*Designer note: When deck removal is warranted, the bid item “Cleaning Decks” should be added to the plans.*

Polyester Polymer Concrete Overlay, Item SPV.0180.xx;

**A Description**

This special provision describes furnishing and applying a polyester polymer concrete (PPC) overlay with a high molecular weight methacrylate (HMWM) resin prime coat, to the limits shown on the plans. Minimum thickness of finished overlay thickness to be as shown on plans.

Provisions in standard spec 509 for concrete masonry overlays apply unless otherwise specified herein.

**B Materials**

The PPC system shall consist of a polyester resin binder and aggregate, and a compatible primer.

**B.1 Primer**

The primer shall be a HMWM resin that is low viscosity, wax free, low odor, and shall meet the following requirements:

|  |  |  |
| --- | --- | --- |
| **Property** | **Requirements** | **Test Method** |
| Viscosity A B | ≤ 25 cps | ASTM D 2196 – Brookfield RVT |
| Specific Gravity A B | ≥0.90 | ASTM D 1475 |
| Flash Point B | ≥ 180°F | ASTM D 3278 |
| Tack-free Time A | ≤ 400 minutes | California Test Method 551 |
| Vapor Pressure A B | ≤ 0.04-in Hg | ASTM D 323 |
| Volatile Content B | < 30% | ASTM D 2369 |
| PCC Saturated Surface Dry Bond Strength C | ≥ 500 psi (24hrs) | California Test Method 551 |

A Value based on specimens or samples cured or aged and tested at 77°F

B Test performed prior to adding the initiator

C Value based on specimens or samples stored at 70±1ºF

The initiator for the methacrylate shall consist of a metal drier and peroxide. These materials must be stored separately and in a manner which will not allow the materials to contact each other if spilled or if the packaging leaks.

**B.2 Resin**

The resin shall be an unsaturated isophthalic polyester-styrene co-polymer with the following properties:

|  |  |  |
| --- | --- | --- |
| **Property** | **Requirements** | **Test Method** |
| Viscosity A B | 75-200 cps | ASTM D 2196 – Brookfield RVT |
| Specific Gravity A B | 1.05-1.10 | ASTM D 1475 |
| Absorption | ≤ 1 percent (24 hr) | ASTM D 570 |
| Tensile Elongation | 35-80 percent (7 days) | ASTM D 638 |
| Tensile Strength | ≥ 2,500 psi (7 days) | ASTM D 638 |
| Styrene Content B | 40-50 percent by weight | ASTM D2369 |
| Silane Coupler | > 1 percent by weight of resin |  |
| PCC Saturated Surface Dry Bond Strength C | ≥ 500 psi (24 hrs) | California Test Method 551 |
| Permeability to Chloride ion | ≤ 100 coulombs (28 days) | AASHTO T 277 |

 A Values are based on specimens or samples cured or aged and tested at 77°F

 B Test performed prior to adding initiator

 C Values are based on specimens or samples cured or aged and tested at 70ºF

The silane coupler shall be an organsilane ester, gammamethacryloxypropyltrimethoxysilane. The promoter/hardener shall be compatible with methyl ethyl ketone peroxide and cumene hydroperoxide initiators.

**B.3 Aggregates**

For mixing with the polyester polymer resin, furnish natural or synthetic aggregates that have a proven record of performance in applications of this type. Furnish aggregates that are non-polishing; clean; free of surface moisture; fractured or angular in shape; and free from silt, clay, asphalt, or other organic materials. The fine aggregate shall be natural sand. The aggregate gradation shall meet either of the following gradation requirements:

|  |  |  |
| --- | --- | --- |
| **Sieve Size** | **% Passing by Weight** | **% Passing by Weight** |
| 1/2-in | 100 | 100 |
| 3/8-in | 100 | 83-100 |
| No. 4 | 62-85 | 65-82 |
| No. 8 | 45-67 | 45-64 |
| No. 16 | 29-50 | 27-48 |
| No. 30 | 16-36 | 12-30 |
| No. 50 | 5-20 | 6-17 |
| No. 100 | 0-7 | 0-7 |
| No. 200 | 0-3 | 0-3 |

The coarse aggregate shall have a Moh’s hardness of 7.0 or greater. The percent wear shall not exceed 50%, and the weighted soundness loss shall not exceed 12% per ASTM C131and C88, respectively.

