December 28, 2017

REVISION OF SECTION 518

POLYESTER CONCRETE END DAM

**NOTICE**

This is a standard special provision that revises or modifies CDOT’s *Standard Specifications for Road and Bridge Construction.* It has gone through a formal review and approval process and has been issued by CDOT’s Project Development Branch with formal instructions for its use on CDOT construction projects. It is to be used as written without change. Do not use modified versions of this special provision on CDOT construction projects, and do not use this special provision on CDOT projects in a manner other than that specified in the instructions unless such use is first approved by CDOT’s Standards and Specifications Unit. The instructions for use on CDOT construction projects appear below.

Other agencies which use the *Standard Specifications for Road and Bridge Construction* to administer construction projects may use this special provision as appropriate and at their own risk.

**Instructions for use on CDOT construction projects:**

Use on projects having polyester concrete end dams.

Section 518 of the Standard Specifications is hereby revised for this project as follows:

Subsection 518.01 shall include the following:

This work consists of furnishing and placing a Polyester Concrete End Dam system which includes Polyester-based Polymer Concrete (PPC) and High-molecular-weight Methacrylate (HMWM) resin primer. The system shall be used for Portland Cement Concrete blockouts (PCC) of bridge expansion devices on the concrete bridge deck, abutment backwalls, and approach slabs as shown on the plans.

Delete subsection 518.06 and replace with the following:

**518.06 Polyester Concrete End Dam.**

1. *Submittals.* 15 days prior to the Polyester Concrete Pre-placement Conference the Contractor shall submit the following:
2. Polyester Concrete End Dam System. The Contractor shall submit to the Engineer 2 copies of the Manufacturer’s written instructions for the installation of the Polyester Concrete End Dam system. The literature shall contain pertinent materials and installation data for the PPC supplied on the project. The Contractor shall submit the proposed testing procedures, mix design, form installation, and criteria for all PPC materials.
3. Manufacturer Qualifications.The Contractor shall install a Polyester Concrete End Dam system with all components of PPC provided through a single manufacturer. The manufacturer shall have documented experience supplying 5 successful projects of similar size and scope within the past 5 years. The Contractor shall submit documentation of the manufacturer’s project experience including the following:
4. Project construction dates.
5. PPC quantities.
6. Reference names and contact information for owner representatives.
7. Contractor Qualifications. The Contractor shall submit documentation of at least 10 successful projects with one or more of the following: (1) placing structural concrete (bridge deck or concrete pavement), (2) Thin Bonded Overlay (Polyester Concrete), and (3) Polyester Concrete End Dam, to established grade lines using similar equipment as specified in subsection 518.11(c) below within the past 5 years. The documentation of Contractor qualifications shall include the following:
8. Project construction dates.
9. PPC quantities.
10. Reference names and contact information for owner representatives.

If the Contractor does not have at least 10 documented successful projects of experience with placing structural concrete and PPC systems, the Contractor shall arrange for a qualified Manufacturer’s Technical Representative with at least 5 documented successful projects of experience with PPC system placements within the past 5 years to be on site throughout the duration of the project to provide technical support for the material mixing and placement.

If the Contractor has at least 10 documented successful projects of experience with placing structural concrete and PPC systems, the qualified Manufacturer’s Technical Representative with at least 5 documented successful projects of experience with PPC system placements within the past 5 years shall, at a minimum, be on site the first day of PPC placements, and shall be available as requested by the Engineer if it is necessary.

1. Manufacturer’s Technical Representative Qualifications*.* The Manufacturer’s Technical Representative shall have at least 5 documented successful projects of experience of similar size and scope with PPC system placements using similar equipment as specified herein within the past 5 years, and be competent in all aspects of the work including all materials to install the PPC systems. This includes, but not limited to, surface preparation, PPC application and PPC curing. The Technical Representative shall be available on site for the first day of PPC placement to facilitate the installation.

