – Concrete Structures and Prestressed Concrete Members is amended to insert the following:

Working Drawings for concrete structures and prestressed concrete members which are reinforced with Carbon Fiber Reinforced Polymer (CFRP) tendons and other CFRP reinforcement shall provide the following, as required for the successful prosecution of the Work and which are not included in the Plans furnished by the Department: additional details related to tendon coupler locations, stressing sequence accounting for coupler locations and differing moduli of elasticity, and spacing and ties for reinforcing. All additional information shall be included in the sealed package submitted for approval.

12-09-16 (SPCN)

SECTION 223 – STEEL REINFORCEMENT of the Specifications is renamed **TENSILE REINFORCEMENT OF CONCRETE** and amended as follows:

Section 223.02(a)8 – Carbon Fiber Reinforced Polymer (CFRP) reinforcement is inserted as follows:

Carbon Fiber Reinforced Polymer (CFRP) reinforcement shall have an ultimate tensile strength of at least 338 ksi based on the nominal area and a minimum ultimate strain of 1.30% when tested in accordance with ASTM D7205.

Section 223.02(b) – Prestressing Tendons is replaced with the following:

Prestressing Tendons, as designated on the Plans, shall be one of the following**:**

1. **Seven-wire, whether stress-relieved strands, stress-relieved wire**, **or low-relaxation strands,** shall conform to ASTM A416, Grade 270; ASTM A421; and ASTM A416, Supplement I, respectively, with the following modifications:

    a. Strands or wires used in units of any one-bed layout shall be manufactured by the same plant.

    b. A manufacturer's certification and load-elongation curve in accordance with ASTM A416 or ASTM A421 shall be obtained by the prestressed concrete fabricator for each lot of strand planned for use in fabrication. The strand or wire manufacturer shall submit the data in permanent record form to the Design-Builder Engineer of Record for approval prior to fabrication.

2. **CFRP tendons** shall be from the VDOT Materials Division's Special Products Evaluation List (SPEL).

The CFRP tendons shall have a nominal diameter as indicated on the Plans or Standard Drawings. CFRP tendons shall be free of scoring. “Nicks” or “gouges” will not be acceptable. Materials shall be shipped in coil form and shall be stored in such a way that kinks do not develop when the coil is unwound. Any CFRP tendon found to be damaged on the surface, bent, subjected to temperatures above 122°F at any time, or stored out of doors shall be discarded. A special handling guidelines manual shall be provided for CFRP tendons by the manufacturer.

12-09-16 (SPCN)

SECTION 403 – BEARING PILES of the Specifications is amended as follows:

Section 403.03(b) – Precast Concrete Piles is amended by replacing the first paragraph with the following:

Precast Concrete Piles: Precast concrete piles with conventional or Carbon Fiber Reinforced Polymer (CFRP) reinforcement or tendons shall be furnished in accordance with these Specifications. Prestressed concrete piles shall be furnished in accordance with the requirements of Section 405. Piles shall be manufactured to conform to Section 404. The Class of Concrete shall be as specified on the Plans or the Specifications. If not specified, then Class A3 concrete shall be used for piles which are not prestressed.

Section 403.03(b)1 – Casting is replaced with the following:

Casting

a. **All Piles:** Forms shall conform to Section 404 and shall be accessible for vibrating, tamping, and consolidating concrete. Care shall be taken to place concrete to produce a satisfactory bond with the reinforcement and avoid segregation of components, honeycombs, or other defects.

   Concrete shall be continuously placed in each pile form and consolidated by vibrating. Forms shall be overfilled, the surplus concrete screeded off, and the top surface finished to a uniform, even texture similar to that produced by forms.

b. **Piles using CRFP Reinforcement:**

   The Contractor shall use self-consolidating concrete (SCC) conforming to Section 217.11 when using CRFP. During concrete placement, internal vibrators shall be encased with a protective polyurethane sheath. External vibrators will be acceptable. Extreme care shall be taken to avoid damage to CFRP tendons and reinforcement from internal vibrators. SCC will not require any vibration; however, limited vibration that will not cause segregation may be applied to ensure flow of material in congested areas, and to provide a smooth surface.

   Materials, including anchorages, couplers, and other miscellaneous hardware, shall be carefully handled to prevent any damage or deformation along the reinforcement surface, and will be stored in their original containers until required for use. Materials, including anchorages, couplers, and other miscellaneous hardware, shall not be placed directly on the ground and shall be kept free from grease, dirt, and dust. Any damaged material shall be removed from the final product prior to stressing. Workers shall not walk on or step on CFRP prestressing tendons during the placement of the tendons.

   CFRP reinforcement shall be suitably covered to eliminate any environmental factors such as temperatures above 122°F, ultraviolet rays, and chemical substances; and shall be protected

from sudden shocks or heavy hard objects and welding sparks. The CFRP reinforcement shall not be mishandled, handled in a rough manner, nor damaged (e.g. shall not be stepped on, walked on, or dragged over rough or dirty surfaces nor through rough or jagged holes in steel or wood).