Aggregates shall have an absorption not to exceed 1% and the moisture content shall not exceed one half of the aggregate absorption. Aggregates retained on the No. 8 sieve shall have a maximum of 45% crushed particles when tested in accordance with AASHTO Test Method T335.

The finishing sand aggregate shall be commercial quality dry blast sand with an average absorption of no more than 1%. 95% of the sand shall pass the No. 8 sieve and at least 95% shall be retained on the No. 20 sieve.

**B.4 Required Properties of Overlay System**

The required properties of the overlay system are listed in the table below:

|  |  |  |
| --- | --- | --- |
| **Property** | **Requirements** A | **Test Method** |
| Minimum Compressive Strength | 2,000 psi (8 hrs)5,000 psi (24 hrs) | ASTM C 579Method B, Modified B |
| Set Time | 30-120 minutes | ASTM C 266 |
| Minimum Pull-off Strength | 500 psi (24 hrs) | ASTM C1583  |

 A Based on samples cured or aged and tested at 75°F

 B Plastic inserts that will provide 2-in by 2-in cubes shall be placed in the oversized brass molds.

**B.5 Approval of Bridge Deck Polymer Overlay System**

A minimum of 15 working days prior to the pre-construction meeting, submit to the engineer for acceptance the product data sheets and specifications from the manufacturer, product history/reference projects report, an overlay placement plan, and a certified materials report from an independent testing laboratory. The engineer may request samples of the primer, resin, and/or aggregate prior to application for the purpose of acceptance testing by the department.

The product history/reference projects report shall consist of a minimum of 5 bridge/roadway locations where the proposed overlay system has been applied in Wisconsin or in locations with similar climate, and on bridges of similar size and scope to the contract project. Include contact names for the facility owner, current phone number and e-mail address, and a brief project description including structure ID’s and overlay quantities placed. These projects must have been open to traffic for at least 1 year.

Product data sheets and specifications from the manufacturer consist of literature from the manufacturer showing general instructions, application recommendations/methods, product properties, and any other applicable information.

**C Construction**

**C.1 General**

**C.1.1 Pre-Installation Conference**

Conduct a pre-installation conference with the manufacturer's representative prior to construction to establish procedures for maintaining optimum working conditions and coordination of work. Furnish the engineer with a copy of the recommended procedures, the manufacturer’s instructions, contractor’s personnel experience record, and the PPC mix design including the recommended initiator percentages for the expected application temperature.

**C.1.2 Contractor Personnel Requirements**

A minimum of 15 days prior to the pre-construction meeting, submit to the engineer for approval the contractor’s personnel experience and qualifications successfully placing concrete bridge deck overlays or PPC overlays using similar equipment as specified within this special provision within the last 5 years. Placement of thin polymer overlays does not qualify. Include contact names for the facility owner, current phone number and e-mail address, and a brief project description including structure ID’s and overlay quantities placed. The engineer shall contact the Bureau of Structures Chief Structures Design Engineer to verify experience and qualifications.

Experienced personnel are required to be actively present during the overlay application according to the following:

Experience and qualifications of manufacturer’s representative: Must be employee of the current company for at least one year in good standing with experience performing a minimum of 10 PPC overlays on bridges of similar size and scope to the contract project in the last 5 years. Scope shall be evaluated by placement temperature, existing deck condition, placement thickness, number of stages, average daily traffic, and any other factors unique to the application. Acceptable project experience must be in current service showing no signs of installation deficiency, major distress, excessive wear, or delamination. A manufacturer's representative familiar with the overlay system installation procedures shall be present at all times during surface preparation and overlay placement to provide quality assurance that the work is being performed properly. This includes, but is not limited to, pre-installation conference, deck preparation, trial overlay, PPC application, and PPC cure.

Experience and qualifications of crew foreman or lead finisher: Must be employee of the current company for at least one year in good standing with experience performing a minimum of 2 PPC overlays to highway bridge decks in the last 5 years. Multiple stages of PPC overlay on one bridge deck will be accepted as one single application.

Experience and qualifications of crew/laborers: All crew members involved with the placement or finishing of the PPC overlay must be an employee of the current company for at least one year in good standing In addition, laborers finishing the PPC material in place must have at least 2 years of experience finishing concrete. All crew/laborers must participate and fulfill the same role for both the trial and final PPC overlays.