The Contractor shall submit documentation of the Technical Representative’s experience including the following:

1. Years of experience with PPC systems.
2. Project construction dates.
3. PPC quantities.
4. Reference names and contact information for owner representatives.
5. Certified Test Report.The Contractor shall furnish a Certified Test Report, in accordance with subsection 106.13, confirming that all materials required for a Polyester Concrete End Dam system have been pretested, and meet all requirements.
6. Placement Plan. The Contractor shall submit a Polyester Concrete Placement Plan that includes the following:
7. Schedule of work and required testing.
8. Placement sequence and procedure.
9. Description of all equipment used.
10. Method for preventing leakages of HMWM primer and Polyester Concrete.
11. Method for measuring, and maintaining thickness and profile for each lift.
12. Tining plan showing methods and locations.
13. Finishing surface method including sequence and repair of damaged sections.
14. Cure time for Polyester Concrete.
15. Storage and handling of resin and PPC components.
16. Procedure for disposal of excess resin, PPC and containers.
17. Procedure for cleanup of mixing and placement equipment.
18. Equipment*.* The Contractor shall submit documentation of certification of scales that will be used to calibrate the mobile mixing truck. The certification shall be dated within the last month. A new certification shall be done if any adjustments are made to the scales.

The Contractor shall submit a documented history of the use of the paving machine to successfully place Polyester Concrete End Dams on major bridge projects for review and approval by the Engineer.

1. Material Samples. Representative material samples used for the project shall be submitted by the manufacturer a minimum of 60 days prior to the PPC application. The exact samples of materials from the same lots used for the project, for all components of the PPC system shall be submitted by the manufacturer, if requested, a minimum of 15 days prior to the PPC application. The quantities of the material samples shall consist of one 4-liter sample for each liquid with corresponding amounts of catalysts and accelerators, and a 50 pound sample for each dry component.
2. *Material Requirements.* Materials for the Polyester Concrete End Dam shall be as follows:
3. PPC. The PPC shall consist of Polyester Resin Binder, catalysts and dry aggregate specified in Table 518-3. It shall also include a compatible primer applied on the prepared concrete areas, which when mixed with other specified ingredients and applied as specified herein, shall produce a PPC meeting the requirements of this specification. Accelerators may be required to speed up the chemical reaction, and achieve proper Set Time of the PPC. They shall be used as recommended by the PPC Manufacturer.
4. Polyester Resin Binder. Polyester Resin Binder shall have the following properties:
5. Be an unsaturated Isophthalic Polyester-styrene Co-polymer. The Polyester Resin content shall be 12 percent +1 percent of the weight of the dry aggregate.
6. Contain at least 1.0 percent by weight Gamma-methacryloxypropyltrimethoxysilane, an Organosilane Ester Silane coupler.
7. Be used with a promoter that is compatible with suitable Methyl Ethyl Ketone Peroxide and Cumene Hydroperoxide initiators.
8. Have the values for the material properties shown in Table 518-1.

**Table 518-1**

**POLYESTER RESIN BINDER PROPERTIES**

**(Tested each lot sent to the job)**

|  |  |  |
| --- | --- | --- |
| Property | Test Method | Value |
| Viscosity\* | ASTM D 2196 | 0.1x10-5 to 2.9x10-5 psi-sec (0.075 to 0.20 Pa-s) RVT No.1 Spindle, 20 RPM at 77°F |
| Specific Gravity\* | ASTM D 1475 | 1.05 to 1.10 at 77°F |
| Elongation | ASTM D 638 | 35 percent, minimum Type I specimen, thickness 0.25 ± 0.03” at Rate = 0.45 inch/minute. |
| ASTM D 618 | Sample Conditioning: 18/25/50+5/70 |
| Tensile Strength | ASTM D 638 | 2,500 psi, minimum Type I specimen, thickness 0.25 ± 0.03” at Rate = 0.45 inch/minute. |
| ASTM D 618 | Sample Conditioning: 18/25/50+5/70 |
| \* Test shall be performed before adding initiator. | | |

1. Primer*.* Primer for the concrete blockout surfaces shall be a wax-free low odor, High-molecular-weight Methacrylate primer (HMWM), and consist of a resin, initiator, and promoter.

When initiators and promotors are required to achieve proper modifications for working under different temperature conditions and applications of the primer, they shall be used as recommended by the PPC Manufacturer.

HMWM primer shall be applied to bond in PCC surfaces and promote adhesion to the PPC materials. The primer shall be tested for the Bond Strength in accordance with CP-L4302. The primer shall have a maximum volatile content of 30 percent prior to adding the initiator, when tested in accordance with ASTM D 2369, and conform to Table 518-2.

Initiators for the Methacrylate Resin shall consist of a metal drier and Peroxide. If supplied separately from the resin, the metal drier shall not be mixed with the Peroxide directly. The containers shall not be stored in a manner that allows leakage or spilling to contact the containers or materials of the other.

