PRECAST PRESTRESSED CONCRETE PAVEMENT

The Standard Specifications are revised as follows:

SECTION 509, AFTER LINE 285, INSERT AS FOLLOWS:

SECTION 509 - PRECAST PRESTRESSED CONCRETE PAVEMENT

509.01 Description

This work shall consist of the fabrication, installation, post-tensioning, and grouting of precast prestressed concrete panels for pavement reconstruction. 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 expansion joints.

MATERIALS

509.02 Materials

Materials shall be in accordance with the following:

*Concrete**	*707.04(c)*
Portland Cement	*901.01*
Water	*913.01*
Admixtures	*912.03*
Fly Ash	*901.02*
Coarse Aggregate, Class AP, Size No. 8	*904*
Fine Aggregate, Size No. 23	*904*
Epoxy Coated Non-Prestressed Reinforcing Steel	*910.01(b)9*
Dowel Bars	*910.01(b)10*
Polyethylene Sheeting	*912.01(f)*
Mortar	*906.03*
Silicone Joint Seal	*906.02(a)1*
Preformed Elastomeric Joint Seal	*906.02(a)3*
Rapid Setting Patch Material	*901.07*
Epoxy Resin Based System for Bonding Plastic Concrete to Hardened Concrete	*909.11*

Pretensioning materials shall be in accordance with 707. Unless otherwise shown in the plans, all pretensioning material shall be Grade 270, 7-wire, low-relaxation strand in accordance with 910.01(b)7. Low-relaxation, Grade 270, uncoated strands shall be used for both longitudinal and transverse post-tensioning. The longitudinal post-tensioning strand shall be 0.6 in. nominal diameter. The transverse post-tensioning strand shall be 0.5 in. nominal diameter.

Post-tensioning ducts shall be rigid galvanized corrugated metal or rigid corrugated polypropylene. The ducts shall have an inside diameter a minimum of 3/8 in. larger than the nominal diameter of the post-tensioning strand. Flat post-tensioning ducts, having the horizontal dimension larger than the vertical dimension, shall be permitted so long as the dimensional requirements shown above are met.

The subbase shall be as shown on the plans.

The tendon grouting mixture shall be in accordance with ASTM C 1107, and shall be approved by the Engineer prior to use. Grout shall be proportioned in accordance with the manufacturer's recommendations.

The underslab grouting materials shall consist of Type I, II, or III Portland cement, a fluidifier, Class C fly ash, and water. Fluidifier materials data sheet shall be submitted to the Engineer for approval prior to placement of the pre-cast concrete. The fluidifier shall be a cement dispersing agent possessing such characteristics that will:

(a) inhibit early stiffening of the pumpable mortar;

(b) tend to hold the solid constituents of the fluid mortar in suspension; and

(c) prevent completely all setting shrinkage of the grout.

509.03 Job Control

Control of Precast Prestressed Portland Cement Concrete Pavement for air content, slump, or relative yield will be determined on the basis of tests performed by the Engineer in accordance with Frequency Manual. Concrete and necessary labor for sampling shall be furnished as required by the Engineer.

The Engineer will notify the Contractor when test results for air content, slump, or relative yield are outside the requirements of 507.04. Rounding will be in accordance with 109.01(a). The Contractor shall adjust the mixture such that it is in accordance with 707.04.

MANUFACTURE

509.04 Panel Manufacture

(a) Precast Panel Tolerances

Tolerances for precast panels regardless of the type shall be as shown in the following table.

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[1]* *+/- 1/4" Horizontal*
Position of post-tensioning ducts at mating edges	*+/- 1/8" Vertical[1]* *+/- 1/8" Horizontal*
Straightness of post-tensioning ducts	*+/- 1/4" Vertical[1]* *+/- 1/4" Horizontal*
Vertical Dowel Alignment (parallel to bottom of panel)	*+/- 1/8" [1]*
Horizontal Dowel Alignment (normal to expansion joint)	*+/- 1/8"*
Dowel Location (deviation from shop drawings)	*+/- 1/4" Vertical[1]* *+/- 1/4" Horizontal*
Dowel Embedment (in either side of expansion joint)	*+/- 1"*
Position of lifting anchors	*+/- 3"*
Position of non-prestressed reinforcement	*+/- 1/4"*
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.

(b) Grout Ports

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 in. 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 ft apart between the ends, unless otherwise approved.

(c) Lifting Anchors

Lifting anchors shall be approved by the Engineer prior to use. Lifting anchors shall be located as shown on the panel detail sheets. The top of the lifting anchors shall be recessed 1/2 in. minimum from the surface of the panel.

