# POLYESTER POLYMER CONCRETE OVERLAY NJSP-19-04

**1.0 Description.** This work shall consist of constructing a wearing surface of polyester polymer concrete on a prepared surface in accordance with these specifications as shown on the plans or as directed by the engineer. Polyester polymer concrete shall be composed of the following three components – polyester resin binder, high molecular weight methacrylate (HMWM) resin and aggregate.

**2.0 Materials.**

**2.1 Primer.** The prepared surface shall receive a wax-free low odor, high molecular weight methacrylate prime coat. The primer shall comply with the following requirements:

| **High Molecular Weight Methacrylate (HMWM) Resin** | | |
| --- | --- | --- |
| **Property** | **Requirement** | **Test Method** |
| Viscosity \* | 4.0 x 10-5 psi (0.025 Pa-s), maximum  (Brookfield RVT with UL adapter, 50 RPM at 77°F) | ASTM D 2196 |
| Specific Gravity \* | 0.90, minimum  (at 77°F) | ASTM D 1475 |
| Volatile Content \* | 30%, maximum | ASTM D 2369 |
| Flash Point \* | 180°F, minimum | ASTM D 3278 |
| Vapor Pressure \* | 0.04 in. (1.0mm) Hg, maximum  (at 77°F) | ASTM D 323 |
| Tack Free Time | 400 minutes, maximum  (at 77°F) | ASTMC 679 |
| PCC Saturated Surface-Dry Bond Strength | 500 psi, minimum  (24 hrs at 70 +/- 1°F) | California Test 551, Part 5 |

\*Tested prior to adding initiator

**2.1.1 Mixing Requirements.** The prime coat initiator shall consist of a metal drier and peroxide. If supplied separately from the resin, at no time shall the metal drier be mixed directly with the peroxide.

**2.1.2 Storage.** The containers shall be stored in a manner that will not allow leakage or spillage from one material to contact the containers or materials of the other.

**2.2 Aggregates.**

**2.2.1 Polyester Concrete.** The aggregates shall comply with Sec 1005, except as specified herein.

**2.2.1.1 Crushed Particles.** Aggregate retained on the No. 8 sieve shall have a maximum of 45 percent crushed particles as determined by AASHTO T 335.

**2.2.1.2 Absorption.** The aggregate absorption shall not exceed 1.0 percent as determined by AASHTO T84 and T 85.

**2.2.1.3 Combined Gradation.** Aggregate for polyester polymer concrete shall comply with the following requirements:

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| --- | --- | --- |
| **Combined Aggregate** | | |
| **Sieve Size** | **1/2” Max. Percent Passing** | **3/8” Max. Percent Passing** |
| ½” | 100 | 100 |
| 3/8” | 83 – 100 | 100 |
| #4 | 65 – 82 | 62 – 85 |
| #8 | 45 – 64 | 45 – 67 |
| #16 | 27 – 48 | 29 – 50 |
| #30 | 12 – 30 | 16 – 36 |
| #50 | 6 – 17 | 5 – 20 |
| #100 | 0 – 7 | 0 – 7 |
| #200 | 0 - 3 | 0 – 3 |

**2.2.1.4 Fine Aggregate.** The fine aggregate shall consist of natural sand.

**2.2.2 Finishing Sand.** The sand for abrasive finish shall be commercial quality blast sand having at least 95 percent passing the No. 8 sieve and at least 95 percent retained on the No. 20 sieve when tested in accordance with AASHTO T 27. The absorption of the sand shall not exceed 1% when tested in accordance with AASHTO T 84. The finishing sand shall be dry at the time of application.

**2.3 Polyester Resin Binder**. The resin shall be an unsaturated isophthalic-styrene co-polymer conforming to the following requirements:

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| **Polyester Resin Binder** | | |
| **Property** | **Requirement** | **Test Method** |
| Viscosity \* | 0.1 x 10-5 to 2.9 x 10-5 psi (0.075 to 0.200 Pa-s)  (RVT, No. 1 Spindle, 20 RPM at 77°F) | ASTM D 2196 |
| Specific Gravity \* | 1.05 to 1.10  (at 77°F) | ASTM D 1475 |
| Elongation | 35%, minimum  (Type I at 0.45”/min.  Thickness = 1/4“ +/- 0.04”) | ASTM D 638 |
| Sampling Condition:  18 hrs/77°F/50% RH + 5 hrs/158°F | ASTM D 618 |
| Tensile Strength | 2,500 psi, minimum  (Type I at 0.45”/min.  Thickness = 1/4“ +/- 0.04”) | ASTM D 638 |
| Sampling Condition:  18 hrs/77°F/50% RH + 5 hrs/158°F | ASTM D 618 |
| Styrene Content \* | 40 to 50%  (by weight) | ASTM D 2369 |
| Silane Coupler | 1.0%, minimum  (by weight of polyester-styrene resin) |  |