**Table 518-2**

**HIGH MOLECULAR WEIGHT METHACRYLATE RESIN PROPERTIES**

**(Tested yearly)**

|  |  |  |
| --- | --- | --- |
| Property | Test Method | Value |
| Viscosity\* | ASTM D 2196 | 4.0x10-5 psi-sec (0.025 Pa-s) maximum (Brookfield RVT with UL adapter, 50 RPM at 77°F) |
| Volatile Content\* | ASTM D 2369 | 30 percent, maximum |
| Specific Gravity\* | ASTM D 1475 | 0.90 minimum at 77°F |
| Flash Point\* | ASTM D 3278 | 180 °F minimum |
| Vapor Pressure\* | ASTM D 323 | 0.04 inch Hg, maximum at 77°F |
| PCC Saturated Surface-Dry Bond Strength (Adhesive) | CP-L4302 | 700 psi, minimum at 24 hours and 70 + 1°F  (with Polyester Concrete at 12 % resin content by weight of the dry aggregate) |
| \* Test shall be performed before initiator is added | | |

1. Aggregate*.*  Aggregate for Polyester Concrete shall:
2. Have not more than 45 percent crushed particles retained on the No. 8 sieve when tested in accordance with AASHTO Test Method T335.
3. Provide fine aggregate consisting of natural sand.
4. Have a weighted-average aggregate absorption of no more than 1.0 percent when tested under AASHTO Test Methods T84 and T85.
5. At the time of mixing with resin, have moisture content of not more than one half of the weighted-average aggregate absorption when tested under AASHTO Test Method T255.
6. Comply with the requirements for the aggregate gradation shown in Table 518-3.

**Table 518-3**

**AGGREGATE GRADATION**

**(Tested yearly)**

|  |  |
| --- | --- |
| Sieve Size | Percent Passing |
| 3/8” | 100 |
| No. 4 | 62-85 |
| No. 8 | 45-67 |
| No. 16 | 29-50 |
| No. 30 | 16-36 |
| No. 50 | 5–20 |
| No. 100 | 0-7 |
| No. 200 | 0-3 |

1. Sand*.* Sand for abrasive sand finish shall:
2. Be commercial-quality blast sand.
3. Have not less than 95 percent pass the No. 8 sieve, and not less than 95 percent retained on the No. 20 sieve when tested under AASHTO Test Method T27.
4. Have an average absorption of not more than 1.0 percent when tested under AASHTO Test Method T85.
5. CompositeSystem Properties*.*Polyester Concrete End Dam system shall have the values for the composite system properties shown in Table 518-4:

**Table 518-4**

**COMPOSITE SYSTEM PROPERTIES**

**(Tested every 2 years)**

|  |  |  |
| --- | --- | --- |
| **Property** | **Test Method** | **Values** |
| Abrasion Resistance | CP-L4301 | < 2g weight loss (at 12% resin content by weight of the dry aggregate) |
| Modulus of Elasticity | ASTM C 469 | 1,000,000 psi to 2,000,000 psi (at 12% resin content by weight of the dry aggregate) |
| PPC (Bond Strength) | CP-L4302 | 500 psi, minimum at Minimum of 24 hours and 70°F (without Primer, at 12 % resin content by weight of the dry aggregate, and saturated surface dry specimen) |
| Compressive Strength at Final Set Time | ASTM C 805 | 3,000 psi at Minimum of 4 hours |
| Compressive Strength at Cure Time | ASTM C 39 | 4,500 psi at Minimum of 24 hours |

Delete subsection518.11 and replace with the following:

**518.11 Polyester Concrete End Dam.**

1. *Pre-placement Conference*. A Polyester Concrete Pre-placement Conference shall be held at least 15 days before any PPC placement operation begins. Attendees shall include all parties involved in the work.
2. *Trial Application.* The Contractor shall construct a test box for a test pour. The test box shall be at least 4 feet long, the depth of the Polyester Concrete End Dams, and the maximum width of the End Dams, or as approved by the Engineer. Prior to constructing the Polyester Concrete End Dams, one or more trial applications shall be placed in the test box to determine the Initial Set Time (Gel Time), Final Set Time, and Cure Time and to demonstrate the effectiveness of the mixing, placing, and finishing equipment proposed. The Final Set Time can be determined when the in-place PPC cannot be deformed by pressing with a finger, indicating the resin binder is no longer in a liquid state.

