

VIRGINIA DEPARTMENT OF TRANSPORTATION  
SPECIAL PROVISIONS FOR  
**PRECAST PRESTRESSED CONCRETE PAVEMENT**

January 7, 2009

**I. DESCRIPTION**

This provision shall cover the fabrication, installation, post-tensioning, and grouting of precast prestressed concrete panels for pavement reconstruction. Herein, the term "panel" shall refer to individual precast concrete panels, including Base Panels, Joint Panels, and Anchor Panels. The term "slab" shall refer to a post-tensioned section of precast panels between the expansion joints contained within Joint Panels (Type A).

**II. MATERIALS**

Materials shall conform to the requirements of the 2007 VDOT Road and Bridge Specifications referenced herein, except where noted in these Special Provisions.

**III. PRECAST PANEL FABRICATION**

**A. Plant Certification**

The precast manufacture plant supplying the precast panels shall have Precast/Prestressed Concrete Institute (PCI) certification as per Section 405.03.

**B. Tolerances**

Tolerances for precast panels, regardless of type shall be as shown below in Table 1.

**Table 1  
Tolerances for Precast Panels**

Length (parallel to long axis of panel)	+/- 1/4"
Width (normal to long axis of panel)	+/- 1/8"
Nominal Thickness	+/- 1/8"
Squareness (difference in measurement from corner to corner across top surface, measured diagonally)	+/- 1/8"
Horizontal Alignment (upon release of stress)—Deviation from straightness of mating edge of panels	+/- 1/8"
Vertical Alignment—Camber (upon release of stress)	+/- 1/8"
Deviation of ends (horizontal skew)	+/- 1/8"
Deviation of ends (vertical batter)	+/- 1/8"
Keyway Dimensional Tolerance	+/- 1/16"
Position of Strands	+/- 1/8" Vertical <sup>1</sup> +/- 1/4" Horizontal
Position of post-tensioning ducts at mating edges	+/- 1/8" Vertical <sup>1</sup> +/- 1/8" Horizontal
Straightness of post-tensioning ducts	+/- 1/4" Vertical <sup>1</sup> +/- 1/4" Horizontal
Vertical Dowel Alignment (parallel to	+/- 1/8" <sup>1</sup>

bottom of panel)	
Horizontal Dowel Alignment (normal to expansion joint)	+/- 1/8"
Dowel Location (deviation from shop drawings)	+/- 1/4" Vertical <sup>1</sup> +/- 1/4" Horizontal
Dowel Embedment (in either side of expansion joint)	+/- 1"
Position of lifting anchors	+/- 3" <sup>2</sup>
Position of non-prestressed reinforcement, including tie-bars (unless tolerance otherwise provided in plans)	+/- 1/4" <sup>3</sup>
Straightness of expansion joints	+/- 1/8"
Initial width of expansion joints	+/- 1/8"
Dimensions of blockouts/pockets	+/- 1/8"

1. Measured from bottom of panel
2. From position shown in precast shop drawings
3. Unless different tolerance shown in plans

### C. Concrete Mixture

The concrete mixture used shall meet the strength requirements set forth in Section 217.07 for Class A5 concrete, as per Section 405, "Prestressed Concrete." The mixture will be required to reach a compressive strength of 3,500 psi at release of prestress and 5,000 psi at 28 days, as per Section 405.05. The mixture shall be workable enough to achieve the required surface finish as described below. The installation Contractor must approve the coarse aggregate to be used by the precast fabricator with specific consideration given to requirements for diamond grinding of the finished surface of the precast panels. Aggregate shall be non-polishing.

### D. Non-Prestressed Reinforcement

Non-prestressed reinforcement shall be Grade 60 epoxy-coated deformed bars conforming to the requirements of Section 223.

### E. Pre-stressing Materials

Pre-stressing materials shall conform to Section 223. Unless otherwise shown on the plans, all pre-stressing material shall be 0.5-inch Grade 270, 7-wire low-relaxation strand. Pre-stressing procedures shall conform to the requirements of Section 405.

### F. Post-tensioning Materials

All post-tensioning anchors, ducts, strand, and bar shall be selected and specified by the post-tensioning contractor or supplier.

Post-tensioning ducts shall be rigid galvanized corrugated metal or rigid corrugated polypropylene or polyethylene conforming to the requirements of Section 2.7 of the Post-Tensioning Institute's "Specification for Grouting of Post-Tensioned Structures" (published 2003). Unless otherwise shown on the plans, all post-tensioning strands shall be epoxy filled and epoxy-coated 0.6-inch Grade 270, 7-wire low-relaxation strand conforming to Section 223 and all post-tensioning bars shall be epoxy-coated 1-inch diameter, Grade 150 low-relaxation threaded bars which can be coupled together with mechanical couplers.