The engineer will accept or reject the contractor’s personnel experience record. If the contractor does not provide personnel with the required experience and qualifications, the contractor will not be authorized to proceed with any work until replacement personnel are reviewed and accepted by the engineer. The engineer may suspend work if the contractor substitutes unqualified personnel for accepted personnel during construction.

**C.1.3 Material Storage and Safety Plan**

Store resin materials in their original containers in a dry area. Store and handle materials according to the manufacturer’s recommendations. Store all aggregates in a dry environment and protect aggregates from contaminants on the job site.

Safety Plan: Prior to arrival of the product on the job site, provide a product shipping, storage, and use safety plan to detail how the product will be delivered and stored on site in a manner that will not allow the constituent components to come in contact with each other in the event of a spill or container leakage. This plan must also include a description of the safety training workers applying the product have received regarding the product’s use, and list any and all safety precautions which must be taken during application of the product.

**C.1.4 Trial Overlay**

Place trial overlay(s) on a properly prepared concrete surface within the project limits to determine the initial set time and to demonstrate the effectiveness of the surface preparation, mixing, placing, and finishing equipment and techniques. Each trial overlay shall be the width and thickness of the proposed placement on the bridge and at least 25 ft long. The trial overlay(s) shall be tined in the same manner as the deck overlay. Construct trial overlay(s) in similar weather conditions as those expected during the construction of the deck overlay and at a similar time of day unless directed otherwise by the engineer. Use the same equipment and laborers/operators, including deck preparation equipment, as that which will be used for the deck overlay.

The number of trial applications required shall be as many as necessary to demonstrate the contractor’s ability to construct an acceptable overlay and competency to perform the work to the satisfaction of the engineer. If, after two trial applications, the engineer is not satisfied with the trial placements, hold another pre-installation conference, as described in Section C1.1. Do not proceed with deck overlay work prior to receiving the engineer’s approval of the trial overlay(s). Conduct all trial overlays in the presence of the engineer. If the trial overlay is placed on the deck surface and found acceptable by the engineer, the contractor may leave trial overlay in place. If the trial overlay is placed on the deck surface and found not acceptable, the material must be removed and replaced at no additional cost.

**C.2 Deck Preparation**

**C.2.1 Deck Repair**

When specified on the plans, remove the entire surface of the bridge deck receiving the new overlay. Remove all asphaltic patches and unsound or disintegrated areas of the concrete decks as the plans show, or as the engineer directs. Work performed to remove and repair the concrete deck will be paid for under other items.

Use deck patching products that are compatible with the overlay system. Patching materials with magnesium phosphate shall not be used. Place patches after surface is prepared via shot blasting and cleaning as described in Section C.2.2 of this specification. Portland cement concrete patches shall be used for joint repairs and full depth deck repairs with a plan area larger than 4 SF, unless approved otherwise by the Bureau of Structures Design Section. If PPC is used to fill deck repair areas, prime the patch area as described in Section C.3.1 of this specification. If rapid-set concrete is used, place patches per the manufacturer’s recommendation. If Portland cement concrete is used, place patches per standard spec 509.3.9.1.

Deck patching shall be filled and properly finished prior to overlay placement. Do not place overlay less than 1 hour, or per the manufacturer’s recommendation, after placing PPC or rapid-set concrete patches in the repair areas. Do not place overlay less than 28 days after placing Portland cement concrete patches in the repair areas.

**C.2.2 Surface Preparation**

Determine an acceptable shotblasting machine operation (size of shot, flow of shot, forward speed, and/or number of passes) that provides a surface a profile meeting CSP 5 according to the International Concrete Repair Institute Technical Guideline No. 03732. Test the tensile bond strength according to ASTM C1583. The surface preparation will be considered acceptable if the tensile bond strength is greater than or equal to 250 psi or if there is a failure into the substrate where more than 50% of the core area has failed deeper than 1/4-in. Continue adjustment of the shotblasting machine and necessary testing until the surface is acceptable to the engineer or a passing test result is obtained. Test the tensile bond strength of the prepared concrete substrate at a minimum of 2 locations in the first 500 SF and a minimum of 1 location every additional 5000 SF, as determined by the engineer. Perform all tests in the presence of the engineer.

The engineer may consider alternate surface preparation methods per the overlay system manufacturer’s recommendations. The engineer must approve the final surface profile and deck cleanliness prior to the contractor placing the PPC overlay.