\*Tested prior to adding initiator

**2.3.1 Silane Coupler.** The silane coupler shall be an organosilane ester, gamma methacryloxypropyltrimethoxysilane.

**2.3.2 Hardener.** The promoter/hardeners shall be compatible with suitable methyl ethyl ketone peroxide (MEKP) and cumene hydroperoxide (CHP) initiators. MEKP initiators shall be used when the surrounding concrete temperatures are above 60°F. A blend of initiators may be used as approved by the engineer when the surrounding concrete temperature is 50 – 60°F.

**2.4 Delivery of Materials.** All materials shall be delivered in their original containers bearing the manufacturer’s label, specifying date of manufacturing, batch number, trade name, and quantity. Each shipment of polyester resin binder and HMWM resin shall be accompanied by a Material Safety Data Sheet (MSDS).

**2.5 Storage of Materials.** The material shall be stored to prevent damage by the elements and to ensure the preservation of their quality and fitness for the work. The storage space shall be kept clean and dry, and shall contain a high-low thermometer. The temperatures of the storage space shall not fall below nor rise above that recommended by the manufacturer. Every precaution shall be taken to avoid contact with flame.

**2.5.1 Inspection.** Stored materials shall be inspected prior to their use, and shall meet the requirements of this Specification at the time of use.

**2.5.2 Failure.** Any material which is rejected because of failure to meet the required tests or that has been damaged so as to cause rejection shall be immediately replaced at no additional expense to the Commission.

**2.5.3 Required Amount.** Sufficient material to perform the entire polyester concrete application shall be in storage at the site prior to any field application, so that there shall be no delay in procuring the material for each day’s application.

**2.6 Training.** The contractor shall arrange to have the material supplier furnish technical service related to application of material and health and safety training for personnel who are to handle the polyester polymer concrete and the HMWM resin prime coat.

**2.7 Technical Support.** The materials supplier shall have a representative onsite during placement of the polyester polymer concrete. The representative shall have a minimum of 5 years of experience with all aspects of polyester polymer concrete. The contractor shall submit documentation of the technical representative’s experience including the following:

1. Years of experience with polyester polymer concrete
2. List of construction projects with dates
3. Overlay quantities
4. Reference name and contact information for owners representative

**3.0 Mix Design.** The contractor shall prepare and submit the polyester polymer concrete mix design and mixing procedures to the Construction and Materials Division for approval at least 14 days prior to placement. The mix design shall include a recommended initiator percentage for the expected application temperature. The contractor shall not begin ordering materials for application of the polyester polymer concrete until the polyester polymer concrete mix design and mixing procedures are approved. The polyester polymer concrete mix shall meet the following requirements:

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| **Polyester Polymer Concrete Mixture Properties** | | |
| **Property** | **Requirement** | **Test Method** |
| PPC Saturated  Surface Dry  Bond Strength | 500 psi minimum at 24 hrs. and 70° F (without primer, at 12% resin content by weight of the dry aggregate, on saturated surface dry specimen) | California Test 551 |
| Abrasion Resistance | < 2 gram weight loss (at 12% resin content by weight of the dry aggregate) | California Test 550 |
| Modulus of Elasticity | 1,000,000 psi to 500,000 psi (at 12% resin content by weight of the dry aggregate) | ASTM C 469 |

**4.0 Contractors Qualifications.** The contractor shall submit documentation for at least 10 polyester polymer concrete overlay projects placed successfully within the past 5 years. Documentation needs to be submitted to the engineer for review and approval prior to materials being delivered to the project and before the preconstruction meeting. Documentation shall include the following information:

1. List of construction projects with dates
2. Overlay quantities
3. Reference name and contact for owners representative

**5.0 Construction.**

**5.1 Surface Preparation.** The concrete surface shall be prepared by removing all material which may act as bond breaker between the surface and the polyester polymer concrete.

**5.1.1 New Bridge Decks.** On new concrete decks, the surface shall be given a very rough texture while still plastic by use of a wire comb or other approved texturing device which will produce a bondable surface acceptable to the engineer. The concrete shall exceed the compressive strength shown on the plans prior to the placement of the polyester polymer concrete overlay.

**5.1.2 Existing Bridge Decks.** On existing concrete decks, the surface shall be uniformly scarified in accordance with Sec 216. The surface shall be scarified to an approximate depth of 1/4 inch. The scarifier shall not produce a polish or slick surface. Any epoxy patches encountered shall be completely removed to sound, natural concrete. Polyester polymer concrete or other patching material, approved by the engineer, may be used to repair the deck. Surfaces of concrete patches placed in the deck after scarifying shall be textured to an approximate depth of 1/4 inch before placing the overlay.

**5.1.3 Existing Bridge Decks Containing Wearing Surface.** On existing concrete decks with an existing wearing surface, the wearing surface shall be removed prior to placing the polyester polymer concrete. The exposed concrete surface shall meet the requirements contained in Section 4.1.2 of this specification.

**5.1.4 Removing Contaminates.** The textured or scarified deck shall be sand blasted followed by an air blast. The sand blasting shall remove all dirt, oil and other foreign materials, as well as any unsound concrete or laitance from the surface and edges against which new polyester polymer concrete is to be placed. The compressor shall be equipped to prevent oil in the air supply. Any loose or foreign material detected on the concrete surface prior to placement of the polyester polymer concrete shall be removed by sand or air blasting. The concrete surface may require retexturing where penetration of foreign material is evident. No contamination of the retextured or scarified concrete surface shall be permitted. With approval from the engineer, the contractor may use automatic shot blasting units in lieu of sand blasting. The automatic shot blasting units shall be self-propelled and include a vacuum to recover spent abrasive. The abrasive shall be steel shot. Magnetic rollers shall be used to remove any spent shot remaining on the deck after vacuuming. Cleaned surfaces shall not be exposed to vehicular or pedestrian traffic other than that required by the overlay operation.

**5.1.5 Steel Surfaces.** All steel surfaces that will be in contact with the overlay shall be cleaned in accordance with SSPC-SP10, Near–White Blast Cleaning, except that wet blasting methods shall not be allowed.

**6.0 Application of Prime Coat.** One coat of HMWM prime coat shall be applied to the prepared concrete and steel surfaces immediately before placing the polyester polymer concrete. The prime coat shall be uniformly applied to completely cover the surface to receive the overlay. Excess material shall be removed or distributed to areas with insufficient coverage. Primer shall be placed within 5 minutes of minutes of mixing and at the manufacturers recommended application rate. Primer shall be reapplied to any areas that appear dry after 15 minutes due to absorption the material. The area receiving the prime coat shall be dry and have no exposure to any moisture within the past 24 hours. Prior to applying the prime coat, the surface shall be cleaned with compressed air to remove accumulated dust and any other loose material.

**6.1 Surface Temperature.** The concrete bridge deck surface shall be between 50°F and 100°F when applying the prime coat.

**6.2 Relative Humidity.** Polyester polymer concrete shall not be placed when the relative humidity is above 90 percent.

**6.3 Curing.** Polyester polymer concrete shall be placed immediately after the prime coat is applied to the bridge deck.

**6.4 Prime Coat Contaminated.** If the primed surface becomes contaminated, the contaminated area shall be cleaned by abrasive blasting and re-primed at no additional expense to the department.

**6.5 Containment.** Primer shall not be allowed to leak onto areas that have not received surface preparation.

**7.0 Placement of Polyester Polymer Concrete.**

**7.1 Placement Time.** The polyester polymer concrete shall be placed on the prime coat within two hours of placing the prime coat.

**7.2 Surface Temperature.** The surface temperature of the area to receive polyester polymer concrete shall be the same as specified in Section 5.1 of this special provision.

**7.3 Mixing Equipment.** The concrete shall be volumetrically mixed at the bridge site by a continuous mixer in accordance with Sec 501.

**7.3.1 Batching Information.** The continuous mixer shall be equipped with a metering device that automatically measures and records the aggregate volumes and corresponding resin volumes. The volumes shall be recorded at no greater than five minute intervals along with the time and date of each recording. A printout of the recordings shall be furnished to the engineer at the end of each shift. Readout gages shall be visible to the engineer at all times.

**7.3.2 Mixture Consistency.** The concrete discharged from the mixer shall be uniform in composition and consistency. Mixing capability shall be such that initial and final finishing operations can proceed at a steady pace.

**7.4 Contamination.** The contractor shall prevent any cleaning chemicals from reaching the polyester polymer concrete mix during the mixing operation

**7.5 Addition of Initiator.** Polyester polymer concrete shall be placed prior to gelling and within 15 minutes following the addition of initiator, whichever occurs first. Polyester polymer concrete that is not placed within this time shall be discarded.

**7.6 Amount of Polyester Resin.** The polyester resin binder in the polyester polymer concrete shall be 12 percent +/- 1 percent by weight of the dry aggregate. The contractor shall determine the exact percentage as approved by the engineer.

**7.7 Amount of Peroxide Initiator.** The amount of peroxide initiator used shall result in a polyester polymer concrete set time between 30 and 120 minutes during placement. The initial set time will be determined by using an initial-setting time Gillmore needle in accordance with ASTM C266. Accelerators or inhibitors may be required as recommended by the polyester resin supplier and as approved by the engineer.

**7.8 Aggregate Moisture Content.** At the time of mixing with the resin, the moisture content of the aggregate, as determined by AASHTO T 255, shall not exceed one half of the aggregate absorption.

**7.9 Aggregate Temperature.** The aggregate temperature shall be between 45°F and 100°F at the time of mixing.

**7.10 Finishing Equipment.** Finishing equipment shall be capable of consolidating the polyester polymer concrete and striking off the polyester polymer concrete to the final grade, thickness and cross-sections as shown in the contract documents.

**7.10.1 Additional Finishing.** Although the paver should yield a finished surface, additional finishing may be necessary.

**7.10.2 Surface Finishing.** The polyester polymer concrete surface shall be finished to produce slight bleeding of the resin which indicates complete consolidation of the aggregates.

**7.11 Minimum Overlay Thickness.** The polyester polymer concrete overlay shall be placed to the thickness shown in the plans. In no case should the polyester polymer concrete overlay be placed less than ¾ inch thick.

**7.12 Application of Finishing Sand.** A finishing sand of at least 2.2 lbs. per square yard shall be broadcast onto the glossy surface immediately after finishing and before setting of the resin. Surface sand shall be broadcast after finishing and prior to tining by hand. If the tining device is mounted directly to the paving machine the surface sand shall be broadcast after tining. The surface of the completed polyester polymer concrete overlay shall be free of any smooth or “glassy” areas such as those resulting from insufficient quantities or surface aggregate. These areas shall be corrected by the contractor prior to opening the polyester polymer concrete overlay to traffic.

**8.0 Surface Texturing.** The roadway surface, except within 12 inches of the inside face of the curb, shall be textured as soon as the condition of the polyester polymer concrete will permit. The roadway finishing shall otherwise be in accordance with Sec 502. Hand-operated devices producing a satisfactory texture will be permitted. At the contractor's option, a finned float with a single row of fins may be used. The grooves produced by the finned float shall be approximately 1/8 inch wide at 5/8 to 3/4-inch centers and shall be approximately 1/8 inch deep. This operation shall be performed at such a time and in such a manner that the desired texture will be achieved while minimizing displacement of the layer aggregate particles.

**9.0 Curing.** Traffic and construction equipment shall not be permitted on the polyester polymer concrete overlay for at least two hours and until the polyester polymer overlay has reached a minimum compressive strength of 3,000 psi as verified by the rebound number determined in accordance with ASTM C805.

**10.0 Smoothness.** Prior to opening to traffic, the riding surface will be thoroughly straight edged by the engineer, and all variations exceeding 1/8 inch in 10 feet will be plainly marked. Any area more than 1/8 inch above the straight edge shall be removed by an approved device consisting of multiple curing edges leaving a grooved surface comparable to diamond grinding.

**11.0 Testing**. Bond testing shall be performed for each placement on each day. Testing will be conducted at three locations within 48 hours after placement. Testing will be performed in accordance to ASTM C 1583. A passing test is the failure of the concrete substrate or bond strength above 250 psi.

**12.0 Corrective Action.** Any areas of the polyester polymer concrete overlay that does not comply with these specifications will need to be corrected by the contractor at no additional cost to the project. The contractor shall submit a written corrective work proposal to the engineer, which shall include the methods and procedures that will be used to address these defective areas. The contractor shall not commence corrective work until the methods and procedures have been approved in writing by the engineer.

**13.0 Method of Measurement.** Final measurement will not be made except for authorized changes during construction or where appreciable errors are found in the contract quantity. Where required, the area of polyester polymer concrete will be measured to the nearest square yard of accepted, in-place polyester polymer concrete. The revision or correction will be computed and added to or deducted from the contract quantity.

**14.0 Basis of Payment.** The contract unit price for polyester polymer concrete will be full compensation for all materials and other items entering into the construction of the polyester polymer concrete. The accepted quantity of polyester polymer concrete will be paid for at the contract unit price.