CFRP reinforcement shall be properly cut to the lengths as specified on the Plans. Cutting of carbon reinforcement shall be performed by use of a high-speed rotary grinder approved by the Design-Builder Engineer of Record, which will not damage the material. Heat oriented cutting tools, such as gas welding torches, shall not be used. Heating CFRP in any manner is dangerous and shall not be used. CFRP reinforcement shall not be field bent. Draping (harping) of tendons shall only be allowed as provided for in the Plans.

All supports, such as chairs, and tie wires shall be non-metallic material and shall not be in contact with metal reinforcement such as stainless steel. The Contractor shall use an inert, non-metallic, insulating material to prevent direct contact. All CFRP reinforcement shall be sufficiently tied down prior to placing of concrete to eliminate “floating” of reinforcement.

The Contractor shall be responsible for installing the special anchoring system on the CFRP tendons for pretensioning according to the guidelines provided by the CFRP tendon manufacturing company. The jacking operation shall be the same as for conventional steel, except that steel transfer couplers shall be used to transfer prestressing force to the CFRP tendons. The end preparation material and steel transfer coupler shall be provided by, or approved for use with the CFRP tendon by, the CFRP tendon manufacturer.

At least 5 days prior to jacking, the Contractor shall provide the Department with PE approved shop drawings showing the CFRP tendon layout, to include coupler placement locations and offset requirements necessary to prevent collision of couplers during pretensioning due to elongation of the tendon. The Contractor shall perform sequenced tendon jacking operations as noted on the approved Working Drawings. The Design-Builder Engineer of Record shall approve each strand force and strand elongation prior to “lock off” and jack removal. Jacking operations shall proceed to the next strand as sequenced on the approved Working Drawings. Steel transfer coupler shall temporarily be supported for vertical loads and prevented from any rotation movement during prestressing as noted on the approved Working Drawings. Release of the prestressing force for anchoring shall be uniform and gradual and shall not expose any part of the pile cross section to sudden eccentric stresses. A sudden release of pretensioning force shall not be permitted except as part of the approved detensioning process. Release of force shall also be simultaneous at each end of the pile. The jacking force for CFRP tendons shall be 10% greater than desired or effective prestressing force.

Section 403.03(b)2 – Curing is replaced with the following:

Curing: Steam curing will be permitted if the concrete temperature is kept below 165°F. If CFRP is specified, the environment outside the pile where the coupler is located shall be kept below 122°F, as high temperatures will have detrimental effects on carbon reinforcement and slippage in the coupling or the anchoring.

As soon as piles have set sufficiently, side forms shall be removed and the piles moist-cured for at least 7 days. However, if CFRP is used or the concrete piles are to be used in brackish water, tidal water, or alkali soils, the piles shall be moist-cured for at least 30 days before use. Piles shall not be driven until the concrete has reached the minimum 28-day compressive strength specified in Section 217.

SECTION 405 – PRESTRESSED CONCRETE of the Specifications is amended as follows:

Section 405.02(a) – Concrete is amended by inserting the following:

Calcium nitrite will not be required for corrosion protection in piles when Carbon Fiber Reinforced Polymer (CFRP) tendons are specified.

The Contractor shall use self-consolidating concrete (SCC) conforming to Section 217.11 when using CFRP. Vibration of SCC shall conform to Section 403.03(b)1.

Section 405.05(b) – Placing Strands and Wires and Applying and Transferring Pretension is amended to replace the sixth paragraph with the following:

The final stressing of strands shall be performed by applying tension to each strand individually or to all CFRP tendons as a group. The strands shall be tensioned to the total pre-tensioning force as indicated on the plans, with a maximum applied stress indicated below.

Strand Type	Percent of guaranteed ultimate strength
CFRP Strand	65%
Stress-Relieved Strands	70%
Low-Relaxation Strands	75%

The nominal area of the strand and reinforcing shall be confirmed between the precast concrete producer and the strand supplier. Care shall be exercised when cutting the strand to prevent damage to the region adjacent to the cut end.

12-09-16 (SPCN)

SECTION 406 – REINFORCING STEEL of the Specifications is amended as follows:

Section 406.02(e) – Carbon Fiber Reinforced Polymer (CFRP) pile confinement reinforcement is inserted as follows:

Carbon Fiber Reinforced Polymer (CFRP) pile confinement reinforcement shall be made from a product listed on VDOT Materials Division's Special Products Evaluation List (SPEL). Ties for pile confinement shall be corrosion free. CFRP confinement reinforcement shall have a reinforcing strength per foot which meets or exceeds the force indicated on the plans.