Grout ports shall be located in the Joint Panels (Type A) and Base Panels (Type B), as shown on the panel detail sheets. The grout ports shall have a minimum 1/2-inch inside diameter and shall be compatible with the post-tensioning ducts, providing a water-tight seal between the duct and port. Grout ports shall not protrude from the finished surface of the panels, and shall be located at the extreme ends of each tendon, and not more than 50 feet apart between the ends, unless otherwise approved.

#### **G. Lifting Anchors**

Lifting anchors shall be approved by the Engineer prior to use. Final locations of the lifting anchors shall be determined by the precast concrete producer and shown on the precast shop drawings. Unless otherwise approved, lifting anchors shall be galvanized or epoxy coated threaded coil inserts which can be left unpatched prior to opening the pavement to traffic. The top of the lifting anchors shall be recessed a minimum of 1/2-inch from the surface of the panel. All inserts shall be grouted prior to completion of the project.

#### **H. Dowels and Expansion Joints**

Shop drawings for the expansion joint detail shall be submitted for approval prior to fabrication of the Joint Panels. The expansion joint shall be able to withstand the expansion and compression requirements specified in 6.7. Dowels for the expansion joints shall conform to the requirements of Section 316.04(g)(5), and may be epoxy coated, solid stainless steel, or stainless steel clad. The entire length of the dowel shall be coated with graphite grease or other approved bond breaker prior to placement of concrete for the Joint Panels. Armored joints shall be fabricated using galvanized steel components.

Dowels shall remain parallel to the bottom surface of the panel and normal to the expansion joint during casting. Dowel baskets shall not be used to support the dowels in the forms. Unless otherwise shown on the plans, the minimum length of dowel embedment on either side of the expansion joint shall be one-half the length of the dowel minus the specified initial width of the expansion joint.

Dowel expansion caps specified in the plans shall be approved prior to use. A minimum of 1.5 inches of free movement of the dowel end (within the expansion cap) shall be provided.

A bond breaking material shall be used to prevent the two halves of each Joint Panel (Type A) from bonding to each other. Grease, polyethylene sheeting, Styrofoam, or other approved material shall be used for the bond breaker.

#### **I. Finishing**

Unless otherwise approved by the Engineer, the top surface of the panels (driving surface) shall receive a grooved texture finish typically used for Portland cement concrete pavement in accordance with Section 316.04(h)(4). The texture shall be applied in a timely manner after final screeding such that the desired texture depth is achieved without disturbing the underlying concrete or turning over aggregate.

#### **J. Placement in forms**

Concrete formwork and placement procedures shall conform to the requirements of Section 405.05 with the exception that only metal (non-aluminum) forms will be permitted. Concrete shall be placed in a single lift (i.e., placed in a single operation) and distributed in such a manner that embedded items such as reinforcement, ducts, dowels, anchors, and lifting devices are not dislodged by the concrete mass. Proper consolidation must be achieved such that honeycombing or segregation of the concrete does not occur and all spaces around embedded items and around the panel forms are filled.

## **K. Curing**

Curing of the precast panels shall conform to the requirements of Section 405.05. The Contractor shall submit the proposed curing methods and procedures for approval prior to placing concrete. Curing shall commence immediately after the surface finishing operation and as soon as marring of the concrete surface will not occur.

Membrane curing, in accordance with Section 316.04(j)(1), may be permitted at the discretion of the Engineer. A minimum two applications of the curing membrane, applied immediately after surface texture finishing, shall be required for membrane curing. Membrane curing residue shall be removed from all adjoining surfaces prior to shipment of the panels to the jobsite.

Curing shall be maintained on the sides and top surface of the panels for a minimum of 72 hours from the beginning of curing operations, or until the required 28-day compressive strength is achieved. While in the forms, the forms will be considered to provide adequate curing for the edges (vertical faces) of the panels. If any part of the form is removed, the exposed surface shall receive curing in accordance with Section 316.04(j). Removal of panels from the forms to a storage area shall be done in such a manner that curing is not interrupted for more than four hours for any member.

The precast panels shall be protected from cold and hot weather in accordance with Section 316.04(j).

## **L. Form Removal and Storage**

Panels shall be removed from the forms in such a manner that no damage occurs to the panel. Form removal shall conform to the requirements of Section 405.05. Any materials forming blockouts in the panels shall be removed such that damage does not occur to the panel or the blockout.

