

NEW YORK STATE DEPARTMENT OF TRANSPORTATION

OFFICE OF STRUCTURES



PRESTRESSED CONCRETE CONSTRUCTION MANUAL

APRIL 2017



NEW YORK
STATE OF
OPPORTUNITY.

**Department of
Transportation**

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PRESTRESSED CONCRETE CONSTRUCTION MANUAL

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**NEW YORK STATE
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New York State Department of Transportation
Prestressed Concrete Construction Manual
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FOREWORD

We are pleased to present the Third Edition of the Prestressed Concrete Construction Manual (PCCM). The PCCM was first published in June of 1987 and revised in September of 2000.

This new edition is part of our continuing effort to advance the use of structural precast and prestressed concrete bridge components in New York State. This edition will help keep New York State Department of Transportation (NYSDOT) specifications current with industry advances in design practice, materials, fabrication methods and construction techniques. It is our hope that the implementation of this manual will result in the increased use, improved quality and lower cost of structural precast and prestressed concrete bridge components in New York State projects.

Appreciation is given to the many individuals within NYSDOT and The Federal Highway Administration (FHWA), as well as the leadership and members of the Precast Concrete Association of New York (PCANY) and the Association of General Contractors (AGC) who reviewed draft copies of this manual. Their many insightful comments have greatly contributed to the quality of this edition of the PCCM.

Michael B. Twiss, P.E.
Concrete Engineering Unit

SECTION 1

INTRODUCTION

1.1 PURPOSE

The New York State Prestressed Concrete Construction Manual (PCCM) has been prepared to be part of the specifications for structural precast and prestressed concrete units fabricated under the authority of the Deputy Chief Engineer Structures (DCES).

1.2 APPLICABILITY

This manual applies to all structural precast and prestressed concrete units in New York State Department of Transportation (NYSDOT) projects fabricated under the authority of the DCES. To determine if this manual applies to a particular precast or prestressed unit, refer to the specification associated with the item number for that unit. Units to which the PCCM applies include, but are not limited to, the following:

- Prestressed Concrete Box Beams.
- Prestressed Concrete Hollow and Solid Slab Units.
- Prestressed Concrete AASHTO I-Beams.
- Prestressed Concrete Bulb Tee Beams.
- Prestressed Concrete Deck Bulb Tee Beams.
- Prestressed Concrete NEXT Beams.
- Post-Tensioned Segmental Box Girders.
- Reinforced Concrete Span Units (Three-Sided Structures) including Wingwalls, Invert Slabs and Cutoff Walls.
- Precast Concrete Bridge Deck Panels.
- Precast Concrete Approach Slab Panels.
- Prestressed Concrete Piles.
- Precast Concrete Footings.
- Precast Concrete Abutments and Wingwalls.
- Precast Concrete Piers including Pier Walls, Capbeams and Columns.

1.2.1 Locally Administered Federal Aid Projects

For all locally administered Federal Aid Projects on the State or National Highway System that include structural precast or prestressed concrete items, all provisions of this manual shall apply. For all locally administered Federal Aid Projects off of the State or National Highway System (including highways that are signed as US or NY touring routes but are not State owned) that include structural precast or prestressed concrete items, all provisions of this manual shall apply except that the Local Authority shall be responsible for providing Quality Assurance (QA) for the fabrication of the units. This includes the review and approval of shop drawing submittals as well as providing inspection and material testing at the precast facility. NYSDOT may choose to provide QA for the fabrication of precast units in a locally administered Federal Aid Projects off of the State or National Highway System if it involves an innovative or nontraditional structure as documented in the Design Approval Document.

1.2.2 Design-Build Projects

For Design-Build Projects in New York State, all provisions of this manual shall apply except as modified by NYSDOT's Design-Build Procedure Manual or in the Request for Proposals (RFP) for the specific project.

SECTION 2

DRAWINGS

2.1 CONTRACT DRAWINGS

2.1.1 Definition

The drawings that are part of the contract documents are hereinafter referred to as the "plans." The plans are not intended to be used as "shop drawings," "installation drawings" or "erection drawings."

2.1.2 Requests for Clarification

Requests for clarification of the contract requirements for items covered by this specification should be directed to the Concrete Engineering Unit, with informational copies sent to the Engineer-In-Charge (EIC). The Concrete Engineering Unit will furnish the clarification to the Contractor.

2.1.3 Dimensions

In case of a difference on the plans between scaled dimensions and numbers, the numbers shall be followed.

2.1.4 Errors

The Contractor shall verify and be responsible for the correctness of all dimensions other than the principal controlling dimensions shown on the plans, and shall call to the attention of the Concrete Engineering Unit any errors or discrepancies that may be discovered. The Contractor shall have no claim for damages that may result from following an error, except for an error in the principal controlling dimensions or material properties shown on the plans or listed in the specifications.

On bridge rehabilitation projects, the Contractor shall be responsible for field verifying all principal controlling dimensions prior to fabrication. Shop drawings for all primary

components on bridge rehabilitation projects shall include a note indicating the date that the dimensions were field verified.

2.1.5 Principal Controlling Dimensions and Material Properties

The following shall be considered principal controlling dimensions and material properties. Any change requires pre-authorization by the DCES.

- Length of span (i.e., the horizontal distance between bearing centerlines, or other points of support).
- Length of the precast or prestressed concrete unit.
- Width of the precast or prestressed concrete unit.
- Depth of the precast or prestressed concrete unit.
- Thickness of flanges and webs.
- Elevations of pedestals, bridge seats, and other supports for precast and prestressed concrete units.
- Jacking force.
- Ultimate strength of prestressing steel.
- Yield strength or grade of reinforcing bars.
- Compressive strength of concrete.

2.1.6 Fabricating Dimensions

The Contractor or the Contractor's designee shall be responsible for modifying the dimensions of precast units to compensate for elastic shortening, shrinkage, grade correction, and other phenomena that make in-process fabricating dimensions different from those shown on the plans.

2.2 SHOP DRAWINGS

2.2.1 Preparation

Complete and accurate drawings shall be made by the Contractor or the Contractor's designee, showing how each concrete unit is to be fabricated. These drawings shall be made as soon as possible after the contract award and shall be designated as shop

drawings. Supporting documents are sometimes required as part of a shop drawing submittal. Supporting documents include any additional information required by the Concrete Engineering Unit and intended to supplement the shop drawings, such as design calculations. When a shop drawing submittal includes calculations meeting the requirements of Section **9 Contractor's Design Calculations**, both the drawings and the calculations shall be stamped and signed by a Professional Engineer licensed to practice in New York State. Shop drawing submittals that are not complete (as determined by the DCES) may be returned without examination (see Section **2.2.3 Returned Without Examination**).

2.2.2 Drawing Size and Type

2.2.2.1 Standard Size

The size of the shop drawings as well as the size of all margins shall be in conformance with current Department standards. For information on current Department standards, contact the Concrete Engineering Unit.

2.2.2.2 Neatness and Clarity

Shop drawings shall be complete, neatly drawn and clearly legible. Letter and number sizes shall be in conformance with current Department standards. For information on current Department standards, contact the Concrete Engineering Unit.

2.2.2.3 Title Block

Each shop drawing shall have a title block conforming to current Department standards and identical in shape and size to the title blocks used on the plans. The title block shall show the contract number, the project identification number (PIN), the project name, the structure name, the pay item number, the bridge identification number (BIN), the name of the county, and the drawing number. The title block shall also show the initials of the person who prepared the drawing and the person who independently checked the drawing. A space shall be provided at the left of the title block of sufficient size to accommodate each required stamp (i.e., NYSDOT approval stamp, professional

engineer's stamp, etc.). For information on current Department title block standards, contact the Concrete Engineering Unit.

2.2.3 Returned Without Examination

Shop drawings not meeting the requirements of Section **2.2.1 Preparation** and Section **2.2.2 Drawing Size and Type** may be returned without examination. If installation drawings are required in accordance with Section **2.3 INSTALLATION DRAWINGS**, they shall be submitted together with (at the same time as) the shop drawings. If a set of shop drawings is submitted without the required installation drawings, the shop drawings may be returned without examination.

2.2.4 Electronic Format

The Contractor shall submit shop drawings, and supporting documents in electronic format (PDF file). Electronic submissions shall be made using an electronic file management system designated by the Department. Contact the Concrete Engineering Unit for information on electronic submissions.

2.2.5 Information Required in Shop Drawing Submissions

The shop drawings shall include the following information.

2.2.5.1 Production Notes

- Fabricating plant production schedule, including anticipated start date, duration of production, and shipping date. If the work is not yet scheduled at the time of the initial shop drawing submission, indicate "not yet scheduled" on the drawing. As soon as the work is scheduled, the Contractor shall notify the Concrete Engineering Unit.
- Description of the fabrication plant, including any backup concrete mixing facilities, and proposed method of placement.
- Concrete mix design, including all brand names, brand codes, source numbers, source locations, suppliers and supplier locations from the appropriate NYSDOT Approved Lists. Modifications or deviations from the original mix at any time after

the shop drawings have been approved shall be subject to the approval of the DCES. If the Fabricator intends to use a Self-Consolidating Concrete (SCC) mix, it shall be clearly stated in the Production Notes. If high performance concrete meeting the requirement of §718-06 High Performance Concrete for Precast and Prestressed Bridge Beams of the NYSDOT Standard Specifications, Construction and Materials, is being used, a table showing the pre-production testing results and a strength gain curve shall be shown.

- All quality control tests and procedures, including anticipated test results.
- Unit and cylinder curing procedures, as required by Section **5.11 CURING**.
- Required compressive strength for each phase of fabrication, including transfer of prestressing force, removal of forms, lifting, discontinuation of cure, and shipping.
- Proposed method of handling and transporting precast concrete units, including appropriate details.
- Cold weather or hot weather concreting procedures, if need is anticipated.
- Material and manner of applying penetrating sealer, including application rate in ft² per gal, as required by Section **6.2.3 Sealing of Concrete Units**.
- Finishing procedures.
- Tolerances.
- Unit Summary Table showing the number of units and the unit piece marks.
- A complete bill of materials.
- Index of drawings.

2.2.5.2 Additional Information Required in the Production Notes for Pretensioned Units

- The date the high performance concrete mix design was approved by the DCES.
- The name of the NYSDOT approved manufacturer of the prestressing steel, including any alternate source.
- Calculations of strand elongation for each unique casting length (grip to grip). Actual data shall be used in this calculation whenever available.

- Tensioning force (initial and final).
- Transfer of prestressing force procedure for all unit types to be fabricated.
- Strand cutting method, sequence and material as well as the manner of protecting the exposed portions of the prestressing steel.
- The assumed camber due to the prestressing force and beam dead load at transfer of prestressing force (without growth) as shown on the plans. If this anticipated camber value is not shown on the plans, the Contractor shall notify the Concrete Engineering Unit.
- The assumed camber due to the prestressing force and beam dead load at shipping (with growth) as shown on the plans. This is the camber value that the designer assumes when determining pedestal/bridge seat elevations. If this anticipated camber value is not shown on the plans, the Contractor shall notify the Concrete Engineering Unit.

2.2.5.3 Layout Details

- North arrow.
- Plan layout of structure.
- General cross section views looking “up station.”
- Piece mark and its location on each unit.
- Bridge begin, end, and pier stations as needed.
- Center to center of bearing dimensions, for all spans.
- Necessary section details.

2.2.5.4 Precast Unit Details

- Unit plan dimensions.
- Unit elevation.
- Unit cross section dimensions.
- Reinforcing layout, including plan, elevation and cross section views.
- Details of reinforcing steel shall clearly show the size, spacing, cover, and

location of bars, including any special reinforcing required but not shown on the contract plans.

- The top reinforcing mat for buried bridge structures with less than 2 feet of fill shall be one of the following:
 - o Epoxy-coated bar reinforcement meeting the requirements of §709-04.
 - o Galvanized bar reinforcement meeting the requirements of §709-11.
 - o Stainless steel bar reinforcement meeting the requirements of §709-13.
 - o Any other non-corrosive bar reinforcement approved by the DCES.

This requirement is in addition to the corrosion inhibitor requirement in Section **4.1.1 Materials for Concrete.**

- Bar list including bar sizes, bend dimensions (conforming to CRSI standards), etc. shall be shown on the same drawing on which reinforcing details are shown.
- Locations of any prestressing strands as well as any strand debonding or draping details.
- Railing anchorage layout and details.
- Miscellaneous details, including diaphragms, required daps, special beam end requirements, and special surface finishes.
- Details and locations of all other items to be embedded in the units, such as inserts, post-tensioning hardware, etc. shall be clearly detailed.
- Fully and accurately dimensioned views of precast units shall show clearly the three-dimensional relationship of all embedded items. These views shall show all projections, recesses, shear keys, notches, openings, blockouts, and other pertinent details.
- Type and location of lifting device for all concrete units to be fabricated.
- Details showing how the units will be lifted and/or rotated, how they will be stored in the precaster's yard, and all relevant transportation details, including how they will be placed on the truck.
- For drainage purposes, buried bridge structure units shall show a positive top slope that will produce a minimum 1% final installed slope.

2.2.5.5 Additional Information Required for Precast Units which will be Installed Using Segmental Construction (Non-Match Cast Joints)

The following minimum information shall be shown on the shop drawings at appropriate locations:

- All joint and connection details.
- When required, surface finishes for keyways (blast, exposed aggregate, etc.).

2.2.5.6 Additional Information Required for Precast Units with Post-Tensioning (Match Cast and Non-Match Cast Joints)

The following minimum information shall be provided. These provisions do not apply to transverse post tensioning of adjacent box beams and adjacent slab units.

- When any post-tensioning work is to be performed in the casting facility, all relevant information required in Section **2.3.3 Additional Information Required for Precast Post-Tensioned Units** shall be shown on the shop drawings.
- Shop drawings shall be integrated and show all reinforcing steel, tendons and hardware within each unit. The size and type of ducts for all post-tensioning tendons with horizontal and vertical profiles shall be clearly detailed and mathematically defined. Details of duct supports, grout tubes, vents, and drains shall be shown including type, size, and locations. Details and locations of all couplers shall be shown. All conflicts between tendons, ducts, couplers, anchorages and reinforcing steel shall be resolved.
- The Contractor's supplier of the post-tensioning hardware is responsible for designing and furnishing local zone anchorage reinforcement. Design calculations for the local zone anchorage reinforcement shall be included in the shop drawing submission as a part of the supporting documents.
- Complete details of the anchorage system for post tensioning meeting the post-tensioned-anchorage zone requirements of Section 5.10.9.7 of the LRFD Bridge Design Specifications are required.
- Details for reinforcing steel required to resist local zone stresses at post-tensioning-anchorage systems are required.
- The orientation of the bearing plate, usually by providing offsets to a horizontal

and vertical plane, shall be shown. These planes usually coincide with the plane of the form.

- Method(s) for the protection of the ducts from chloride contamination, dirt contamination, crushing, excessive bending, ultraviolet degradation, etc. during handling, storage and transportation (grout caps, etc.).
- Certified copies of the reports covering tests performed on prestress anchorage devices and other post-tensioning materials as required by Section **4.6 MATERIALS FOR POST-TENSIONING** shall be included in the shop drawing submittal as a part of the supporting documents.

2.2.5.7 Additional Information Required for Precast Units which will be Installed Using Segmental Construction (Match Cast Joints)

The following minimum information shall be shown on the shop drawings at appropriate locations:

2.2.5.7.1 Geometry Control

A description of the Contractor's proposed geometry control procedure shall be provided. This information shall include, but shall not be limited to, the following items:

- A detailed description of the theoretical principles underlying the geometry control procedure, including any use of geometry control software.
- A detailed narrative of the step-by-step geometry control procedure.
- Detailed calculation forms.
- A set of sample calculations.
- A description of all measuring equipment and procedures.
- The location of the control points to be established on each segment.
- The qualifications and responsibilities of personnel who will carry out the geometry control.

2.2.5.7.2 Casting Curves

Casting curves shall include the following information:

Casting curves shall correspond to the casting and installation methods, the installation

schedule, loads, and material properties proposed by the Contractor. Casting curves shall be sufficiently accurate to allow the determination of control point settings for accurately casting the segments to meet the profile and the alignment shown on the plans.

The preparation of casting curves shall recognize all deviations from straight line and deformations due to the final required alignment, dead load, superimposed dead loads, erection loads, post-tensioning stresses including secondary moments, creep, shrinkage, and installation schedule. The preparation of casting curves shall be done at no additional cost and shall be considered incidental to the contract. Because the casting curves are dependent on the Contractor's erection and sequence schedule, the Contractor shall produce new casting curves whenever there is a change in the erection sequence and/or schedule. Casting curves shall be stamped and signed by a Professional Engineer licensed to practice in New York State and who is, in the opinion of the DCES, experienced in concrete segmental bridge design and construction.

2.2.5.8 Forms for Precast Units with Match Cast Joints

Shop drawings shall be submitted for forms and form travelers. The forms used to cast the concrete segments shall be capable of:

- Match casting.
- Producing the segments within the tolerances permitted.
- Accommodating blockouts, openings and protrusions.
- Adjusting to changes in segment geometry as shown in the plans, or for correcting previous minor casting errors to prevent accumulation.
- Stripping without damage to the concrete.
- The form design shall provide a tight, leak-proof joining to the previous segment. The bulkhead shall be capable of connecting the ducts in a manner to hold their position and prevent intrusion of grout.
- Where sections of forms are to be joined, on the exterior face of the segment, an offset exceeding 1/16" for flat surfaces and 1/8" for corners and bends will not be permitted.

- All side, bottom, inside, and header forms for precast segmental construction shall be constructed of steel unless use of other materials is approved by the DCES.
- Forms shall be of sufficient thickness, with adequate external bracing and stiffeners, and shall be sufficiently anchored to withstand the forces due to placement and vibration of concrete.
- Internal bracing and holding devices in forms shall be limited to stay bolts in webs which can be removed from the concrete surface to permit patching following form removal.
- Joints shall be designed and maintained for mortar tightness.
- All form surfaces for casting members shall be constructed and maintained to provide segment tolerances.

2.3 INSTALLATION DRAWINGS

If the precast elements that will be fabricated using the approved shop drawings are to be connected together in the field (segmental construction), a separate set of drawings hereinafter referred to as "installation drawings" shall be required. These drawings are required to be submitted together with, and at the same time as, the shop drawings for the approval of the DCES and shall meet the requirements of Sections **2.2.1, 2.2.2, 2.2.3, and 2.2.4**. Submission, examination, approval and distribution of these drawings shall be as per Sections **2.4** and **2.5**.

Supporting documents are sometimes required as part of an installation drawing submittal. Supporting documents include any additional information required by the Concrete Engineering Unit and intended to supplement the installation drawings, such as design calculations, material test results, lifting and handling stress checks, and construction load checks on existing structures. Calculations required as supporting documents to the installation drawings shall be stamped, and signed by a Professional Engineer licensed to practice in New York State and who is, in the opinion of the DCES, experienced in concrete segmental bridge design and construction. These calculations

shall meet the requirements of Section **9 Contractor's Design Calculations** of this manual. When calculations are required as supporting documents to installation drawings, each of the drawings shall also be stamped and signed by the same engineer (a Professional Engineer licensed to practice in New York State) who stamped and signed the calculations. All details and notes shall be shown on the Installation Drawings. All calculations shall be considered part of the supporting documents. The requirement for installation drawings and supporting documents may be waived when, in the opinion of the DCES, the plans contain sufficient installation details.

The following information is required in Installation Drawing submissions:

2.3.1 Installation Notes

The following information shall be provided:

- A detailed step-by-step description of the Contractor's proposed installation procedure. For precast segmental box girders, the construction method (span by span, balanced cantilever, progressive cantilever, etc.) shall be stated.
- The Contractor's proposed installation schedule.
- A table of theoretical elevations and alignment of the geometry control points established during casting shall be provided for each segment. This information shall be shown for each stage of erection.
- The proposed method for measuring and recording the elevation and alignment of all control points at each stage of installation.

2.3.2 Installation Details

Complete details showing how the units will be connected together in the field are required.

2.3.3 Additional Information Required for Precast Post-Tensioned Units

For units post tensioned in the field, the following minimum information meeting the requirements of Section **8.5 POST TENSIONING** shall be provided.

- Complete details and description of post-tensioning systems to be used for both permanent and temporary tendons are required.
- Design parameters for the proposed post-tensioning systems, including friction coefficients, anchor set, and relaxation curves are required.
- Designation of the specific prestressing steel, anchorage devices, bar couplers, duct material and accessory items to be used, including the manufacturer.
- Properties of each of the components of the post-tensioning system.
- Details covering assembly of each type of post-tensioning tendon.
- Equipment to be used in the post-tensioning operation.
- Procedure and sequence of operations for post-tensioning.
- Parameters to be used to calculate the typical tendon force, such as expected friction coefficients and anchor set.
- Procedure for in-place friction test and field pressure test.
- Procedure for detensioning.
- A table detailing the post-tensioning jacking sequence, jacking forces and initial elongation of each tendon at each stage of erection for all post-tensioning.
- The operation of grouting post-tensioning tendons, the type and manufacturer of the grout, details of equipment for mixing and placing grout, for flushing, backup equipment, and methods of mixing and placing grout.
- Calculations to substantiate the post-tensioning system and procedures to be used including stress strain curves typical of the prestressing steel to be furnished, required jacking forces, elongation of tendons during tensioning, seating losses, short term prestress losses, temporary overstress, stresses in prestress anchorages including distribution plates and reinforcing steel needed in the concrete to resist stresses imposed by prestress anchorages. These calculations shall show a typical tendon force after applying the expected friction coefficient and anticipated losses for the stressing system to be used including anchor set losses. The modulus of elasticity used in elongation calculations shall be that of the prestressing steel shown in the plans. Adjustments to the calculations shall be made based on the strand area and modulus of elasticity furnished by the Manufacturer.

2.3.3.1 Calculations of Theoretical Elevations and Alignment

Calculations shall be provided addressing the following factors:

- The effects of as-cast geometry established from surveys during casting of segments.
- Effects of construction dead and live loads.
- Effects of post-tensioning.
- Effects of creep and shrinkage.
- Effects of long-term-camber growth.
- Effects of the final profile of the roadway as shown on the plans.

2.3.4 Additional Information Required for Precast Units Connected Together with Field Cast Joints or Closure Pours

- Complete details of field cast joints or closure pours including required formwork and any additional reinforcement.
- Bar lists including bar sizes, bend dimensions, etc. (conforming to CRSI standards) for any field cast joints or closure pours. Bar lists shall be shown on the same drawing on which the field cast joint or closure pour details are shown.
- Concrete mix design or grout brand name and manufacturer for any field cast joints or closure pours.
- A description of how the concrete or grout material will be stored and protected from the weather at the job site.
- A description of the concrete or grout mixing procedure.
- A description of the equipment that will be used to mix the concrete or grout.
- Concrete testing requirements for the concrete mix or grout used for any field cast joints or closure pours, including a description of how many and what type of test samples (cylinders, grout cubes, etc.) will be taken and a description of the tests that will be performed on the test samples including required test results
- The required temperature range for the mixing, placing, and curing of the concrete or grout as recommended by the manufacturer.