12-09-16 (SPCN)

VIRGINIA DEPARTMENT OF TRANSPORTATION
SPECIAL PROVISION COPIED NOTE FOR
STAINLESS STEEL STRAND
for Design-Build and PPTA Contracts

December 9, 2016

SECTION 223-STEEL REINFORCEMENT of the Specifications is revised as follows:

223.02(b), paragraph 1 —Detail Requirements is replaced with the following:

(b) **Prestressing Tendons: Seven-wire** low-relaxation strands shall be stainless steel shall have a minimum ultimate strength of 250 ksi. The stainless steel strand shall be Type 2205 (UNS S32205), meet the compositional requirements of ASTM A1022 and meet ASTM A416 except that the minimum elongation at breaking strength shall be 1.2%.

Section 405.05(b) is amended to replace paragraph 7 (which begins with "The final stressing of strands") with the following:

The final stressing of strands shall be performed by applying tension to each strand individually or to all strands as a group. The strand shall be tensioned to the total pre-tensioning force as indicated on the Approved for Construction (AFC) plans, with a maximum applied stress of 60% of the ultimate strength for low relaxation stainless steel strand. The nominal area of the strand shall be confirmed between the precast concrete producer and the stainless steel supplier. Strand shall be furnished in a weldless state. Care should be exercised when cutting the strand to ensure wire does not become raveled.

12-9-16 (SPCN)

SECTION 406-REINFORCING STEEL of the Specifications is revised as follows:

Section 406.02(a) is replaced with the following:

(a) **Steel used for reinforcement** shall conform to the requirements of Section 223, except that spiral bars shall be stainless steel (size number W 3.5) that meets the requirements of ASTM A1022 – Type 304 (UNS S30400), minimum Grade 60. Tie wires shall be Gage 16 stainless steel. Tie wires of other alloys or materials shall be submitted to the Design Builder's Engineer for review.

12-9-16 (SPCN)

VIRGINIA DEPARTMENT OF TRANSPORTATION

STRUCTURE AND BRIDGE DIVISION

INSTRUCTIONAL AND INFORMATIONAL MEMORANDUM

GENERAL SUBJECT: Post-Tensioned Bridge Structures	NUMBER: IIM-S&B-93
SPECIFIC SUBJECT: Minimum Inspectability Requirements for Post-Tensioned Bridges	DATE: December 13, 2016 SUPERSEDES: None
DIVISION ADMINISTRATOR APPROVAL: /original signed/ Kendal R. Walus, P.E. State Structure and Bridge Engineer Approved: December 13, 2016	

New IIM

EFFECTIVE DATE:

This Memorandum is effective on December 13, 2016.

REFERENCES:

IIM-S&B-91 General Requirements for the Usage, Design and Specification of Post-Tensioned Bridge Superstructures

IIM-S&B-92 General Requirements for the Usage, Design and Specification of Substructures Supporting Post-Tensioned Bridge Superstructures

IIM-S&B-80 VDOT Modifications to the AASHTO LRFD Bridge Design Specifications, 7th Edition, 2014.

DESIGN AND DETAILING APPROACH – SUPERSTRUCTURE:

SEGMENTAL BRIDGES**:**

<u>Lighting and Utilities:</u>

The Design Builder shall be responsible for all coordination efforts, including permits between District utility company and local municipality, prior to beginning work.

Installation of all electrical work shall conform to the latest edition of the VDOT Road and Bridge Specifications and Dominion Virginia Power Requirements.

Utilities (liquid, gas and power not used for lighting) shall be placed outside of boxes.

Power and lighting shall be provided in each span for any box section (and in each cell when multiple cells are used).

- Lighting shall provide continuous minimum uniform illumination of 20 foot candles of the floor, walls and ceiling. Lighting shall not induce glare for individuals walking in the box or inspecting walls or ceilings while standing on the box floor per OSHA or other applicable regulations.
- Wiring shall be in conduits.
    - Conduit runs shall be installed in a manner to prevent conflicts with equipment and structural conditions.
    - Pull strings shall be provided in all empty conduit to facilitate pulling of cables in the future.
- The Design Builder shall provide all required pull boxes and junction boxes for installation of the wiring.
    - All junction and pull boxes shall be labeled with their voltage and usage.
- The Design Builder shall provide all necessary components required for making final connection of all equipment installed.
- All electrical equipment installed against concrete shall be installed with a ¼" space between the equipment and the mounting surface. Spacers shall be stainless steel, PVC or nylon.

The Design Builder shall submit a list of all major equipment and fixtures to the Design Builder's Engineer for review and approval. No substitutions will be allowed without the permission of the Design Builder's Engineer in writing. All equipment shall be new and bear the manufacturer's name and trade name. All equipment shall be UL listed.

- Series rating of circuit breakers shall not be allowed unless specifically indicated in the Approved for Construction (AFC) Plans.
- The Design Builder shall not locate conduit, outlets, lights, panelboards, or other items where they will interfere to post-tensioning conduits.
- A minimum of 4 independent circuits shall be provided:
    - One circuit shall provide 30 amps and plugs.
    - Two circuits shall provide 20 amps each. One circuit shall be for permanent lighting only; the other circuit shall be for powering temporary lights and small tools and shall have plugs only.
    - One circuit or more independent circuits shall be provided in order to power the acoustic emission system as required by the system supplier.
    - More than three circuits shall not be installed in one home-run.