Panels shall be stored in such a manner that adequate support is provided to prevent cracking or creep-induced deformation (sagging). Supports beneath the panels shall be located at approximately the same location as the lifting anchors. Panels shall be stacked no higher than five panels per stack, with adequate support between panels. Panels shall be stacked such that individual panels or stacks of panels are not touching one another. Panels stored for long periods of time (longer than one month) shall be checked at least once per month to ensure creep-induced deformation does not occur.

## **M. Unobstructed Ducts**

After removal from the forms and prior to shipment, the precast fabricator shall check for obstructions and residual water in all post-tensioning ducts. The post-tensioning ducts shall be checked for obstructions by feeding a post-tensioning strand or bar of the same size as that specified for final post-tensioning completely through each duct. If the strand or bar does not slide freely through the duct, the cause of the obstruction shall be remedied, at the expense of the Contractor, before the panel is shipped. Compressed air shall be used to remove any residual water (from concrete placement or curing operations) from the ducts prior to shipment.

## **N. Lifting and Handling**

Panels shall be handled and shipped in accordance with Section 405.05. Lifting anchors cast into the panels shall be used for lifting and moving the panels at the fabrication plant. The

angle between the top surface of the panel and the lifting line shall not be less than sixty degrees (60°), when measured from the top surface of the panel to the lifting line.

Provision shall be made to secure the two halves of each Joint Panel (Type A) together such that the expansion joint remains closed or at a uniform specified width during handling and transportation. A plan for securing the two halves of the Joint Panels together shall be submitted for approval prior to fabrication of the Joint Panels. The fastening technique shall prevent the expansion joint from opening or closing during lifting and handling and shall not rely upon the dowel bars to resist hinging at the expansion joint. Damage caused to any Joint Panel, including bending of dowel bars, as a result of inadequate bracing shall be repaired at the expense of the Contractor to the satisfaction of the Engineer.

#### **O. Transportation**

Panels shall be transported in such a manner that the panel will not be damaged during transportation. Panels shall be properly supported during transportation such that cracking or deformation (sagging) does not occur. If more than one panel is transported per truck, proper support and separation must be provided between the individual panels. Panels shall be lying horizontally during transportation, unless otherwise approved.

#### **P. Repairs**

Repairs of damage caused to the panels during fabrication, lifting and handling, or transportation shall be addressed on a case-by-case basis and must be approved by the Engineer prior to implementation. Damage within acceptable limits caused to the top surface (driving surface) or to keyed edges of the panels shall be repaired using an approved repair method at the fabrication plant at the expense of the Contractor. Repetitive damage to panels shall be cause for stoppage of fabrication operations until the cause of the damage can be remedied.

#### **Q. Demonstration of Panel Fit**

The precast fabricator shall initially fabricate only three panels and assemble these panels at the fabrication plant to demonstrate the fit of the panels. The panels shall be assembled over a level surface that will not cause damage to the panels during or after assembly. Post-tensioning will not be required for this trial assembly, and epoxy will not be required in the joints between panels. Joints between panels should not be more than 1/8-inch wide when assembled. Any problems with fitting the panels caused by imperfections in the panels shall be corrected prior to proceeding with panel fabrication. Panel fabrication may commence following the trial assembly with approval from the Engineer.

### **IV. REMOVAL OF EXISTING PAVEMENT**

#### **A. Removal Method**

Existing PCC pavement shall be removed by sawcutting and lifting out the existing pavement. Rubblization, power breaking, or other impact methods which may damage the underlying base shall not be used.

#### **B. Timing of Removal**

Sawcutting the existing pavement for removal may be completed up to 7 days prior to commencement of removal. Sawcutting and removal shall be completed in accordance with Section 509. Sawcutting depth should not exceed the actual pavement slab thickness by more than 1 inch.

### **C. Additional Removal**

No more than 12 inches of additional pavement may be removed beyond the amount of PPCP to be installed during each operation. If the gap between the end of the PPCP installed during a nightly operation and the existing pavement exceeds one inch, it shall be temporarily covered or filled with a suitable material such as bituminous cold-patch materials which can be removed prior to installing additional PPCP panels. Temporary fill material shall be removed completely from the gap, and the end of the PPCP shall be protected from adhesion of the temporary fill material. The cost of temporary fill materials shall be included in the price bid for PPCP slabs.

## **V. BASE PREPARATION**

The precast panels shall be placed over a prepared base as shown on the plans. The surface shall be free from debris and other materials that prevent the panels from fully resting on the base.

### **A. Grade Control for Placement**

Grade control shall be established for placement of the base material using string lines, laser guidance, or other comparable methods.

### **B. Surface Test**

The finished surface of the base material directly beneath the precast pavement shall provide full support beneath the panels. The evenness of the surface of the base material shall be checked in both the longitudinal and transverse direction by the Contractor using 10-ft straightedge. The variation of the surface shall be such that a 6-inch diameter circular plate, 1/8-inch thick cannot be passed beneath the straightedge. Any areas of the base surface not conforming to this smoothness requirement must be corrected at the Contractor's expense; pay adjustments shall not be permitted.