(d) Dowels and Expansion Joints

Shop drawings for the expansion joint detail shall be submitted to the Engineer for approval prior to fabrication of the Joint Panels. The expansion joint shall be in accordance with the expansion and compression requirements specified in 509.04(c)3. The entire length of the dowel shall be coated with graphite grease or other bond breaker approved by the Engineer prior to placement of concrete for the Joint Panels.

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 in. 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, or other approved material shall be used for the bond breaker.

(e) Instrumentation

The precast fabricator shall permit the installation of instrumentation by the Department in the panel forms prior to placement of concrete. A schematic layout and instrumentation plan shall be provided to the fabricator and the Engineer by the Designer for approval prior to beginning panel fabrication. The precast fabricator shall provide at least 7 days advanced notice to the instrumentation installer before casting the instrumented panels. Instrumentation shall include, but is not limited to, temperature sensors, strain gages, and load cells. Instrumentation shall not compromise the integrity of the reinforcing steel, prestressing system, or the precast panel itself. The precast fabricator shall protect the integrity of the instrumentation, including lead wires and connectors at the surface and edges of the precast panels, during fabrication and handling of the instrumented panels.

(f) Placement in Forms

Concrete formwork and placement procedures shall be in accordance with the requirements of 707. Concrete shall be placed in a single lift 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 shall be achieved such all spaces around embedded items and around the panel forms are filled.

(g) Finishing

The top driving surface of the panels shall be finished and textured in accordance with applicable portion of 504.03. 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.

(h) Curing

Curing of the precast panels shall be in accordance with 707.07. The Contractor shall submit the proposed curing methods and procedures for approval by the Engineer 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.

A liquid membrane forming curing compound, in accordance with 504.04(a), will be permitted at the discretion of the Engineer. Membrane curing residue shall be removed from all adjoining surfaces prior to shipment of the panels to the jobsite.

Curing shall be maintained for a minimum of 72 hr from the beginning of curing operations on the sides and top surface of the panels. If any part of the form is removed, the exposed surface shall receive wet curing in accordance with Section 707.07. 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.

(i) Form Removal and Storage of Panels

Panels shall be removed from the forms in such a manner that no damage occurs to the panel. Form removal shall be in accordance with 707.07. All 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 longer than one month shall be checked at least once per month to ensure creep-induced deformation does not occur.

(j) Unobstructed Ducts and Conduit

After removal from the forms and prior to shipment, the precast fabricator shall check for obstructions in all post-tensioning ducts. The post-tensioning ducts shall be checked by feeding a post-tensioning strand of the same size as that specified for final post-tensioning completely through each duct. If the strand does not slide freely through the duct, the cause of the obstruction shall be remedied before the panel is shipped.

(k) Lifting and Handling

Panels shall be handled and shipped in accordance with 707.08. 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 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,, as a result of inadequate bracing shall be repaired to the satisfaction of the Engineer. Bent dowel bars shall be replaced.

(l) Transportation

Panels shall be transported in such a manner that the panel shall 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.

(m) Repairs

Repairs of damage caused to the panels during fabrication, lifting and handling, or transportation shall be addressed on a case-by-case basis. 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.

(n) 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 1/4 in. wide when assembled. All 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.

CONSTRUCTION REQUIREMENTS

509.05 Construction

(a) Subbase Preparation

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

Grade control shall be established for placement of the subbase material using stringlines, laser guidance, or other approved method.

The finished surface of the subbase material directly beneath the precast pavement shall provide full support beneath the panels. The smoothness of the surface of the subbase 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 corrected to 1/8 in. or less in accordance with 501.11. All areas of the subbase surface not conforming to this smoothness requirement shall be corrected.

(b) Instrumentation

The Contractor shall permit access to instrumentation in the precast panels during the panel installation process and shall permit instrumentation of the precast panels and post-tensioning system during the construction process. A schematic layout and an instrumentation plan will be provided to the Engineer and Contractor for approval at least one month prior to commencement of panel installation. Instrumentation will include, but is not limited to, temperature sensors, strain gages, and load cells. Instrumentation will not compromise the integrity of the subbase material, pavement, or the post-tensioning system. The Contractor shall protect the integrity of the instrumentation, including lead wires and connectors extending from the surface of the precast panels, during the panel installation and post-tensioning process.

(c) Panel Placement

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 subbase material prior to or during panel installation. All damage to the prepared subbase material shall be repaired to the satisfaction of the Engineer.