- Exterior grade grounded outlets shall be located at a maximum of 50 foot intervals.
  - Outlets shall be placed approximately 4ft above the floor of the box, but height shall be adjusted to avoid tendons which would obstruct the outlets.
  - A single duplex outlet shall be provided at each location on the 30 amp circuit.
  - A single 4-plex outlet shall be provided at each location on the 20 amp circuit.
- Lights shall be LED; fixtures shall be suitable for outdoors including features to allow for lighting at low temperature and shall be waterproof. Light fixtures may be, but need not be, collocated with outlets as long as uniform light levels are maintained.

Access Path and Ramps:

A continuous access path (including ramp access for all openings in diaphragms) shall be provided to allow wheeled tools and equipment to pass through the entire length of the box superstructure.

- The minimum width of path through the box shall be 5’-6” wide unless approved otherwise by the District Structure & Bridge Engineer (DBE). The minimum width shall not be less than 3’-6” unless approved by the State Structure & Bridge Engineer.
- Openings through diaphragms for access between spans shall be a minimum of 7’-0” tall for interiors 8’-0” tall; for depths greater than 8’-0”, openings shall be not less than 1’-0” from the bottom of the deck, but need not exceed 10’-0” (e.g. for 11’-0” depths and deeper the opening will be fixed at 10’-0” maximum height). The bottom of the opening shall be flush with the floor of the box in uniform depth structures unless a ramp is provided; in haunched structures, ramps between the floor of the box and the opening shall be provided.
- Ramps providing access between spans (through diaphragms) shall be a minimum of 6’-0”; where OSHA requires railings, the width between railings shall be a minimum of 5’-6”. Railings shall be continuous over the ramp.
- Ramp grades shall be 12% or less; differential grades (e.g. at transition from deck bottom to ramp) shall be 12% or less. Ramps shall be designed for pedestrian loads in accordance with the AASHTO LRFD Guide Specifications for Pedestrian bridges. Ramps shall carry the maintenance vehicle load without pedestrian loading. Ramp elements shall be corrosion resistant without painting.

General Requirements for Marking:

Boxes shall be clearly and permanently marked as noted below:

- Each span shall be numbered to match the AFC Plans, or consecutively from Abutment A to Abutment B, if the AFC Plans do not have a consecutive numbering system.
  - Span identifying labels shall be placed on the inside of each web approximately 6’-0” up from the floor of the box, in an unobstructed location.
  - At locations where ramps are in place, labels shall also be placed at approximately 6’-0” from the ramp elevation, in an unobstructed location.

Horizontal Location Markings:

At a minimum, labels shall be placed at 10th points along the span on each interior wall and bottom of the deck; interval spacing shall not exceed 20'-0". The label shall include the name of the support on each side and distance to the centerline (CL) of the nearest support in each direction. For Example:

Abutment A 20 ft	Pier 1 180 ft

- The text shall be at least 12" tall. The paint color shall be Fed Std 595C color 37030 (flat black) for text over Fed Std 595C color 37925 (flat white).
- The limits of the white background behind black text, labels or numbers shall be at least 3" beyond the limits of any text or number and shall be rectangular.
- Font shall be similar to Arial for all text or labels. Numbers shall match the shape of the numbers as shown: 1 2 3 4 5 6 7 8 9 0.
- Painted text and numbers shall be added using stencils or similar means of application which produces a clearly legible result.
- No identification shall be applied freehand.

Vertical Location Markings:

When the box depth exceeds 8'-0", the depth of box shall be marked with dashed lines at tenth points, not to exceed 20'-0" spacing, parallel to the bottom of the deck at a 4'-0" interval starting from the bottom of the deck. Dashes shall measure no smaller than 3 inches x 12 inches. Lines shall be marked for all web walls and diaphragms. Lines shall be embedded or formed into the concrete. Lines which are formed into concrete shall also be painted Fed. Std. 595C 12199 (gloss orange); embedments shall be colored or finished to match Fed. Std. 595C 12199 (gloss orange). Identifying text and numbers shall be painted on concrete. Paint color shall be Fed. Std.595C color 37030 (flat black) for text and numbers over Fed. Std. 595C color 37925 (flat white).

Locations, size and content of labels shall be included in the AFC Plans and shall be duplicated in the shop drawings. The method of marking shall be included in the shop drawings.

Locating Tendon Geometry:

Every tendon path and anchorage embedded in concrete location shall be permanently marked and identified on the inside of the box for all deck, floor and web tendons.

Markings may be painted or embedded in the concrete. The floor tendon locations may be embedded or painted unless approved by the District Structure & Bridge Engineer.

Deck tendons shall be marked using Fed. Std. 595C color 38913 (fluorescent red), wall tendons using Fed. Std. 595C color 38907 (fluorescent yellow) and floor tendons using 38901 (fluorescent green). Text labels for tendons shall be black Fed. Std. 595C color 37030 (flat black) for text over Fed. Std. 595C color 37925 (flat white).

