

## **COMPOSITE PORTLAND CEMENT CONCRETE PAVEMENTS (Tollway)**

**Effective: January 30, 2012**

**Revised: May 8, 2013**

### **DESCRIPTION**

This work consists of:

1. Furnishing, mixing, and placing ternary concrete mixes for special applications to composite pavements as shown and described on the Drawings and in this Special Provision;
2. Supplying and installing all specified reinforcement;
3. Developing concrete mix design(s) that meets the performance requirements for the intended pavement;
4. Constructing a trial section as required;
5. Constructing the composite pavement on a prepared subgrade, or subbase, without forms.
6. Verifying dowel bar alignment with periodic magnetic particle scans of joints using a magnetic imaging tomography (MIT) device.

Ternary concrete mix refers to concrete that incorporates portland cement, ground granulated blast furnace slag, fly ash, and other supplementary cementitious materials (SCM) as constituent materials. A Type IT blended ternary cement in accordance with AASHTO M 240 shall be acceptable. A Type IP or IS blended cement in accordance with AASHTO M 240 may be used when an SCM is combined as a constituent material to produce a ternary mix. Slag, fly ash, and any other SCM's combined as constituent materials in a mix or as part of a blended cement may consist of no less than 35% and no more than 50% of the total cementitious material in any mix design.

This special provision only applies to a concrete composite pavement of two rigid concrete layers constructed wet-on-wet.

### **REFERENCE STANDARDS**

Except where modified by the Illinois Department of Transportation or the Tollway, the following Standards shall apply:

- Standard Specifications for Road and Bridge Construction, Adopted January 1, 2012.
- Supplemental Specifications and Recurring Special Provisions, Current Edition.
- Tollway Supplemental Specifications to the Illinois Department of Transportation Standard Specifications for Road and Bridge Construction, Current Edition.

## **MATERIALS**

Materials shall be according to Article 420.02 of the Standard Specifications except as modified herein:

Concrete supplied for the bottom layer of a concrete composite pavement under this special provision will be designed in accordance with the Performance Related Special Provision for Ternary Concrete Mix Designs for Composite Pavement.

Concrete supplied for the top layer of a concrete composite pavement under this special provision will be designed in accordance with Section 1020 of the Standard Specifications as an IDOT approved Class PV mix using coarse aggregate sources that are certified by IDOT as 30 year life aggregates, or in accordance with the Performance Related Special Provision for Ternary Concrete Mix Designs for Composite Pavement with only virgin aggregate sources that are certified by IDOT as 30 year life aggregates. An IDOT approved Class PV mix shall be required for top layer placements when composite pavements are placed before the date of April 1<sup>st</sup> or after the date of October 15<sup>th</sup>.

## **EQUIPMENT**

Equipment shall be according to Article 420.03 of the Standard Specifications except as modified herein.

Add the following to Article 420.03 of the Standard Specifications:

“(k) MIT-Scan-2. Tollway QA shall use a MIT-Scan-2 device which is manufactured by MIT GmbH to measure dowel bar alignment following concrete placement. The device shall be calibrated on the Tollway’s approved MIT Scan calibration system for the specific dowel bar size or load transfer device being placed, and should be operated within the manufacturer’s tolerances.”

## **CONSTRUCTION METHODS**

The Composite Concrete Pavement shall be constructed as a Jointed Plain Concrete Pavement according to Articles 420.04 through 420.18 of the Standard Specifications except as modified herein.

Add the following paragraph to Article 420.05(a) of the Standard Specifications:

“Both transverse and longitudinal joints of composite concrete pavements shall be cut at depth of 3.5 inches below the finished surface. For paving of 2 lanes or wider, the longitudinal joints shall be saw cut at the same time as transverse joints are cut. If sparks are witnessed during saw cutting operations at a transverse joint or at a longitudinal joint, the joint shall be marked for removal and full-depth patching at the Contractor’s expense.”

Replace Article 420.05(c)(2) of the Standard Specifications with the Following:

- (2) Dowel Bar Assemblies/Insertions. When dowel bars are specified in the Contract, they shall be installed with the dowel bars parallel to the proposed pavement surface and to each other. Installation shall be within the tolerances specified. The bar size, grade, and spacing shall be as specified. Dowel bars shall be furnished in a rigid welded assembly or placed by a dowel bar insertion (DBI) machine. With placements using a dowel bar assembly, the assembly shall be at right angles to the centerline of pavement.

The dowel bar assembly, if used, shall act as a rigid unit with each component securely held in position relative to the other members of the assembly. Horizontal support wires or shipping tie wires shall be non-deformed bars or wires with a diameter less than or equal to 0.3249 inches (gauge 0 wire). The number of horizontal support wires or shipping tie wires shall be limited to five per assembly. The entire assembly shall be held securely in place by means of nails which shall penetrate the stabilized subbase. At least ten nails shall be used for each 10, 11, or 12 foot section of assembly. Bearing plates shall be punched to receive the nails. When bearing plates are omitted on stabilized subbase, other methods for securing the assembly with nails shall be provided.

Metal stakes shall be used instead of nails, with soil or granular subbase, to secure the dowel bar assembly. The stakes shall loop over or attach to the top parallel spacer bar of the assembly and penetrate the subgrade or subbase at least 12 inches.

The horizontal support wires or shipping tie wires of the dowel bar assembly shall be cut prior to concrete placement. At the location of each dowel bar assembly, the subgrade or subbase shall be reshaped and re-tamped when necessary.

A dowel bar inserter (DBI) used with a slip-form paver meeting the requirements of Article 1103.16 may be used in lieu of the dowel bar assemblies specified above. When a dowel bar inserter is used to install dowel bars, space the bars according to design requirements. Dowel bar inserters shall insert dowel bars into the top lift plastic concrete which has been placed and consolidated to full depth. The bars shall be inserted ahead of the finishing beam or screed and the installing device shall so consolidate the concrete that no voids exist around the dowel bars. The forward movement of the finishing beam or screed shall not be interrupted by the inserting of the dowel bars.

When a DBI is used, the Contractor shall submit details and specifications of the proposed slip-form paver and DBI to the Engineer a minimum of 14 calendar days prior to the concrete pavement pre-paving meeting. The DBI shall be used with the slip-form paver used for placing the top lift concrete. The Contractor shall detail his methodology for ensuring correct marking of dowel bar insertion points and correct sawing of the joints. The Contractor shall ensure that the slip-form paver is compatible with the DBI.

Add the following to Article 420.05(c) of the Standard Specifications:

“(3) Verification of Dowel Bar Alignment.

- a. Dowel Alignment Tolerances. Dowel placement tolerances for 18 inch dowel bars shall be as follows:

A weighted-score system will be used to conduct a joint-by-joint evaluation of rotational misalignments of the dowel bars. The Joint Score, as defined in this evaluation, is a measure of the combined effects of rotational misaligned dowel bars at a transverse joint between any two longitudinal joints or between a longitudinal joint and edge of pavement. A Joint Score is determined by summing the product of the weights (given in the table below) and the number of bars in each misalignment category and adding 1. For example, if a joint has four misaligned bars in the 0.6 to 0.8 inch range, the joint score is 9; if a joint has one misaligned bar in the 0.6 to 0.8 inch range and one bar in the 1 to 1.5 inch range, the score is 8. A joint score of 12, irrespective of the number of dowel bars at the joint, is the critical level, above which the risk of joint locking is considered high.

Range of Rotational Misalignment	Weight
0.4 in. < d < 0.6 in.	0
0.6 in < d < 0.8 in.	2
0.8 in. < d < 1 in.	4
1 in. < d < 1.5 in.	5

Rejection Criteria:

Horizontal and Vertical Rotational Alignment –

- Five or more consecutive joints with joints scores greater than 12..
- Any individual bars with misalignment greater than 1.5 inches.

Longitudinal (side) Shift –

- For joints with bars only in the wheel path, any joints with fewer than three bars with a minimum embedment length of 6.0 inches.
- For joints with dowels fully across the joint, any joint where the first ten bars from the right travel lane edge contains fewer than six bars with a minimum embedment length of 6.0 inches.

#### Depth –

- Any bar with the concrete cover above the bar less than 4 inches from the concrete surface.
- Reject any bar that has been cut during the saw cutting operation.
- For joints with bars only in the wheel path, any joint with more than two bars closer than 3.0 inches from the bottom of the slab.
- For joints with dowels fully across the joint, any joint where the first ten bars from the right travel lane edge contain more than four bars closer than 3.0 inches from the bottom of the slab.

#### Corrective Measures:

The following corrective measures will be considered for the bars or joints that fail to meet the minimum standard as described by the Rejection Criteria. The Contractor shall submit his method of repair to the Engineer for approval. All materials shall be preapproved.

#### Joint Score -

- Replace one or more joints with Class B patches so that there are no more than four consecutive joints with a Joint Score of 12 or more.

#### Individual Bar Rejection –

- Saw cut any bar with horizontal or vertical rotational alignment greater than 1.5 inches.

For all other rejection issues, ensure that a minimum of three bars per wheel path are acceptable for joints with bars only in the wheel path. For joints with dowels fully across the joint, ensure that a minimum of six bars are acceptable. Corrective measures can be Class B patching or dowel bar retrofits.

Regardless of the dowel bar placement method used, the Contractor shall demonstrate their ability to place dowel bars in conformance with the specifications by placement of a trial section.”

Insert the following at the beginning of Article 420.06.

“Forms shall only be used for short stretches of pavement, such as at ramp transitions, between mainline bridges, or other areas inaccessible to formless pavers, and shall be constructed in one lift using the concrete mix specified for the top lift of the composite pavement. Locations for manual single lift formed placements in place of two lift placements using formless pavers shall be approved by the Engineer and any manual single lift formed placements shall be performed at no additional cost to the Tollway.”

Add the following to Article 420.07 of the Standard Specifications:

- “(a) Placing Composite Portland Cement Concrete Pavement. The pavement shall be placed in two lifts, with the second top lift being of a lesser thickness as designated by contract design and placed between 15 and 45 minutes after the placement of the first lower lift. Any portions of the bottom lift of concrete which have been placed more than 45 minutes without being covered with the top lift shall be removed and replaced with freshly mixed concrete, at the Contractor’s expense if bonding between layers or consolidation of concrete is determined by the Engineer to be unsuitable.

A 300-foot trial section shall be constructed by the Contractor at a location agreed upon by the Engineer. The purpose of the trial section is to replicate the actual construction process, equipment, materials (including dowel bars), placement methods, tining, smoothness, and haul times that will be used on the actual composite pavement mainline construction either for single lane or multiple lane placements.

The bottom concrete lift shall not require curing, texturing, or sawing before the top concrete lift is placed, and shall be struck off to provide a nominal bottom lift thickness that complies with the pavement design and allows for the top lift to be struck off after placement to obtain the minimum top lift thickness required and to allow for the finished total pavement to conform to the cross section shown on the plans. If a dowel bar inserter is used with a formless paver to place dowel bars, the dowels can be inserted during placement of the top lift.

The frequency of the vibrators shall be established based on the workability of the concrete and experience from the demonstration slab. Electronic, internal, T-shaped, poker vibrators shall be used (either of the surface or internal vibration type). Other types of vibrating equipment may be approved by the Engineer. The vibrator impulses shall be delivered directly to the concrete and the intensity of vibration shall be sufficient to consolidate the concrete mass thoroughly and uniformly throughout its entire depth and width. The Contractor will be allowed to increase the speed of the vibrators with the permission of the Engineer.

Two slip-form pavers shall be used in sequence for the composite pavement construction in accordance with Article 420.14 of the Standard Specifications. In order to maintain the consistency of material properties, of concrete placement, and of finishing; to reduce the potential for mix contamination; and to maintain proper distances between pavers, the concrete mix for each pavement lift shall be produced at separate production plants during composite pavement construction. The Contractor may propose and demonstrate other formless placement methods / equipment for bottom lift placement through the trial section. The slip-form paver and any other formless paving equipment that may be approved by the Engineer

for bottom lift placement shall operate in such a way to distribute and evenly consolidate the concrete mixture and to maintain positive grade control. During production placement when an alternative to a slip-form paver is used for the bottom lift, if more than 15% of the dowels are measured at any section location to exceed the specified rejection criteria and/or poor consolidation below dowel bars are found commonly present by the engineer at any location, the Contractor will be required to resume paving of composite pavements using two slip form pavers. Any additional trial sections and equipment modifications required will be at the Contractor's expense. The second paver shall follow the first paver by no more than 45 minutes with a distance between pavers to be no more than 150 feet, except on hot summer days when the maximum time and distance between paving operations may have to be reduced to obtain sufficient consolidation. The requirement of a spreader in front of the bottom lift paver may be waived if a slip-form paver equipped with an automatic dowel bar inserter is used and a continuous operation can be maintained with concrete placed in front of the first paver.

Paving of composite concrete pavements shall be continuous between transverse joint locations shown on the plans. The composite pavement may be substituted with a single lift standard concrete pavement using the top lift concrete mix throughout the placement only at locations approved by the Engineer where isolated cut out or block out locations that do not exceed 500 feet. in length adjacent to mainline bridges, near crossovers or at ramp locations. Approved substitution of composite paving with single lift paving shall be at no additional cost to the Tollway.

1. Procedures for Verification of Dowel Bar Alignment. When using either dowel bar assemblies or an automatic dowel bar inserter, the Tollway shall use the calibrated MIT-Scan-2 to verify the position and alignment of the dowel bars within the trial sections and during production. The Contractor shall ensure that the surface to be tested is clear of any loose stone or other debris. To facilitate data analysis, all joints evaluated shall be scanned by the Tollway with the MIT-Scan-2 device moving in the same direction as concrete placement.

Following placement of the trial section for composite pavements, the Contractor shall shut down the paving operations. During the shutdown period, the Tollway shall evaluate all joints in the trial section using the MIT-Scan-2 device in the presence of the Engineer on the next business day after placement, analyze the results, and submit the results to the Engineer. Paving operations shall not be restarted until the Engineer approves the trial section results, which should be completed by the Tollway within 5 days of the trial section placement. The trial section will be found acceptable if 85% of the dowel bars placed are found to be acceptable. All dowel bars exceeding the rejection criteria must be addressed using the specified corrective measures.

Additional trial sections will be required for the following:

- a. When the slip-form paving equipment has been modified to accommodate a change in the paving width, or disassembled;
- b. At the beginning of each construction season; and
- c. When the slip-form paving equipment has been replaced by different equipment.

If the Project has less than 500 linear feet of pavement, the trial section will not be required. If a Project does not have sections of continuous pavement greater than 45 linear feet, the trial section will not be required.

Upon completion of the trial section(s) and for each week of production, Tollway Quality Assurance shall prepare a report from the measurements obtained. All data shall be submitted in the manufacturer's native file format, along with the calibration files. Tollway Quality Assurance shall submit a standard report generated using MagnoProof or approved equivalent software (electronic Excel report) to the Engineer at the start of each working week during production for the previous week's work.

The electronic report shall include the following:

- a. Contract number, date, highway number and direction of traffic.
- b. Joint number, lane number and station.
- c. Bar number and x-location of dowel bar.
- d. Horizontal and vertical misalignment in inches.
- e. Side shift in inches.
- f. Depth to center of dowel bar in inches.
- g. Depth to the top end of the dowel bar in inches.
- h. Joint Score.
- i. All out-of-tolerance readings shall be highlighted in red.

Due to potential magnetic interference from tie bars, dowel bars located within 15 inches of a tied longitudinal joint shall not be included in the evaluation. Joints located directly under high voltage power lines that cross over the roadway shall not be evaluated.

If the trial section is found to be unacceptable to the Engineer, the Contractor shall perform corrective actions to the equipment, materials, and/or processes and place a second trial section at the Contractor's expense. The Contractor shall develop a written plan outlining the steps to be taken in order to pave a successful trial section. This plan shall be submitted to the Engineer for review and approval. The Contractor cannot conduct full-day paving or pave more than 500 feet per day until a trial section has been successfully completed

## 2. Verification of Dowel Bar Alignment During Production



Once a trial section is successfully completed and approved, dowel bar placement testing frequency by Tollway QA shall be a minimum of one location of each continuous traffic lane or ramp lane paved each day. Sections of mainline designed to be greater than 150 linear feet and less than 1,250 linear feet during a day of placement require a minimum of one test location. Testing locations shall be determined by a random procedure so that each area has a randomly selected transverse joint location. At each location, ten consecutive joints shall be tested by Tollway QA using the MIT-Scan-2 device. If a joint is rejected on the basis of the Joint Score or of the individual bar criteria, then additional joints adjacent to the ten original joints are tested until at least five consecutive joints meet all acceptance criteria. Satisfactory control is considered to have been established when no rejectable dowel bars have been identified during three consecutive days of concrete paving. Once satisfactory control is established, a minimum of one location (ten joints) within every three days of production shall be selected by the Engineer for evaluation. If a joint rejection then occurs, Tollway QA will conduct daily MIT Scan analysis until satisfactory control is re-established.

Sections of continuous pavement constructed by the project less than 150 linear feet will not require dowel bar placement testing.

All delays or costs associated with proposed equipment, materials, or processes being rejected for use by the Engineer will not be paid for by the Tollway.

- (b) Verification of Consolidation. At each 300 feet trial section placed with only one slip form paver, within 24 hours of placement the Contractor shall take one core through one joint of each 100 ft of the trial section. The cores shall be observed by the Tollway QA and the Engineer for verification of satisfactory consolidation below the dowels and to verify thickness as specified. During production, cores taken in accordance with Article 420.15 to determine pavement thickness shall be taken at a location 9 inches off a sawed joint in close proximity of a dowel bar to verify suitable consolidation under the dowels as well.”

Revise Article 420.09(e)(1) of the Standard Specifications to read:

“Type A. Texturing of the top lift of plastic concrete shall be obtained by the use of an artificial turf drag followed immediately by a mechanically operated metal comb longitudinal tining device. Hand finishing methods will be permitted only in the event of breakdown of the mechanical equipment or for confined locations where the mechanical equipment cannot be operated. Hand methods may be used to strike off, consolidate, and finish the concrete only in the confined locations and where the concrete has already been deposited on the grade when the breakdown occurs.

The artificial turf shall be made of molded polyethylene with synthetic turf blades approximately 0.85 inches long and contain approximately 7,200 individual blades per square foot. The drag shall be suitably attached to an approved device that will permit control of the time and rate of texturing. The artificial turf shall be full pavement width and of sufficient size that during the finishing operation; approximately 2 feet. of the turf parallel to the pavement centerline will be in contact with the pavement surface. The drag shall be operated in a longitudinal direction so as to produce a uniform appearing

finish meeting the approval of the Engineer. If necessary for maintaining intimate contact with the pavement surface, the drag may be weighted using lumber, rebar, or other suitable material.

The metal comb shall consist of a single line of tempered spring steel tines spaced at 0.75-inch centers and securely mounted in a suitable head. The tines shall be flat and of a size and stiffness sufficient to produce a groove of the specified dimensions in the plastic concrete without tearing of the pavement edge or surface. The Contractor shall modify the equipment or operations if an acceptable pavement edge or surface is not produced. The mechanically operated metal comb shall be attached to an exclusive piece of equipment which is mechanically self-propelled.

The tining device shall be operated so as to produce a relatively uniform pattern of grooves parallel to the pavement centerline spaced at approximately 0.75-inch centers, 0.13 to 0.19 inch deep, and 0.13 inch wide. Longitudinal tining shall stop at the edge of travel lanes. Tining devices shall be maintained clean and free from encrusted mortar and debris to ensure uniform groove dimensions. The tining finish shall not be performed too soon after pavement placement whereby the grooves may close up. The tining grooves shall be neat in appearance, parallel with the longitudinal joint, uniform in depth and in accordance with these specifications.

Hand tining or tining with a mechanically operated comb combined with the curing equipment specified in Article 1101.09 of the Standard Specifications will be permitted where the specifications permit hand finishing or vibratory screeds, one lane construction up to 16 ft. wide, gaps, projects with a net length of ½ mile or less, and where the production rate on any paving day will be less than 1,500 cubic yards per day. A foot bridge shall be provided for the hand tining operation for all pavement over 12 ft. wide, unless it can be demonstrated to the satisfaction of the Engineer that an alternate texturing operation produces satisfactory results.”

Change the first paragraph of Article 420.14 to read:

“Slip-form paving (formless paver) methods, according to the following, shall be the primary construction method used for the composite concrete pavements, and shall be required for any top lift placement, and required for any bottom lift placement unless it can be demonstrated to the satisfaction of the Engineer that an alternate formless placement method and equipment for the bottom lift can produce satisfactory results. . Slip form paving methods shall replace the strike off, consolidation, and finishing requirements of Article 420.09(a) unless equipment breakdown occurs.”

Revise Article 420.15 of the Standard Specifications to read:

“Tolerance in Thickness. Determination of the total pavement thickness, computation of the pavement’s total thickness, computation of the lift thicknesses, and requirements relative to deficient total thickness shall be according to Article 407.10 except for the following.

- (a) Width of Sublots and Lots, or Units. The width of a subplot and lot, or unit, shall be the width from the pavement edge to the adjacent longitudinal joint, from one longitudinal joint to the next, or between pavement edges where there is no longitudinal joint.

- (b) The Contractor shall strive to construct the total pavement and the top lift to the designed thickness. A thickness deficiency of the top lift up to 0.5 inches will not be penalized. A top lift thickness deficiency more than 0.5 inches will require removal and replacement by the Contractor at no expense to the Tollway.”

## **SURFACE TESTS**

Surface testing of the finished pavement shall be according to the IDOT Supplemental Specifications.

## **OPENING TO TRAFFIC**

Composite concrete pavement shall not be opened to construction paving or loaded supply truck equipment or other heavy equipment until both lifts of concrete have attained an age of 7 days if concrete strength tests are not conducted; or until all specimens sampled for both lifts have reached a minimum flexural strength of 450 psi and a minimum compressive strength of 2,850 psi at no less than 5 days of age as approved by the Engineer.

Perform construction operations on new pavement as approved by the Engineer and in accordance with the following:

- 1) Construct a temporary ramp to prevent damage to the pavement slab when moving on and off the pavement.
- 2) Operate the paving equipment on protective mats to prevent damage to the pavement surface and joints. Sweep the pavement surface free of debris before placing the protective mats.
- 3) Operate equipment on a slab without causing damage. If damage results, suspend operations and take corrective action as approved by the Engineer. Do not operate the equipment wheels or tracks within 6 inches of the slab edge.

Composite concrete pavement shall be opened to public traffic according to Article 701.17(c)(5) of the Standard Specifications except as follows:

Revise the second and third sentences of Article 701.17(c)(5) of the Standard Specifications to read:

“The earliest the pavement will be opened to public traffic will be when test specimens for the top layer of concrete have attained a flexural strength of 650 psi or a compressive strength of 3,500 psi, and the test specimens for the bottom layer of concrete have attained a flexural strength of 575 psi and a compressive strength of 3,200 psi at no less than 14 days age. If concrete strength tests are not conducted, the pavement shall not be opened to traffic until 28 days when ternary mixtures are used for either lift.”

Test specimens for strength measurements shall be obtained from both lifts of concrete.

The determination of compressive or flexural strength shall be based on the following:

Test cylinders for the concrete of both lifts shall be fabricated at the time of placement and at the same locations of placement at the specified frequency, field cured under conditions comparable to the in-place concrete, and tested in accordance with AASHTO T 22. Test beams for the concrete of both lifts shall be fabricated at the time of placement at the same locations of placement, field cured under conditions comparable to the in-place concrete, and tested in accordance with AASHTO T97.

## **METHOD OF MEASUREMENT**

This work will be measured for payment in accordance with Article 420.19 of the Standard Specifications.

## **BASIS OF PAYMENT**

This work will be paid for at the contract unit price per square yard for COMPOSITE PORTLAND CEMENT CONCRETE PAVEMENT (JOINTED), of the total thickness specified.

Pavement fabric will be paid for at the contract unit price per square yard for PAVEMENT FABRIC.

When the contract requires the Contractor to furnish a profilograph, the work will be paid for according to Article 407.12.

Protective coat will be paid for at the contract unit price per square yard for PROTECTIVE COAT.

Removing and replacing curing and protective cover, when required, will be paid for according to Article 109.04.

Test strips will be evaluated for payment at the contract unit price per each for CONSTRUCTING COMPOSITE CONCRETE TEST STRIP, according to the following.

- (a) If the initial composite concrete test strip is determined to be acceptable, the pavement and test strip will be paid at the contract unit prices.
- (b) If the initial composite concrete test strip is placed on-site and determined to be unacceptable to remain in place by the Engineer, the initial pavement and test strip will not be paid for and shall be removed at the Contractor's expense.
- (c) If the Contractor requests and is granted approval for a concrete mix design other than the initially approved concrete mix designs or equipment for paving is modified for any reason, the Contractor shall construct a test strip for the new mix design or modified paving train at no additional cost to the Tollway.