A single layer of polyethylene sheeting will be placed over the prepared subbase material, beneath the precast panels as shown on the plans. Polyethylene sheeting shall have a minimum nominal thickness of 6.0 mills unless otherwise specified. Provision shall be made to prevent folds and creases in the sheeting beneath the panels. The surface of the prepared subbase shall be free from loose debris which may puncture the polyethylene sheeting. All tears or punctures in the polyethylene sheeting shall be repaired to the satisfaction of the Engineer prior to placement of the precast panels. Provision shall be made to prevent the polyethylene sheeting from becoming pinched in the joints between individual precast panels during panel installation.

Panels shall be installed one at a time, and shall be installed in such a manner that neither the subbase nor the polyethylene sheeting 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° when measured from the horizontal surface of the panel to the lifting line.

The subbase 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 subbase causing voids beneath the precast panels.

Panels shall be aligned in the longitudinal direction using the centerline of the panels. The centerline of each panel shall be marked on the top surface of the panel at the adjoining edges. The location of the centerline on each panel shall be determined from the location of the post-tensioning duct openings at the adjoining edges of the panels. The edges of the panels shall not be used for aligning the panels.

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 subbase prior to installation of the panels. Unless otherwise indicated on the plans, the centerline of the panels shall be within ¼ in. of the surveyed centerline marked on the surface of the subbase, and the centerline of adjoining panels shall be within 1/8 inch of each other at the adjoining edge. Shims may be placed in the joints between panels to correct horizontal misalignment of the centerline of the panels. The total thickness of shims used in any joint shall be no more than 1/8 in. All damage caused to the panels by shims shall be repaired to the satisfaction of the Engineer.

Panels shall be temporarily post-tensioned together in the longitudinal direction during placement to ensure closure of transverse joints prior to final post-tensioning. Unless otherwise specified, temporary post-tensioning shall be completed after placement of no more than two adjacent panels. The anchor access pockets in the Joint Panels shall be used to feed the temporary post-tensioning strands into the longitudinal ducts. Temporary post-tensioning tendons shall be spaced no more than 10 feet apart and no more than 2 ft from the edge of the panels, as measured across the width of the pavement.

Strands use for temporary post-tensioning shall be either 1/2 in. or 0.6 in. nominal diameter, with corresponding temporary anchorage. All damage to the precast panels during temporary post-tensioning shall be repaired to the satisfaction of the Engineer prior to installation of additional panels.

Each pavement slab shall be post-tensioned prior to installation of panels of a subsequent slab.

Vertical alignment of the panels shall be such that the top surface of an individual panel is no more than 3/16 in. 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 in. after completion of temporary post-tensioning.

1. Longitudinal Joints

The longitudinal joint between adjacent post-tensioned slabs shall be as shown in the plans. Transverse post-tensioning shall not be completed until the mortar grout in the longitudinal joint has reached adequate strength to withstand the post-tensioning forces.

2. Transverse Joints Between Panels

Unless otherwise shown in the plans, an epoxy resin based system in accordance with 909.11 shall be applied to the adjoining surfaces of the precast panels prior to assembly. The material shall be approved prior to use. Epoxy shall be proportioned and in accordance with the manufacturer's recommendations.

Epoxy shall be applied to both faces of adjoining panels, and shall be kept a minimum of 1/2 in. away from duct openings. The set time of the epoxy shall be such that final post-tensioning can be completed 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 panel details. The seal shall be continuous around each duct opening and shall be compressible such that it will not protrude from the gasket recess shown in the panel details when compressed. 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.

3. Expansion Joints

Expansion joint seals shall be provided as shown in the plans. The header material on either side of the expansion joint shall be approved by the Engineer prior to use and shall be installed at the fabrication plant prior to shipment of the panel, unless otherwise approved by the Engineer for installation at the job site. The header material and joint seal shall be compatible with each other. A letter of compatibility shall be provided by the manufacturer and approved by the Engineer.

The seal for the expansion joints shall be selected by the Contractor and approved by the Engineer. The joint seal shall be able to accommodate at an expansion

or stretch of 1.5 in. and a compression of 0.75 in. Both dimensions are measured from the initial width at the joint at installation. Groove dimensions ("W" and "D" on plans) and installation width for the joint seal shall be specified by the manufacturer. The width of the expansion joint at the level of the dowels shall be adjusted on-site immediately following completion of post-tensioning based upon the approximate ambient temperature according to:

T ≤ 50°F: 0.75"
50°F < T < 90°F: 0.5"
T ≥ 90°F: 0.25"

Unless otherwise specified on the plans, expansion joint seals shall be installed following final post-tensioning and prior to opening the pavement to traffic. The width of expansion joints after final post-tensioning shall be adjusted to the width specified on the plans. All debris in the joint shall be removed using compressed air or other approved technique approved by the Engineer prior to installing the joint seal.