The limits of the white background behind black text, labels or numbers shall be at least 3” beyond the limits of any text or number and shall be rectangular.

Locations, size and content of markings shall be included in the AFC Plans and shall be duplicated in the shop drawings. The method of marking shall be included in the shop drawings.

Any metal marking elements or attachments made to the floor shall be stainless steel; metal marking elements or attachments made to walls and bottom of the deck may be polymer or stainless steel.

Painted text shall be a minimum of 1” tall, painted numbers shall be a minimum of 2”; engraved, stamped or raised text and numbers in metal shall be a minimum of ½”. Engraved, stamped or raised text and numbers shall be filled or otherwise colored to be black over a white background.

Font shall be similar to Arial for all text or labels. Numbers shall match the shape of the numbers as shown: 1 2 3 4 5 6 7 8 9 0.

Painted text and numbers shall be added using stencils or similar means of application which produces a clearly legible result.

No identification text or labels shall be applied freehand.

<u>Box Access:</u>

When superstructure approach spans are greater than 84” deep, the following shall be required:

- The Design-Builder shall provide a lockable steel door with a solid steel surface for box end access.
    - The minimum door size shall be 6’-8” x 6’-0” at both ends of the continuous unit. Two doors panels shall be provided with a total width of the opening 6’-8” x 6’-0” after opening both panels.
- If the minimum opening size cannot be provided at the box end then an access point shall be provided in the bottom of the slab with the minimum dimensions 6’-0” x 4’-0”.
- Provision for cutting one 8’-0” x 6’-0” access panel in the top of the deck per each cell or between each pair of webs shall be provided, at a location determined by the DBE, and accounted for in the design.
    - A galvanized or stainless steel grid shall be used to create a platform between approach beams for a minimum length of 10’-0”; the width shall be not less than the clear spacing between the bottom flanges (or bulbs, in a bulb tee) less 8” in front of the door.
    - The platform shall be designed for pedestrian loads.
    - If necessary, a ramp shall be provided from grid to door front at a slope not to exceed interior ramps.
    - The grid and attachment hardware shall be capable of supporting pedestrian loads plus an additional 2 kip point load.

- The webs and or flange elements shall be reinforced to carry the platform loads.
  - Box Maintenance Vehicle: At the District Structure & Bridge Engineer's sole discretion, the Design-Builder shall increase sizes of openings to ensure access for an electric inspection or maintenance vehicle (including, but not limited to, equipment cart, scissors lift or man-lift) based on the Designer's approved preliminary AFC Plans. Unless mutually agreed upon by the Design-Builder and the Department, the vehicle shall not exceed 5,000lbs; in fully loaded and at extreme extension, the single-tire or outrigger reaction shall not exceed 2,000 lbs).

When approach spans are less than 7'-0" (84") deep, the following shall be required:

- Box end access need not be provided unless directed by the District Structure & Bridge Engineer.
- At least one access point shall be sized for maintenance and rehabilitation access; additional points shall be required if the required equipment cannot be moved from this access point along the entire bridge length.
  - This access point shall be a minimum of 7'-0" x 5'-0" clear opening in the bottom of the slab.
  - The access point shall be in the bottom of the box. The access point shall have a derrick or hoist with 2000 lb service capacity.
- One fall protection anchorage or a series of anchorages shall be provided at each access point such that they ensure easy ingress and/or egress from the box. Two additional fall protection anchorages shall be provided on each side of the access point in the webs of the box to facilitate a safe working space for multiple workers. Capacity of the fall protection anchorages shall meet applicable OSHA, state and local requirements.
  - A railing meeting applicable OSHA requirements shall be provided on four sides. Railing shall be removable and a storage rack shall be provided on the inside of the box.

<u>Access Point Doors (all locations):</u>

Openings in the bottom of boxes shall be covered and protected with a counterweighted, lockable steel door which carries 100 psf or the specified inspection/maintenance vehicle, whichever controls, in the closed position.

Doors shall swing into the box.

The District Structure & Bridge Engineer (DBE) shall specify lock requirements, including requirement for internal or external lock.

If the DBE wishes to have the lock keyed to match locks at other VDOT facilities, the Design-Builder shall make arrangements to rekey the provided locks before the final acceptance.

Access point doors shall be able to be opened by a single person.

The top of the door shall either be flush with the floor of the box when closed or the Design-Builder shall provide a flooring material which provides a smooth transition over the opening when the door is closed.

The flooring materials (grid or plate) shall have a durable screen or solid plate permanently mounted to the access point door in order to prevent insect and critter access.

Segment Access Platforms:

The Contractor shall provide for two segment access platforms with railings. Segment access platforms shall be installed at a location selected by the District Structure & Bridge Engineer. Railings shall be removable and a storage rack for the railing shall be provided inside the box.