- A description of how the temperature will be measured.
- If the Contractor anticipates the ambient temperature will be outside of this range during the mixing, placing, and curing of the concrete or grout, a description of the actions that will be taken (such as adding ice to the mix, applying external heating, etc.) shall be shown.
- Preparation of precast surfaces prior to installation of field cast joints or closure pours, including the procedures for surface cleaning and pre-wetting prior to concrete or grout placement.
- Procedure for placing the concrete or grout.
- Procedure for curing the concrete or grout.
- Procedure for finishing the concrete or grout including any required equipment.
- Concrete or grout strength requirements for discontinuing the cure, removal of any forms, finishing, and applying service loads.

2.3.5 Temporary Structures and Equipment

Complete details and design calculations for falsework, special formwork, erection equipment, and any other temporary construction which will be subjected to calculated stresses shall be provided. This shall include complete information covering the design and details for the scheme to be used to erect, align and secure segments during erection of the structure.

2.3.6 Checks and Modifications of Permanent Structural Components for Construction Loads

These documents shall include:

- A complete set of calculations, stamped and signed by a Professional Engineer licensed to practice in New York State, showing that loads imposed on permanent structural components by construction equipment, erection equipment, and temporary falsework will not adversely affect the integrity of the structure and that the allowable stresses as shown on the plans are not exceeded during construction, is required.

- Complete detail drawings of any modifications to permanent structural components proposed by the Contractor, with supporting calculations demonstrating that the modifications are both necessary and adequate to accommodate loads due to the proposed erection sequence, are required. Both the detail drawings and supporting calculations shall be stamped and signed by a Professional Engineer licensed to practice in New York State.
- Calculations and drawings covering all phases of construction shall be submitted and approved before any erection work can begin. Partial submissions are not allowed unless written permission is granted by the DCES.

2.3.7 Revised Installation Drawings

Revised installation drawings shall be resubmitted each time the Contractor proposes to deviate from the requirements listed in **Section 2.3.1 Installation Notes** that are contained in the previously approved installation drawings

2.4 SUBMISSION OF SHOP DRAWINGS AND INSTALLATION DRAWINGS

When the shop drawings and installation drawings are completed and independently checked, check prints (along with any supporting documents) shall be submitted to the Concrete Engineering Unit.

2.4.1 Check Prints

Check prints shall be submitted electronically using an electronic file management system designated by the Department. After posting check prints to the system, the Contractor shall notify the Concrete Engineering Unit and the Engineer-In-Charge. If the contract involves a railroad, another State Agency (Thruway Authority, Bridge Authority, etc.), or a local authority, the Contractor shall send them paper copies of the check prints. For access to the Department's electronic file management system or information on the electronic submission of check prints, contact the Concrete Engineering Unit.

2.5 EXAMINATION OF SHOP DRAWINGS AND INSTALLATION DRAWINGS

2.5.1 Examination Time

The time taken for the examination of shop drawing and installation drawing submissions can vary greatly depending on the construction schedule, the fabricators' production/shipping schedule, and the Concrete Engineering Unit's workload. The Concrete Engineering Unit will normally take two work days for the examination of each drawing in a complete set of shop and installation drawings, with a minimum of ten work days per one complete set. A set of shop and installation drawings is defined as all drawings received by the Concrete Engineering Unit from any Contractor for a particular item in a contract on any one day. A set of drawings will be considered complete only if it contains all the information necessary to correctly fabricate, ship, install and fully document the precast member(s) for which the drawings are prepared. If the drawings are detained for examination for a period longer than that stated above, such detention may be taken into account by the Engineer-In-Charge when considering application by the Contractor for an extension of time for the completion of the contract.

2.5.2 Special Circumstances

2.5.2.1 Large Sets of Drawings

When a set of shop drawings and/or installation drawings contains more than 20 sheets, the Concrete Engineering Unit will make every effort to limit the total examination time to 40 working days.

2.5.2.2 Design Calculations

When a shop drawing and/or installation drawing submittal includes calculations meeting the requirements of Section **9 CONTRACTOR'S DESIGN CALCULATIONS**, the examination time for the shop drawings will begin on the date of acceptance of the submitted design calculations.

2.5.2.3 Contract Changes

If shop drawings and/or installation drawings are submitted while the Department is considering changes to the contract, evaluating value engineering proposals, etc., the Concrete Engineering Unit will not start the examination of the drawings until a final resolution has been reached and all necessary field revision drawings and specifications have been approved.

2.5.2.4 Contract Award

If shop drawings and/or installation drawings are submitted prior to the award of the contract, the Concrete Engineering Unit will not start the examination of the drawings until the contract has been awarded.

2.5.3 Concrete Mix Designs

Approval of the shop drawings alone does not constitute approval of the concrete produced using the mix design shown on the shop drawings. The Fabricator is responsible for the quality of the concrete produced.

2.5.4 Approved as Noted

The Concrete Engineering Unit will review the drawings and indicate thereon such changes as may be necessary to fulfill the needs of the State. If, in the opinion of the Concrete Engineering Unit, the revisions are minor, the drawings with the required changes indicated will be stamped "Approved as Noted" and returned to the Contractor. The Contractor may then use the drawings to begin fabrication of the units. The Contractor shall then submit revised drawings for final approval as soon as possible. When the DCES is satisfied that the drawings are acceptable, the drawings will be approved. No approval for shipment and/or payment will be made until the final approval of the drawings.

2.5.5 Returned with Comments

If the Concrete Engineering Unit determines that the noted required changes are significant enough to require resubmission, they will be returned with comments by the

Concrete Engineering Unit. The drawings will be uploaded to the Department's designated electronic file management system and the Concrete Engineering Unit will notify the Contractor, the Fabricator, and the Engineer-In-Charge. When the revisions have been completed, the drawings shall be resubmitted to the Concrete Engineering Unit for approval by the DCES. When the DCES is satisfied that the drawings are acceptable, they will be approved.

2.5.6 Final Approval

Final approval of the shop drawings and/or installation drawings by the DCES does not relieve the Contractor of responsibility if any of the shop or installation drawings and/or any required calculations are subsequently found to contain errors or not to be in conformance with the contract documents.

2.5.7 Distribution of Approved Shop Drawings and Installation Drawings

Once the shop drawings and/or installation drawings have been approved by the DCES, the Concrete Engineering Unit will upload the approved drawings to the Department's designated electronic file management system and notify the Contractor, the Fabricator, and the Engineer-In-Charge. If the contract involves a railroad, another state agency (Thruway Authority, Bridge Authority, etc.), or a local authority, the Concrete Engineering Unit will send them copies of the approved drawings.

2.6 ERECTION DRAWINGS

2.6.1 General

The Contractor shall submit erection drawings, with each drawing stamped and signed by a Professional Engineer licensed to practice in New York State, to the Regional Director for each structure in the contract. One copy shall be submitted to the Concrete Engineering Unit for informational purposes. The number of sets of drawings required will be determined by each Regional Director. These drawings shall meet all the requirements of Section **2.2.2 Drawing Size and Type**. Copies shall also be sent for comments to any Railroad Company or other Agency affected by the proposed erection

procedure. These drawings shall be submitted at least 30 calendar days prior to the proposed beginning of erection. The Regional Director will review and either approve or reject the erection procedure based upon its structural adequacy and the requirements given in Section **2.6.2 - Required Information**. This review will consider, but not be limited to, stability of units during erection, effects on the maintenance of traffic, modifications to existing pavement, the flow of water, etc. The Regional Director's Office will forward all of the comments to the Contractor for incorporation into the erection procedure.

2.6.2 Required Information

The following minimum information shall be placed on the erection drawings for each structure. Erection procedures for similar structures or twin bridges may be shown on the same sheet:

- Plan of the work area showing support structures, roads, railroad tracks, canals or streams, utilities including any high voltage power lines, or any other information pertinent to erection.
- Erection details for all units, showing how the units will be lifted at the job site. This includes unloading units from trucks, lifting units to and from storage locations, and erecting units onto permanent or temporary supports.
- Erection sequence for all units, noting use of holding cranes or temporary supports, false work and bents.
- Delivery location of each unit and storage location, if applicable.
- Location and range for each pick.
- A capacity chart for each crane and boom length used in the work. Cranes lifting over active railroad facilities shall have a minimum lifting capacity of 150 percent of the lift weight.
- Pick point location(s) on each member.
- Lifting weight of each member, including clamps, spreader beams, etc.
- Lift and setting radius for each pick (or maximum lift radius).
- Description of lifting devices or other connecting equipment, including capacity.

- Beam tie down details or other method of stabilizing erected beam units, if required.
- Blocking details, if required, for stabilizing members supported on expansion bearings and on bearings that do not limit movement in the transverse direction.
- Crane outriggers or their bearing mats, if used, shall be located no closer to the back of the substructure than a distance defined by a line projected upward from the top of the footing at a one (vertical) to one (horizontal) slope. For crane positions located inside this line, the Contractor shall submit calculations stamped and signed by a Professional Engineer licensed to practice in New York State showing that the crane location will not cause harm to the substructure. The calculations shall be submitted to the Regional Director for review and approval or rejection.

SECTION 3

INSPECTION

3.1 QUALITY

Quality Control fabrication inspection and testing and Quality Assurance verification inspection are separate functions. For the purposes of this manual, the terms Quality Control (QC) and Quality Assurance (QA) shall be used.

3.1.1 Quality Control

Quality control is the responsibility of the Contractor. Quality control (QC) shall be performed by the Contractor to insure that materials and workmanship meet the requirements of the contract documents. The Contractor's Quality Control Inspector is the duly designated person who acts for and on behalf of the Contractor on all inspection and quality matters within the scope of the contract documents.

3.1.2 Quality Assurance

Quality assurance (QA) is the responsibility of New York State. Quality assurance is performed by the State to verify the Fabricator's performance in fabricating a quality product according to the contract documents. The Quality assurance inspector is the duly designated person who acts for and on behalf of the State on all inspection and quality matters within the scope of the contract documents. When the word *inspector(s)* is used without further clarification, it applies to QA within the limits of responsibility designated in this manual.

Quality assurance inspectors are assigned by the DCES (Concrete Engineering Unit). The assignment of quality assurance inspectors will be based on the schedule of production as shown in the production notes in the approved shop drawings. If the Fabricator needs to change the schedule shown in the approved shop drawings, a request shall be sent to the DCES (Concrete Engineering Unit) a minimum of three working days prior the beginning date of the scheduled change.

3.2 QUALIFICATIONS OF INSPECTORS

3.2.1 Qualifications of QC and QA Inspectors

QC and QA Inspectors shall possess a current ACI (American Concrete Institute) Certification for Concrete Field Testing Technician - Grade I, or approved equal, as determined by the DCES. In addition, QC and QA Inspectors involved in the inspection of prestressed concrete units shall possess a current PCI (Precast/Prestressed Concrete Institute) certification, Level I or II, or approved equal, as determined by the DCES.

3.2.2 QC Tests

QC Tests required by the contract and shown on the shop drawings shall be performed by the QC Inspector in the presence of the QA Inspector.

3.3 RESPONSIBILITIES OF INSPECTORS

3.3.1 Quality Control Inspector

The Contractor shall furnish the QC Inspectors with a complete set(s) of approved shop drawings and those portions of the contract documents that describe material and quality requirements for the products to be fabricated.

The QC Inspector shall make certain that all fabrication, handling, storage, and transportation are performed in accordance with the provisions of the contract documents and the approved shop drawings. The QC Inspector shall make certain that only materials conforming to the requirements of the contract documents and the approved shop drawings are used. All materials used shall be approved by the NYSDOT Materials Bureau in accordance with their procedures and directives.

3.3.2 Quality Assurance Inspector

The QA Inspector shall witness that the fabrication of each unit meets the requirements of the contract documents and the approved shop drawings. All fabrication-related activity shall only be performed in the presence of the QA Inspector. Any request to

perform any fabrication-related activities without the QA Inspector present shall be preapproved by the DCES prior to performing such activities. The QA Inspector shall have the authority to inspect all materials and fabrication procedures to determine whether they conform to the contract documents and the approved shop drawings. Copies of all certifications shall be given to the QA Inspector.

Inspection by the QA Inspector is not a substitute for Quality Control by the Contractor.

3.4 INSPECTOR'S MARK OF ACCEPTANCE FOR SHIPMENT

When the QA Inspector agrees that a precast concrete unit has been fabricated in accordance with NYSDOT specifications and is ready for shipment from the plant, the QA Inspector shall affix the acceptance stamp to the precast unit and shall complete and sign Part A of the "Report of Acceptance/Shipping of Structural Concrete," as indicated in Section **3.5. REPORT OF ACCEPTANCE OF STRUCTURAL CONCRETE**. This acceptance mark shall be made by paint or indelible ink stamp and shall be placed near the erection mark on the precast unit. The precast unit may then be shipped to the job site or may be stored prior to shipping.

The QA Inspector's acceptance stamp indicates that, at the time of acceptance, it was the opinion of the inspector that the precast unit was fabricated from accepted materials, in accordance with the contract documents and the approved shop drawings, and that it met the criteria in Section **6.3 ACCEPTANCE OF UNITS**. However, the inspector's acceptance stamp does not imply that the precast unit will not be subject to rejection by the State after it has been shipped from the plant, or relieve the Contractor of responsibility if the precast concrete unit is subsequently found to be defective or not to be in conformance with the contract documents.

3.5 REPORT OF ACCEPTANCE OF STRUCTURAL CONCRETE

The acceptance document for all structural concrete products subject to plant inspection is titled "Report of Acceptance/Shipping of Structural Concrete" (See Section **6.6 SHIPPING OF UNITS** and **Appendix C REPORT OF ACCEPTANCE /SHIPPING OF**

STRUCTURAL CONCRETE). Prior to product shipment from the plant, the QA Inspector shall complete and sign Part A of the "Report of Acceptance/Shipping of Structural Concrete". The QC Inspector or other authorized agent of the Contractor shall sign Part B of the "Report of Acceptance/Shipping of Structural Concrete" at the time of shipping. The completion of Part A of this document shall indicate to the Engineer that the structural precast product may be paid for under the payment rules established by the Department.

3.6 FACILITIES FOR INSPECTION

The Contractor shall provide all facilities for inspection of material and workmanship at the fabrication site. Each QA Inspector shall have sole access to a safe, secure, and private work station which includes the following minimum requirements:

- Desk with a chair.
- File cabinet with lock.
- Telephone with answering machine or voice mail.
- Secure fax machine.
- A dedicated computer with an operating system that is compatible with the operating system currently used by NYSDOT, with high-speed internet service. The system shall also include a secure printer and a secure scanner of acceptable quality, as determined by the DCES.

3.7 OBLIGATIONS OF THE CONTRACTOR

The Contractor shall be responsible for the acceptability of the fabricated units. The QC Inspector shall take all necessary steps to assure that all materials, fabrication procedures and the final product meet all the requirements of the contract documents and the approved shop drawings.

The Fabricator shall give the QA Inspector free access throughout the fabrication site to verify that the work being done is in conformance with the contract documents and the approved shop drawings. If the QA Inspector is not present to witness the work, the Fabricator shall stop the work and immediately notify the Concrete Engineering Unit.

Work done while the QA Inspector has been refused access shall be automatically rejected.

3.7.1 Informing the DCES of Work Schedule

The Contractor shall notify the Concrete Engineering Unit a minimum of three work days prior to:

- Commencement of fabrication.*
- Commencement of fabrication after a work suspension of two work days or more.
- Unit shipping.

* If someone other than the Concrete Engineering Unit is responsible for shop drawing review and approval, the Contractor shall notify the Concrete Engineering Unit a minimum of ten work days prior to commencement of fabrication.

3.7.2 Informing the QA Inspector of Work Schedule

The Fabricator or Contractor shall keep the QA Inspector informed of the day-to-day scheduling of operations.

SECTION 4

MATERIAL REQUIREMENTS

4.1 CONCRETE

4.1.1 Materials for Concrete

Concrete shall meet the requirement of §501-2 Portland Cement Concrete, Materials, of the NYSDOT Standard Specifications, Construction and Materials, with the following modifications:

- §501-2.01 Composition of Mixtures - shall not apply.
- Type I, II, or I/II cements conforming to §701-01 Portland Cement shall be used. Blended cements meeting the requirements of §701-03 may only be used with the written approval by the DCES.
- Coarse aggregate gradation shall be New York No. 1 Size or ASTM D448, No. 67 or No. 7.

REQUIRED COARSE AGGREGATE GRADATIONS							
SIZE DESIGNATION	% PASSING---SIEVE SIZE---SQUARE OPENINGS						
	1 in.	3/4 in.	1/2 in.	3/8 in.	1/4 in.	No. 4	No. 8
NYSDOT #1	100	----	90-100	----	0-15	----	----
ASTM D448 #67	100	90-100	----	20-55	----	0-10	0-5
ASTM D448 #7	---	100	90-100	40-70	---	0-15	0-5

- Precast concrete units that incorporate the final riding surface shall meet the requirements of §501-2.02 B2.
- A corrosion Inhibitor is required in all concrete mixes, unless approved by the DCES, and shall consist of a calcium nitrite solution containing 30 ±2%

calcium nitrite solids by weight with a specific gravity (S.G.) of 1.27 ± 0.02 . A representative quart sample, from each delivery of corrosion inhibitor intended for Department use, shall be taken at the precast plant for acceptance testing. Samples shall be taken as directed by the QA Inspector.

The corrosion inhibitor must be added to the mix immediately after air entraining and retarding admixtures have been introduced into the batch. The corrosion inhibitor shall be added to the concrete as an aqueous solution at a dosage rate of 5.0 gallons per cubic yard unless otherwise approved by the DCES. An automatic corrosion inhibitor dispensing system shall be required. The dispensing system shall meet the following requirements:

Delivery accuracy of $\pm 3\%$ (by weight or volume).

Program quantity (gallons, nearest tenth).

System interlocks.

Print requirements:

- o Project number and/or batch number.
- o Date and time.
- o Delivered quantity (gallons, nearest tenth).

Calibration of the dispensing system shall be in accordance with procedures approved by the NYSDOT Materials Bureau.

- Air content shall be $7\% \pm 2\%$. A minimum air content of 3% will be accepted, provided that the Fabricator has previously demonstrated that concrete from an identical mix, at the lower air content, meets the requirements of AASHTO T161 ($80\% \leq x$, where x = the relative dynamic modulus of elasticity after 300 cycles).

- The use of calcium chloride, or an admixture containing calcium chloride will not be permitted.
- The water/cementitious material ratio shall not exceed 0.40, as measured by AASHTO T318. The AASHTO T318 test measures the free water available for hydration of the cement plus the bound water in the saturated aggregate. The bound water may amount to 1-2% of the mass of the aggregate.

4.1.2 Materials for Lightweight Concrete

If lightweight concrete is required in accordance with the contract documents, the concrete shall meet the requirements of Section 4.1.1, Materials for Concrete, with the following modifications:

- Type I, II, or I/II cements conforming to §701-01 Portland Cement shall be used. Type IT or SF blended cements conforming to §701-03 Blended Portland Cement may only be used with the written approval of the DCES.
- The minimum cementitious content of lightweight concrete shall be 675 lb./cy.
- 15% to 20% pozzolan conforming to §711-10 Fly Ash or §711-12 GGBFS shall be used. 6% to 10% microsilica conforming to §711-11 microsilica shall be used. When a blended cement is used, the addition of microsilica is not required.
- Use lightweight aggregate meeting the requirements of §703-10 Lightweight Aggregates of the Standard Specifications.
- Lightweight coarse aggregate gradation shall be one of the following, unless approved by the DCES:

REQUIRED LIGHTWEIGHT COARSE AGGREGATE GRADATIONS								
SIZE DESIGNATION	% PASSING---SIEVE SIZE---SQUARE OPENINGS							
	1 in.	3/4 in.	1/2 in.	3/8 in.	No. 4	No. 8	No. 16	No. 200
3/4" to 3/16"	100	90-100	---	10-50	0-15	---	----	0-10
1/2" to 3/16"	---	100	90-100	40-80	0-20	0-10	---	0-10
3/8" to 3/32"	---	---	100	80-100	5-40	0-20	0-10	0-10

- Lightweight coarse aggregate stockpiles shall be continuously and uniformly sprinkled with clean, potable water meeting the requirements of §712-01. Only sprinkler systems approved by the DCES shall be used. The stockpile shall be periodically agitated so as to maintain uniform moisture throughout the pile. Water shall be applied for a minimum of 48 hours, or until the stockpile has achieved a minimum internal moisture content of 15% by weight. At the end of the wetting period, stockpiles shall be allowed to drain for 12 hours immediately prior to use, unless otherwise directed by the DCES.
- Produce concrete with an average dry unit weight ranging from 110 to 115 lb./ft³ when tested in accordance with ASTM C567.
- The QA Inspector shall take a 1-quart microsilica sample in accordance to Materials Method 9.1 prior to each day's placement for testing by the Department.
- A trial batch is required when lightweight concrete is used. The Contractor shall produce a trial batch using the proposed lightweight concrete mix for the approval of the DCES. At least 10 working days prior to concrete placement, the Contractor shall provide the DCES with the lightweight concrete mix design used for the trial batch along with the following information:

- o The cement content as determined by a yield test in accordance with ASTM C138.
- o The fine and coarse aggregate (saturated surface dry condition) content in lb./cy.
- o The cementitious material content in lb./cy.
- o The water content in lb./cy.
- o The unit weight of the freshly mixed concrete in accordance with ASTM C138.
- o The dry unit weight in accordance with ASTM C567.
- o 28-day compressive strength in accordance with ASTM C39.
- o Batch weights.

Once the DCES has approved the trial batch, production may begin. During production, the Fabricator shall periodically correct batch weights to account for changes in the fine aggregate, fineness modulus and aggregate moisture content in accordance with Materials Method 9.1.

4.1.3 Materials for High Performance Concrete

If high performance concrete is required in accordance with the contract documents, the concrete shall meet the requirement of §718-06 HIGH PERFORMANCE CONCRETE FOR PRECAST AND PRESTRESSED BRIDGE BEAMS. A corrosion inhibitor, in accordance with Section **4.1 CONCRETE**, is required in all high performance concrete mixes.

4.2 REINFORCEMENT AND PRESTRESSING STEEL

- Reinforcement shall meet the requirements of §556-02.
- Prestressing steel shall meet the requirements of §709-06.
- Prestressing bars shall meet the requirements of ASTM A722, Type II. Unless otherwise noted on the plans, prestressing bars shall have a minimum ultimate tensile strength of 150 ksi.

- Where debonding of prestressing steel is required, plastic sheathing (or spilt sheathing) shall be used.
- Chairs or other devices necessary to ensure the proper placement of steel items shall meet the requirements of §556-2.01.
- Chairs and other metal devices, shall be equipped with snug fitting, high density polyethylene tips which provide 1/4 in. minimum clearance between the metal of the chair and any exposed surface. Chairs may be made of a dielectric material or stainless steel without polyethylene tips and shall meet the requirements of ASTM A493, and AISI Type 430.
- Bearing Plates (if required) shall meet the requirements of §715-01.