Prepare the entire deck, or portion of the deck to be overlaid in one placement when staged construction is being employed, using the final accepted adjustments to the shotblasting machine as determined above. Blasting shall remove all dirt, oil, asphalt, rubber, curing compound, paint, carbonation, grease, slurry, membranes, striping, rust, weak surface mortar, laitance, and other foreign or potentially detrimental materials. Thoroughly blast clean with hand-held equipment any areas inaccessible by the shotblasting equipment. Do not perform surface preparation more than 24 hours prior to the application of the primer. Blasted surface shall not be exposed to vehicular or pedestrian traffic other than that required for overlay placement and approved by the Engineer.

Prepare the vertical or nearly vertical concrete surfaces adjacent to the deck a minimum of 2-in above the overlay per SSPC-SP 13 by sand blasting, using wire wheels, or other approved method.

Just prior to overlay placement, clean all dust, debris, and concrete fines from the deck surface including vertical faces of curbs and barrier walls up to a height of 2-in above the overlay with compressed air. The air stream must be free of oil and moisture. Any grease, oil, or other foreign matter that rests on or has absorbed into the concrete shall be removed completely.

Protect drains, expansion joints, access hatches, or other appurtenances on the deck from damage by the shot and sand blasting operations and from material adhering and entering. Tape or form all construction joints to provide a clean straight edge.

**C.2.3 Transitional Area**

If the plans show, create a transitional area approaching the transverse expansion joints and end of the deck using a diamond grinder or blasting method. Remove concrete to the depth of the overlay thickness adjacent to the joint or end of deck and provide a transition as the plans show.

If the plans show, create a transitional area on the approach pavement. Remove concrete to the depth of the overlay thickness and provide a transition as the plans show. Prepare and place overlay beyond the end of the deck the same width as the deck.

**C.3 Application of the Overlay System**

Apply the overlay system conforming to the manufacturer’s instructions.

Do not apply the overlay system if any of the following is true:

* Ambient air temperature is below or expected to drop below 50°F, or the manufacturer’s recommended temperature, within 8 hours
* Deck surface temperature is below 50°F or above 100°F
* Moisture content in the deck exceeds 4.5% when measured by an electronic moisture meter or shows visible moisture after 2 hours when measured in accordance with ASTM D4263.
* Materials component temperatures are below 50°F or above 100°F
* Concrete age is less than 28 days, unless approved by the engineer
* Gel time is 15 minutes or less at predicted high air temperature for the day
* The relative humidity is greater than 85%

**C.3.1 Application of the Primer**

Apply primer to the deck surface within 5 minutes of mixing at approximately 1 gallon per 100 square feet or the rate specified by the manufacturer. Use a squeegee, roller, broom, low pressure sprayer, etc. to distribute the material uniformly and to completely cover the area receiving the overlay. Remove excess buildup and re-prime any areas that appear dry from absorbing material. Wait a minimum of 15 minutes or as recommended by the manufacturer before placement of the overlay. If the primed surface becomes contaminated, clean and re-prime it.

**C.3.2 Application of the Overlay**

Perform the handling and mixing of the polymer resin and hardening agent in a safe manner to achieve the desired results according to the manufacturer’s instructions. Mix PPC using a plant/mixer calibrated according to the manufacturer’s recommendations. Calibrate the plant/mixer in the presence of the engineer.

The polyester concrete shall be placed within 15-120 minutes after the primer has been applied, or per the manufacturer’s recommendation.

The polyester concrete shall contain 11-13% polyester resin by weight of dry aggregate; the exact percentage will be determined by the engineer during placement to enable proper finishing and texturing of the overlay surface.

The amount of initiator used in polyester concrete shall be sufficient to produce an initial set time between 30-90 minutes, when the in-place PPC cannot be deformed by pressing with a finger.

If initial set does not occur within 30-90 minutes, the material must be removed and replaced at no additional cost.

Place the PPC before gelling or within 15 minutes of adding the initiator, whichever comes first, or within a more restrictive range if recommended by the manufacturer. Discard any PPC not placed within this time limit at no additional cost.