Cover plates and/or edge drains shall be provided at both ends of each expansion joint as shown on the plans. A cover plate with an edge drain shall be installed at each end of the expansion joint where water is expected to drain to. Cover plates shall be installed such that they will not inhibit free movement of the expansion joint. Expansion joints shall be cleared of debris prior to installation of cover plates/edge drains.

(d) 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 precast pavement. Diamond grinding in accordance with 507.06 shall be used to bring the top surface of the existing pavement and precast pavement into tolerance if necessary.

(e) Mid-Slab and End-Slab Anchors

Mid-slab (Panel Type C) and end-slab (Panels A1 and A3) anchors shall be provided as shown on the plans to tie the precast pavement slab to the existing subbase. Alternative mid-slab or end-slab anchors may be used with the approval of the Engineer.

(f) Post-Tensioning

The Contractor shall use the post-tensioning system shown in the plans, unless a comparable system is approved for use. Shop drawings showing the post-tensioning anchorage details, stressing sequence, elongation calculations, and jacking forces shall be developed by the post-tensioning supplier and submitted to the Engineer for approval prior to panel fabrication. The dimensions of the anchor access pockets may be adjusted as needed prior to fabrication of the Joint Panels (Type A) in order to accommodate the stressing ram. The pocket dimensions shall be such that construction traffic can pass over the pockets without damage to the vehicle or disruption to the driver. Dimensions other than those shown in the plans shall be approved by the Engineer prior to fabrication of the Joint Panels (Type A).

1. 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 approved by the Engineer. Provision shall be made to prevent separation of the individual wires from the strand during strand insertion.

Transverse post-tensioning strands shall be inserted into the ducts at the anchorage assemblies at either end of the transverse post-tensioning ducts. Transverse post-tensioning strands shall be inserted into the ducts prior to commencement of longitudinal post-tensioning to ensure that adjacent post-tensioning ducts are properly aligned.

2. Tendon Stressing

Both ends of each of longitudinal post-tensioning tendon shall be stressed. Longitudinal post-tensioning strands shall be stressed to 75% of the guaranteed ultimate tensile strength of the strand supplied. The tendon stressing sequence shall be approved by the Engineer prior to the start of post-tensioning. Stressing shall be completed in a single stage unless otherwise specified. Stressing of longitudinal tendons shall start with a tendon at or near the midpoint of the panels, subsequently alternating between the tendons on either side of the centerline until all tendons have been stressed. Tendon elongations shall be measured and recorded during the stressing operation.

Transverse post-tensioning tendons shall be stressed only after completion of longitudinal post-tensioning for adjacent slabs. Transverse post-tensioning strands shall be stressed to 75% of the guaranteed ultimate tensile strength of the strand supplied. Stressing shall start with the tendons closest to the middle of each slab and alternate outward to the tendons at the ends of the slab.

After completion of post-tensioning, the tails of the post-tensioning strands shall be trimmed, and a grease cap approved by the Engineer will be used to cover and seal the end of the strand and post-tensioning anchor. Transverse tendon anchor recesses shall be patched with an approved dry-pack mortar.

3. 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 to the Engineer. No wire failures will be accepted. The Contractor shall provide and install a new strand in the event of a wire failure.

4. Patching and Repairs

Anchor access pockets in Panel Type A shall be patched only after completion of post-tensioning but prior to grouting the post-tensioning tendons. The pockets shall be patched with an approved rapid setting patching material with a minimum aggregate size of at least 3/8 in., but no greater than 1 in. The patching material shall be finished flush and textured to match the surface of the surrounding concrete.

Damage caused to the precast panels during any part of the panel installation process shall be repaired to the satisfaction of the Engineer. Repairs of damaged areas

will be addressed on a case-by-case basis by the Engineer. Damage within acceptable limits caused to the top surface (driving surface) or to keyed edges of the panels shall be repaired using repair methods and materials approved by the Engineer. Repetitive damage to panels shall be cause for stoppage of installation operations until the cause of the damage can be remedied. Patching of post-tensioning anchor access pockets, lifting anchor recesses, and all other recesses shall be completed using approved patching materials and methods.

5. Tendon Grouting

Unless otherwise shown on the plans, the longitudinal and transverse post-tensioning systems shall be grouted tendons.

Grouting equipment shall consist of the following as a minimum:

a. *Equipment for accurately measuring and proportioning by volume or weight the various materials composing the grout;*

b. *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;*

c. *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;*

d. *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*

e. *A stop watch and flow cone conforming to the dimensions and other requirements of ASTM C 939.*

A grouting plan shall be submitted to the Engineer for approval at least 4 weeks before starting grouting operations. Grouting shall be completed within 7 days after stressing of the post-tensioning tendons, unless otherwise approved. Grouting shall not be performed until the anchor access pockets, Panel Type A, have been patched. Compressible foam approved by the Engineer shall be injected into the bottom of each expansion joint to seal the bottom of the joint from grout intrusion. The shoulders shall be 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 10 and 30 sec after mixing. 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 at least once per day during grouting operations. Three compressive strength cubes will be made during each sampling and tested for compressive strength at 28 days in accordance with ASTM C 1107. The average compressive strength of three cubes shall be a minimum of 5,000 psi at 28 days.

Grout shall be pumped into the lowest end of each tendon. 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.

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. All grout that flows into an expansion joint shall be flushed from the expansion joint immediately. All grout that hardens in an expansion joint shall be removed.

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. All grout that flows onto the finished surface of the pavement during the grouting operation shall be immediately flushed from the surface. All 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.

(g) Underslab Grouting

Underslab grouting shall be used to fill all voids beneath the precast panels that may be present after placing the panels over the prepared subbase. Underslab grouting shall utilize the underslab grout ports shown on the plans.

Equipment for underslab grouting shall consist of the same equipment as specified in 509.05(f)5.

The mixture used in underslab grouting, herein referred to as Grout Slurry, shall consist of Portland cement, fly ash, fluidifier and water. The Contractor shall submit the proposed mix design to the Engineer prior to placement. The grout slurry produced shall be in accordance with the following:

1. *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 10 and 20 sec. The flow test shall be performed in accordance with ASTM C 939.*

2. *The grout slurry shall achieve initial set in less than 4 hr. 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 has been reached.*

3. The 7 day compressive strength in accordance with ASTM C 942 of the grout slurry shall not be less than 200 psi.

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. Likewise, 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. 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.

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 shall be pumped into the nearest intermediate port. All grout that flows into an expansion joint shall be flushed from the expansion joint immediately. All grout that sets up in an expansion joint shall be removed.

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. All grout that flows onto the finished surface of the pavement during the grouting operation shall be immediately flushed from the surface. All residual grout which hardens on the pavement surface shall be removed using a technique approved by the Engineer.

The finished pavement surface shall be tested for smoothness using a 16 ft straightedge in accordance with 501.25. Corrective action to improve the smoothness and all necessary re-texturing shall be completed in accordance with 501.25.

509.06 Method of Measurement

Precast Prestressed Portland Cement Concrete Pavement (PPPCCP) will be measured by the square yard (square meter) of the thickness specified. The area of PPPCCP will be the planned width of the pavement multiplied by the length of the pavement, or as directed in writing. The width of the pavement will be as shown on the typical cross section of the plans. The length of the pavement will be measured parallel to the surface of the pavement along the centerline of the roadway or ramp, excluding paving exceptions as shown on the plans.

509.07 Basis of Payment

The accepted quantities of PPPCCP will be paid for at the contract unit price per square yard (square meter) for the thickness specified, complete in place.

Payment will be made under:

Pay Item	***Pay Unit Symbol***
PPPCCP, _____ thickness, in. (mm)	*SYS (m2)*

The cost of correcting the subbase surface smoothness or damage to the subbase material shall be no additional payment.

The cost of repairing damage caused to joint panels, including bending of dowels as a result of inadequate bracing shall be no additional payment.

The cost of repairing damage to panels by the shims shall be no additional payment.

The cost of repairing damage to the precast panels during any part of the panel installation process shall be no additional payment.

The cost of repairing damage to the top surface and to keyed edges of the panels shall be no additional payment.

The cost of removing hardened grout from expansion joints and from the pavement surface due to grouting operations shall be no additional payment.

The cost of diamond grinding necessary to meet tolerances between existing pavement and installed panels and meeting the smoothness requirement of the installed panels and necessary retexturing of the surface shall be included in the cost of the PPPCCP.

The cost of replacing faulty anchors or wire failures shall be no additional payment.

The cost of trial batch demonstrations shall be included in the cost of PPPCCP.

The cost of corrections for pavement smoothness and re-texturing shall be included in the cost of the panels.

Removal and replacement of PPPCCP found to be deficient or damaged by freezing shall be completed with no additional payment.

The cost of coring and refilling of the pavement holes for appeals shall be included in the cost of PPPCCP.

The cost of providing all labor and materials and installation for the PPPCCP panels hall be included in the cost of the panels.