4.3 MATERIALS FOR CURING

- Quilted Covers (for curing) shall meet the requirements of §711-02.
- Plastic Coated Fiber Blankets (for curing) shall meet the requirements of §711-03.
- Other materials may be used only with the written approval of the DCES.

4.4 MATERIALS FOR FINISHING

4.4.1 Concrete Finishing Materials

These materials shall meet the requirements of §701-04, §701-06, §701-08 or §701-09, except the water demand shall be as the manufacturer suggests for the needed application. Fine aggregate shall meet the requirements of §703-03, Mortar Sand; or §703-04, Grout Sand. Fine aggregate shall be absolutely dry. Concrete finishing material used shall meet the performance criteria of the concrete used in the unit.

4.4.2 Penetrating Sealers

The protective sealer used on concrete surfaces shall appear on the Department's Approved List, except that water-based products shall not be used. Sealers shall meet

the requirements of Section §717-03 Penetrating Type Protective Sealers. Penetrating sealers shall be applied prior to the application of concrete finishing materials.

4.5 MATERIALS FOR INSTALLATION

4.5.1 Transverse Post-Tensioning Steel

Prestressing steel used for the transverse post-tensioning of adjacent box beams or slab units shall be a low-relaxation Grade 270 strand meeting the requirements of §709-06. The strand shall be encased in corrosion inhibitor and a seamless, inert polymer sheath shall be extruded directly onto the strand.

4.5.2 Shear Key and Field Cast Joint Material

4.5.2.1 Adjacent Box Beams Units, Hollow Slab Units and Solid Slab Units

Shear key material for adjacent box beam units, hollow slab units and solid slab units shall be a grout meeting the requirements of §701-06, Cement Based Grout Materials for Shear Keys. Rapid Hardening Concrete Repair Material meeting the requirements of §701-09 shall not be used without the approval of the DCES. Field cast joint material, if required on the plans, shall be Ultra High Performance Concrete (UHPC).

4.5.2.2 Deck Bulb Tee Beams, NEXT Type “D” Beams, Precast Concrete Deck Panels, and Precast Concrete Approach Slabs

Field cast joint material for deck bulb tee beams, NEXT beams, precast concrete deck panels, or precast concrete approach slabs shall be a grout meeting the requirements of §701-06, Cement Based Grout Materials for Shear Keys, Ultra High Performance Concrete (UHPC) or a concrete mix approved by the DCES. Rapid Hardening Concrete Repair Material meeting the requirements of §701-09 shall not be used without the approval of the DCES.

4.5.3 Anchorage Block-Out Grout for Transverse Post-Tensioning

The mortar shall consist of one of the following materials:

- §701-05, Concrete Grouting Material.
- §701-06, Cement Based Grout Material for Shear Keys.
- §701-08, Vertical and Overhead Patching Material.
- A two-component epoxy system and a completely dry fine aggregate, using a combination of one epoxy and one fine aggregate chosen from the list below:
 - o §721-01, Epoxy Resin System.
 - o §721-03, Epoxy Polysulfide Grout.
 - o §721-05, Epoxy Repair Paste.
 - o §703-03, Mortar Sand.
 - o §703-04, Grout Sand.
 - o §703-07, Concrete Sand.

4.5.4 Anchor Dowel Fill Material

4.5.4.1 Expansion End Material Option

- NYS Mat. Spec. §702-0700 - Asphalt Filler.

4.5.4.2 Fixed End Material Option

- NYS Mat. Spec. §721-01 - Epoxy Resin System with Sand. Bone-dry, sandblast sand shall be added in the ratio of (1) part epoxy to (2) parts sand by volume.
- NYS Mat. Spec. §721-03 - Epoxy Polysulfide Grout with Sand. Bone-dry, sandblast sand shall be added in the ratio of (1) part epoxy to (2) parts sand by volume.
- NYS Mat. Spec. §701-05 - Concrete Grouting Material.
- NYS Mat. Spec. §701-06 - Cement Based Grout Materials for Shear Keys.

4.5.5 Grouted Splice Sleeve Couplers

Grouted Splice Sleeves shall meet the requirements of §709-15 Grouted Reinforcing Bar Splice Sleeves, of the NYSDOT Standard Specifications.

4.5.6 Epoxy Bonding Agent for Match-Cast Precast Segments

The epoxy bonding agent shall meet the requirements of ASTM C881, Type VI or VII. Finished color shall match that of the finished concrete of segmental units.

The manufacturer shall supply the Department with results from an independent AASHTO accredited testing laboratory, certifying that the material satisfies ASTM C881. Testing shall be done by lot. Certification is required for all temperature range formulations anticipated by the Contractor.

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 the precast concrete segments. Epoxy bonding agents shall be thermosetting 100% solid compositions that do not contain solvent or any non-reactive organic ingredient except for pigments required for coloring. Epoxy bonding agents shall be insensitive to damp conditions during application and after curing shall exhibit high bonding strength to cured concrete, good water resistivity, low creep characteristics and tensile strength greater than the concrete.

In addition to the packaging requirements in ASTM C881, the components' labels shall include the range of substrate (surface of concrete) temperature over which the application is suitable, the date of formulation, the shelf life and manufacturer's lot number.

Instructions shall be furnished by the manufacturer for the storage, handling, mixing and

application of the material. The Contractor shall allow sufficient lead time to review test data and verify manufacturer's material through random sampling by Department personnel. The Contractor shall include the anticipated formula and material submission dates in all schedules required in accordance with the Contract Documents.

4.6 MATERIALS FOR POST-TENSIONING

4.6.1 Post-Tensioning Anchorages

The body of the anchorage shall be galvanized, meeting the requirements of ASTM A123. Other components of the anchorage including wedges, wedge plate and local zone reinforcement are not required to be galvanized. The bearing surface and wedge plate shall be constructed of ferrous metal. Anchorages shall be equipped with a permanent fiber reinforced plastic grout cap that is vented and bolted to the anchorage. Permanent grout caps shall be made from a fiber reinforced plastic containing an anti-oxidant additive to ensure an enduring, maintenance-free, life of 75 years with an environmental stress cracking endurance of 192 hours per ASTM D 1693. Caps shall be secured to the anchor plate and be rated for a minimum pressure of 150 psi.

Anchorages shall be fabricated with grout outlets suitable for inspection from either the top or front of the anchorage. The grout outlet will serve the dual function of grout outlet and post-grouting inspection access (endoscope inspection). The grout outlet must be drillable from either direction using a straight bit to facilitate endoscope inspection directly behind the anchor plate. 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.

Trumpets associated with anchorages shall be made of either ferrous metal or plastic conforming to ASTM D3350 with a minimum cell classification of 344464C.

Anchorage systems shall conform to the requirements of Section 10.3.2 of the AASHTO

LRFD Bridge Construction Specifications. Certified test reports covering tests performed on prestress anchorage devices, as required by Section 10.3.2 of the AASHTO LRFD Bridge Construction Specifications shall be included in the shop drawing submittal as a part of the supporting documents.

4.6.2 Post-Tensioning Couplers

Couplers for prestressing strand shall develop at least 96% of the actual ultimate strength of the prestressing steel, when tested in an unbonded state, without exceeding anticipated set.

Couplers for prestressing bars shall be capable of developing at least 125% of the ultimate strength of the bar with a minimum elongation of 2% when tested in the unbonded condition, measured over a 10-foot gage length without failure of either the coupler or the bar.

The coupling of tendons shall not reduce the elongation at rupture below the requirements of the tendon itself. Couplers and/or coupler components shall be enclosed in housings long enough to permit the necessary movements. Couplers for tendons shall be used only at locations specifically indicated and/or approved by the Engineer. Couplers shall not be used at points of sharp tendon curvature.

Couplers shall conform to the requirements of Section 10.3.2 of the AASHTO LRFD Bridge Construction Specifications. Certified test reports covering tests performed on couplers, as required by Section 10.3.2 of the AASHTO LRFD Bridge Construction Specifications shall be included in the shop drawing submittal as a part of the supporting documents.

4.6.3 Ducts

For external post-tensioning systems, smooth plastic duct or steel pipe shall be used.

For internal post-tensioning systems, corrugated plastic duct shall be used. Corrugated steel duct can only be used for internal post-tensioning systems with the approval of the DCES.

Duct material shall be sufficiently rigid to withstand loads imposed during the placing of concrete as well as internal pressure during grouting operations, while maintaining its shape, remaining in proper alignment, and remaining watertight.

Duct systems, including all connectors, connections and components of post-tensioning systems, shall be air and watertight to effectively prevent the entrance of cement paste or water into the system and shall effectively contain pressurized grout during the grouting of tendons. Duct systems shall be capable of withstanding water pressure during the flushing of a duct in the event the grouting operation is aborted.

Duct systems for bonded tendons shall be capable of transmitting design forces from the grout to the surrounding concrete.

For ducts containing prestressing strands, the nominal internal cross sectional area of circular duct shall be at least 2.25 times the net area of the strands; or 2.50 times for strands installed by the pull-through method. In case of space limitations, the minimum duct area may be only 2.00 times the strand area for relatively short tendons up to approximately 100-feet long.

For ducts containing a single bar, the internal duct diameter shall be at least $\frac{1}{2}$ in. greater than the maximum outside dimension of the bar. For bars with couplers, the

internal duct diameter shall be at least $\frac{1}{2}$ in. greater than the maximum outside dimension of the bar or coupler, whichever is greater.

4.6.3.1 Metal Ducts

Smooth steel pipes shall be galvanized and shall conform to ASTM A53, Type E, Grade B, Schedule 40. Pipes shall have smooth inner walls. When required for curved tendon alignments, the pipe shall be pre-fabricated to the required radius.

Corrugated steel ducts, when approved for use by the DCES, shall be spirally wound to the necessary diameter from strip steel with a minimum wall thickness of 26 gage for ducts less than or equal to 2-5/8 in. diameter and 24 gage for ducts greater than 2-5/8 in. diameter. The strip steel shall be galvanized to ASTM A653 with a coating weight of G90. Ducts shall be manufactured with welded or interlocking seams with sufficient rigidity to maintain the correct profile between supports during concrete placement. Ducts shall also be able to flex without crimping or flattening. Joints between sections of duct and between ducts and anchor components shall be made with positive, metallic connections that provide a smooth interior alignment with no lips or abrupt angle changes.

4.6.3.2 Plastic Ducts

Smooth plastic duct shall be manufactured from polyethylene resin meeting the requirements of ASTM D3350 with a minimum cell class of 344464C and shall be resistant to degradation from ultraviolet light in accordance with ASTM D1248. Smooth plastic ducts shall have a standard dimension ratio of 17.0 or less. Smooth plastic ducts shall have a minimum pressure rating of 100 psi and be manufactured in accordance with ASTM D3035 or ASTM F715. An Oxidative Induction Time (OIT) test shall be performed on the material in accordance with ASTM D3895. Certifications and test results shall be included in the shop drawing submittal as a part of the supporting documents.

Corrugated plastic ducts shall be manufactured from polyethylene resin meeting the requirements of ASTM D3350 with a minimum cell class of 344464C. Corrugated plastic ducts shall have a minimum material thickness of 0.079 in. ± 0.010 in. Corrugated plastic duct shall be designed so that a force equal to 40% of the ultimate tensile strength of the tendon will be transferred through the duct into the surrounding concrete in a length of 2-½ feet. Twelve (12) static pull out tests shall be conducted to determine compliance with this requirement. If ten (10) of these tests exceed the specified force transfer before failure, the duct will be deemed acceptable.

Components of the corrugated plastic ducts system shall be tested to assure compliance with the requirements of Chapter 6 of FIB Technical Report; Bulletin 75 entitled "Polymer Duct Systems for Internal Bonded Post-Tensioning." In addition, the manufacturer shall establish, through testing, the minimum bending radius for the duct. The required test shall be a modified duct wear test as described in of Chapter 6, Article 6.8 of FIB Technical Report; Bulletin 75 entitled "Polymer Duct Systems for Internal Bonded Post-Tensioning."

Certifications and test results shall be included in the shop drawing submittal as a part of the supporting documents.

4.6.3.3 Duct Connections, Fittings and Grout Vent Pipes

All duct splices, joints and connections to anchorages shall be made with couplings and connectors that produce a smooth interior duct alignment with no lips or kinks. Special duct connectors may be used in match-cast joints between precast segments and similar situations if necessary to create a continuous, air and watertight seal. All fittings and connections between lengths of plastic duct and between ducts and steel components (e.g., anchors or steel pipe) shall be made of materials compatible with corrugated plastic ducts. Plastic materials shall contain antioxidant stabilizers and have an environmental stress cracking of not less than 192 hours as determined by ASTM D 1693 "Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics",

Condition C.

Connections between sections of smooth plastic pipe shall be made using heat welding techniques or with mechanical couplers per the manufacturer's recommendations or as approved by the Engineer. Connections shall have a minimum pressure rating of 150 psi and produce a smooth interior alignment with no lips or kinks.

Connections between external smooth plastic duct and steel pipe embedded in the concrete shall be made using circular sleeve (boot) made of Ethylene Propylene Diene Monomer (EPDM) having a minimum (working) pressure rating of 150 psi. EPDM shall have 100% quality retention as defined by ASTM D1171 "Standard Test Method for Rubber Deterioration - Surface Ozone Cracking Outdoors (Triangular Specimens) Method B". The minimum wall thickness shall be 3/8-in. reinforced with a minimum of four-ply polyester reinforcement. Sleeves shall be secured with 3/8-in. wide power seated, 316 stainless steel band clamps, using one on each end of the sleeve (boot) to seal against leaking grout. The power seating force shall be between 80 and 120 lbf. Alternatively, connections may be made using mechanical couplers with plastic components made of approved plastic resins meeting the same requirements as for external plastic pipes and metal components of grade 316 stainless-steel. Mechanical connections shall meet the same pressure rating requirements (above) and have seals to prevent grout leaks.

Steel and plastic pipe may be connected directly when the outside diameters do not vary by more than ± 0.08 in. A reducer or spacer shall be used when outside this tolerance. When installed correctly, a single band clamp around each end of the sleeve shall be sufficient. Double banding may be necessary to fix an apparent leak of air, water or grout.

Grout vent pipes, valves and plugs shall be made of polyethylene meeting the requirements for plastic, corrugated ducts. Permanent threaded plugs shall be made of stainless steel or any non-metallic material containing antioxidant stabilizers and having

an environmental stress cracking of 192 hours as determined by ASTM D 1693, Condition C. Temporary items not included in the permanent features of the finished structure may be of any other suitable material.

Attachments for grout vents (inlets and outlets), including seals between grout caps and anchors, shall be capable of withstanding at least 150 psi internal pressure. Tubes for grout vents for strand tendons shall have a minimum inside diameter of $\frac{3}{4}$ -in. For bar tendons and for tendons comprising up to four strands, tubes shall be at least $\frac{3}{8}$ -in. internal diameter. Grout vents shall be closed with suitable valves or plugs. For grouting of long vertical tendons, dual mechanical shut-off valves are usually necessary to facilitate intermediate stages of grouting and venting.

Grout vents shall be arranged and attached to ducts, anchorages and grout caps in a manner that allows all air and water to escape in order to ensure that the system is completely filled with grout.

4.6.4 Grout for Post-Tensioning Ducts

Grout for Post-Tension Ducts shall meet the requirements of §701-10 Duct Grouting Materials, of the NYSDOT Standard Specifications.

SECTION 5

FABRICATION REQUIREMENTS

5.1 PLANT FACILITY

Precast plants fabricating structural precast and/or prestressed concrete units covered by this manual shall meet the following minimum requirements, as determined by the DCES:

- Have well trained and knowledgeable personnel, experienced in the fabrication of structural precast and/or prestressed concrete units.
- Have a business office including a computer system with internet access, telephone facilities with an answering machine or voice mail, and a fax machine.
- Have inspector facilities as required by Section **3.6 FACILITIES FOR INSPECTION**.
- Have sufficient area for concrete batch plant and raw material storage if the plant produces concrete.
- Have sufficient area for storage of precast and/or prestressed concrete units.
- Have prestressing equipment and beds, if necessary.
- Have all necessary concrete forms.
- Have a Quality Control Manual and an implemented Quality Control Plan.
- Have all required quality control equipment.
- Have all required equipment for proper curing of concrete units.

In addition, precast plants shall meet one of the following requirements:

- Is currently PCI certified for the appropriate type of work as defined by PCI.
- Has performed similar satisfactory work for NYSDOT within the last five years, as determined by the DCES.
- Has been approved for structural precast and/or prestressed concrete fabrication by the DCES.

5.2 ORDERING OF MATERIALS

The Contractor shall bear all costs for damages and unacceptable material which may result from the ordering of materials prior to the approval of the shop drawings.

5.3 DATA FOR QA INSPECTORS

- Certificates of acceptance for all materials shall be provided to the QA Inspector.
- A calibration certificate attesting to the fact that the concrete cylinder testing machine to be used has been calibrated within the last 12 months.
- A calibration certificate indicating the load calibration of each gauge and hydraulic jack combination used for tensioning. The gauge shall be calibrated from zero, throughout its entire load range. The gauge shall have clearly marked divisions that are easily readable at the initial and final tensioning force. The calibration date of each combination of a gauge and hydraulic jack shall be within the 12-month period immediately prior to use. More than one gauge can be calibrated for one jacking system.

5.4 CONCRETE FORMS

5.4.1 General

Forms shall be well constructed, carefully aligned, clean, substantial and firm, securely braced and fastened together and sufficiently tight to prevent leakage of concrete. They shall be strong enough to withstand the action of mechanical vibrators. All forms for each unit shall be approved by the Inspector prior to placing concrete.

All form surfaces that come in contact with the concrete shall be thoroughly treated with an approved form coating in the manner and at the rate specified by the Manufacturer. Forms so treated shall be protected against damage and other contamination prior to placing the concrete. Any form coating material that sticks to or discolors concrete shall not be used.

5.4.2 Void Producing Forms

Void forms shall be waterproof or be coated with a waterproofing material on the outside and shall have a $\frac{3}{4}$ inch minimum drain placed at each end of each void. All voids shall be vented during curing unless waived by the DCES. The vents shall be plugged with approved material after curing.

5.5 EMBEDDED STEEL

5.5.1 Reinforcing and Prestressing Steel

Prior to installation in the units, reinforcing steel and prestressing steel shall be free of frost, dirt, oil, paint, mill scale, corrosion or any foreign material that may prevent a bond between the steel and the concrete. Some rust on steel is acceptable provided the rust is not loose and the steel is not pitted. Tack welding of design bar reinforcement shall not be permitted. Tack welding of redundant steel may be allowed to provide extra rigidity to the steel cage. Reinforcing steel shall be adequately secured by chairs or blocking to forms or by ties to tendons so it maintains its position during the casting of the concrete. Heat bending of prestressing steel is not allowed.

5.5.2 Welded Wire Fabric

Welded wire fabric, plain or deformed, may be substituted for the bar reinforcement provided that:

- The required cover is maintained.
- The design steel area of the fabric equals or exceeds that of the bar reinforcement.
- The wire fabric shall be of the same material as the specified bar reinforcement.
- Splices to the fabric are made in accordance with the requirements of Section 5.11.2.5 – Welded Wire Fabric, of the LRFD Bridge Design Specifications.
- The details shall be indicated on the shop drawings.

5.5.3 Inserts

All inserts shall be placed according to the plans and held firmly in position during the placing of the concrete. All inserts, including those that are for the convenience of the Contractor, shall be shown on the shop drawings for approval by the DCES. All steel inserts shall be stainless steel or shall be galvanized as per Section 719-01 (Type I or II) of the Standard Specifications. All inserts shall be recessed 1 inch unless otherwise shown on the drawings. The adequacy and location of the inserts is the responsibility of the Contractor.

5.6 STRESSING REQUIREMENTS FOR PRETENSIONING

5.6.1 General

Two stages shall be followed in tensioning all prestress strands:

- Initial Tension Force - Application of a force of 10% to 15% of the required jacking force to straighten the strand, eliminate slack and provide a reference point for measuring elongation.
- Final Tension Force - This is the total force required for each strand as shown on the plans. This force shall be measured by a properly calibrated gauge and verified by strand elongation, unless an alternate procedure is allowed by the DCES. For straight strands, the agreement between the two methods shall be 3% and for draped strands, 5%.

5.6.2 Tensioning of Tendons

In all methods of tensioning, the force induced in the tendons shall be measured by gauge. The exact initial tensioning force will be shown on the Production Note Sheet of the shop drawings.

After the initial force has been applied to the tendon, reference points for measuring elongation due to additional tensioning forces shall be established. Calculations for elongations shall include an allowance for friction, strand slippage and movement of the

abutments. The final tensioning force shall be measured by properly calibrated gauges and verified by measuring strand elongation.

5.6.3 Methods of Force Measurement

5.6.3.1 Initial Tensioning

Initial force shall be determined by one of the following:

- Pressure Gauges
- Dynamometers
- Load Cells

5.6.3.2 Final Tensioning

Tendon elongation shall be computed using the modulus of elasticity of the tendon shown on the stress-strain curves furnished by the manufacturer. The actual elongation shall agree with the computed elongation, with appropriate tolerance (see Section 7 **FABRICATION TOLERANCES**).

5.6.3.3 Gauging System

- Pressure gauges shall be used on loads which are not less than one fourth and not more than three fourths of the total graduated capacity.
- Gauges shall have indicating dials of at least 6-inch diameter.
- Gauges shall be mounted at or near working eye level and within 6 feet of the Operator and positioned so that readings can be obtained without parallax.
- Gauging systems shall have been calibrated within the last 12 months, by a registered Professional Engineer.
- Gauges for single strand jacks shall be calibrated by means of an approved and calibrated load cell.
- Gauges for large multiple strand jacks acting singularly or in multiple shall

be calibrated by proving rings or by load cells placed on either side of the movable end carriage.

- In multiple strand tensioning, use of a master gauge system to monitor accuracy of hydraulic gauges is acceptable.

5.6.4 Prestressing Strands

Prestressing strand shall meet the requirements of §709-06.

5.6.5 Control of Jacking Force

Manual or automatic pressure cutoff valves shall be used for stopping the jack at the required load. When manual cutoffs are used, the rate of loading shall be such that the jack can be stopped at the specified load of the strand. If automatic pressure cutoff valves are used, it shall be capable of adjustment to assure that the proper force is induced into the strand.

5.6.6 Wire Failure in Tendons

Failure of wires in pretensioned strand is allowed, providing the total area of wire failure is not more than 2% of the total area of tendons in any member. When a prestressing strand fails during tensioning, the gauge that is connected to the tensioning system shall be recalibrated before it is reused. The recalibration may be waived if the gauge is adequately protected by snubbers.