Consolidate and finish to the required grade and cross-section per standard spec 509. Taper at drains and expansion joints as specified by the manufacturer or as indicated on the plans. Terminating edges of the overlay may require application and finishing by hand trowel. Finishing and texturing equipment shall be fitted with vibrators and tines or other means of consolidating and texturing the polyester concrete to a compaction no less than 97% or as recommended by the manufacturer. A vibratory screed may be used for placement lengths less than 300 ft. A roller type screed is not allowed. If a vibratory screed is used, the surface shall be tested in accordance with standard spec 415.3.10.

If the overlay is placed with a paving machine which incorporates tines, apply the finishing sand immediately after texturing. Otherwise, apply the finishing sand immediately before texturing or as directed by the manufacturer. The finishing sand must be applied before gelling occurs.

The finish sand shall be applied by either mechanical or hand dispersion immediately after strike-off, before gelling occurs. Apply at approximately 15 to 20 lbs per 100 square foot or until saturation as determined by the engineer.

Texture the overlay surface by transverse grooving as soon as the condition of the PPC will permit. Use a steel tined tool or a finned float with a single row of fins. Grooves shall be approximately 3/16-in wide at 3/4-in to 1-in on center with a depth of approximately 1/8-in. Longitudinal grooving is acceptable when steel tines are mounted to the paving machine. Do not tine within 1 ft of gutters. Tining may be performed manually provided that the finish obtained is satisfactory to the engineer.

The completed PPC overlay surface shall be free of any smooth areas and shall be neat in appearance. Any surface defects shall be repaired by the contractor to the satisfaction of the engineer at no additional cost.

Allow material to fully cure to a firm, hard surface before allowing traffic on the overlay. Cure times will vary depending on product and ambient temperature; refer to manufacturer’s recommendation. Before opening to traffic, a properly calibrated Schmidt hammer must register a value not less than 25. The overlay shall be protected from moisture while it cures.

Prior to opening to traffic, clean expansion joints and joint seals of all debris and polymer. All working deck joints shall be extended through the overlay and sealed according to plan details. If required by the engineer, a minimum of 3 days following opening to traffic, remove loosened aggregates from the deck, expansion joints, and approach pavement.

If the overlay is not completed within the work period (including if staged construction is used), the polyester polymer overlay edges shall be properly terminated as specified by the manufacturer. Prime the edges of butt joints of the previously placed overlay before placing the next portion of the overlay.

**C.3.3 Acceptance Testing**

**C.3.3.1 Bond Strength**

Between 24 and 48 hours after overlay placement, conduct two tensile bond tests per pour, including in the trial overlay area if placed on the bridge deck, as specified in either ASTM C1583. Drill cores through the overlay and into the existing concrete a minimum of 1/4-in but no more than 1/2-in. A passing test will have a tensile strength greater than 250 psi, or a failure into the substrate where more than 50% of the core area has failed deeper than 1/4-in. Immediately patch test core holes by blowing out with oil- and moisture-free compressed air and filling with PPC per manufacturer’s instructions.

**C.3.3.2 Smoothness Quality**

The finished surface, when tested with a 10-foot straightedge, shall not vary by more than 1/4-in. Any surface that fails to conform to the above tolerance shall be corrected with a diamond grinder.

**C.4 Repair of Polyester Polymer Concrete Overlay**

Repair all areas determined by the engineer to be unbonded, uncured, segregated, or damaged at no cost to the Department. Submit repair procedures from the manufacturer to the engineer for approval. Absent manufacturer’s repair procedures and with the approval of the engineer, complete repairs as follows: Cut the limits of the area to the top of the concrete; remove the overlay by scarifying, grinding, or other approved methods; shot blast or sand blast and air blast the concrete surface prior to placement of overlay material; and place the PPC overlay according to C.3.

**D Measurement**

The department will measure Polyester Polymer Concrete Overlay bid item in area by the square yard acceptably completed.

**E Payment**

The department will pay for measured quantities at the contract unit price under the following bid item:

|  |  |  |
| --- | --- | --- |
| ITEM NUMBER | DESCRIPTION | UNIT |
| SPV.0180.xx | Polyester Polymer Concrete Overlay | SY |

Payment for Polyester Polymer Concrete Overlay is full compensation for preparing the surface; for tensile bond testing; for creating the transitional area, for acceptably completing trial overlay(s); providing, hauling, placing, finishing, curing, and protecting the overlay; for cleanup; for sweeping/vacuuming and disposing of excess and waste materials; and for the presences of the manufacturer’s representative on the site.

When specified on the plans, the department will pay separately for Cleaning Decks.

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