The Design Builder shall provide design and details for an access ladder, safety extension pole, hatch, safety railing, and access platform. The Design Builder is responsible for providing all details meeting the loading requirements, all OSHA and VOSH standards. All details shall be submitted to the Design Builder's Engineer for review and approval prior to fabrication.

Chain link fabric shall be placed on the inside of posts and rails.

- Access platform, attachment assembly, chain link fabric, posts, rails and other associated hardware shall be galvanized structural steel.
- Ends of wire ties shall be turned to the outside of the platform to prevent injury.

Segment access platform shall be designed for a minimum live load of 300 psf.

All bolts shall be high strength (ASTM A325).

A concrete block for an extension ladder shall be provided; extension ladder will be provided by others.

- Concrete for extension ladder block shall be Class A3.
- Maximum distance between level surface of concrete block and surface of access platform shall be not more than 16'-6".

Segment access hatch shall be roof access style and sized to allow for full use of a minimum hatch opening size of 3'-0" x 5'-0".

- Segment access hatch shall be mounted level on the inside of the box.
- Segment access hatch shall be able to be operated from the inside and one hand operable. Access hatch shall be key-locked.

Miscellaneous Box Requirements (All depths):

Provision for cutting an 8'-0" X 6'-0" access panel in the top of the deck shall be provided at a location determined by the DBE.

- The perimeter shall have bars with threaded couplers. The perimeter shall also be reinforced with pin bars (oriented with legs near the top and bottom layers of top slab). Corners of the opening shall be reinforced to minimize cracking.

An anchorage for a removable derrick shall be embedded adjacent to the maintenance and rehabilitation opening. A derrick shall be provided with a permanent boxed storage location inside the box. The derrick and anchorage system shall be capable of carrying 2000 lbs at service levels and shall fit an electric hoist approved by the District Structure & Bridge

Engineer. The derrick arm shall be approximately 7'-0" feet off the floor of the box when rotated, or as acceptable by the District Structure & Bridge Engineer.

POST-TENSIONING SYSTEM REQUIREMENTS:

DUCTS:

External tendons shall be no closer than 6" clear to the floor of the box or ceiling of the box to allow for inspection.

External tendons shall be placed to facilitate replacement. To minimize tendons whipping after failure, external tendons shall be routed through diabolos formed in concrete blisters similar to deviator blocks at intervals not to exceed 20'-0".

ANCHORAGE ENDS:

Strand ends and wedges at anchorages shall be sealed using removable plastic covers manufactured by the anchorage fabricator for the purpose of preventing strand corrosion at anchorage ends.

Anchorages shall be manufactured using materials which will not be subject to corrosion when embedded in hydraulic cement concrete or permanently exposed for inspection purposes.

Anchorages which terminate outside the limits of the box shall be protected with a pour-back or other cover approved by the District Structure & Bridge Engineer.

ACOUSTIC EMISSIONS HEALTH MONITIORING SYSTEM

Acoustic Emissions Health Monitoring Systems shall be provided in accordance with the Special Provision for Acoustic Emission Monitoring System for Detecting and Locating Wire Breaks in Strands in Tendons for Design-Build and PPTA Contracts.

DESIGN AND DETAILING APPROACH – SUBSTRUCTURE:

BOX ACCESS TO PIERS:

In each span at least one access point shall be sized and provided for pier inspection access.

- Each inspection access point shall be a minimum of 3'-0" x 3'-6".
- One fall protection anchorage or a series of anchorages shall be provided at each access point such that they ensure easy ingress and/or egress from the box. Two (2) additional fall protection anchorages shall be provided on each side of the access point in the webs of the box to facilitate a safe working space for multiple workers. Capacity of the fall protection anchorages shall meet applicable OSHA, state and local requirements.
- The access point shall be in the bottom of the box.

Pier inspection openings where pier height exceeds 32'-0" from ground to top of pier cap:

- At each pier, a 3'-6" x 3'-0" opening in the bottom of the box shall be provided on each side of the pier. The opening shall be detailed with an inward opening door and shall include two (2) fall protection anchorages and two (2) anchorage points suitable for inspection personnel to rappel down the face of the piers. Design Builder shall include

hand holds, ladder steps or other hardware suitable to facilitate ingress/egress of inspection personnel as directed by the District Structure & Bridge Engineer.

- At each pier inspection access location, a segment access platform shall be provided on the face of the pier meeting all requirements for segment access platforms provided above.
- In addition to floor openings, critter and insect control shall be provided at all other entry locations as well as any permanent opening in any element (walls, floor, slab, etc.) in the concrete. Unless otherwise directed by the District Structure & Bridge Engineer in writing for a particular opening, critter and insect control shall be provided on each face of every opening.

A railing meeting applicable OSHA requirements shall be provided on four sides.

Railing shall be removable and a storage rack shall be provided on the inside of the box.