5.6.7 Time Allowed Between Tendon Tensioning and Concrete Placement

The maximum time allowed between the tensioning of the tendons and concrete placement shall be 72 hours.

5.6.8 Detensioning of Tendons

Prestressing strands can be cut using mechanical means (electric powered saw) or by flame cutting with a torch. In order to reduce the likelihood of the concrete cracking during detensioning of the strands, the following steps shall be taken:

- Prestressing strands shall be cut using a symmetrical cutting sequence. Unless otherwise approved by the DCES, strands shall be detensioned from the inner most stands to the outer strands.
- To avoid sudden transfer of the strand force to the member when cutting prestressing strands with an electric powered saw, strands shall be cut slowly to avoid cutting all of the wires in the strand at once.
- To avoid sudden transfer of the strand force to the member when flame cutting prestressing strands, strands shall be cut with a sweeping motion with a minimum sweep of 3 inches side to side (6 inches total) along the direction of the strand. No extra oxygen shall be applied to the cutting flame to speed up the process.

5.7 MATCH CAST SEGMENTS

Care shall be exercised in setting up forms for casting segments. All materials to be embedded in concrete shall be properly positioned and supported. Provisions for all projections, recesses, notches, openings, blockouts and other pertinent items shall be made in accordance with the plans. Extreme care shall be taken in positioning the match cast segment in relation to the segment to be cast. The match cast segment shall not be torsionally distorted (twisted).

The abutting surface of the bulkhead segment shall be covered with a thin film of bond breaker consisting of flax soap and talc, or other material approved by the DCES. The soap and talc mixture shall be appropriately five parts flax soap to one part talc. The mixture may be varied based on job experience and results. The acceptability of a material other than flax soap and talc shall be determined prior to use in casting of segments by demonstration on a specimen with a facial area of at least four (4) square feet.

Prior to each use, the interior surfaces of forms shall be cleaned of all dirt, mortar, and foreign material. Before placing reinforcing steel and other embedded items, forms shall

be thoroughly coated with an approved form oil or other equivalent coating that permits the ready release of the forms and that do not discolor the concrete.

5.8 CONCRETE MIX DESIGN AND PROPORTIONING

The Fabricator shall be responsible for designing a concrete mix to produce the strength and other requirements specified in the contract documents. If no strength is indicated, the required minimum compressive strength shall be 6500 psi. When water is added in stages, details regarding measuring of water and the mixing operation after such addition shall be clearly stated in the Production Notes.

The concrete mixing operation shall exactly follow the approved procedure on the Production Note Sheet. Equipment used for the mixing and/or transportation of an approved concrete mix shall be thoroughly cleaned prior to use to ensure that there will be no contamination from other concrete mixes. The QA Inspector shall be provided with all batch tickets.

5.9 PLACING CONCRETE

5.9.1 Preparation

No concrete shall be placed without the QA Inspector's approval. Compliance with the precasting tolerances listed under Section **7 FABRICATION TOLERANCES** of this manual is a prerequisite for approval by the QA Inspector.

5.9.2 Cold Weather

When the ambient temperature is below 45° F, the fabrication of the units shall be in accordance with the cold weather concreting procedures, as approved on the approved shop drawings.

5.9.3 Hot Weather

When the ambient temperature is above 90° F, the fabrication of the units shall be in

accordance with the hot weather concreting procedures, as approved on the approved shop drawings.

5.9.4 Mass Placement

When the dimensions of any unit meets the definition of “Mass Placement” as defined in the NYSDOT Bridge Manual, the Contractor shall submit a mass concrete placement procedure, curing procedure, and thermal control plan to the DCES for approval.

5.9.5 No Segregation

Suitable means shall be used for placing concrete without segregation. The concrete mixture shall not be dropped from a height greater than 12 inches above the top of the forms.

5.9.6 Placing

When the casting of a unit requires more than one concrete placement, concrete delivery shall be scheduled so that the preceding placement is still plastic when the new concrete is placed (to avoid cold joints). The maximum time between successive placements shall be 45 minutes.

Special care shall be taken to deposit the concrete in its final position in each part of the form. Vibrators shall be used only to consolidate the concrete after it has been properly placed. Vibrators shall not be used to distribute the concrete in forms.

5.9.7 Consolidation

The plastic concrete shall be consolidated in place by either external or internal vibration methods, or both, if necessary. The vibrators shall be of a type and design approved by the Inspector and the size of the vibrating head shall be governed by the spacing of the prestressing steel and reinforcement. When reinforcement is epoxy coated, vibrators shall be rubber tipped.

5.10 CONCRETE SURFACES

5.10.1 Surfaces

Surfaces of concrete shall be true and even, free from rough, open or honeycombed areas, and with no visible depressions or projections. Exposed surfaces shall be free of staining and shall have uniform color. The Fabricator shall produce well formed, matching units with an overall pleasing appearance, as determined by the DCES.

5.10.2 Top Surfaces

After all the concrete has been placed and thoroughly consolidated as required under Section **5.9.7 Consolidation**, the tops of units shall receive a finish as shown on the plans, unless otherwise directed by the QA Inspector.

5.10.3 Exposed Surfaces

All surfaces which will be exposed in their installed condition (as determined by the DCES) shall be finished using a procedure approved by the DCES.

5.10.4 Keyway Surfaces

Keyways for Deck Bulb Tee Beams, NEXT Type "D" Beams, Precast Concrete Deck Panels, and Precast Concrete Approach Slabs shall receive an exposed aggregate finish with a minimum amplitude of 1/8 inch.

5.11 CURING

5.11.1 General

The Contractor shall indicate on the shop drawings, for approval, the method of cure and a complete outline of the proposed curing procedure under each of the phases of the curing cycle. The Contractor may choose any one of the following acceptable curing methods. Acceptable methods are:

- Natural Cure
- Low Pressure Steam

For both curing methods, the external surface of the concrete shall be covered (saturated cover), as soon as the concrete has started setting and the concrete can be covered without marring the surface. The cover material shall be heavy, water saturated burlap, or other material acceptable to the Inspector. All exposed surfaces shall be kept saturated and the concrete surface temperature shall not drop below 50° F. The Contractor shall submit all materials for covers to the QA Inspector for approval prior to the commencement of work. For match cast segments, both the segment being cast ("wet cast segment") and the segment being cast against ("match cast segment") shall be covered.

5.11.2 Natural Cure

The saturated cover shall remain in place until the concrete has reached 70% of its specified compressive strength and any prestressed strands have been detensioned.

5.11.3 Steam Curing

After the external surface of the precast unit is covered with a saturated cover, but prior to the application of steam, an enclosure shall be placed over the casting bed. The steam curing cycle shall include a gradual heating period during which the rate of change in temperature within the curing enclosure shall not exceed 40° F per hour.

Until the concrete reaches a compressive strength of 500 psi, as indicated by a penetrometer test meeting the requirements of ASTM C403, the temperature within the enclosure shall be maintained between 50° F and 100° F.

Once the concrete strength has reached a compressive strength of 500 psi, the temperature within the enclosure shall be maintained between 120° F and 160° F.

Once the concrete has reached 70% of its specified compressive strength, the temperature within the curing enclosure shall be decreased at a rate not exceeding 40° F per hour until the temperature within the curing enclosure is within 20° F of the ambient temperature of the storage area (at which time the enclosure can be removed).

Once the enclosure is removed and the concrete has reached the required strength for detensioning (as stated on the Production Note Sheet), prestressing strands shall be detensioned. The saturated cover shall remain in place until the concrete has reached 70% of its specified compressive strength and all prestressed strands have been detensioned.

5.11.4 Record of Curing Time and Temperature

Temperatures shall be recorded every 100 feet maximum along the length of the precast unit. The recorders shall continuously record curing temperatures for the entire curing process. Sensors shall be carefully placed within the curing enclosure (for steam curing) or on the concrete surface (for saturated cover curing) to ensure that temperature conditions are measured at the designated locations. The ambient temperature shall also be measured. Recorder accuracy shall be certified once every 12 months and the certificate displayed with each recorder. In addition, random temperature checks of each recorder shall be made by the Inspector.

Temperature charts shall indicate the casting bed, date of casting, time of commencing, graphic plot and the units that are represented by the chart. The start of artificial heat and the transfer of prestress shall be indicated on each graphic record.

After completion of the final curing phase, the charts shall be properly marked and given to the QA Inspector. Temperatures recorded on the charts shall be considered as verification of whether the units have been cured in accordance with the approved shop drawings and the PCCM.

5.11.5 Transfer of Prestress

Transfer of prestress shall be in the manner approved on the shop drawings. Transfer of prestress shall not occur until the concrete has reached at least 70% of the design compressive strength, unless noted otherwise on the contract plans.

5.12 REMOVAL OF FORMS

Forms shall remain in place until the concrete has reached the compressive strength specified on the shop drawings. Care shall be exercised in removing the forms to prevent spalling and chipping of the concrete. For match cast units, prior to moving a unit from its as-cast position, erection marks shall be affixed identifying its location in the structure and order in the erection sequence, and match marks indicating its orientation relative to the adjacent segment.

5.13 PRODUCTION TESTING OF CONCRETE

5.13.1 Testing Cylinders for Strength

5.13.1.1 Casting Test Cylinders

The concrete strength shall be determined from concrete test cylinders made in conformance with ASTM C31 or ASTM C1758 (see Section **5.13.1.2** for curing requirements). All cylinders shall be made by the Fabricator in the presence of the QA Inspector. The Fabricator shall cast a sufficient number of concrete test cylinders to fulfill the concrete strength test requirements as stated in Section **5.13.1.3**. The expected number of test cylinders to be cast for each unit shall be shown on the shop drawings.

The cylinders shall be made from the same batch of concrete actually placed in the precast units. The QA Inspector shall be the sole judge of which cylinders are defective or damaged and are not to be included in the determination of the strength class.

5.13.1.2 Curing Test Cylinders

All cylinders used to test for concrete strength shall be cured in the same manner as the units they represent unless otherwise indicated on the shop drawings. Match curing systems may be submitted for approval.

5.13.1.3 Testing for Concrete Strength

A minimum of two cylinders representing each unit shall be tested in immediate succession to verify the strength of the concrete. Cylinders shall be tested according to the requirements of ASTM C39, except that the use of 4 inch x 8 inch cylinders is acceptable. Use of neoprene caps shall follow the procedural directives of the Materials Bureau. A minimum of four cylinders shall be tested for units weighing over 55 tons.

Each cylinder shall have strength of at least 95% of the required strength. The average strength of the cylinders tested must be equal to or greater than the required strength. If this requirement is not met, another pair of cylinders may be tested at a later time.

5.13.2 Testing Slump

For all concrete except self-consolidated concrete, slump shall be tested on each batch of concrete according to ASTM C143.

5.13.3 Testing Air Content

Air content shall be tested on each batch of concrete according to Pressure Method ASTM C231. For Light Weight Concrete, air content shall be tested in accordance to ASTM C173/C173M, Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.

5.13.4 Temperature

The concrete temperature shall be measured as directed by the Inspector.

5.13.5 Water/Cementitious Materials Ratio

The water/cementitious materials ratio shall be measured according to AASHTO T318. The water/cementitious ratio shall be measured by the Fabricator for the first batch of concrete in a day's placement and monitored by slump tests throughout production. Additional water/cementitious ratio tests may be ordered by the Inspector if slump indicates the maximum water-to-total-cementitious material ratio may be exceeded. For non-self-consolidated concrete mixes having initial slumps less than 4 inches, a slump increase greater than 1 inch will be considered cause to suspect an increase in the water/cementitious materials ratio. For slumps greater than 4 inches, an increase greater than 1½ inch will be considered cause to suspect an increase in the water/cementitious materials ratio. For self-consolidated concrete mixes, a spread increase of 25% or more will be considered cause to suspect an increase in the water/cementitious materials ratio.

5.13.6 Unit Weight

The unit weight of each batch shall be measured according to ASTM C138.

5.13.7 Additional Tests for Self-Consolidating Concrete (SCC)

5.13.7.1 General

If the Fabricator intends to use a Self-Consolidating Concrete (SCC) mix, it shall be clearly stated in the Production Notes (see Section **2.2.5.1 Production Notes**). All requirements of Section **5.13 PRODUCTION TESTING OF CONCRETE** shall apply to Self-Consolidating Concrete with the following modifications:

5.13.7.2 Slump Flow

Slump flow shall be tested on each batch of concrete according to ASTM C1611. A slump test (ASTM C143) is not required for SCC mixes.

5.13.7.3 Visual Stability Index

The Visual Stability Index (VSI) shall be measured for each batch as per AASHTO T 351, "Standard Method of Test for Visual Stability Index (VSI) of Self-Consolidating Concrete." A VSI rating of less than 2 is an indication that the SCC mixture is stable and should be suitable for the intended use. A VSI rating of 2 or greater is an indication that the SCC mixture is unstable and could be cause for rejection.

5.14 GEOMETRY CONTROL OF MATCH CAST SEGMENTS

5.14.1 General

After a given segment is cast and before separating it from the adjacent match cast segment, the positions of the two adjoining segments shall be checked from established control points. If the positions do not agree within a specified tolerance with the control point settings from the approved casting curve, corrections to the geometry shall be made in the next segment cast using the established control points.

5.14.2 Geometry Control Method

The Contractor shall submit a Geometry Control Plan to the DCES for approval.

5.14.3 Reference Points and Bench Marks

A minimum of two permanent horizontal reference points shall be established in line with the instrument mounting point. A permanent bench mark shall be established at a location where it will not be disturbed by construction activities. The horizontal reference points and bench mark shall be located so as to be continuously visible from the instruments.

5.15 POST-TENSIONING

All post-tensioning work done at the precasting facility shall be done according to the approved shop drawings and as per Section **8.5 POST-TENSIONING** of this manual.

SECTION 6

HANDLING, FINISHING, AND ACCEPTANCE

6.1 HANDLING

Segments shall be handled with care to prevent damage. Handling shall be done only by using the devices shown on the approved shop drawings for this purpose.

The Contractor shall inspect each segment visually for evidence of damage or defects before, during, and after critical operations and as often as necessary to ensure adequate quality control. The Contractor shall immediately bring all evidence of damage or defects to the attention of the QA Inspector.

6.2 FINISHING

6.2.1 Surface Cleaning

All concrete surfaces shall be cleaned by blast cleaning (pressure washing, abrasive blasting, etc.) to remove all laitance, loose particles, etc. Keyway surfaces shall be blast cleaned to remove any material which may prevent bonding (i.e. oil, grease, dirt, etc.) Blast cleaning must be completed prior to coating the surface with a penetrating sealer.

6.2.2 Exposed Steel

All exposed steel shall be protected so it is not damaged during blast cleaning.

6.2.3 Sealing of Concrete Units

After blast cleaning, all concrete units shall be coated on all surfaces with a penetrating sealer in accordance with Section **6.2.3.2 Sealer Application**. Keyway surfaces shall be coated with a penetrating sealer unless otherwise approved by the DCES. Penetrating sealers shall meet the requirements of Section **4.4.2 Penetrating Sealers**.

If water is used to blast clean the concrete, the surfaces shall be allowed to dry for 24

hours before the penetrating sealer is applied. All surface cleaning shall be completed and approved by the QA Inspector, before sealer application can commence.

6.2.3.1 Weather Limitations

Sealer materials shall not be applied during wet weather conditions. Any unit exposed to wetting within 12 hours after sealing shall be recoated. Ambient and surface temperatures shall be a minimum of 40° F during sealer application and until the sealed concrete is dry to the touch. Application by spray methods shall not be used during windy conditions.

6.2.3.2 Sealer Application

The sealer shall be used as supplied by the manufacturer without thinning or alterations, unless specifically required in the manufacturer's instructions. Thorough mixing of the sealer before and during its use shall be accomplished as recommended by the manufacturer. Equipment for sealer application shall be clean of foreign materials.

A minimum of two (2) coats of sealer shall be applied. The total quantity of sealer applied by each coat shall be equal to the quantity required at the application rate specified in the Approved List and on the shop drawings. Each coat shall be allowed to dry before the next coat is applied. On sloping and vertical surfaces, sealer application shall progress from bottom to top. Care shall be taken to ensure that the entire surface of the concrete is covered and all pores filled.

6.2.4 Finishing Surfaces

All surfaces which will be visible in their installed position (as determined by the DCES) shall be finished as described in the Production Notes Sheet (see Section **2.2.5.1 Production Notes**) and approved by DCES. Material used for finishing shall meet the requirements of Section **4.4.1 Concrete Finishing Materials**. Surface finishing shall not be done until after the penetrating sealer has been applied and is dry to the touch.

6.2.5 Cleaning, Sealing, and Finishing

Each individual precast unit shall be blast cleaned, sealed, and finished before shipping. Units shall be cleaned, sealed, and finished no later than 15 calendar days after the forms are removed, unless otherwise approved by the DCES.

6.3 ACCEPTANCE OF UNITS

All units which are complete in all aspects and are fabricated in accordance with the contract documents and meeting each of the following criteria will be accepted prior to shipping in accordance with Section **3.4 INSPECTOR'S MARK OF ACCEPTANCE FOR SHIPMENT** of this manual.

6.3.1 Strength Requirement

A concrete element which has reached the required strength, when tested as per Section **5.13 PRODUCTION TESTING OF CONCRETE**, will be accepted for strength, even if the time for reaching that strength exceeded the specified number of days.

6.3.2 Performance Criteria

The units shall meet all the performance criteria established in the contract documents.

6.3.3 Durability

The units shall be free of defects such as cracks, honeycombed areas, cold joints, exposed steel, inadequate cover over steel, and any other defect which may reduce the durability of the completed structure.

6.3.4 Injurious Materials

The units shall be free of material injurious to concrete or steel within concrete. Concentrations of total chloride ions in excess of 0.06% by weight of cement are considered injurious. Other materials with injury potential will be determined by the DCES.

6.3.5 Tolerances

The units shall meet the tolerances of Section **7 FABRICATION TOLERANCES**. Note that pretensioned concrete products have additional tolerances that must be met within 24 hours of transfer of prestressing force.

6.4 DEFECTIVE UNITS

A unit which does not meet the requirements of Section **6.3** is a defective unit. The Contractor will be issued a **Notice of Defect** (sometimes referred to as a Discrepancy Report) as soon as the defect is discovered (See **Appendix D**). Once a Notice of Defect is issued, the Contractor will have five working days to submit a proposed repair procedure. Defects shall be characterized as either nonstructural or structural by the DCES.

6.4.1 Nonstructural Defects

Nonstructural defects are those that do not affect the ability of the unit to resist construction or service loads or reduce the life expectancy of the structure. This category of defect includes superficial discontinuities such as minor cracks, small spalls, small honeycombed areas, or any defect that does not extend beyond the centerline of any reinforcing steel. Determination by the DCES that a defect is structural or nonstructural will be final. Repair of nonstructural defects shall be made in such a manner that the aesthetics and structural integrity of the unit is restored. The repairs shall be done in the presence of the QA Inspector using a written repair procedure approved by the DCES.

6.4.2 Structural Defects

Defects of structural significance are defects that will impair the ability of any unit to adequately resist construction or service loads or that will reduce the life expectancy of the structure. Examples of such defects include significant cracks, large spalls and honeycombed areas, major segregation or breakage of concrete. Determination by the DCES that a defect is structural or nonstructural will be final. Repair of units with defects of structural significance shall be according to the provisions of Section **6.4.3. Repairs**

of Structural Defects and shall be done in the presence of the QA Inspector.

6.4.3 Repairs of Structural Defects

Drawings shall be prepared by the Contractor to completely document the defect(s) on the unit and to describe and document the proposed repair procedure. The drawings shall meet the requirements of Section **2.2.2 Drawing Size and Type** of this manual. These drawings shall be prepared, stamped and signed by a Professional Engineer registered in New York State. Any engineering calculations required in accordance with Section **6.4.3.4 Engineering Calculations** shall also be stamped and signed by the same Professional Engineer registered in New York State who stamped and signed the drawings.

6.4.3.1 Documentation of Defects

The drawings shall completely document the defect(s) by showing appropriate views of the units with all pertinent information about the defect. All information shown shall be verified by the Inspector. If the unit concerned has spalled, honeycombed or heavily cracked (disintegrated) areas, concrete from such areas shall be removed as approved by the QA Inspector before documenting the defect.

6.4.3.2 Description of Repairs

The drawing shall show a detailed description of the proposed repair procedure including all preparatory work and materials to be used. A post repair inspection procedure shall be shown.

6.4.3.3 Supporting Material

The submittal shall include supporting material such as photographs of the defect, data sheets for materials to be used, etc.

6.4.3.4 Engineering Calculations

The submittal shall include all necessary engineering calculations to substantiate the soundness of the proposed repair. The calculations shall meet the requirements of

Section **9 CONTRACTOR'S DESIGN CALCULATIONS** of this manual.

6.5 STORAGE

Units shall be stored on dunnage capable of supporting the unit without damage. The units shall be spaced far enough apart so that visual inspection along the length is possible. No stacking of units will be allowed, unless approved by the DCES. Anchor dowel holes shall be open at the bottom at all times to allow for drainage. The storage area shall have proper drainage.

If a precast unit has exposed black rebar or prestressing strands, the rebar and/or strands shall be protected against corrosion during storage in a manner approved by the DCES. If a precast unit with exposed epoxy coated rebar is to be stored outdoors for more than 30 calendar days, all exposed epoxy rebar shall be protected from ultraviolet rays with opaque plastic sheeting or sleeves.

The Contractor is responsible for monitoring camber growth of prestressed units in storage. If the measured camber exceeds the anticipated camber at shipping as shown on the shop drawings by more than the tolerance shown in Section **7 FABRICATION TOLERANCES**, the Contractor shall contact the Concrete Engineering Unit immediately for directions on how to proceed. Camber measurements shall be taken with precision surveying equipment. String lines shall not be used.

6.6 SHIPPING OF UNITS

The QC Inspector shall verify the following prior to shipping:

- All units bear the stamp of the QA Inspector, and the QA Inspector has signed Part A of the Report of Acceptance/Shipping of Structural Concrete for each unit.
- All units are properly supported and adequately tied to prevent movement during shipping.
- Plastic guards or other devices shall be used to protect the concrete where anchor chains would otherwise be in direct contact with the concrete.

- The units shipped are free of any unrepaired defect.

The QC Inspector shall sign Part B of the Report of Acceptance/Shipping of Structural concrete (see Section **3.5 REPORT OF ACCEPTANCE OF STRUCTURAL CONCRETE** and **Appendix C REPORT OF ACCEPTANCE/SHIPPING OF STRUCTURAL CONCRETE**), give the report to the transporter, and direct the transporter to give the report to the EIC at the project site at time of delivery of the units.

SECTION 7

FABRICATION TOLERANCES

7.1 GENERAL

The provisions of this Section shall apply to the unit types listed in Sections **7.2** through **7.16**. If a different unit type is used, its tolerances will be indicated in the specification for that particular unit type.