After mixing all PPC materials, the PPC begins to harden and reaches the Initial Set Time between 30 to 120 minutes. Then the PPC achieves the Final Set Time after 4 hours, and the Compressive Strength Test shall meet the acceptable strength as specified herein. After 24 hours, the PPC reaches the Cure Time and it shall achieve the full strength as specified herein.

The trial applications shall be tined as per the tining requirements as stated in the Contractor’s Tining Plan for the final application. The trial application shall replicate field conditions and be constructed using the same equipment as the production work. The location of the trial application shall be as approved by the Engineer. Trial applications shall be properly disposed of off-site by the Contractor.

The number of trial applications required shall be as many as necessary for the Contractor to demonstrate the ability to construct an acceptable trial end dam section and competency in ability to perform the work. All Set Times are based on anticipated application temperatures, conditions, and lane closure timing. The Contractor shall adjust the mix design, and construct a test box and demonstrate that the adjusted mix consolidates and sets properly. The methods, installer, or the PPC system may be rejected after three trial applications if not shown to be adequate or in compliance with this specification as directed by the Engineer.

PPC Pull Bond Tests shall be performed in accordance with the accepted testing as specified herein. Acceptable test results shall be achieved on a trial application before installation may proceed.

1. *Equipment.* All equipment for cleaning the existing concrete surface, and mixing and applying the PPC system shall be in accordance with the Material Manufacturer’s recommendations as approved by the Engineer prior to commencement of any work.
   1. Measuring Equipment. The following equipment shall be provided:
2. Certified Scales used to calibrate the mobile truck mixing equipment.
3. Means to measure the resin levels in the tank of the mobile truck mixer during paving operations and access to the resin tank.
   1. Mixing Equipment. A continuous mixer shall be used for all PPC applications. The continuous mixer shall:
4. Employ an auger screw/chute device.
5. Be equipped with an automatic metering device that measures and records aggregate and resin volumes. Record volumes at least every five minutes, including time and date. Submit recorded volumes at the end of the work shift.
6. Have a visible readout gage that displays volumes of aggregate and resin being recorded.
7. Produce a satisfactory mix consistently during the entire placement.
8. Be calibrated by certified scales provided by the Contractor. Calibration shall be demonstrated by comparing the computer tickets to three consecutive batches of aggregate verified to be within 2% of one another. The process shall be repeated for three consecutive batches of resin, also verified to be within 2% of one another. This calibration process shall be witnessed by the Engineer, and the calibration shall be done every 90 days.

A portable mechanical mixer of appropriate size for proposed batches, as recommended by the manufacturer and approved by the Engineer, may be used for all PPC applications and for smaller area applications of less than 2000 cubic feet per contract.

* 1. Finishing Equipment: PPC materials may be placed using a vibratory screed, a slip form paving machine or a placing machine as approved by the Engineer, which is modified or specifically built to effectively place the PPC in a manner such that the finish shall match the adjacent deck or pavement surfaces, and meet the requirements of the project. It shall be used for all PPC applications. If finishing of the PPC in small areas is done using hand finishing tools, it shall be completed to make new Polyester Concrete in the concrete blockouts flush with the top of the deck or pavement surface.

1. *Surface Preparation.* Prior to HMWM primer and PPC applications, the concrete surfaces to be treated shall be cleaned by shot-blasting, scarifying, chipping, or sandblasting until all unsound materials and contaminants which may interfere with the primer and PPC have been removed from the concrete blockouts. Exposed concrete surfaces shall be protected from precipitation and heavy dew during and after the application of the primer.
2. *Forms.* Forms of the concrete blockouts shall be tight, and sufficiently rigid to prevent distortion due to the pressure of the PPC and other loads incidental to the PPC. The formwork shall be inspected by the Engineer prior to the PPC placements. The forms shall be sealed water tight so that there is no leakage.
3. *HMWM Primer Application.* Prior to placing HMWM primer in the concrete blockouts, the exposed surfaces of the existing concrete shall be completely dry and blown clean with oil-free compressed air. However the primer shall be placed after 28-day curing time of new concrete.

After the exposed concrete surfaces have been prepared and cleaned, the primer shall be applied in accordance with the Manufacturer's recommendations. The primer shall be applied within 5 minutes of mixing at a spread rate of approximately 90 square feet per gallon, and uniformly spread to completely cover any surfaces which PPC materials will bond. The primer shall be reapplied to any areas that appear dry after 15 minutes of absorbing the materials. The concrete surface temperature shall be at 40°F and rising to 95°F maximum, and the relative humidity shall be not more than 85 percent.

1. *Polyester Concrete Application.* The Polyester Concrete shall be applied in the concrete blockouts within 2 hours after the primer has been applied. Prior to PPC placement, the surface temperature of the concrete blockouts to receive PPC shall be at 40°F and rising to 95°F maximum.

The PPC shall be placed prior to the Initial Set Time and 15 minutes following addition of an initiator, whichever occurs first, or within a more restrictive temperature range if recommended by the manufacturer. After placing PPC in the concrete blockouts, if the Initial Set Time of PPC has exceeded 120 minutes, the materials shall be removed and replaced at the Contractor’s expense.

After a minimum of 4 hours and prior to opening to traffic, the Compressive Strength Test for Polyester Concrete End Dams shall be performed in accordance with the Rebound Hammer of Hardness Concrete, ASTM C 805. The test results shall achieve the Compressive Strength of 3,000 psi minimum. After the Polyester Concrete End Dams achieves the Final Set Time, it can be opened to traffic safely.

Cured Density Test after 24 hours on the site shall be performed in accordance with the ASTM C 138 for the acceptable consolidation of the PPC materials, and the average test results shall be within 135 + 5 pounds per cubic foot of three core samples. If the PPC exhibits an insufficient set at the Cure Time, the PPC materials shall be removed and replaced at the Contractor’s expense.

If the Polyester Concrete End Dams are thicker than 6 inches, the PPC materials shall be placed in lifts. The maximum thickness of each lift shall be recommended by the manufacturer or approved by the Engineer. Each lift of the PPC shall be consolidated and achieve a relative compaction in the concrete blockouts accepted by the Engineer. A PPC core sample, which is used to determine Initial Set Time, will be taken for each lift by Engineer prior to the PPC placement of next lift. If the Engineer determines through a visual inspection that the Initial Set Time or consolidation of the PPC materials in each lift has not occurred, core samples shall be taken in each lift as directed by the Engineer. The cores shall have a minimum diameter of at least 2 inches, and the Contractor shall completely patch the core holes in each lift with new PPC materials. The core holes in the final lift shall be patched to the proposed finish grade.

1. *Surface Finishing.* The proposed surface of Polyester Concrete End Dams shall be consolidated and finished to the required grade and cross slope using finishing equipment as approved by the Engineer.

Sand finish shall be applied by either mechanical means or hand broadcasting onto the glossy surface at a minimum rate of 2.2 lbs. per square yard immediately after finishing and before the Initial Set Time occurs. The smoothness of the PPC surface shall be tested with a 10 foot straightedge transversely and longitudinally. Deviations greater than 3/8 of an inch shall be diamond ground to the proposed finish grade. The thickness of the PPC shall not be reduced by more than 3/8 of an inch. Where there is a low spot reduced by more than 3/8 of an inch on the PPC surface, the low area shall be removed at least ¾” and replaced with new PPC system to the proposed finish grade as directed by the Engineer. If there is a damaged surface on the PPC, the Contractor shall remove unsound PPC surface and replace it with new PPC system in accordance with the Finishing Surface Method.

After final surface finishing, traffic or equipment shall not be allowed on the treated surface until the PPC has achieved the Final Set Time. The Polyester Concrete End Dams shall be protected from moisture until Final Set Time has been obtained. The Contractor shall follow all Manufacturer’s recommendations including surface preparation and all Set Times prior to opening treated surfaces to traffic or completing the work.

In subsection 518.12, delete the fifth paragraph and replace with the following:

Polyester Concrete End Dam will be measured by the number of cubic feet completed in place and accepted. The pay volume for each discrete location (a contiguous treated area not touching other treated areas) shall be rounded up to the next whole cubic foot.

In subsection 518.13, delete the fifth paragraph and replace with the following:

The accepted quantity of Polyester Concrete End Dam will be paid for at the contract unit price per cubic foot, and shall include all work and materials necessary to complete the item including surface preparation, HMWM primer application, PPC application, surface finishing, trial application test boxes, testing, the technician representative and all miscellaneous work required.

Subsection 518.13 shall include the following:

Payment will be made under:

**Pay Item**  **Pay Unit**

Polyester Concrete End Dam Cubic Foot