## **VI. PANEL INSTALLATION ON-SITE**

The Contractor shall allow **up to 4** site visits by large groups of up to 50 people **per visit** for the purposes of reviewing on-site installation procedures and processes. The Contractor shall also co-ordinate with representatives of the Federal Highway Administration (FHWA) for the purposes of documenting construction processes and procedures.

### **A. Equipment**

The Contractor shall have all equipment required for panel installation, post-tensioning, and grouting on-site prior to beginning panel installation. Lifting and transporting equipment shall not damage the prepared base material prior to or during panel installation. Any damage to the prepared base material will be repaired at the Contractor's expense to the satisfaction of the Engineer.

### **C. Friction Reducing Membrane**

A single layer friction reducing membrane will be placed over the prepared base material, beneath the precast panels, as shown on the plans. A geotextile drainage fabric meeting the requirements of Section 245.03 (c) shall be used as the friction reducing membrane unless otherwise specified. Provision shall be made to prevent folds and creases in the sheeting beneath the panels. The surface of the prepared base shall be free from loose debris which may puncture the sheeting. Any tears or punctures in the sheeting shall be repaired to the satisfaction of the Engineer prior to placement of the precast panels over the sheeting.

Provision shall be made to prevent the material from becoming pinched in the joints between individual precast panels during panel installation.

#### **D. Temporary Post-Tensioning**

Panels shall be temporarily post-tensioned together in the longitudinal direction during installation to ensure closure of transverse joints between panels and to provide temporary longitudinal prestress between consecutive panel installation operations prior to final longitudinal post-tensioning.

Unless otherwise specified, temporary post-tensioning shall be completed after placement of no more than two adjacent panels. Temporary post-tensioning tendons shall be stressed to maintain a minimum clamping pressure of 30 psi across the full width of the pavement between consecutive panel installation operations.

Bar tendons shall be used for temporary post-tensioning by coupling bars from adjacent panels together. The post-tensioning contractor or supplier shall specify the anchorage and temporary stressing details to be used for temporary post-tensioning. Any damage to the precast panels during temporary post-tensioning shall be repaired at the Contractor's expense to the satisfaction of the Engineer prior to installation of additional panels.

The anchor access pockets in the Joint Panels shall be used for the temporary post-tensioning tendons, and shall be covered when the pavement is open to traffic between consecutive panel installation operations.

#### **E. Transverse Joints Between Panels**

Unless otherwise shown in the plans, epoxy shall be applied to the adjoining surfaces of the precast panels prior to assembly. The epoxy material shall be suitable for bonding hardened concrete to hardened concrete and shall be approved prior to use. Epoxy shall be of a consistency that it can be applied a minimum of 1/8-inch thick, and shall be proportioned and applied according to the manufacturer's recommendations.

Epoxy shall be applied to both faces of adjoining panels, and shall be kept a minimum of 1/2-inch away from duct openings. The set time of the epoxy shall be such that the minimum clamping pressure can be applied through temporary or final post-tensioning before the epoxy hardens. Excess epoxy squeezed out of the joint onto the driving surface of the precast pavement during assembly and/or post-tensioning shall be removed before it hardens.

A compressible foam or neoprene gasket shall be placed around the opening of each post-tensioning duct as shown in the project plans. The seal shall be continuous around each duct opening and shall be compressible such that it will permit the joints between panels to close completely. The seal shall not cover any part of the opening to the duct and shall not inhibit the flow of grout. Damaged gaskets shall be replaced prior to panel installation.

Alternatively, duct couplers which provide a positive, water-tight connection between ducts of adjacent panels may be used with approval of the Engineer.

**F. Placement Technique**

Panels shall be installed one at a time, and shall be installed in such a manner that neither the base material nor the friction reducing material is damaged during installation. The angle between the top surface of the panel and the lifting line attached to each lifting anchor shall not be less than 60 degrees (60°), when measured from the horizontal surface of the panel to the lifting line.

Panels may be aligned in the longitudinal direction (parallel to the roadway centerline) using the face of the adjacent existing pavement or new PPCP as the control line. Alignment of the ducts between panels shall be continuously checked using a reference mark on the top surface of the panels at adjoining edges directly above a given post-tensioning duct.

Alternatively, the centerline of the panels shall be aligned to a line laid out by a surveyor (provided by the Contractor) on the surface of the base prior to installation of the panels. Panels may be offset to correct horizontal misalignment of the centerline of the panels, but not more than 1/4-inch between any two adjacent panels. Shims may not be used in the joints between panels to correct alignment.