7.2 PRESTRESSED CONCRETE AASHTO I-BEAM UNITS, NORTHEAST BULB TEE (NEBT) UNITS, PRESTRESSED CONCRETE COMMITTEE FOR ECONOMICAL FABRICATION (PCEF) BULB TEE UNITS, AND DECK BULB TEE (DBT) UNITS

7.2.1 Precasting

In accordance with the provisions of Section **5.9 PLACING CONCRETE**, all forms, reinforcing and prestressing steel, etc., shall be inspected for compliance with the tolerances listed below:

- Length: $\pm 1/4$ in. per 25 ft. length, ± 1 in. maximum
- Width (flanges and fillets): $+ 3/8$ in., $- 1/4$ in.
- Depth (overall): $+ 1/2$ in., $- 1/4$ in.
- Width (web): $+ 3/8$ in., $- 1/4$ in.
- Depth (flanges and fillets): $\pm 1/4$ in.
- Location of Dowel Bars Extending from Unit: $\pm 1/4$ in.
- Composite Bars (projection above top of the beam): $+ 1/4$ in., $- 1/2$ in.
- Reinforcement Cover: $- 0$, $+ 1/4$ in.
- Position of Pretensioning Strands: $\pm 1/4$ in.
- Position of Deflection Points for Deflected (Draped) Strands: ± 12 in.
- Location of Inserts: $\pm 1/4$ in.
- Stirrup/Confinement Reinforcement (longitudinal spacing): ± 2 in.
- Stirrup/Confinement Reinforcement (longitudinal spacing - within a distance equal to the depth of the beam from the ends of the beam): ± 1 in.

- Bulkhead (deviation from square or designated skew)
 - o Horizontal: $\pm 1/8$ in. per 1 ft. width, $\pm 1/2$ in. maximum
 - o Vertical: $\pm 3/16$ in. per 1 ft. depth, ± 1 in. maximum
- Location of Handling Devices:
 - o Parallel to Length of Member: ± 6 in.
 - o Transverse to Length of Member: ± 1 in.

7.2.2 Tolerance Check after Detensioning

All units shall be checked for compliance with the following tolerances within 24 hours after detensioning, except that shipping camber shall be checked within three days of shipping.

- Sweep - (Horizontal misalignment of the outside surface, measured as a deviation from straight line parallel to the centerline of the unit):
 - o $\pm 1/8$ in. per 10 ft. length
 - o $\pm 0.1\%$ of unit length but no more than 1 in. for lengths greater than 80 ft.
- Local Smoothness of Any Surface: $1/4$ in. per 10 ft.
- Bearing Area (deviation from plane surface when tested with a straight edge through middle half of unit): $\pm 1/8$ in.
- Actual Prestressing Strand Elongation Deviation from Calculated Theoretical Elongation on the Shop Drawings: $\pm 3\%$ (Straight Strands), $\pm 5\%$ (Draped Strands).
- Camber deviation from release camber on the shop drawings: $\pm 0.1\%$ of unit length
- Camber deviation from shipping camber on the shop drawings: $\pm 0.1\%$ of unit length
- Unless modified in the contract documents, the differential Camber between Adjacent Deck Bulb Tee Beams of the Same Design: $\pm 0.2\%$ of unit length, $3/4$ in. maximum

7.3 PRESTRESSED CONCRETE BOX BEAM UNITS, HOLLOW SLAB UNITS, AND SOLID SLAB UNITS

7.3.1 Precasting

In accordance with the provisions of Section **5.9 PLACING CONCRETE**, all forms, reinforcing and prestressing steel, etc. shall be inspected for compliance with the tolerances listed below.

- Length: ± 1 in.
- Width (overall): $\pm 1/4$ in.
- Depth (overall): $+ 5/8$ in., $- 1/4$ in.
- Width (web): $\pm 3/8$ in.
- Depth (top flange): $\pm 5/8$ in.
- Depth (bottom flange): $+ 5/8$ in., $- 1/8$ in.
- Location of Dowel Bars Extending from Unit: $\pm 1/4$ in.
- Composite Bars (projection above top of the beam): $+ 0$ in., $- 3/8$ in.
- Reinforcement Cover: $- 0$ in., $+ 1/4$ in.
- Position of Pretensioning Strands: $\pm 1/4$ in.
- Void Position: ± 1 in. from the end of the void to the center of the transverse tendon hole
- Position of Transverse Tendon Holes (distance between hole centers and distance between the centers of holes and the unit ends): $\pm 3/4$ in.
- Position of Transverse Tendon Holes (distance between the centers of holes and the bottom of the unit): $\pm 3/8$ in.
- Location of Inserts: $\pm 1/4$ in.
- Stirrup Bars (longitudinal spacing): ± 1 in.
- Bulkhead (deviation from square or designated skew):
 - o Horizontal: $\pm 1/2$ in.
 - o Vertical: $\pm 1/2$ in.
- Dowel Tubes (spacing between the centers of tubes and from centers of

tubes to the ends of the unit): $\pm 5/8$ in.

- Location of Handling Devices:
 - o Parallel to Length of Member: ± 6 in.
 - o Transverse to Length of Member: ± 1 in.

7.3.2 Tolerance Check after Detensioning

All units shall be checked for compliance with the following tolerances within 24 hours after detensioning, except that shipping camber shall be checked within three days of shipping.

- Sweep - (Horizontal misalignment of the outside surface, measured as a deviation from straight line parallel to the centerline of the unit):
 - o $\pm 1/4$ in. for lengths up to 40 ft.
 - o $\pm 3/8$ in. for lengths from 40 ft. to 60 ft.
 - o $\pm 1/2$ in. for lengths greater than 60 ft.
- Local Smoothness of Any Surface: $1/4$ in. per 10 ft.
- Bearing Area (deviation from plane surface when tested with a straight edge through middle half of unit): $\pm 1/8$ in.
- Actual Prestressing Strand Elongation Deviation from Calculated Theoretical Elongation on the Shop Drawings: $\pm 3\%$
- Camber Deviation from Release Camber on the Shop Drawings: $\pm 0.1\%$ of unit length
- Camber Deviation from Shipping Camber on the Shop Drawings: $+ 0.1\%$, $- 0.05\%$ of unit length
- Differential Camber between Adjacent Beams of the Same Design: 0.2% of unit length, $3/4$ in. maximum

7.4 PRESTRESSED CONCRETE NEXT BEAM UNITS (TYPES F AND D)

7.4.1 Precasting

In accordance with the provisions of Section **5.9 PLACING CONCRETE**, all forms, reinforcing and prestressing steel, etc. shall be inspected for compliance with the tolerances listed below:

- Length: ± 1 in.
- Width (overall): $\pm 1/4$ in.
- Web Width: $\pm 1/4$ in.
- Distance Between Webs: $\pm 1/4$ in.
- Distance from Web to Outside Edge of Top Flange: $\pm 1/4$ in.
- Depth (overall): $\pm 1/4$ in.
- Depth of Top Flange: $+ 1/4$ in., $- 1/8$ in.
- Location of Dowel Bars Extending from Unit: $\pm 1/4$ in.
- Composite Bars (projection above top of the beam): $+ 1/4$ in., $- 1/2$ in.
- Reinforcement Cover: $- 0$, $+ 1/4$ in.
- Position of Pretensioning Strands: $\pm 1/4$ in.
- Location of Inserts: $\pm 1/4$ in.
- Stirrup Bars (longitudinal spacing): ± 2 in.
- Stirrup Bars (longitudinal spacing within a distance equal to the depth of the beam from the ends of the beam): ± 1 in.
- Bulkhead (deviation from square or designated skew):
 - o Horizontal: $\pm 3/4$ in.
 - o Vertical: $\pm 3/4$ in.
- Location of Handling Devices:
 - o Parallel to Length of Member: ± 6 in.
 - o Transverse to Length of Member: ± 1 in.

7.4.2 Tolerance Check after Detensioning

All units shall be checked for compliance with the following tolerances within 24 hours after detensioning, except that shipping camber shall be checked within three days of shipping.

- Sweep - (Horizontal misalignment of the outside surface, measured as a deviation from straight line parallel to the centerline of the unit):
 - o $\pm 1/4$ in. for lengths up to 40 ft.
 - o $\pm 3/8$ in. for lengths from 40 ft. to 60 ft.
 - o $\pm 1/2$ in. for lengths greater than 60 ft.
- Local Smoothness of Any Surface: $1/4$ in. per 10 ft.
- Bearing Area (deviation from plane surface when tested with a straight edge through middle half of unit): $\pm 1/8$ in.
- Actual prestressing strand elongation deviation from calculated theoretical elongation shown on the shop drawings: $\pm 3\%$
- Camber Deviation from Release Camber on the Shop Drawings: $\pm 1/4$ in. per 10 ft., $\pm 3/4$ in. maximum
- Camber Deviation from Shipping Camber on the Shop Drawings: $\pm 1/4$ in. per 10 ft., $\pm 3/4$ in. maximum
- Unless modified in the contract documents, the differential Camber between Adjacent Units of the Same Design: $1/4$ in. per 10 ft., $3/4$ in. maximum

7.5 PRECAST CONCRETE BRIDGE DECK PANELS

7.5.1 Precasting

In accordance with the provisions of Section **5.9 PLACING CONCRETE**, all forms, reinforcing and prestressing steel, etc. shall be inspected for compliance with the tolerances listed below:

- Length: $\pm 1/4$ in.
- Width (overall): $\pm 1/4$ in.

- Depth (overall): $\pm 1/8$ in.
- Location of Dowel Bars Extending from Unit: $\pm 1/4$ in.
- Reinforcement Cover: - 0 in., + $1/4$ in.
- Position of Pretensioning Strands: $\pm 1/4$ in.
- Position of Post-Tensioning Ducts: $\pm 1/4$ in.
- Location of Inserts: $\pm 1/2$ in.
- Location of Blockouts: ± 1 in.
- Length and Width of Blockouts: $\pm 1/2$ in.
- Location of Leveling Devices: $\pm 1/2$ in.
- Location of Handling Devices:
 - o Parallel to Length of Member: ± 6 in.
 - o Transverse to Length of Member: ± 1 in.

7.5.2 Tolerance Check after Casting and/or Detensioning

All units shall be checked for compliance with the following tolerances after casting. If the panels are prestressed, all units shall be checked for compliance with the following tolerances within 24 hours after detensioning:

- Variation from Specified End Squareness or Skew: $\pm 1/4$ in.
- Local Smoothness of Any Surface: $1/4$ in. per 10 ft.
- Sweep - (Horizontal misalignment of the outside surface, measured as a deviation from straight line parallel to the centerline of the unit): $\pm 1/8$ in. If panels are prestressed, all units shall be checked for compliance within 24 hours after detensioning.
- If panels are prestressed, the actual prestressing strand elongation deviation from calculated theoretical elongation shown on the shop drawings: $\pm 3\%$
- If panels are prestressed, the differential Camber between Adjacent Units of the Same Design Receiving a Topping (Overlay): $1/4$ in. per 10 ft., $3/4$ in. maximum

- If panels are prestressed, the differential Camber between Adjacent Units of the Same Design Not Receiving a Topping (Overlay): 1/8 in. per 10 ft., 3/8 in. maximum

7.6 PRECAST CONCRETE THREE-SIDED STRUCTURES

7.6.1 Precasting

In accordance with the provisions of Section **5.9 PLACING CONCRETE**, all forms, reinforcing and prestressing steel, etc. shall be inspected for compliance with the tolerances listed below:

- Span: $\pm 1\%$ of Span Length, ± 1 in. maximum
- Rise: $\pm 1\%$ of Rise, ± 1 in. maximum
- Wall and Slab Thickness: - 1/4 in., + 1/2 in.
- Haunch dimension: $\pm 1/4$ in.
- Length of Section: The underrun in length of any one unit shall not be more than 1/2 in. maximum.
- The Laying Length of two adjacent units shall not vary by more than 5/8 in. maximum in any section, except where beveled ends for laying of curves are specified in the plans.
- Location of Dowel Bars Extending from Unit: $\pm 1/4$ in.
- Reinforcement Cover: - 0 in., + 1/4 in.
- Location of Inserts: $\pm 1/2$ in.
- Variation from Specified End Squareness or Skew: $\pm 1/4$ in.
- Local Smoothness of any Surface: 1/4 in. per 10 ft.
- Location of Handling Devices: ± 1 in.

7.6.2 Tolerance Check after Erection

After the units have been erected in the field, they shall be inspected for compliance with the tolerances listed below:

- Span – Variation from Post-Pour Measurement (On Shipping Paperwork): $\pm 3/8$ in.
- Vertical Difference Between Tops Of Adjacent Units: $\pm 1/2$ in.
- Width of Joints Between Adjacent Units: $\pm 3/8$ in.

7.7 PRECAST CONCRETE INVERT SLABS

7.7.1 Precasting

In accordance with the provisions of Section **5.9 PLACING CONCRETE**, all forms, reinforcing and prestressing steel, etc. shall be inspected for compliance with the tolerances listed below:

- Length: $\pm 1/4$ in.
- Width: $\pm 1/4$ in.
- Depth: $\pm 1/4$ in.
- Reinforcement Cover: - 0 in., + $1/4$ in.
- Location of Dowel Bars Extending from Unit: $\pm 1/4$ in.
- Location of Inserts: $\pm 1/2$ in.
- Location of Keyways: $\pm 1/2$ in.
- Length and Width of Keyways: $\pm 1/4$ in.
- Depth of Keyways: $\pm 1/8$ in.
- Location of Leveling Devices: $\pm 1/2$ in.
- Variation from Specified End Squareness or Skew: $\pm 1/2$ in.
- Local Smoothness of Any Surface: $1/4$ in. per 10 ft.
- Sweep - (Horizontal misalignment of the outside surface, measured as a deviation from straight line parallel to the centerline of the unit): $\pm 3/8$ in.
- Location of Handling Devices:
 - o Parallel to Length of Member: ± 6 in.
 - o Transverse to Length of Member: ± 1 in.

7.8 PRECAST CONCRETE CUTOFF WALLS

7.8.1 Precasting

In accordance with the provisions of Section **5.9 PLACING CONCRETE**, all forms, reinforcing and prestressing steel shall be inspected for compliance with the tolerances listed below:

- Length: $\pm 1/2$ in.
- Width: $\pm 1/2$ in.
- Depth: $\pm 1/4$ in.
- Reinforcement Cover: - 0 in., + $1/4$ in.
- Location of Leveling Devices: $\pm 1/2$ in.
- Variation from Specified End Squareness: $\pm 1/2$ in.
- Local Smoothness of Any Surface: $1/4$ in. per 10 ft.
- Sweep - (Horizontal misalignment of the outside surface, measured as a deviation from straight line parallel to the centerline of the unit): $\pm 3/8$ in.
- Location of Handling Devices:
 - o Parallel to Length of Member: ± 6 in.
 - o Transverse to Length of Member: ± 1 in.

7.9 SEGMENTAL BOX GIRDERS

7.9.1 Precasting

In accordance with the provisions of Section **5.9 PLACING CONCRETE**, all forms, reinforcing and prestressing steel, etc. shall be inspected for compliance with the tolerances listed below:

- Length of Segment (non cumulative): $\pm 1/8$ in/ ft., $\pm 3/4$ in. maximum
- Width (top slab): $\pm 1/16$ in./ft., $\pm 3/4$ in. maximum
- Width (bottom slab): $\pm 1/16$ in./ft., $\pm 1/2$ in. maximum
- Thickness of web: $\pm 3/8$ in.

- Thickness of bottom slab: $\pm 3/8$ in.
- Thickness of top slab: $\pm 3/8$ in.
- Thickness of diaphragm: $\pm 1/2$ in.
- Location of Dowel Bars Extending from Unit: $\pm 1/4$ in.
- Grade of form edge and soffit (vertical curve and superelevation): $\pm 1/8$ per 10 ft.
- Location of Post-Tensioning Ducts: $\pm 1/4$ in.
- Position of shear keys: $\pm 1/4$ in.
- Reinforcement Cover: - 0 in., + $1/4$ in.
- Location of Inserts: $\pm 1/2$ in.
- Local Smoothness of Any Surface: $1/4$ in. per 10 ft.
- Location of Handling Devices: ± 1 in.

Dimensions from segment to segment shall be adjusted to compensate for any deviations within a single segment or series of segments so that the overall dimensions of the completed structure conform to the dimensions shown on the plans. Installation tolerances shall be as per Section **8.7.1 Installation Tolerances**.

7.10 PRESTRESSED CONCRETE PILE UNITS

7.10.1 Precasting

In accordance with the provisions of Section **5.9 PLACING CONCRETE**, all forms, reinforcing and prestressing steel shall be inspected for compliance with the tolerances listed below:

- Width and Depth (square piles) or Diameter (round piles): - $1/4$ in., + $3/8$ in.
- Wall Thickness: - $1/4$ in., + $1/2$ in.
- Position of Stirrups or Spiral Reinforcement: $\pm 3/4$ in.
- Position of Pretensioned Strands: $\pm 1/4$ in.
- Reinforcement Cover: - 0 in., + $1/4$ in.

7.10.2 Tolerance Check after Detensioning

All units shall be checked for compliance with the tolerances listed below within 24 hours after transfer of prestress.

- Length: ± 1 in.
- Sweep (Horizontal misalignment of the outside surface, measured as a deviation from straight line parallel to the centerline of the unit): $\pm 1/8$ in. per 10 ft., ± 1 in. maximum
- Actual prestressing strand elongation deviation from calculated theoretical elongation shown on the shop drawings: $\pm 3\%$
- Variation from Specified End Squareness or Skew: $\pm 1/8$ in. per 12 in. of width, $\pm 1/2$ in. maximum
- Location of Dowel Bars Extending from Unit: $\pm 1/4$ in.
- Position of steel driving tip: $\pm 1/2$ in.

7.11 PRECAST CONCRETE FOOTING UNITS

7.11.1 Precasting

In accordance with the provisions of Section **5.9 PLACING CONCRETE**, all forms, reinforcing and prestressing steel shall be inspected for compliance with the tolerances listed below:

- Length: $\pm 1/2$ in.
- Width: $\pm 1/2$ in.
- Depth: $\pm 1/4$ in.
- Reinforcement Cover: - 0 in., + $1/4$ in.
- Location of Dowel Bars Extending from Unit: $\pm 1/4$ in.
- Location of Inserts: $\pm 1/2$ in.
- Location of Blockouts for Piles: $\pm 1/2$ in.
- Location of Keyways: $\pm 1/2$ in.

- Length and Width of Keyways: $\pm 1/4$ in.
- Depth of Keyways: $\pm 1/8$ in.
- Location of Leveling Devices: $\pm 1/2$ in.
- Variation from Specified End Squareness: $\pm 1/2$ in.
- Local Smoothness of Any Surface: $1/4$ in. per 10 ft.
- Sweep - (Horizontal misalignment of the outside surface, measured as a deviation from straight line parallel to the centerline of the unit): $\pm 3/8$ in.
- Location of Handling Devices:
 - o Parallel to Length of Member: ± 6 in.
 - o Transverse to Length of Member: ± 1 in.

7.12 PRECAST CONCRETE ABUTMENT STEMS, ABUTMENT BACKWALLS, ABUTMENT WINGWALLS, AND PIERWALL UNITS

7.12.1 Precasting

In accordance with the provisions of Section **5.9 PLACING CONCRETE**, all forms, reinforcing and prestressing steel shall be inspected for compliance with the tolerances listed below:

- Length: $\pm 1/4$ in.
- Width: $\pm 1/4$ in.
- Depth: $\pm 1/4$ in.
- Reinforcement Cover: - 0 in., + $1/4$ in.
- Location of Dowel Bars Extending from Unit : $\pm 1/4$ in.
- Location of Inserts: $\pm 1/2$ in.
- Location of Grouted Splice Couplers: $\pm 1/4$ in.
- Location of Blockouts for Piles: $\pm 1/2$ in.
- Variation from Specified End Squareness or Skew: $\pm 1/2$ in.
- Local Smoothness of Any Surface: $1/4$ in. per 10 ft.
- Sweep - (Horizontal misalignment of the outside surface, measured as a

deviation from straight line parallel to the centerline of the unit): $\pm 3/8$ in.

- Location of Handling Devices: ± 1 in.

7.13 PRECAST CONCRETE PIER COLUMN UNITS

7.13.1 Precasting

In accordance with the provisions of Section **5.9 PLACING CONCRETE**, all forms, reinforcing and prestressing steel shall be inspected for compliance with the tolerances listed below:

- Length: $\pm 1/2$ in.
- Width and Depth or Diameter: $\pm 1/4$ in.
- Reinforcement Cover: - 0 in., + $1/4$ in.
- Location of Dowel Bars Extending from Unit : $\pm 1/4$ in.
- Location of Inserts: $\pm 1/2$ in.
- Location of Grouted Splice Couplers: $\pm 1/4$ in.
- Variation from Specified End Squareness or Skew: $\pm 1/8$ in. per 12 in., $\pm 3/8$ in. maximum
- Local Smoothness of Any Surface: $1/4$ in. per 10 ft.
- Sweep - (Horizontal misalignment of the outside surface, measured as a deviation from straight line parallel to the centerline of the unit): $\pm 1/8$ in. per 10 ft., $\pm 1/2$ in. maximum
- Location of Handling Devices: ± 1 in.

7.14 PRECAST CONCRETE PIER CAPBEAM UNITS

7.14.1 Precasting

In accordance with the provisions of Section **5.9 PLACING CONCRETE**, all forms, reinforcing and prestressing steel shall be inspected for compliance with the tolerances listed below:

- Length: $\pm 1/2$ in.
- Width: $\pm 1/4$ in.
- Depth: $\pm 1/4$ in.
- Reinforcement Cover: - 0 in., + $1/4$ in.
- Location of Dowel Bars Extending from Unit : $\pm 1/4$ in.
- Bars Projection (projection above top of unit): + $1/4$ in., - $1/2$ in.
- Position of Post-Tensioning Ducts: $\pm 1/4$ in.
- Location of Inserts: $\pm 1/2$ in.
- Stirrup Bars (longitudinal spacing): ± 2 in.
- Stirrup Bars (longitudinal spacing - within a distance equal to the depth of the beam from the edge of columns): ± 1 in.
- Location of Grouted Splice Couplers: $\pm 1/4$ in.
- Location of Blockouts for Piles: $\pm 1/2$ in.
- Variation from Specified End Squareness or Skew: $\pm 1/8$ in. per 12 in. width, $\pm 1/2$ in. maximum
- Local Smoothness of Any Surface: $1/4$ in. per 10 ft.
- Sweep - (Horizontal misalignment of the outside surface, measured as a deviation from straight line parallel to the centerline of the unit):
 - o $\pm 1/4$ in. for lengths up to 40 ft.
 - o $\pm 1/2$ in. for lengths from 40 ft. to 60 ft.
 - o $\pm 5/8$ in. for lengths greater than 60 ft.
- Location of Handling Devices: ± 1 in.