HOLLOW PIERS:

The following access requirements for inspection and maintenance of the bridge structure shall be incorporated into design and detailing of the piers. All features noted below shall be designed to be in compliance with the Virginia Work Area Protection Manual and OSHA:

- Inspection access doors shall be located at each hollow pier, approximately ten (10) feet above ground level for security purposes and face the uphill side of the slope. The inspection access doors shall be lockable, using a keyed locking system (no padlocks) and an exterior platform with an open steel mesh floor shall be provided at each door. The access doors will be accessed by ladder brought by the inspection team at time of inspection. No permanent exterior ladder shall be installed.
- An interior stairway/ladder platform system shall be provided inside each hollow pier column for inspection purposes. The type of interior platform system shall be approved by the Department.
- Hollow pier caps, if any, should have access either in the form of doors from the top of the interior pier stairwells, or from manholes located in the top of the pier caps.
- Interior lighting shall be provided for all hollow pier columns, caps and in superstructures constructed of segmental units.
    - Lighting shall provide continuous minimum uniform illumination of 20 foot candles of the floor, walls and ceiling.
    - Lighting shall not induce glare for individuals walking in the box or inspecting walls or ceilings while standing on the box floor per OSHA or other applicable regulations.
- There shall be a minimum of one (1) lockable electrical access port at each hollow pier to allow the use of a portable generator.
    - The electrical access port shall be located near the elevated inspection door.
    - Lighting throughout the structure shall be connected so that all lights will operate when a single portable generator is connected to any port.

  - A ventilation study shall be conducted to determine if additional openings are required to provide adequate ventilation during inspection. Any openings required for ventilation shall be fitted with protective screening.

- The interior of each hollow pier shall be marked with elevations, starting at the bottom of the hollow pier, at a minimum of every ten feet for the entire height of column. The elevations will be used as a reference during bridge safety inspections.
  - The text shall be at least 12” tall. The paint color shall be Fed Std. 595C color 37030 (flat black) for text over Fed Std. 595C color 37925 (flat white).
  - The limits of the white background behind black text, labels or numbers shall be at least 3” beyond the limits of any text or number and shall be rectangular.
  - Font shall be similar to Arial for all text or labels. Numbers shall match the shape of the numbers as shown: 1 2 3 4 5 6 7 8 9 0.
  - Painted text and numbers shall be added using stencils or similar means of application which produces a clearly legible result.
  - No identification shall be applied freehand.
  - Lines shall be embedded or formed into the concrete. Lines, including lines which are formed into concrete, shall be painted Fed. Std. 595C 12199 (gloss orange); embedments shall be colored or finished to match Fed. Std. 595C 12199 (gloss orange).

STRUCTURE VULNERABILITY MITIGATION REQUIREMENTS:

Hollow columns shall be detailed per IIM-S&B-92.

- Access roads to the box access openings shall have lockable gates at the access road entrances to deter unauthorized entry. The Design Builder shall provide a locking mechanism to match similar VDOT facilities and shall re-key locks to meet requirements of the District Structure & Bridge Engineer.
- A minimum “standoff” distance of twenty five (25) feet shall be provided at the base of each pier. The standoff distance is defined as the minimum distance a vehicle can be parked away from the pier column. The standoff distance shall be obtained by placing permanent barriers at the end of each access road to prevent vehicles from approaching the face of the pier columns.

VEHICULAR ACCESS POINTS:

Permanent service roads shall be constructed to provide access to Piers for inspection and maintenance purposes. The access roads shall be designed in accordance with the VDOT Road Design Manual as a GS-9 Standard Service Road Dead End (under 25 VPD), 15 mph Design Speed. Access at piers on slopes shall be via Standard Steps S-2 from the top of slope. Conceptual layouts of temporary and permanent access roads shall been shown in preliminary bridge plans and road plans; final pavement typical section shall be in accordance with Geotechnical Recommendations.

The permanent access road shall include any necessary provisions for crossing waterways present on the site via box culvert or pipe structures (minimum 25 feet wide curb-to-curb). The crossing shall be sized to meet all appropriate permanent storm water management regulations.

The District Structure & Bridge Engineer shall approve vehicular access to each entry point in the bottom of the box. If the maintenance and rehabilitation access point is not over a public road, a permanent access road or path to each entry point in the bottom of the box shall be constructed. The road shall be suitable for the 10 kip bridge maintenance vehicle and for a bucket truck with boom of sufficient length to reach the bottom of the box. Access roads shall terminate under each opening in the bottom of the box and provide sufficient room for the vehicles to turn around.

A concrete pad or gravel platform shall be constructed under each opening which will allow access via bucket truck, self-propelled man lift or by use of a ladder. Access type (bucket truck, man lift or ladder) and the location to be approved by District Structure & Bridge Engineer. The pad shall provide a minimum 200 square feet level area to allow for placement of a generator and ladder on the pad and delivery of materials on pallets. The pad shall be between 2” and 4” above prevailing ground and shall deviate from level only to the extent that it is necessary to ensure drainage at a rate of not less than 1% nor more than 2%. Concrete reinforcing shall be sized to allow for the bridge maintenance vehicle or bucket truck to park on the pad in a service load condition with the maximum wheel load not less than 6” from the pad edge without damage.

CC: Chief Engineer
Division Administrators
District Administrators
District Construction Engineers
District Maintenance Engineers
Assistant State Structure and Bridge Engineers
District Structure and Bridge Engineers
Residency Administrators/Engineers
Structure and Bridge Program Managers
FHWA: Bridge Section

VIRGINIA DEPARTMENT OF TRANSPORTATION

STRUCTURE AND BRIDGE DIVISION

INSTRUCTIONAL AND INFORMATIONAL MEMORANDUM

GENERAL SUBJECT: Post-Tensioned Bridge Structures	NUMBER: IIM-S&B-94
SPECIFIC SUBJECT: Requirements for Qualification, Job Site Testing and Acceptance of Grouts Being Used in Post-Tensioned Structures	Date: December 13, 2016 SUPERSEDES: None
DIVISION ADMINISTRATOR APPROVAL: /original signed/ Kendal R. Walus, P.E. State Structure and Bridge Engineer Approved: December 13, 2016	

New IIM

EFFECTIVE DATE:

This Memorandum is effective on December 13, 2016.

REFERENCES:

IIM-S&B-91 General Requirements for the Usage, Design and Specification of Post-Tensioned Bridge Superstructures

QUALIFICATION OF GROUTS:

Grout shall meet PTI M55.1-12(13) Table 3.1 Class B or C and the following additional requirements:

- Temperature testing, water content testing, segregation testing, and mock-up testing shall be performed for each manufacturer of grout, from each manufacturing facility.
- Temperature testing: Grout prepared for all tests required by PTI M55.1-12(13) shall be prepared at the high (one set of grout tests and test specimens) and low (one set of grout tests and test specimens) temperatures anticipated for the grouting of tendons. The grout is acceptable if passing test results are obtained at both temperatures. Multiple grouts may be approved to address temperature issues.

- Water content testing: Grout prepared for all tests required by PTI M55.1-12(13) shall be prepared with 10 percent more water than the maximum amount recommended by the manufacturer. The grout is acceptable if passing test results are obtained.
- Segregation testing: Construct a 4-feet high by 2-inch diameter cylinder specimen of grout at the anticipated project low temperature. Cut three (3) 4-inch long cylinder specimens from the top 12-inches of the 4-feet specimen and cut three (3) 4-inch long cylinder specimens from the bottom 12-inch of the 4-ft specimen. Test the six (6) cylinders for compressive strength at 28 days (ASTM C39). The grout is acceptable for use when the average strength from three (3) top portion specimens is within 10 percent of the three (3) bottom portion specimens.
- Mock-up test: The Mock-up shall be constructed to simulate the longest tendon in the structure to be grouted plus an additional 10 percent in length and the largest elevation difference in a single tendon in the structure plus an additional 10 percent in elevation difference. The tendon in the Mock-up shall be constructed with the same materials and number of strands that will be used in the structure to be grouted. The strands do not need to be tensioned.
- Lot testing: Prior to using each lot of grout, perform the Acid-Soluble Chloride Test, Compressive Strength Test, Volume Change Test, Wick-induced Bleed Test or Schupack Pressure Bleed Test (PTI M55.1-12(13)) and the Grout Segregation Test (VTM 138). The grout is approved for use if passing test results are obtained for each test.

JOB SITE TESTING AND ACCEPTANCE:

Grout shall meet the requirements of PTI M55.1-12(13) and the following additional requirements:

- Fluidity and wet density testing: Prior to injecting a tendon with grout the grout shall have a fluidity (PTI M55.1-12(13) section 4.4.5) and wet density within the ranges that have been established when the grout qualification tests have been done. Grout coming from the outlet end of each tendon shall be tested for fluidity and wet density. Grouting of the tendon shall continue until the grout has a fluidity (PTI M55.1-12(13) section 4.4.5) and wet density within the ranges that were established when the grout qualification tests have been done. If acceptable results cannot be obtained the tendon shall be flushed to remove all grout and additional tendons shall not be grouted until passing results can be obtained.
- Compressive strength testing: At 4 hour intervals, after passing test results are obtained for fluidity and wet density, two sets of grout cubes shall be prepared, one at mixer and one at the longest duct. A minimum of two sets of cubes shall be prepared each day. Cubes shall be tested for strength at 7 days. Chloride ion testing: Once a day, after passing test results are obtained for fluidity and wet density, a set of grout strength cubes from the mixed grout shall be prepared and tested at 24 hours for compressive strength and the broken cubes shall be tested for the acid-soluble chloride ion (Cl-) content.
- Anchorage inspections: After the grouting is complete all anchorages shall be inspected using a fiber scope or video scope or by removing the end cap. All bleed water,

segregated grout and soft grout shall be removed and the void shall be filled with the grout used to grout the tendon.

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