**G. Placement Tolerances**

Unless otherwise indicated on the plans, alignment of adjacent panels, as indicated by the reference marks on the top surface of the panels, shall not deviate more than 1/4-inch if the existing remaining pavement is used as the control line. If a pre-surveyed centerline is used for alignment, the panels shall be within 1/4-inch of the pre-surveyed centerline marked on the surface of the base.

Vertical alignment of the panels shall be such that the top surface of an individual panel is no more than 3/16-inch higher or lower than the top surface of an adjoining panel at any point along the joint between the panels. The width of the gap between adjoining panels at the top surface of the joint shall be no more than 1/8 inch after completion of temporary post-tensioning.

**H. Expansion Joints**

Expansion joint seals shall be provided as shown in the plans and shall conform to the requirements of Section 420 for preformed elastomeric joint seals. The seal for the expansion joints shall be selected by the Contractor and approved by the Engineer. The seal shall be installed according to manufacturer's recommendations. Expansion joints may be sawcut to the necessary width to receive the seal prior to installing the seal. Sawcuts shall not be greater than 3 inches deep to avoid contact with the dowel bars.

Expansion joint seals shall be able to accommodate (from the initial width at installation) expansion/stretch of 1 inch and compression of 1/2-inch. The width of the expansion joint at the level of the dowels may be adjusted on-site as necessary. The initial joint width (as shipped from the precast producer) shall be based on the estimated daily average ambient temperature during construction according to Table 2.

**Table 2  
Initial Expansion Joint Widths for Panel Type A**

<b>Daily Average Ambient Temperature (F)</b>	<b>Initial Expansion Joint Width (PPCP Slab Lengths = 150'-160')</b>
T ≤ 50°F	0.75"

50°F < T < 90°F	0.5"
T ≥ 90°F	0.25"

Unless otherwise approved by the Engineer, expansion joint seals shall be installed prior to opening the pavement to traffic. Any debris in the joint shall be removed using compressed air or other approved technique prior to installing the joint seal.

**I. Longitudinal Joints**

The longitudinal joints between PPCP sections shall be sealed according to Section 316.04(m) using a hot-poured joint sealant or low-modulus silicone rubber joint sealant conforming to the requirement of Section 212.02. The longitudinal joint may be sawcut if necessary to receive the joint sealant, according to Section 326.04(g)(1c).

**J. Transverse Joints**

Transverse joints between the PPCP and existing pavement shall be sealed according to Section 316.04(m) using hot-poured joint sealant or low-modulus silicone rubber joint sealant conforming to Section 212.02. The joints may be sawcut if necessary to receive the joint sealant, according to Section 326.04(g)(1c).

**K. Protection of Expansion Joint Ends**

Exposed open ends of the expansion joints shall be sealed or covered to prevent the intrusion of debris and incompressible materials. Cover plates or sealing material shall not inhibit free movement of the expansion joints. Expansion joints shall be cleared of debris prior to installation of cover plates or sealing material.

**L. Filling Pockets**

Anchor access pockets (Panel Type A) shall be filled only after completion of final longitudinal post-tensioning and prior to underslab grouting and grouting of the post-tensioning tendons. The pockets shall be filled with an approved patching material according to Section 509 except that only non-chloride accelerators will be permitted. High-early-strength hydraulic cement concrete using only non-chloride accelerators may be permitted if the pavement is to be opened to traffic within 6 hours of placement of the patching material. The fill material shall be finished flush and textured to match the surface of the surrounding concrete, and shall be wet mat cured until the pavement is opened to traffic, at which point membrane curing shall be applied.

**M. Repairs**

Damage caused to the precast panels during any part of the panel installation process shall be repaired at the Contractor's expense to the satisfaction of the Engineer. Repairs of damaged areas will be addressed on a case-by-case basis by the Engineer and must be approved by the Engineer prior to implementation. Damage within acceptable limits caused to the top surface (driving surface) or to keyed edges of the panels shall be repaired using approved repair methods and materials. Repetitive damage to panels shall be cause for stoppage of installation operations until the cause of the damage can be remedied.

**N. Voids Beneath Pavement**

The pavement shall be inspected during panel installation for voids beneath the precast panels. At the discretion of the Engineer, the Contractor shall be required to stop panel

installation and correct imperfections in the base material causing voids beneath the precast panels.