7.15 GROUTED SPLICE SLEEVE COUPLERS

All grouted splice sleeve couplers shall be checked for compliance with the following tolerances prior to the installation of the grout:

- Shim pack height: $\pm 3/8$ in.
- Dowel Height: The dowel height and tolerances shall be as per the grouted splice sleeve manufacturer.

- Location of column reinforcing, grouted splice sleeve coupler, and footing dowels measured from a common reference point: $\pm \frac{1}{4}$ in.
- The gap and tolerance between the reinforcement within the splice sleeve coupler shall be as per the grouted splice sleeve manufacturer.

7.16 PRECAST CONCRETE APPROACH SLAB PANELS

7.16.1 Precasting

In accordance with the provisions of Section **5.9 PLACING CONCRETE**, all forms, reinforcing and prestressing steel, etc. shall be inspected for compliance with the tolerances listed below:

- Length: $\pm \frac{1}{4}$ in.
- Width: $\pm \frac{1}{4}$ in.
- Depth: $\pm \frac{1}{4}$ in.
- Reinforcement Cover: - 0 in., + $\frac{1}{4}$ in.
- Location of Dowel Bars Extending from Unit: $\pm \frac{1}{4}$ in.
- Location of Inserts: $\pm \frac{1}{2}$ in.
- Location of Blockouts for Drainage Basins: ± 1 in.
- Length and Width of Blockouts: $\pm \frac{1}{2}$ in.
- Location of Leveling Devices: $\pm \frac{1}{2}$ in.
- Variation from Specified End Squareness or Skew: $\pm \frac{1}{2}$ in.
- Local Smoothness of Any Surface: $\frac{1}{4}$ in. per 10 ft.
- Sweep - (Horizontal misalignment of the outside surface, measured as a deviation from straight line parallel to the centerline of the unit): $\pm \frac{3}{8}$ in.
- Location of Handling Devices:
 - o Parallel to Length of Member: ± 6 in.
 - o Transverse to Length of Member: ± 1 in.

SECTION 8 CONSTRUCTION

8.1 INSPECTION, STORAGE AND HANDLING

Precast concrete units delivered to the construction site shall have the QA Inspector's acceptance stamp affixed to each unit. The units shall also be accompanied by a signed copy of the "Report of Acceptance/Shipping of Structural Concrete." Any units not meeting these two requirements shall be rejected by the Engineer.

Upon arrival at the construction site, units will be inspected by the Engineer to determine if any damage occurred during transportation to the construction site and to make certain the units are in conformance with dimensional tolerances. An additional inspection will be made prior to erection to determine if any damage occurred during handling and storage at the construction site. The Contractor shall handle and store the concrete units with extreme care to prevent damage to the units.

The presence of the QA Inspector's acceptance stamp and the signed copy of the "Report of Acceptance/Shipping of Structural Concrete" does not imply that the precast units will not be subject to rejection by the State at the construction site, or relieve the Contractor of responsibility, if the Engineer finds the units to be defective or not to be in conformance with the contract documents.

8.2 ACCEPTANCE

All Units at the construction site meeting the requirements of Section **6.3 ACCEPTANCE OF UNITS** will be accepted.

8.3 REPAIR OF DAMAGED UNITS

Repairs of units found to be damaged at the construction site shall be according to Section **6.4 DEFECTIVE UNITS** except that the approval authority will be the Engineer instead of the DCES.

8.4 ERECTION

8.4.1 Field Inspection

The Contractor shall provide the Engineer with all facilities necessary to conduct a thorough inspection of all the erection work.

8.4.2 Procedure and Equipment

Prior to erection of the units, the Contractor shall furnish to the Regional Director, the erection procedure as required by Section **2.6 ERECTION DRAWINGS**, with detailed information concerning the proposed method of construction and the construction equipment required. **NO WORK SHALL BE DONE WITHOUT THE ENGINEER'S APPROVAL.**

8.4.3 Bearing Surfaces

Bearing surfaces shall be properly finished and formed to provide full and even supporting surfaces for bearings, bearing plates and concrete units.

8.4.4 Tie Rods, Cables, Strands and Anchor Rods

The installation of any tie rods, cables, strands or anchor rods shall comply with the requirements shown on the plans.

8.4.5 Shear Key Joints for Adjacent Prestressed Concrete Box Beams, Hollow Slab Units, and Solid Slab Units

8.4.5.1 Loading

No loading of any span will be permitted until the following events have occurred:

- All of the longitudinal shear keys of the span have been filled with shear key material.
- At least 24 hours have elapsed from the time the last keyway was filled.

8.4.5.2 Preparation for Placement

Prior to placing shear key material, there shall be no force in the transverse tie rods or strands.

All shear key surfaces shall be thoroughly cleaned using a high-pressure wash. The ends and bottoms of the keyway shall be tightly sealed prior to placing shear key material to prevent grout loss during shear key placement. The work shall be done in such a manner that the sealing material shall be within 3 inches of the bottoms and ends of the beams.

Shear keys that have not been coated with a penetrating sealer shall be continuously pre-wetted over all shear key surfaces for a minimum of 24 hours.

8.4.5.3 Mixing - General

The following mixing requirements shall be adhered to:

- Mixing shall be done as close as possible to the keyway to be filled.
- All necessary equipment for mixing and placing shall be present at the work site prior to the start of mixing. All equipment shall be in good working order as determined by the Engineer.
- Material which, in the Engineer's opinion is not pourable, exhibits signs of setting or hardening, prior to placement, shall not be incorporated in the work. It shall be removed from the work site.

8.4.5.4 Placement of Cement Based Grout Material for Shear Keys

The Grout Manufacturer's instructions regarding mixing and placing shall be followed, except that:

- No aggregate shall be added to the grout.
- The actual water to cement (W/C) ratio used shall comply exactly with the value given for the specific product as published in the Department's approved list titled: Cement Based Grout Materials for Shear Keys, §701-06.

- Grout shall not be placed during rainfalls.
- Grout shall not be placed if the ambient temperature is outside the range of 45° F to 95° F.

No placement interruptions will be permitted. Grout shall be thoroughly rodded as it is placed in the keyway. Grout shall be finished flush with the top of keyway. When a camber differential exists between beams at the shear key joint, the grout shall be filled to the highest beam and trowel finished at a 1 to 4 slope to the lower beam.

Curing shall be in accordance with the Grout Manufacturer's instructions unless otherwise required by the Engineer.

8.4.5.5 Tensioning of Transverse Ties

Tensioning shall be completed prior to performing any further work on the superstructure. Transverse ties shall be tensioned to the force shown on the plans. Tensioning shall not be done until the requirements of Section **8.4.5.4** have been accomplished. No separate installation drawings will be necessary for the tensioning of ties of adjacent prestress box/slab unit superstructures.

Grouting of transverse ties, when required by the plans, shall be done as per Section **8.6**. The anchorage block-outs of fascia units shall be filled with anchorage block-out grout. Grout meeting the requirements of §701-05 or §701-06 shall be prepared and applied in accordance with the manufacturer's instructions.

The temperature of the surface against which the grout is to be placed shall be at least 45° F. No placement of grout shall be permitted if the ambient temperature is less than 45° F, or if the ambient temperature is expected, or predicted, to become lower than 45° F for a period of 12 to 15 hours after placement. After the grout has been placed, it shall be dusted with the same brand and type of cement used in the production of the concrete units. The color shall match the surrounding concrete surface.

8.4.5.6 UHPC

If UHPC is used for joints between adjacent prestressed concrete box beams, hollow slab units, or solid slab units, the provisions of Sections **8.4.6** and **8.4.7** shall apply, except that the shear key shall not receive an exposed aggregate finish.

8.4.6 Field Cast Joints and Closure Pours for NEXT Type D Beams, Deck Bulb Tee Beams, Precast Concrete Abutment or Pier Units, Precast Concrete Bridge Deck Panels and Approach Slab Panels

All work shall be in accordance with the approved Installation Drawings (see Section **2.3.4**). An exposed aggregate finish with a minimum amplitude of 1/8 inch is required on the shear key of the precast concrete units. Unless the concrete contact area (keyway) has been coated with a penetrating sealer, the keyway shall be thoroughly and continuously wet for 24 hours prior to placing of concrete or grout (the keyway surfaces shall be saturated surface dry at the time of placement). All bottom and side formwork must be properly sealed and capable of resisting the hydrostatic pressures from the concrete or grout in the unhardened state. The concrete or grout shall be placed starting from the low end of the pour.

8.4.6.1 Field Cast Joints and Closure Pours Using UHPC

Temperature requirements for UHPC placement shall be as per manufacturer recommendations. A pre-installation meeting shall be held between the Contractor, representatives of the UHPC supplier, and the engineer to discuss the UHPC installation procedure and responsibilities. Flow of field cast UHPC within the joint shall be limited to 10 feet in length. UHPC shall be placed a minimum of ¼ inch above final elevation of the joint and ground down to final elevation after curing. Top forms shall be placed over the UHPC pour to prevent surface dehydration. If the bridge is on a slope, the top forms shall be weighted down to hold the UHPC in place. Sampling and testing of the UHPC at time of placement shall be as per the manufacturer's recommendations.

Placement methods for approved UHPC mixes with thixotropic properties shall be as per the UHPC manufacturer's recommendation, submitted to the DCES for approval.

8.5 POST-TENSIONING

This work shall consist of furnishing, installing, stressing and grouting post-tensioned prestressing steel in accordance with the details shown on the installation drawings approved by the DCES and the requirements of these specifications.

It shall also include the furnishing and installing of any appurtenant items necessary for the particular post-tensioning system and pressure grouting of ducts.

8.5.1 Post-Tensioning System Requirements

- Materials and devices used in the post-tensioning system shall conform to the requirements of Section **4.2 REINFORCEMENT AND PRESTRESSING STEEL** of this manual.
- The net compressive stress in the concrete after all losses shall meet the minimum required by the plans.
- The distribution of individual tendons at each section shall conform to the distribution shown on the plans.
- The ultimate strength of the structure with the proposed post-tensioning system shall meet the requirements of the plans.
- Stresses in the concrete and prestressing steel at all sections and at all stages of construction shall meet the requirements of the design criteria noted on the plans.
- All provisions of the design criteria, as noted on the plans, shall be satisfied.

8.5.2 Protection of Prestressing Steel

All prestressing steel shall be protected against physical damage at all times from manufacture to grouting or encasing in concrete. Prestressing steel that has, in the opinion of the Engineer, sustained physical damage at any time shall be rejected. Any reel of prestressing steel that is found to contain broken wires shall be rejected and the reel replaced.

8.5.2.1 Packaging

Prestressing steel shall be packaged in containers or shipping forms for protection of the steel against physical damage and corrosion during shipping and storage. A corrosion inhibitor, which prevents rust or other results of corrosion, shall be placed in the package or form, or shall be incorporated in a corrosion inhibitor carrier type packaging material, or when permitted by the Inspector, a corrosion inhibitor may be applied directly to the steel. The corrosion inhibitor shall have no deleterious effect on the steel or concrete or bond strength of steel to concrete. Inhibitor carrier type packaging material shall conform to the provisions of Federal Specification MIL-P-3420. Packaging or forms damaged from any cause shall be immediately replaced or restored to original condition.

8.5.2.2 Storage

The prestressing steel shall be stored in a manner which at all times prevents the packaging material from becoming saturated with water and allows a free flow of air around the packages. If the useful life of the corrosion inhibitor in the package expires, it shall immediately be rejuvenated or replaced.

Prestressing steel shall be stored off the ground on level supports and in a manner that will not result in damage or deformation to the materials or in contamination of the materials. Do not use any packaging or wrapping material that retains moisture at the bottom of the reel. Different types and sizes of prestressing tendons and prestressing components shall be stored separately and shall be protected from exposure to conditions which may affect the material. Do not expose the prestressing tendons or prestressing components to temperatures greater than 95° F at any time.

8.5.2.3 Installation

At the time the prestressing steel is installed in the work, it shall be free from loose rust, loose mill scale, dirt, paint, oil, grease or other deleterious material. Removal of tightly adhering rust or mill scale will not be required. Prestressing steel which has

experienced rusting to the extent that it exhibits pits visible to the naked eye shall not be used in the work. The shipping package or form shall be clearly marked with the heat number and with a statement that the package contains high strength prestressing steel, and care is to be used in handling. The type and amount of corrosion inhibitor used, the date when placed, safety orders and instructions for use shall also be marked on the package or form.

8.5.2.4 Protection after Installation

If the period of time between installation of prestressing steel and grouting of the duct will exceed 10 calendar days, the prestressing steel shall be protected from corrosion during the entire period it is in place but ungrouted as provided below.

When corrosion protection of in-place prestressing steel is required, a corrosion inhibitor which prevents rust or other results of corrosion shall be applied directly to the prestressing steel. The corrosion inhibitor shall have no deleterious effect on the prestressing steel or grout or bonding of the prestressing steel to the grout. The inhibitor shall be water soluble. The corrosion inhibitor, the amount and time of initial application, and the frequency of reapplication shall be approved by the DCES.

8.5.3 Post-Tensioning Operations

8.5.3.1 Geometry Control

The Contractor shall carefully measure elevations and alignment of segments at each stage of erection with instruments capable of providing the degree of accuracy necessary to assure that installation tolerances will be met. Geometry control during installation of the segments shall be as per the approved Installation Drawings. This includes the longitudinal alignment, grade and cross-slope of each superstructure segment and the vertical alignment of each substructure segment. Any deviation from the table of elevations and alignment shown on the Installation Drawings shall be corrected so as to prevent accumulation of deviations using a method submitted by the Contractor and signed and sealed by a Professional Engineer licensed to practice in the

State of New York. This method shall not be implemented without approval by the DCES. The contractor assumes full responsibility for all geometry control operations. All geometry control data collected shall be submitted to the Engineer on a daily basis.

8.5.3.2 Tensioning

All post-tensioning steel shall be tensioned by means of hydraulic jacks so that the force of the prestressing steel shall not be less than the value shown on the approved installation drawings. The maximum temporary tensile stress (jacking stress) in prestressing steel shall not exceed 80 percent of the specified minimum ultimate tensile strength of the prestressing steel. The prestressing steel shall be anchored at initial stresses in a way that will result in the ultimate retention of permanent forces, not less than those shown on the approved installation drawings, but in no case shall the initial stress at the anchors, after anchor set, exceed 70 percent of the specified minimum ultimate tensile strength of the prestressing steel. Permanent force and permanent stress will be considered as the force and stress remaining in the prestressing steel after all losses, including creep and shrinkage of concrete, elastic shortening of concrete, relaxation of steel, losses in post-tensioned prestressing steel due to sequence of stressing, friction and take-up of anchorages, and all other losses peculiar to the method or system of prestressing have taken place or have been provided for.

8.5.3.3 Friction

When friction must be reduced, water soluble oil or graphite with no corrosive agents may be used as a lubricant subject to the approval of the DCES. Lubricants shall be flushed from the duct as soon as possible after stressing is completed by use of water pressure. These ducts shall be flushed again just prior to the grouting operations. Each time the ducts are flushed, they shall be immediately blown dry with oil-free air. The Contractor shall submit a plan for capturing all fluids generated by the flushing method for approval by the Engineer. No lubricants or flushing water will be allowed to enter any waterways or environmentally sensitive areas.

8.5.3.4 Stressing Jacks

Each jack used to stress tendons shall be equipped with a pressure gauge having an accurately reading dial at least 6 inches in diameter for determining the jack pressure or jack force.

8.5.3.5 Calibration

Prior to use for stressing on the project, each jack and its gauge shall be calibrated as a unit by a testing laboratory approved by the DCES. Calibration shall be done with the cylinder extension approximately in the position that it will be when applying the final jacking force and with the jacking assembly in an identical configuration to that which will be used at the job site (i.e., same length hydraulic lines). Certified calibration calculations and a calibration chart shall be furnished to the Engineer/Inspector for each jack.

8.5.3.6 Recalibration

Recalibration of each jack shall be done at six-month intervals and at other times when requested by the Engineer/Inspector. At the option of the Contractor, calibrations subsequent to the initial laboratory calibration may be accomplished by the use of a master gauge. The master gauge shall be supplied by the Contractor in a protective waterproof container capable of protecting the calibration of the master gauge during shipment to a laboratory. The Contractor shall provide a quick-attach coupler next to the permanent gauge in the hydraulic lines which enables the quick and easy installation of the master gauge to verify the permanent gauge readings. If any repair to, or modification of, a jack is accomplished, such as replacing the seals or changing the length of the hydraulic lines, the jack shall be recalibrated by the approved testing laboratory. No extra compensation will be allowed for the initial or subsequent jack calibrations or for the use and required calibration of a master gauge.

8.5.3.7 Stressing of Tendons

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.

The tensioning process shall be conducted so that the tension being applied and the elongation of the prestressing steel may be measured at all times. A permanent record shall be kept of gauge pressures and elongations at all times and shall be submitted to the Inspector. A stressing report (see **Appendix E**) shall be completed by the Contractor and presented to the Inspector. The post-tensioning force may be verified as deemed necessary by the DCES. The tendon force measured by gauge pressure shall agree within five percent of the theoretical elongation or the entire operation shall be checked and the source of error determined and remedied to the satisfaction of the Inspector before proceeding with the work. Elongations shall be measured to the nearest 0.01 inch. Equipment for tensioning the tendons must be furnished by the manufacturer of the system. Should agreement between gauge readings and measured elongations fall outside the acceptable tolerance, the Inspector may require, without additional compensation to the Contractor, additional in-place friction tests in accordance with this specification.

In the event that more than two percent of the individual strand wires in a tendon break during the tensioning operation, the strand (or strands) shall be removed and replaced. Previously tensioned strands shall not be allowed unless approved by the Inspector.

Post-tensioning bars used to apply temporary post-tensioning may be reused if they are undamaged.

Prestressing steel shall be cut using an electric powered saw between 3/4 inches to 1-1/2 inches from the anchoring device, or as shown on the installation drawing.

8.5.3.8 Duct Field Pressure Test

After stressing and prior to grouting internal or external tendons, install all grout caps, inlets and outlets and test with compressed air to determine if duct connections require repair. Pressurize the duct to 50 psi and lock off the outside air source. Record the pressure loss for five minutes. A pressure loss of 30% or less is acceptable. If pressure

loss exceeds the allowable, repair leaking duct connections using methods approved by the Engineer.

8.5.3.9 In Place Friction Test

For tendons in excess of 100 feet long, test in place a minimum of one tendon in each tendon group performing the same function. Functional tendon groups are cantilever tendons, continuity tendons, draped external tendons or continuous profiled tendons passing through one or more spans. The selected tendon will represent the size and length of the group of tendons being tested. The in-place friction test is not required on projects with straight tendons used in flat slabs or precast voided slabs.

The test procedure consists of stressing the tendon at an anchor assembly with a load cell or a second certified jack at the dead end. Stress the test specimen to 80% of ultimate tendon strength in eight equal increments. For each increment, record the gauge pressure, elongations and load cell force. Take into account any wedge seating in both the live end (i.e., back of jack) and the dead end (i.e., back of load cell) and any friction within the anchorages, wedge plates and jack as a result of slight deviations of the strands through these assemblies. For long tendons requiring multiple jack pulls with intermediate temporary anchoring, keep an accurate account of the elongation at the jacking end allowing for intermediate wedge seating and slip of the jack's wedges. If the elongations fall outside the $\pm 5\%$ range compared to the anticipated elongations, contact the DCES for directions on how to proceed. The apparatus and methods used to perform the test must be submitted to the Engineer for approval. Tests must be conducted in the Engineer's presence.

8.6 GROUTING OF DUCTS

Grouting operations shall be performed under the direct supervision of a person who is currently an ASBI (American Segmental Bridge Institute) Certified Grouting Technician or possesses a PTI (Post-Tensioning Institute) Level 2 Bonded PT – Field Specialist certification. Written proof of certification shall be presented to the Engineer prior to beginning work.

After post-tensioning and anchoring has been completed and accepted, the duct shall be grouted in accordance with this specification. In the interval between the post-tensioning and grouting operations, the prestressing steel shall be protected. Within four hours after post-tensioning grout caps are installed, all grout vents of each duct shall be temporarily sealed with plugs to prevent entrance of air or water. The plugs shall be left in place until just prior to duct grouting. If tendon contamination occurs, the tendon shall be removed and replaced.

8.6.1 Batching Equipment

Equipment for batching component materials shall be capable of accurately measuring and dispensing the materials.

8.6.2 Mixer

The mixer shall be capable of continuous mechanical mixing of the ingredients to produce a grout which is free of lumps and in which the ingredients are thoroughly dispersed.

8.6.3 Screen

The grouting equipment shall contain a screen having clear openings of 1/8 inch maximum size to screen the grout prior to its introduction into the grout pump. If a grout with a thixotropic additive is used, a screen opening of 1/4 inch is satisfactory. This screen shall be easily accessible for inspection and cleaning.

8.6.4 Grout Pump

Grout pumps shall be capable of pumping the grout in a manner which complies with the provisions of this specification. Pumps shall be a positive displacement type capable of producing an outlet pressure of not less than 150 psi and shall have seals which are adequate to prevent introduction of oil, air or other foreign substance into the grout and to prevent loss of grout or water. Backup pumps shall be available.

8.6.5 Pressure Gauge

A pressure gauge having a full scale reading of no greater than 300 psi shall be placed at some point in the grout line between the pumping outlet and the duct inlet. The grouting equipment shall utilize gravity feed to the pump inlet from a hopper attached to and directly above it. The hopper must be kept at least partially full of grout at all times during the pumping operation to prevent air from being drawn into the post-tensioning duct.

8.6.6 Pipes and Other Fittings

Pipes or other suitable devices shall be provided for injection of grout and to serve as vent holes during grouting. The material for these pipes shall be at least 1/2 inch inside diameter and may be either metal or a suitable plastic which will not react with the concrete or enhance corrosion of the prestressing steel and is free of water soluble chlorides. These pipes shall be fitted with positive mechanical shut-off valves capable of withstanding grouting pressures. All connections between a grout pipe and a duct shall be made with metal or plastic structural fasteners and taped with a waterproof tape as necessary to assure a watertight connection.

8.6.7 Mixing Grout

The sequence for charging the mixer shall be to add water, start the mixer and then add cement. When cement and water are reasonably well mixed, admixtures shall be introduced in accordance with written instructions of the manufacturer of each admixture. The mixing procedures shall avoid having the admixture catch on the blades or the sides of the mixing drum and from forming gel globules. The mixing procedure may be varied in accordance with the written recommendations of the manufacturer of the admixtures. The grout shall be mixed until a uniformly blended mixture is obtained and shall be continuously agitated until it is introduced into the grout pump. Batches of grout shall be placed within 30 minutes of completion of mixing. No water shall be added to the grout to modify its consistency after the initial mixing operation is completed.

8.6.8 Cleaning and Flushing Tendons

If a water-soluble lubricating oil or corrosion inhibiting oil is applied to the prestressing steel or an embedded tendon is discontinuous through a joint between segments, the tendon shall be flushed as provided below.

Immediately prior to grouting operations, the inside of the tendon shall be flushed with water meeting the requirements of this specification (under pressure) to remove all traces of the corrosion inhibitors used to protect the prestressing steel. Flushing operations shall continue until the discharge water is free of any traces of the corrosion inhibitor. All water containing corrosion inhibitor chemicals shall be collected in containers and disposed of as required by governmental regulations. Following the cleaning operations, water shall be totally drained from within the tendon and it shall be blown out with compressed oil-free air to the extent necessary to dry the prestressing steel and the inside surfaces of the pipe.

8.6.9 Placing Grout

Grouting shall start at the lowest injection point with all vent holes open. The pumping pressure through the pipe shall be maintained until grout is continuously wasted at the next vent hole and no visible slugs or other evidence of water or air are ejected and the grout being ejected has the same consistency as the grout being injected. The vent valve shall then be closed, the pumping pressure held momentarily and the valve at the injection port closed.

8.6.9.1 Pressure

The pumping pressure at the tendon inlet shall not exceed 250 psi, however, normal operations shall be performed at 72 psi. If the actual grouting pressure exceeds the maximum recommended pumping pressure, grout may be injected at any vent hole which has been or is ready to be closed as long as a one-way flow of grout is maintained. When one-way flow of grout cannot be maintained, the grout shall be immediately flushed out of the duct with water. The shut-off valves on the pipes serving as injection ports or vent ports shall not be opened until the grout has taken its final set.

8.6.9.2 Temperature

When it is anticipated that the air temperature will 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 is below 45° F. The temperature of the concrete or air surrounding the tendon shall be maintained at 35° F or above from the time grout is placed until the compressive strength of the grout, as determined from tests on 2 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 exceeds 90° F. It may be necessary to chill mixing water or take other special measures to lower the temperature of the grout.

8.6.10 Protection of Prestress Anchorages

As soon as possible after tensioning and grouting is completed, but not exceeding 14 days, exposed end anchorages, strands, and other metal accessories shall be cleaned of rust, misplaced mortar, grout, and other such materials. Immediately following the cleaning operation, the entire surface of the anchorage recess (all metal and concrete) shall be thoroughly dried and uniformly coated with an epoxy bonding compound conforming to AASHTO Specification M235, Class III in accordance with the manufacturer's recommendations.

Immediately following application of the epoxy bonding compound, tight-fitting forms shall be installed and the anchorage recess shall be filled with a non-shrink cement based grout. The grout shall meet the requirements of § 701-05 or 701-06.

8.6.11 Post-Grouting Operations and Inspections

Grouted tendons shall not be subjected to construction loading causing shock vibration within 48 hours of grouting or a test is performed to insure the grout has achieved its

final strength requirements consistent with the material requirements for Section **4.6.4 Grout for Post-Tensioning Ducts.**

Inlets and outlets shall not be removed or opened until the grout has cured for a minimum of 24 to a maximum of 48 hours. After the grout has set, pipes used as injection or vent ports shall be cut off. Metal pipes shall be cut off 1 inch below the surface of the concrete. Plastic pipes shall be cut off flush with the surface of the concrete. After the grout has cured, drill into all outlets located at anchorages and high points along the tendon. Unless grout caps are determined to have voids by sounding, do not remove or drill the cap. Jointly, with the Engineer, visually inspect for voids in the grout using an endoscope grouting process. If voids are found, fill the void with epoxy using the volumetric metering vacuum grouting process. If no voids are found, clean and backfill the drilled hole with a pre-approved epoxy. Use an injection tube to extend to the bottom of the drill hole. During the drilling operations, use equipment that shall automatically cut off when steel is encountered.

Post grouting inspection of tendons having a length of less than 150 feet may utilize the following statistical frequency for inspection.

- For the first 20 tendons, inspect all outlets located at anchors and tendon high points by drilling and proving with an endoscope or probe. If one or more of the inspection locations are found to contain a defect (void), repeat this step (100% inspection) until no defects are detected.
- When no defects are detected as defined above, then the frequency of inspection can be reduced to inspect every other tendon (50%). If a defect is located, inspect 100% of the last five tendons grouted. Return to step 1 above and renew the cycle of 100% tendon inspection.

All inlets and outlets shall be inspected for vertical tendons in substructures. If tendon

grouting operations were terminated without completely filling the tendon, drill into the duct and explore the voided areas with an endoscope or probe. Determine the location, length and ends of all voided areas. Install grout inlets as needed and fill the voids using the volumetric metering vacuum grouting.

8.6.12 Grouting Report

After the grouting operation has been completed, the Contractor shall supply the Grouting Report to the Engineer within 72 hours of each grouting operation.

Report the theoretical quantity of grout anticipated as compared to the actual quantity used to fill the duct. Notify the Engineer immediately of shortages or overages.

Information to be noted in the report shall include, but not necessarily be limited to the following:

- Project name and contract number;
- Name of Contractor and/or Subcontractor;
- Location of grouting operations;
- Identification of the tendon;
- Date and time of starting and completing grouting operations;
- Type of grout, including any admixtures, if any;
- Tendon(s) grouted;
- Negative air pressure of the pump;
- Injection end and applied grouting pressure;
- Ratio of actual to theoretical grout quantity;
- Weather conditions;
- Technical personnel supervising and/or carrying out operations (personnel must have ASBI or PTI certification to fulfill this requirement);
- Results of the QC Tests conducted;
- Summary of any problems encountered and corrective action taken.

8.7 INSTALLATION OF SEGMENTAL BOX GIRDERS

Installation of match cast units shall be according to the installation drawings approved by the DCES and meeting the requirements of this specification and erection drawing approved by the Regional Director.

8.7.1 Installation Tolerances

- The maximum differential between outside faces of adjacent segments in the erected position shall not exceed 1/4 inch.
- Transversely, the angular deviation from the theoretical slope difference between two successive segment joints shall not exceed 0.05 degrees.
- Longitudinally, the angular deviation from the theoretical slope between two successive segments shall not exceed 0.2 degrees.
- The horizontal and vertical position of a pier segment (superstructure segment which rests on a pier) shall be within 1/8 inch of the longitudinal alignment, grade and cross-slope required by the approved erection plans. These tolerances are for relative location of control points, not absolute location.

8.8 INSTALLATION OF REINFORCED CONCRETE SPAN UNITS (THREE-SIDED STRUCTURES)

Installation of Reinforced Concrete Span Units shall be according to the installation drawings approved by the DCES and the requirements of §562. The footing keyways shall be shimmed and grouted prior to release of any temporary horizontal restraints.

SECTION 9

CONTRACTOR'S DESIGN CALCULATIONS

Design calculations meeting the requirements of this section shall be submitted when required by the DCES. The contractor shall submit calculations in electronic format (PDF files). Electronic submissions shall be made using the Department's current electronic file management system. Contact the Concrete Engineering Unit for information on electronic submissions. Design calculations are required under the following circumstances:

- When precast components are designed or analyzed by the Contractor or the Contractor's representative. Calculations shall address all loading conditions including temporary conditions occurring during lifting and handling of the units, storage, shipping, erection and stage construction.
- When required by specification.
- When changes of structural significance (as determined by the DCES) are submitted for review and approval by the DCES. Determination by the DCES that a change is structurally significant will be final.
- When Value Engineering or Substitution proposals involving precast concrete items are submitted for review and approval by the DCES.
- When repair procedures of structural significance (as determined by the DCES) involving precast concrete items are submitted for review and approval by the DCES. Determination by the DCES that a repair procedure is structurally significant will be final.
- When calculations are required in accordance with Section **2.3**

INSTALLATION DRAWINGS.

The Concrete Engineering Unit will normally take one work day for the examination of every four sheets in a complete set of design calculations, with a minimum of ten work days per set. A set of design calculations is defined as all calculation sheets received by the DCES for a particular item in a contract. The actual time taken for the examination of design calculations can vary greatly depending on the complexity of the design, the

construction schedule, the fabricator's production schedule, and the Concrete Engineering Unit's workload. Calculations which include output from computer programs which have not been previously reviewed and accepted by the DCES will take considerably more time to review.

Design calculation submissions shall include a cover sheet, a design/analysis summary, calculation sheets, design sketches, and the input and output from any computer program that is used.

9.1 COVER SHEET

The cover sheet shall include:

- Names of the designer and checker including the designer's address, phone number and e-mail address.
- Total number of sheets included in the package.
- Name of the bridge, Bridge Identification Number (BIN), Project Identification Number (PIN), and NYSDOT contract number.
- Design specification.
- Design loadings.
- Original signature with stamp of a Professional Engineer registered to practice in New York State.

9.2 DESIGN / ANALYSIS SUMMARY

The summary shall include:

- Names of components designed/analyzed and references to all controlling specifications.
- Materials to be used in the design along with minimum strength requirements and/or allowable stresses under various loading combinations.
- Soil parameters to be used in the design as well as assumptions related to soil structure interaction.
- Assumptions related to the geometry of the component.
- Assumptions related to boundary conditions of the component designed.

- Principles related to distribution of loads, computation of impact factors, etc.
- Explanation of analysis of various loading conditions during critical construction phases, including fabrication, lifting & handling, transportation and erection of components designed.
- Method of analysis of long-term performance of the structure including creep, shrinkage and temperature effects.
- Design assumptions related to crack control.

9.3 CALCULATION SHEETS

Calculation sheet requirements:

- All sheets shall be sequentially numbered, dated with a common date and shall clearly show the initials of the designer and the checker.
- Note reference to the appropriate sections of the design specifications.
- When information outside of the design specification is used, the source should be documented. Include relevant information from the source in an Appendix, if appropriate. An explanation justifying its use shall be included.
- Any corrections on the calculation sheets shall be initialed and dated by both the designer and the checker. Any set of calculations is not expected to have a significant number of corrections.

9.4 DESIGN SKETCHES

The submitted package should include design sketches showing the following:

- Geometry of the component designed.
- Critical sections considered in the design.
- Required type and quantity of reinforcement at various locations.
- Cover requirements.
- Table of controlling shears and moments at critical sections.
- Limitations on loading during construction and necessary precautionary measures during shipping, lifting & handling, transportation and installation. Limitations shall be clearly stated on these sketches, and shall be carried over to detail drawings/installation drawings, and erection drawings.

9.5 USE OF COMPUTER PROGRAMS

Computer generated output included in any calculation package shall be from a computer program acceptable to the NYSDOT Office of Structures. Commercially available general structural analysis programs may be used after confirming the acceptability of these programs with the DCES.

- State the name of the programs, with reference to the NYSDOT Office of Structures' communications expressing the acceptability of the program.
- Input data sheets shall precede each run of the program.
- All hand calculations and sketches used for developing the input data shall be included.
- All input data sheets, hand calculations, sketches, computer outputs, etc. shall be numbered, dated and initialed by both designer and checker.
- All critical information on the output data shall be highlighted. If any such data is used for other calculations or development of design sketches, show the page number on which such use is being made.

9.6 OFFICE OF STRUCTURES' REVIEW OF COMPUTER PROGRAMS

Computer programs submitted for review and acceptance by the Office of Structures shall include:

- The name of the program, version number, developer, owner, date of most recent update, and operating system(s) on which the program will run.
- The type of structural elements to be designed and/or analyzed by the submitted program including the range of sizes of these elements.
- Name(s) of other governmental agencies that have approved or accepted this program.
- Explanation of limitations of the program.
- Explanation of the logic the program uses to produce the design/analysis. This explanation shall include:
 - o The design specification on which the program is based.
 - o Significant assumptions used in the design.
 - o Equations, including identification of constants and variables.

- o An explanation of input required to produce a correct design/analysis.
- o An explanation of the output of the program, including identification of all critical values, reinforcement requirements, and all other design output.

9.7 VERIFICATION OF COMPUTER PROGRAMS

The verification of the computer program shall be established by providing a number of sample designs ranging from the smallest to the largest size of the element to be designed by the program. The submitted sample designs shall be independently verified by the submitter using one of the following methods:

- Using hand calculations prepared by a Professional Engineer registered in New York State.
- Using another design/analysis program accepted by NYSDOT Office of Structures for design/analysis of similar structural elements.
- Using calculations in a design example from a published textbook, or other verification acceptable to the DCES.

The submitted information shall be stamped and signed by a Professional Engineer registered in New York State.

The submitted set shall have a minimum of five independently verified sample designs evenly distributed in the size range. The DCES may request additional sample designs when deemed necessary.

9.8 ACCEPTANCE OF COMPUTER PROGRAMS

When the DCES is satisfied that the program is capable of consistently producing designs and/or conducting analysis meeting the design criteria, a letter stating the acceptance of the program will be issued to the submitter of the program. All design calculation submissions utilizing the program shall include a copy of this letter.

Changes made to a computer program subsequent to the Office of Structures' determination of acceptability shall void that determination.

Acceptance of a computer program by NYSDOT in no way implies that the Department assumes responsibility for the accuracy, the internal logic or the output of that program.

APPENDIX A

DEFINITIONS

§

Symbol indicating particular sections referred to in the NYSDOT Standard Specifications, Construction and Materials.

A

AASHTO

American Association of State Highway and Transportation Officials

ACI

American Concrete Institute

Admixture

A material other than water, aggregates, or hydraulic cement, used as an ingredient of concrete or grout and added to concrete or grout before or during its mixing to modify its properties.

Ambient Temperature

The temperature of the surrounding air and of the forms into which concrete is to be cast.

Anchor Cavity

The opening in the anchor or anchor block designed to accommodate the strand passing through the proper seating of the wedges.

Anchor Nut

Threaded device that screws onto a threaded bar and transfers the force from the bar to the bearing plate.

Anchorage

A mechanical device comprising all components required to anchor the prestressing steel and permanently transfer the post-tensioning force from the prestressing steel to the concrete.

Anchorage Bursting (Splitting) Force

Tensile force in the anchorage zone acting ahead of an anchorage device and is orthogonal to the axis of the tendons. Bursting forces are typically resisted by special reinforcement (spirals, closed hoops, anchored transverse ties, etc.) provided in the anchorage zone.

Anchorage Zone

The portion of the member through which the concentrated prestressing force is transferred to the concrete and distributed more uniformly across the section. Its extent is equal to the largest dimension of the cross section. For anchorage devices located away from the end of the member, the anchorage zone includes the disturbed regions ahead of and behind the anchorage.

Anticipated Set

The expected movement of the wedges into the anchorage during the transfer of the prestressing force to the anchorage device.

ASBI

American Segmental Bridge Institute

ASTM

American Society for Testing and Materials

B**Bar Anchorages and Couplers**

Bar anchorages are simple devices based on the principle of a threaded rod secured against a distribution plate by a nut. These anchorages have a small anchor set (1/16 to 1/8 inches) that makes the bar tendon very suitable for short lengths. The anchor set can be reduced or even eliminated by giving special attention to tightening of the nut.

Bar - Post-Tensioning

High strength steel bars with a typical tensile strength of 150,000 psi. Available sizes range from 5/8 to 1 3/8 inches diameter for deformed bars and 19 to 35 millimeters for plain bars, both with very coarse thread along their length. Bars are very versatile for both temporary and permanent post-tensioning applications.

Bearing Plate

A plate which bears directly against the concrete and is part of an overall anchorage system.

Blast Cleaning

Propelling water or an abrasive medium (such as sand or steel shot) at a high velocity against concrete to clean, roughen, or profile the surface. Methods include water blasting, power washing, pressure washing, sand blasting, shot blasting, and bead blasting.

Blister

A concrete buildup, normally attached to a slab, in which one or more anchorages are located.

Bursting Steel

Reinforcing steel used to control the tensile bursting forces developed at the bearing side of the anchor as the concentrated anchor force from the stressed tendon spreads out in all directions.

C**Cable**

A term used by some to denote a prestressing strand or a single-strand tendon.

Camber

The upward deflection that is caused by the application of prestressing force.

Casting Cell

Refers to 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 precast unit.

Casting Curve

The curve of casting geometry that shall be followed at the casting bed to achieve the theoretical profile after final deformations have taken place.

Check Prints

A set of shop drawings and installation drawings submitted by the contractor to, but not yet reviewed by, the Concrete Engineering Unit.

Chuck

A cylindrical metal device housing the wedges and normally used with a bearing plate to transfer the prestressing force to the concrete.

Concrete Engineering Unit

A unit in the Department's Office of Structures responsible for structural precast, pretensioned and post-tensioned concrete units.

Contract Documents

The contract documents shall include the advertisement for proposals, the Contractor's proposal, the agreement, Standard Specifications, the plans, any addenda and/or amendments to specifications and all provisions required by law to be inserted in the contract, whether actually inserted or not.

Whenever separate publications, AASHTO Specifications and the NYSDOT Standard Specifications are referenced in the contract documents, it is understood to mean the publication and specifications, as amended, which are current on the date of advertisement for bids.

Contractor

The individual, firm or corporation undertaking the execution of the work under the terms of the contract and acting directly or through agents or employees. The term Contractor may also be used to refer to the Contractor's chosen fabricator.

Coupler

A device designed to connect ends of two strands together, thereby transferring the prestressing force from end to end of the tendon.

Couplers for Strand Tendons

Couplers for strand tendons are normally formed by two special types of anchorages. The wedge plate of each anchorage assembly has the holes and wedges for the strands located along the outside in a circular pattern.

Creep

The time-dependent deformation of concrete under sustained stress (load).

CRSI

The Concrete Reinforcing Steel Institute

Curvature Friction

Friction resulting from bends and curves in the specified prestressing tendon profile.

D**DCES**

Deputy Chief Engineer (Structures), New York State Department of Transportation.

DCETS

Deputy Chief Engineer (Technical Services), New York State Department of Transportation.

Department

The New York State Department of Transportation, a word commonly used to mean the Commissioner of Transportation or the authorized representative.

Detensioning of Strand

Transfer of Prestress - The release of tension from the strand. The prestressing force is transferred from the bed anchorage to the individual pieces cast in the bed.

Detensioning Strength

The strength of the individual concrete pieces at the time the prestressing force is transferred to them (See also **Transfer Strength**).

Deviation Saddle

A concrete block designed to attach external tendons to a concrete structure. This block handles a change of alignment of the external tendon. The duct inside the deviation block will normally be a galvanized steel pipe.

Duct

A conduit (plain or corrugated) to accommodate prestressing steel for post-tensioning installation.

Dynamometer

A device which will measure the tension applied to it when it is connected between two tensile forces.

E**Elongation**

Increase in the length of the prestressing steel under the applied prestressing force.

Engineer (EIC) or Engineer-In-Charge

The Engineer representing the NYS Department of Transportation having direct supervision of the execution of the contract under the direction of the Regional Director.

Exposed Aggregate Finish

The removal of cement paste to a specified depth by mechanical or chemical means

F**Fabricator**

Any firm or corporation whom the Contractor retains to fabricate the precast and/or prestressed concrete units.

FHWA

The Federal Highway Administration

FIB

The International Federation for Structural Concrete (FIB - Fédération Internationale du Béton) is a not-for-profit organisation created in 1998 from the merger of the Euro-International Committee for Concrete (CEB - Comité Euro-International du Béton) and the International Federation for Prestressing (FIP - Fédération Internationale de la Précontrainte).

Field Cast Joint

A reinforced joint between two precast concrete units used to transfer both shear and moment loads from one unit to the other. Field cast joints are typically filled with concrete or some other cementitious material.

Final Prestress

The prestressing force in the concrete after substantially all losses have occurred.

Finishing

Leveling, smoothing, filling in surface imperfections, and otherwise treating the surface of newly placed concrete to produce the desired appearance.

Fixed-End Anchorage

An anchorage at the end of a tendon where stressing jack is not attached during stressing operations. Fixed-end anchorages are typically attached to the strand at the fabrication plant (Dead-End Anchorage).

Flexible Ducts

Flexible duct must be made of corrugated metal for greater flexibility. Flexible duct is made of a much thinner material that can be damaged easily during the casting of concrete units. Therefore, it should be stiffened by mandrels, the tendons themselves, or other methods to prevent crushing during the casting. Flexible duct must be supported at intervals of 16 inches. Larger intervals are possible depending on the material used for stiffening the ducts.

Form Release Agent

A substance applied to the forms for the purpose of preventing bond between the form and the concrete cast in it.

 f_{pu}

Specified tensile strength of pre-stressing steel (for prestressing strand this is typically 270 ksi and for prestressing bars 150 ksi).

G**GGBFS**

Ground-granulated blast-furnace slag (GGBS or GGBFS) is obtained by quenching molten iron slag (a by-product of iron and steel-making) from a blast furnace in water or steam, to produce a glassy, granular product that is then dried and ground into a fine powder.

Grips

The parts of a strand vise which actually contact or grip the wires or strands.

Grout

A mixture of Portland Cement and water and admixtures. The ratio normally used is one bag of cement and up to five gallons of water with appropriate quantity of an admixture as approved by DCES. The water/cement ratio shall not exceed 0.40, and shall meet all the specified requirements in the contract document.

Grouting

Filling the space inside a duct and around the post-tensioned tendons with a mixture of Portland cement, admixture(s) and water. The grout protects the tendon from corrosion and also establishes a firm bond between tendon and concrete.

H**Honeycombing**

Voids in the concrete caused by inadequate consolidation.

HPC (High Performance Concrete)

A type of concrete designed to provide several benefits in the construction of concrete structures. These benefits include early high strength, long-term mechanical properties, toughness, volume stability, ease of placement and consolidation without affecting strength, and longer life in severe environments.

I**Initial Prestress**

The force in the tendon immediately after transferring the prestressing force to the concrete. This occurs after the wedges have been seated.

Inlet

Opening used to inject grout into the duct.

Inspector

Person designated by the Fabricator or the State to determine the compliance of the fabricated item with the contract requirements.

Installation Drawings

Drawings furnished by the Contractor, showing a detailed step-by-step description of the Contractor's proposed installation procedure. The installation drawing submission may include supporting documents in non-drawing format.

Intermediate Anchorage

An anchorage located at any point along the tendon length, which can be used to stress a given length of tendon without the need to cut the tendon. Normally used at concrete pour breaks.

J**Jack**

A mechanical device (normally hydraulic) used to apply force to a prestressing tendon.

Jack Calibration

A chart showing related gauge pressure to actual force applied to a tendon.

K**Keyway**

A recess or groove in a precast or prestressed unit which is filled with grout during construction and used to transfer shear force between adjacent units.

L

Load Cell

A sensitive electrically operated strain gauge attached to a calibrated cell to provide direct readings of loads applied to the cell.

Local Authority

County, city, town, village or other public agency, public authority or nonprofit organization authorized and designated under its agreement with NYSDOT to design, acquire ROW, advertise, open bids, award, and administer contracts for federal aid transportation projects. The administering agency may also be referred to as the local public agency, agency, local government, municipality, owner, or sponsor.

Loss of Prestress

The reduction of the prestressing force resulting from the combined effects of relaxation in the tendons, creep and shrinkage in the concrete and elastic deformation of the concrete.

M

Match-cast

A precast concrete fabrication procedure whereby a segment is cast against the preceding segment, thereby producing a matching interface that for superstructure segments will permit re-establishment of the cast geometry at the time of erection.