**O. Matching Existing Pavement**

The precast panels shall be tied into the existing pavement as shown on the plans. The top surface of the precast pavement shall no more than 1/4 inch above or below the surface of the existing pavement. Diamond grinding shall be used bring the top surface of the existing pavement and precast pavement into tolerance if necessary. A single pass of diamond grinding has been specified on the plans for the entire length of the PPCP slab placement area as well as an additional 50' on either end. All grinding required to achieve a smooth transition between the PPCP slabs and the existing pavement and to meet the requirements of the special provision for rideability shall be included in the price bid for diamond grinding. A maximum of one pass of diamond grinding will be paid.

**P. Mid-Slab Anchors**

Mid-slab anchors (Panel Type C) shall be provided as shown on the plans to anchor the middle of each precast pavement slab to the underlying base/subbase. Alternative mid-slab or end-slab anchors may be used with the approval of the Engineer. Mid-slab anchors shall be installed only after completion of final longitudinal post-tensioning. Mid-slab anchors shall be filled with an approved patching material according to Section 509 except that only non-chloride accelerators will be permitted. High-early-strength hydraulic cement concrete using only non-chloride accelerators may be permitted if the pavement is to be opened to traffic within 6 hours of placement of the patching material. The fill material shall be finished flush and textured to match the surface of the surrounding concrete, and shall be wet mat cured until the pavement is opened to traffic, at which point membrane curing shall be applied.

**Q. Grouting of Mechanical Couplers for Tie Bars**

Adjacent sections of PPCP panels shall be tied across the longitudinal joints using grout-filled mechanical couplers as shown on the plans. The couplers shall be grouted using procedures and grout material recommended by the manufacturer. Grouting of the mechanical couplers shall be completed only after completion of final longitudinal post-tensioning of the sections being tied together.

**VII. POST-TENSIONING**

The Contractor, or sub-contractor, who performs post-tensioning shall have a minimum 2 years of experience with post-tensioning work of similar nature to the work identified on the plans and in the specifications. The Contractor, or sub-contractor, shall furnish to the Engineer for review and acceptance, a certification detailing the date, location, owner's name and contact information and description of previous post-tensioning work. The Contractor shall use the post-tensioning system shown in the plans. The post-tensioning contractor or supplier shall develop and provide final details for all post-tensioning materials, stressing pocket dimensions, equipment, and stressing procedures prior to fabrication of the precast panels. Shop drawings showing the post-tensioning anchorage details, stressing sequence, elongation calculations, and jacking forces shall be developed by the post-tensioning contractor or supplier and submitted to the Engineer for approval prior to panel fabrication.

## **A. Materials**

Low-relaxation, Grade 270, epoxy filled and epoxy coated 7-wire strands with a 0.6-inch nominal diameter shall be used for the longitudinal strand tendons. Low-relaxation, Grade 150, epoxy filled and epoxy coated threaded bars which can be coupled together with mechanical couplers, shall be used for the two bar tendons in each slab.

## **R. Tendon Installation**

Longitudinal post-tensioning strands shall be inserted into the ducts at the Joint Panels (Type A), as shown on the plans. Strands shall be either pushed or pulled through the ducts by hand or using an approved mechanical strand pusher. Provision shall be made to prevent separation of the individual wires from the strand during strand insertion.

Longitudinal post-tensioning bars shall be inserted in the ducts of each panel just prior to installation of the panel. A coupler shall be used to couple the bar from the panel being installed to the bar extending from the adjoining panel already in place.

## **S. Tendon Stressing**

Both ends of each of longitudinal post-tensioning tendon shall be stressed. Tendons shall be stressed to 75% of the guaranteed ultimate tensile strength of the strand or bar supplied. The tendon stressing sequence shall be approved prior to the start of post-tensioning. Stressing of the strand tendons shall be completed in a single stage unless otherwise approved. Tendon elongations shall be measured and recorded during the stressing operation.

After completion of post-tensioning, the tails of the post-tensioning strands shall be trimmed, and an approved grease cap will be used to cover and seal the end of the strand and post-tensioning anchor prior to filling the stressing pockets. Bar tendons shall be trimmed to the appropriate length specified by the post-tensioning contractor or supplier prior to filling the stressing pockets.

## **T. Faulty Anchors and Wire Failures**

In the event of a faulty post-tensioning anchor, the Contractor shall submit a repair or alternate stressing strategy for approval. No wire failures shall be accepted. The Contractor shall provide and install a new strand in the event of a wire failure.

## **VII. TENDON GROUTING**

Unless otherwise shown on the plans, the longitudinal post-tensioning system shall consist of grouted tendons.

### **A. Materials**

The grout mixture shall be a pre-packaged grout conforming to the requirements for Class C grout specified by the Post-Tensioning Institute's "Specification for Grouting of Post-Tensioned Structures" (published 2003). Grout shall be proportioned with water according to the manufacturer's recommendations.

### **B. Equipment**

Grouting equipment shall consist of at least the following:

- Equipment for accurately measuring and proportioning by volume or weight the various materials composing the grout,

- A colloidal mixer, capable of operating in a range from 800 rpm to 2,000 rpm and thoroughly mixing the various components of the grout in an approved manner,
- A positive action pump capable of forcing grout into the post-tensioning ducts. The injection pump shall be capable of continuous pumping at rates as low as 1-1/2 gal. per minute,
- The discharge line shall be equipped with a positive cut-off valve at the nozzle end, and a bypass return line for recirculating the grout back into a holding tank or mixer unless otherwise approved, and
- A stop watch and flow cone conforming to the dimensions and other requirements of ASTM C 939, "Standard Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method)."

### **C. Procedures**

A grouting plan shall be submitted for approval at least 2 weeks before starting grouting operations. Grouting shall be completed within 7 days after stressing of the post-tensioning tendons, unless otherwise approved by the Engineer. Grouting shall not be performed until the anchor access pockets (Panel Type A) have been patched. Compressible foam shall be injected into the bottom of each expansion joint to seal the bottom of the joint from grout intrusion. The sides of the pavement slab shall be backfilled (or shoulders constructed) to prevent grout leakage from beneath the slab.

The grout fluidity shall be checked according ASTM C 939. Efflux time for fluidity shall be between 11 and 30 seconds after mixing, but no more or less than recommended by the manufacturer. Fluidity shall be adjusted to achieve the necessary flow requirements to achieve fully grouted tendons. If excessive bleeding of the grout is observed, the Engineer may require the Contractor to adjust the grout mixture to reduce bleed. The fluidity of the grout shall be checked at the beginning of each grouting operation and after each time the grout pump and hose is flushed.

Samples for grout compressive strength determination will be collected by the Department at least once per day during grouting operations. A minimum of three strength cubes shall be made by the Department during each sampling. The average compressive strength of three cubes shall be a minimum of 3000 psi at 7 days and 5,000 psi at 28 days.

Grout shall be pumped into the lowest end of each tendon if an elevation difference exists between the ends. Grouting pressure shall not exceed the bursting pressure of the duct/port connection or 145 psi, whichever is less. If grout does not flow from the nearest intermediate port after the maximum grouting pressure has been reached, grout may be pumped into an intermediate port. A diagram of grout flow shall be produced by the Contractor to demonstrate full grouting of the tendons.

### **D. Grouting Problems**

If grout is observed leaking into an expansion joint, from the end of a joint between panels, from beneath the slab, or out of an adjacent duct, pumping shall be stopped and grout shall be pumped into the nearest intermediate port. Any grout that flows into an expansion joint shall be flushed from the expansion joint immediately. Any grout that hardens in an expansion joint shall be removed at the Contractor's expense.

### **E. Cleanup**

Upon completion of grouting, recesses in the surface of the panels at the grout ports shall be filled with an approved mortar and finished flush with the surface of the pavement. Any grout that flows onto the finished surface of the pavement during the grouting operation shall be immediately flushed from the surface. Any residual grout which hardens on the pavement

surface shall be removed using an approved technique to the satisfaction of the Engineer at the expense of the Contractor.

## **VIII. UNDERSLAB SEALING**

Underslab grouting shall be used to fill any voids beneath the precast panels that may be present after placing the panels over the prepared base. Underslab grouting shall utilize the underslab grout ports cast into each of the panels, as shown in the plans. The Contractor shall attempt to pump grout at each grout port location.

### **A. Materials**

Grout materials shall consist of a mixture of Type I, II or III Portland cement, a fluidifier, fly ash and water. All materials shall be furnished by the Contractor.

The fluidifier shall be a cement dispersing agent possessing such characteristics that will inhibit early stiffening of the pumpable mortar, tend to hold the solid constituents of the fluid mortar in suspension and prevent completely all setting shrinkage of the grout.

Class C fly ash shall be selected from the Department's list of approved Fly Ash sources.

### **B. Equipment**

Equipment for underslab grouting shall consist of the same equipment listed in VIII.B.

### **C. Proportioning Grout Mixture**

The mixture used in underslab grouting shall consist of proportions of Portland cement, fly ash, fluidifier and water. The Contractor shall furnish the Engineer the proposed mixture design meeting the following requirements:

- The grout slurry shall remain fluid and not exhibit a resistance to flow for a minimum of one hour,
- The time of efflux from the flow cone shall be between 11 and 20 seconds. The flow test shall be performed in accordance with ASTM C 939, "Standard Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method),"
- The grout slurry shall achieve initial set in less than 4 hours. The grout slurry shall not be allowed to carry traffic until which time it has set to the satisfaction of the Engineer; or until which set time, as determined by ASTM C 266, "Time of Setting of Hydraulic Cement Paste by Gillmore Needles," has been reached, and
- The 7 day compressive strength of the grout slurry shall not be less than 200 psi.

### **D. Procedures**

Underslab grouting shall be completed after stressing of the post-tensioning tendons, but not more than 7 days after placement of the precast panels. The Engineer may require grouting to be completed prior to opening the pavement to traffic if significant voids are observed during panel placement. Underslab grouting may be completed prior to tendon grouting only if underslab grouting will not interfere with tendon grouting.

Slab edges shall be backfilled or sealed to prevent grout leakage from beneath the slab during underslab grouting. The bottom of all expansion joints shall be sealed prior to underslab grouting to prevent grout leakage into the joints. The sealant material shall be compressible such that it will not inhibit free movement of the expansion joints.

Underslab grouting shall require minimal pressure to force the grout beneath the pavement slab. Under no circumstances should underslab grouting cause the pavement slab to lift. Grout shall be pumped into each underslab grout port of each panel. Grout shall be pumped until it flows out of an adjacent grout port or until the line pressure on the grout pump reaches 5 psi. Grouting pressure of 5 psi may be exceeded if the Contractor can demonstrate that slab lift is not occurring at higher pressures.

The fluidity of the grout shall be checked at the beginning of each grouting operation and after each time the grout pump is flushed. Grout fluidity shall be checked in accordance with ASTM C 939, "Standard Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method)." Fluidity shall be adjusted to achieve the necessary flow requirements to achieve full undersealing. If excessive bleeding of the grout is observed, the Engineer may require the Contractor to adjust the grout mixture.

#### **E. Grouting Problems**

If grout is observed leaking into an expansion joint, from beneath the slab, or out of an adjacent port, grouting shall be stopped and grout will be pumped into the nearest intermediate port. Any grout that flows into an expansion joint shall be flushed from the expansion joint immediately. Any grout that sets up in an expansion joint shall be removed at the Contractor's expense.

#### **F. Cleanup**

Upon completion of grouting, recesses in the surface of the panels at the grout ports shall be filled with an approved mortar and finished flush with the surface of the surrounding pavement. Any grout that flows onto the finished surface of the pavement during the grouting operation shall be immediately flushed from the surface. Any residual grout which hardens on the pavement surface shall be removed using an approved technique to the satisfaction of the Engineer at the expense of the Contractor.

### **IX. FINISHED SURFACE**

The finished pavement surface (after installation of all precast panels) shall have an average IRI less than 70 inches per mile with no individual 0.01 mile section having an IRI greater than 80 inches per mile when tested for rideability in accordance with the Special Provision for Section 316 Rideability for Hydraulic Cement Concrete Pavement. Corrective action to improve the rideability and any necessary re-texturing shall be completed in accordance with the Special Provision for Section 316 Rideability for Hydraulic Cement Concrete Pavement. The pavement may be opened to traffic prior to meeting the final surface smoothness requirements unless the surface conditions are deemed to be hazardous by the Engineer.

### **X. MEASUREMENT AND PAYMENT**

**Pre-cast pre-stressed concrete pavement** will be measured in square yards of pavement surface area, complete-in-place, and will be paid for at the contract unit price per square yard for the depth specified, which price shall be full compensation for transportation, saw cutting existing pavement to the required depth, removing and disposing of existing concrete, furnishing and placing Aggregate No. 10 leveling material, preparation of sub-layer, furnishing and installing reinforcing steel, furnishing and installing pre-stressing steel, furnishing and installing post-tensioning steel and gaskets for post-tensioning ducts, preformed expansion material, furnishing and installing steel dowels, furnishing and installing reinforcing steel, furnishing, placing, finishing, and curing pre-cast concrete, furnishing and installing concrete patching material, furnishing and installing under slab and other grout, designing, furnishing and installing expansion joints, furnishing and installing mechanical couplers, furnishing and installing epoxy, furnishing and joint

sealants, cleaning and sealing joints, furnishing and installing/removing temporary covers for post-tensioning block-outs and for all materials, labor, tools, equipment, and incidentals necessary to complete the work as well as allowing on-site visitors and representatives of FHWA.

Payment will be made under:

**Pay Item**

**Pay Unit**

Pre-cast Pre-stressed Concrete Pavement (8" Depth)

Square Yard

In areas where the Engineer deems the sublayer insufficient to support the PPCP, the sublayer shall be excavated to sound material and replaced with Aggregate Base Material, Type I, Size No. 21B at a cost of \$30 per ton. This shall be full compensation for excavation and disposal of unsuitable sublayer, and for furnishing, placing, and compacting aggregate material.