Material Certifications

Documentation from the manufacturer that confirms that the quality of material supplied meets all project requirements.

Materials Bureau

The Department's Materials Bureau is responsible for the quality assurance program for materials to be used on the contract and maintains a testing facility in Albany, New York.

Microsilica

Microsilica is an ultrafine powder collected as a byproduct of producing silicon metal or ferrosilicon alloys. Because of its extreme fineness and high silica content, silica fume is a very effective pozzolanic material. Microsilica is added to Portland cement concrete to improve its properties, in particular its compressive strength, bond strength, and abrasion resistance.

Modulus of Elasticity

Ratio of stress to corresponding strain for tensile or compressive stresses below the proportional limit of material.

N

NEXT Beams (Type D & F)

Northeast Extreme Tee (NEXT) Beam. The D Beam (Deck Beam) is a beam with an integral full-depth flange that acts as the structural bridge deck. This allows the bridge to be ready for traffic soon after the beams are erected. The F Beam (Flange Beam) is a beam with a partial-depth flange which serves as the formwork for a conventional cast-in-place reinforced concrete deck. This results in a monolithic deck surface at the expense of a few extra days of site construction. The top flange of the F Beam eliminates the need for deck forming (including the overhang), which is a tremendous time saver.

NYSDOT

The New York State Department of Transportation

O

Office of Structures

An Office in the Department's Engineering Division

Outlet

Opening to allow the escape of air, water, grout and bleed water from the duct during grouting operation.

Oxidative Induction Time (OIT) Test

A standardized test performed using differential scanning calorimetry that measures the level of stabilization of the material tested.

P

PCANY

The Precast Concrete Association of New York

PCCM

The Prestressed Concrete Construction Manual

PCEF

Prestressed Concrete Committee for Economical Fabrication

PCI

Precast/Prestressed Concrete Institute

Plans

The official contract drawings and applicable Standard Sheets that show the location, character, dimensions and details of the work to be performed.

Polyethylene Ducts

Polyethylene ducts are available for most applications. The most common one is for the transverse post-tensioning of a bridge deck. It is often specified for this purpose, since it cannot corrode. This type of duct, like most other types, is available corrugated, circular, or flat. Polyethylene ducts are not suitable when curvature of the tendon is less than 30 feet, since the material cannot withstand the high contact pressures.

Post-Tensioning

Method of prestressing in which prestressing steel is tensioned after concrete has hardened.

Pozzolan

Pozzolans are a broad class of siliceous or siliceous and aluminous materials which, in themselves, possess little or no cementitious value but which will, in finely divided form and in the presence of water, react chemically with calcium hydroxide at ordinary temperature to form compounds possessing cementitious properties.

Prestressing Steel

High-strength steel, most commonly a seven-wire strand, used to impart prestress forces to concrete.

Prestressed Concrete

Structural concrete in which internal stresses are introduced to reduce potential tensile stresses in concrete resulting from applied loads.

Pretensioning

A method of prestressing in which the tendons are tensioned before the concrete has been placed.

Proposal

The offer of the bidder for the work, when executed and submitted on the prescribed form on which the Department requires formal bids to be prepared and submitted for the work.

Proving Ring

An elastic alloy steel ring used to calibrate or measure loads. A dial indicator inside the ring measures deflection under load and calibration curves enable direct determination of load. Standard high capacity rings, certified by the National Bureau of Standards, and accurate to 0.1 of 1%, are used to calibrate mechanical force measuring systems.

Q**Quality Assurance (QA)**

Actions taken by the Owner or his representative to provide assurance to the owner that the work meets the project requirements and all applicable standards of good practice.

Quality Control (QC)

Actions taken by the Contractor to ensure that the work meets the project requirements and all applicable standards of good practice.

R**Regional Director**

The Director, acting through the Commissioner, who is delegated the authority and responsibility to execute the total Department prescribed work plans for the respective Region.

Reinforcing Bar (Rebar)

A steel bar used as a tension device in reinforced concrete structures, to strengthen and hold the concrete in tension.

Relaxation Curves

The observed decrease in stress, in response to the same amount of strain generated in the structure. This is primarily due to keeping the structure in a strained condition for some finite interval of time and hence causing some amount of plastic strain.

Retempering

The addition of water and remixing of concrete which has started to stiffen in order to make it more workable.

Rigid Ducts

The most common type is the rigid metal duct. This may be a smooth or corrugated duct that is flexible enough to allow it to be bent to 10 feet minimum radius, but stiff enough to prevent it from sagging between supports. Rigid ducts can be placed in the concrete without using any inside stiffeners, provided they are tied firmly at intervals of approximately 30 inches to the rebar cage in order to maintain their positions.

S

S.G.

The specific gravity of a given material

SCC (Self-Consolidating Concrete or Self-Compacting Concrete)

A highly workable concrete that can flow through densely reinforced or complex structural elements under its own weight without vibration and adequately fill voids without experiencing segregation or excessive bleeding.

Seating Loss

The relative movement of the wedges into the anchor cavity during the transfer of the prestressing force to the anchorage resulting in some loss of prestressing force.

Segment

A modular section of the superstructure consisting of a certain cross-section shape and length as detailed in the plans.

Segmental Construction

Construction of a bridge using repetitive precast concrete elements that are progressively connected together to form a completed structure.

Shear Key

An unreinforced joint between two precast concrete units used to transfer shear loads from one unit to the other. Shear keys are typically filled with grout or some other cementitious material.

Sheathing

Enclosure around the prestressing steel which forms the void for an embedded tendon or provides protection for an external tendon.

Shop Drawings

Drawings furnished by the Contractor showing all the information necessary to fabricate precast or prestressed structural unit. Shop drawing submissions may include supporting documents in non-drawing format.

Short Line Casting

The method of casting segments one at a time on a casting bed utilizing a fixed or movable bulkhead. The first segment is cast between bulkheads and successive segments are cast, one at a time, against the bulkhead on one end and the repositioned, previously poured segment on the other end.

Standard Dimension Ratio

The ratio of a pipe's outside diameter to the pipe's wall thickness.

Strand

High-strength steel wires helically placed around a center wire. For unbounded tendons, typically a seven-wire strand.

Strand Slippage

Slippage or relative movement of strand with respect to wedges during force transfer. See **Seating Loss**.

Strand Vise

A device for holding a strand under tension.

Stressing

The process of tensioning tendons by attaching one or both ends to hydraulic jacks. The jacks are hydraulically extended using high pressure pumps until a predetermined force is applied to the tendon.

Stressing End

The end of the tendon at which the prestressing force is applied (Live End).

Stressing End Anchorage

The anchorage at the end of a tendon where the stressing jack is attached to the tendon during stressing operations (Live End Anchorage).

Stressing Equipment

Consists normally of a jack, pump, hoses, and a pressure gauge.

Stressing Pocket

The void created by the pocket former between the stressing anchor and the edge of the concrete to allow access for the stressing equipment. After stressing, this void is filled in with an approved grout to provide protection for the tendon end.

Stressing Report

A permanent record of the actual tendon elongations after stressing produced by the inspector.

Supporting Documents

Any additional informational intended to supplement shop or installation drawing submittals, such as design calculations, material test results, lifting and handling stress checks, and construction load checks on existing structures.

Surface Retarder - A chemical applied to the surface of newly placed concrete to delay setting of the cement paste so it can be removed easily later by scrubbing or power washing to produce an exposed aggregate finish.

T**Tendon**

In post-tensioned applications, the tendon is a complete assembly consisting of anchorages, prestressing steel, and sheathing with post-tensioning coating for unbonded applications or ducts with grout for bonded applications.

Transfer Strength

The strength of the individual concrete pieces at the time the prestressing force is transferred to them (see also **Detensioning Strength**).

U

UHPC

Ultra High Performance Concrete is a cementitious composite material composed of an optimized gradation of granular constituents, a water-to-cementitious materials ratio less than 0.25, and a high percentage of discontinuous internal fiber reinforcement. UHPC has a discontinuous pore structure that reduces liquid ingress, significantly enhancing durability compared to conventional concrete.

Unbonded Tendon

Tendon in which prestressing steel is prevented from bonding to concrete and is free to move relative to concrete. The prestressing force is permanently transferred to concrete at the tendon ends by the anchorages only.

W

Wedge Plate

The hardware which holds the wedges of a multi-strand tendon and transfers the tendon force to the bearing plate.

Wedge set

The length by which a wedge is pulled into the wedge plate when the strand is released from the jack at the end of stressing operation. Typically, this is about 1/4 to 3/8 inches, depending upon the post-tensioning system. The lower set occurs when power seating is used. This effect causes a loss of prestressing force in the strand that has to be considered in the design and stressing of the tendon. Wedge set is also referred to as “anchor set”.

Wedges

Pieces of tapered metal with serrations, which bite into the prestressing steel (strand) during transfer of the prestressing force.

Wet-Mix Concrete

Concrete mixtures designed for typical water-cement ratios, slumps and handling and consolidation methods.

Wire

The basic component of a strand, although some proprietary post-tensioning systems are made up of individual wires or groups of straight wires. Wire for strand typically has an ultimate strength of 1860 MPa. Low relaxation wire is now standard for NYSDOT work.

APPENDIX B

SAMPLE INSPECTION REPORT



New York State Department of Transportation

Concrete Inspection System

Date:

Matthew J. Driscoll
Commissioner

Inspection Report for Piecemark: B4

Approval No.: SAMPLE

Item No.: 563.06010016 Prestressed Concrete Deck Bulb Tees

Engineer:

Contractor:

Contract Type: ENGLISH

Organization: NYSDOT

PIN:

Fabricator:

Contract:

County:

Inspectors:

Materials Association

Approved List Code	Description	Certification Detail
4048	Viscocrete 2100 Sika HRWR	HRWR Concrete Admixture Sika Corp
2016	Plastiment Sika Corp	Set retarder Admixture Sika Corp
6-49G	Coarse Aggregate	Buffalo Crushed Stone Alfred, Ny Test#12AG16C Source # 6-49G
6009	SikaCrete 950DP	SikaCrete 950DP Densified Silica Fume
709-06	Strand Tech Martin Summerville, SC	.6" 270KSI Low-relax ASTM A416 Pre-Stressing Strand Lot#: DL15104155
709-13	Salit Specialty Rebar	Stainless Reinforcing ,Couplers,Lenton Threaded Inserts Grade XM28 #4, #5, & #6 Reinforcement
32	Essroc Type II Cement	Type II Cement .70 or less alkali Content from Essroc Picton, Ontario.
6-49F	Fine Aggregate Buffalo Crushed Stone	Fine Aggregate Test#12AF45 Source# 6-49F Buffalo Crushed Stone Alfred Ny.
0000	Well Water	Well Water
0000	Dayton Superior	F-63 Coil Inserts 1/2" & FX-19 Meadowburke 7/8 ferrule inserts"
1051	Sika AEA-14	Air Entrainment Concrete Admixture Sika Corp
711-08	Sika CNI	Corrosion Inhibitor Concrete Admixture Sika Corp

Concrete Batch Association

Batch No.	Pour	# Cyls	Air	Slump	Temperature	Weight	Water Cementitious
06/13/2016 #B4(Load#1)	10:00 AM	10	6.0	9.0	79.0	144.28	0.30
Remarks	First of (2)loads B4-7 Test Time: 9:30 AM Microwave(w/c) and CNI(Hach) test performed on this batch.						
06/13/2016 #B4(Load#2)	10:00 AM	10	6.5	9.0	82.0	144.16	0.00
Remarks	Second of (2)loads B4-7 Test Time: 10:00 AM						



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Cylinder Strength Test

Batch No.	Test Time	Dial Reading	Cylinder Strength
06/13/2016 #B4(Load#1)	06/14/2016 03:00 AM	108355	8,620.00
Remarks	Exceeds minimum 7,000-PSI detensioning strength requirement at this time.(13 hrs of steam cure)		
06/13/2016 #B4(Load#1)	06/14/2016 03:00 AM	103830	8,260.00
Remarks	Exceeds minimum 7,000-PSI detensioning strength requirement at this time.(13 hrs of steam cure)		
06/13/2016 #B4(Load#2)	06/14/2016 03:00 AM	106605	8,481.00
Remarks	Exceeds minimum 7,000-PSI detensioning strength requirement at this time.(13 hrs of steam cure)		
06/13/2016 #B4(Load#2)	06/14/2016 03:00 AM	107325	8,538.00
Remarks	Exceeds minimum 7,000-PSI detensioning strength requirement at this time.(13 hrs of steam cure)		
06/13/2016 #B4(Load#1)	07/05/2016 10:00 AM	135430	10,774.00
Remarks	Exceeds minimum 10,000-PSI Shipping strength requirement at this time. Age at Test: 22 Days		
06/13/2016 #B4(Load#1)	07/05/2016 10:00 AM	135365	10,769.00
Remarks	Exceeds minimum 10,000-PSI Shipping strength requirement at this time. Age at Test: 22 Days		
06/13/2016 #B4(Load#2)	07/05/2016 10:00 AM	135495	10,779.00
Remarks	Exceeds minimum 10,000-PSI Shipping strength requirement at this time. Age at Test: 22 Days		
06/13/2016 #B4(Load#2)	07/05/2016 10:00 AM	135640	10,791.00
Remarks	Exceeds minimum 10,000-PSI Shipping strength requirement at this time. Age at Test: 22 Days		
Calculated Strength:			10,774.00

Pre-Pour Association

No.	Pre-Pour Description
06/14/2016	B4-7 6/10/16-Checked form pallet, drape points, and bulkheads once previous cast beam was removed and form was reset. Light coat of form release agent applied to form pallet once all debris was removed. -Observed the stranding of (40) .6" Low Relax Pre-Stressing strand(32 straight, 8 draped) into the form. Plant applied 3,000 lbs of force to straighten all strand. No crossed strand at this time. -Observed the initial and final tensioning operations to plant generated tensioning data sheet values. All strands were marked and pulled to calculated target force lbs. Measured all elongations and



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Pre-Pour Association

No.	Pre-Pour Description
	recorded values. All values within 3% of specified target elongations. No issues to note at this time. 6/11/16-Performed pre-pour check of bottom and web prior to closing of form. Reinforcing adjustments needed and made to meet proper spacing and coverage as per approved drawing. All dimensions are within allowable tolerance ranges of design. Form pallet was blown off and form walls were set and secured. -Monitored start of top flange setup. Checked all spacing, count, and coverage on all stainless reinforcing as it was installed and secured. Crew will finish remainder of setup early Monday morning. 6/13/16-Observed the re-tensioning of strands to calculated forces. Elongations were re-checked and very little movement discovered from first tensioning (.0625" - .125"). -Observed remainder of setup and performed final pre-pour of top setup once completed. Minor adjustments needed with reinforcement. All dimensions are within allowable ranges of design measurements. Once all was satisfactory, form was released for casting.

Pre-Tensioning

Last Update: 06/10/2016

Measurement	Value	UM
Strand Manufacturer	Strand Tech Martin	
Strand Type	.6" 270KSI 7W ASTM A416 Low-Relax	
Number of Strands	40	
Strand Area	0.217	
Strand Modulus	28.6	
Bed Number	BT	
Tensioning Type	INDIVIDUAL STRAND TENSIONING	
Required Jacking Force	43.8	
Ambient Temperature	65.0	
Bed Temperature	65.0	
Assumed Live End Slippage	0.25	
Adjusted Jacking Force	44.73	
Computed Required Elongation	10.69	
Bed Length	138.67	

Individual Strand Tensioning Last Update: 06/10/2016

Strand Id	Gauge Reading	Jacking Force	Seated Elongation
16-z	44730	44.73	10.38



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Inspectors:

29-z	44730	44.73	10.75
17-z	44730	44.73	10.38
28-z	44730	44.73	10.38
18-z	44730	44.73	10.5
27-z	44730	44.73	10.5
19-z	44730	44.73	10.38
26-z	44730	44.73	10.5
20-z	44730	44.73	10.5
25-z	44730	44.73	10.38
21-z	44730	44.73	11.0
24-z	44730	44.73	10.75
16-y	44730	44.73	10.38
29-y	44730	44.73	10.75
17-y	44730	44.73	10.38
28-y	44730	44.73	10.38
18-y	44730	44.73	10.5
27-y	44730	44.73	10.5
19-y	44730	44.73	10.38
26-y	44730	44.73	10.38
20-y	44730	44.73	10.63
25-y	44730	44.73	10.38
21-y	44730	44.73	10.38
24-y	44730	44.73	10.5
18-x	44730	44.73	10.56
27-x	44730	44.73	10.5
19-x	44730	44.73	10.5
26-x	44730	44.73	10.5
20-x	44730	44.73	10.56
25-x	44730	44.73	10.56
21-x	44730	44.73	10.56
24-x	44730	44.73	10.38
22-m	44730	44.73	10.25
23-m	44730	44.73	10.5
22-l	44730	44.73	10.5
23-l	44730	44.73	10.25



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Contractor:

Contract Type: ENGLISH

Organization: NYSDOT

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Fabricator:

Contract:

County:

Inspectors:

22-k	44730	44.73	10.25
23-k	44730	44.73	10.25
22-j	44730	44.73	10.75
23-j	44730	44.73	10.5

Concrete Observation

Last Update: 06/14/2016

Measurement	Value	UM
Placing	Observed placing of concrete in (2) lifts from concrete bucket suspended over form	
Consolidation	Plant used (1) internal and (2) external vibrators to consolidate concrete.	
Roughness of Top Surface	Top of beam recieved transverse rake finish.	
Initial Curing	Saturated burlap placed on direct concrete surface for moisture retention during cure.	
Final Curing	Plant will apply steam vapor cure once initial set of concrete is achieved.	
Temperature Recording	QC placed (2) temperature recorders at cylinder cure and Live end locations to monitor cure temps.	
Remarks	Weather: Overcast 60 Degrees Fahrenheit Start: 9:35 A.M. Finish (Covered): 11:15 AM 6/13/16-Observed all plastic concrete test for the (2) loads of concrete delivered in revolutionary drum mixer from batch plant for the casting of this beam . All test were within allowable specifications with no rejected material. CNI and Microwave(water/cement AASHTO T-138) were performed on first batch of the day. Total of (20) test cylinders were molded from for representation of piece for strength test verification.(10 from both loads) -Observed placing, consolidating, and finishing of all concrete. Plant placed concrete in (2) lifts with internal and external consolidation for every lift. Top of beam received mag float finish and then raked as specified on drawing. Once top surface was finished , rake finish was applied . Once all was satisfactory, saturated burlap placed on concrete surface and form work covered with insulated tarp.	



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Contractor:

Contract Type: ENGLISH

Organization: NYSDOT

PIN:

Fabricator:

Contract:

County:

Inspectors:

Post-Pour

Last Update: 06/14/2016

Measurement	Value
Camber	3.31" @ Release (Design: 2.64" +1", -.5")
Remarks	6/14/16-Observed the CST for release of beam. At time of test, AVG of (4) cylinders tested exceed minimum 7,000-PSI detensioning strength requirement. -Received and reviewed cure temperature charts with no discrepancies discovered during cure. -Observed removal of tarps, opening of form walls, and single strand detensioning of strands. Strands were released with flame cutting method with specified cutting sequence followed on drawing. Once all strands were free ,piece was lifted from casting bed with straddle cranes and transported to designated prep area. Checked camber of piece once beam was set on wood dunnage with results listed above. Camber is within allowable range at this time but will need to continuously be monitored. Complete post-pour not performed at this time due to top form walls still being on piece. Once all is removed, full post-pour evaluation will be performed. No major surface defects discovered at this time.

Miscellaneous Finishing Work: Last Update: 07/05/2016

Measurement	Value
Sealant Application	6/30/16-Observed the power-washing of all beam surfaces for sealer application preparation. Beam must remain dry for 24-hours before sealer can be applied. 7/2/16-Observed the application of (2) Coats of Sil-ACT ATS 100 to all surfaces of beam. Application between each coat was (2) hours once beam surfaces were completely dry in appearance from first coat.

Inspector Signature: _____

Date: _____

Inspector's Supervisor
Signature: _____

Date: _____

APPENDIX C

REPORT OF ACCEPTANCE/SHIPPING OF STRUCTURAL CONCRETE



New York State Department of Transportation

Concrete Inspection System

Date:

REPORT OF ACCEPTANCE/SHIPPING OF STRUCTURAL CONCRETE

Approval No.:

Item No.:

Inspector:

PIN:

Fabricator:

Contract:

Contractor:

County:

Organization

Contract Type

Structural Concrete Identification

Piece Mark	Date Cast

Remarks

I hereby certify: (a) that the material described herein has been inspected, sampled and tested in accordance with the terms of the current Agreement between the State and my company; (b) that this material has been found to conform to the requirements of the Contract Documents or approved Shop Drawings; and (c) that the accepted material bears the identifying mark of my Company.

Date of Final Examination:

Inspector's Name:

Inspector's Signature:

Part B Shipping Certification

I hereby certify: (a) that the material described herein has been inspected, sampled and tested in accordance with the specification for the product; (b) that this material has been found to conform to the requirements of the Contract Documents or approved Shop Drawings; and (c) that the accepted material has not been damaged since acceptance.

Remarks: _____

Camber: _____

Date Examined: _____ Date of Shipment: _____

Truck No. _____

Part B - QC Inspector's Signature: _____

Note: Shipping Certification not valid without QA Inspector's signature in Part A.

APPENDIX D

NOTICE OF DEFECT



New York State Department of Transportation

Concrete Inspection System

Date:

NOTICE OF DEFECT

Approval No.:

Item No.:

Inspector:

PIN:

Fabricator:

Contract:

Contractor:

County:

Organization

Contract Type:

Structural Concrete Identification

The following precast unit(s) do not conform to the Specifications and, according to Section 6.4 of the PCCM, are defective. Defective units that are repairable may be repaired by following the requirements of Section 6.4 of the PCCM. Defective units may also be replaced with a unit that does conform to the Specifications. The following defect or defects were noted:

Piece Mark	Date Cast

Defects noted as follows:

--

This unit will not be accepted for shipment unless approved for shipment by the Deputy Chief Engineer of Structures of the New York State Department of Transportation.

Very truly yours,

cc: Contractor:

NYSDOT Structures Division, Attention: Supervisor of the CEU

NYSDOT Regional Director of Transportation, Region _____

NYSDOT Engineer-In-Charge: _____

Inspection Agency: _____

APPENDIX E

NYSDOT STRESSING REPORT

NEW YORK
STATE OF
OPPORTUNITY.

**Department of
Transportation**

PROJECT NAME:
CONTRACT NUMBER:
PIN:
BIN:
CONTRACTOR:

DATE OF STRESSING:
REQUIRED CONCRETE STRENGTH:
ACTUAL CONCRETE STRENGTH:
WEATHER CONDITIONS:
GAUGE NUMBER:
JACK TYPE/NUMBER
JACK CALIBRATION DATE:

[illegible]

STRESSING OPERATOR NAME/SIGNATURE/DATE:
INSPECTOR NAME/SIGNATURE/DATE:

