

Special Specification 4106

Polyester Polymer Concrete Bridge Deck Overlay



1. DESCRIPTION

Furnish and place polyester polymer concrete (PPC) overlay system with a high molecular weight methacrylate (HMWM) resin primer on prepared concrete surfaces. The work includes the preparation of the deck surface by shot blasting and as recommended by product manufacturer.

2. MATERIALS

Furnish polyester polymer concrete consisting of polyester resin binder and aggregates with a compatible primer meeting the component and composite material properties specified. All components must be supplied collectively through the same manufacturer.

- 2.1. **Primer.** Furnish a wax-free low odor HMWM primer consisting of a resin, initiator, and promoter in conformance with Table 1, "Requirements for Primer," and the following:

Furnish a prime coat promoter/initiator consisting of a metal drier and peroxide. If shipped separately from the resin, ensure that at no time the metal drier is mixed directly with the peroxide. Store containers in a manner that will not allow leakage or spillage from one material to contact the containers or material of the other.

Table 1
Requirements for Primer

Property	Requirement	Test Method
Volatile Content ¹	30%, maximum	ASTM D 2369
Viscosity (Brookfield RVT with UL adapter, 50 RPM at 77°F) ¹	25 cps, maximum	ASTM D 2196
Specific Gravity ¹	0.90, minimum	ASTM D 1475
Flash Point ¹	180°F, minimum	ASTM D 3278
Vapor Pressure ¹	1.0 mm Hg, maximum	ASTM D 323
Saturated Surface-Dry Bond Strength, with primer ²	700 psi, minimum	CA Test 551, part 5

1. Tested prior to adding initiator.
2. Initiated polyester concrete tested at 12% resin content by weight of the dry aggregates.

- 2.2. **Polyester Resin Binder.** Furnish a polyester resin binder meeting the requirements of the Table 2, "Requirements for Polyester Resin Binder," and the following:
- Unsaturated isophthalic polyester-styrene co-polymer suitable for a polyester concrete mixture with a resin content of 12% ± 1% of the weight of the dry aggregates.
 - Contain at least 1% by weight gamma-methacryloxypropyltrimethoxysilane, an organosilane ester silane coupler.
 - Be used with a promoter that is compatible with suitable methyl ethyl ketone peroxide and cumene hydroperoxide initiators.

Table 2
Requirements for Polyester Resin Binder

Property	Requirement	Test Method
Viscosity (Brookfield RVT with UL adapter, 50 RPM at 77°F) ¹	75-200 cps	ASTM D 2196
Specific Gravity ¹	1.05 to 1.10	ASTM D 1475
Styrene Content	40-50%, by weight	ASTM D 2369
Silane Coupler ¹	1.0%, by weight	NMR Spectrum
Elongation	35%, minimum (Type I specimen, thickness 0.25+ 0.03" at rate = 0.45 inch/minute)	ASTM D 638
	Sample Conditioning: 18/25/50 + 5/70	ASTM D 618
Tensile Strength	2,500 psi, min (Type I specimen, thickness 0.25 + 0.03" at rate = 0.45 inch/minute)	ASTM D 638
	Sample Conditioning: 18/25/50 + 5/70	ASTM D 618

1. Tested prior to adding initiator.

2.3.

Aggregate. Furnish aggregate having the following properties:

- Not more than 45% crushed particles retained on the #8 sieve.
- Fine aggregate consisting of natural sand only.
- Weighted-average aggregate absorption of no more than 1.0% when tested under AASHTO Test Methods T84 and T85.
- 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.
- Aggregate with minimum Mohs hardness of 7.

Comply with the requirements for the aggregate gradation shown in the table below:

Table 3
Aggregate Gradation

Sieve Size	Percent Passing
3/8"	100
No. 4	62-85
No. 8	45-67
No. 16	29-50
No. 30	19-36
No. 50	5-20
No. 100	0-7
No. 200	0-3

- 2.4. **Polyester Concrete.** Provide polyester concrete with the following properties:

Table 4
Polyester Concrete Composite Mixture Properties

Property	Requirement	Test Method
Saturated-Surface Dry Bond Strength, without primer at 12% resin content by weight of the dry aggregate (at 24 hours and 70 ± 1°F)	500 psi, minimum	CT 551
Abrasion Resistance	2 g weight loss, maximum	CT 550
Modulus of Elasticity	1,000 to 2,000 ksi	ASTM C 469

- 2.5. **Sand for friction surface.** Furnish commercial-quality blast sand that is determined by the manufacturer of the PPC overlay system to be compatible with the system. Furnish sand with not less than 95% passing the #8 sieve and not less than 95 retained on the #20 sieve. Sand must be dry at the time of application.

3. EQUIPMENT

- 3.1. **Surface Preparation Equipment.** Provide shot blasting equipment as described in Item 483, "Concrete Bridge Deck Surfacing."
- 3.1.1. **Bulk Removal.** Provide power-driven chipping tools not heavier than a nominal 30 lb. class for bulk removal of concrete. Provide chipping hammers not heavier than a nominal 15 lb. class to remove concrete beneath any reinforcing bars. Bulk removal and repairs will be in accordance with the requirements of Item 429, "Concrete Structure Repair."
- 3.1.2. **Cleaning.** Provide magnetic equipment followed by self-propelled vacuum equipment to remove spent steel shot. Provide equipment to supply oil and moisture free compressed air for final surface preparation.
- 3.2. **Mixing Equipment.** Mix Polyester concrete in a continuous automated mixer meeting the following requirements:
- Employ an auger screw/chute device capable of completely blending catalyzed binder resin and aggregates.
 - Employ a plural component pumping system capable of handling polyester binder resin and catalyst, adjustable to maintain proper ratios to achieve set/cure times within the specified limits.
 - Be equipped with an automatic metering device that measures and records aggregate and resin volumes. Record volumes at least every 5 min., including time and date. Submit recorded volumes at the end of shift.
 - Have a visible readout gage that displays volumes of aggregate and resin being recorded.
 - Produce a satisfactory mix consistently during the entire application process.
 - Be calibrated per Caltrans California Test CT 109 or similar. Submit current certificate of calibration to the Engineer.
 - Portable mechanically operated mixers of appropriate size, as recommended by the System Provider and approved by the Engineer, may be used unless otherwise noted on the Plans.

Provide aggregate spreading equipment or methods capable of uniformly applying the aggregate so 100% of the overlay material is covered to excess.

- 3.3. **Placing and Finishing Equipment.** Place Polyester Polymer Concrete using a vibratory screed on preset forms or rails, or by self-propelled slip-form paving machine, which is modified or specifically built to effectively place polyester polymer concrete overlays in a manner meeting the following requirements:

- Employ a vibrating pan to consolidate and finish the polyester concrete overlay.
- Be fitted with hydraulically controlled grade automation to establish the finished profile, by using the average 15 ft. in front and behind the substrate grade averaging devices on both sides of the new placement; or the sensor that works with string-line control. It is acceptable to match grade when placing lanes adjacent to previously placed polyester overlay.
- Have sufficient engine power and weight to provide adequate vibration of the finishing pan while maintaining consistent forward speed.
- Be capable of forward and reverse motion under its own power.
- Provide side and end forms for supporting the screed and containing the overlay concrete.

Roller screeds will not be permitted.

4. CONSTRUCTION

- 4.1. **Contacto Submittals.** Submit, for approval, a detailed work plan including all product data, equipment, and manpower before beginning any work.
- 4.1.1. **Product Data.** Submit a list of materials to be used. Provide manufacturer's product data sheets that include: material specifications for the proposed polymer overlay system; mechanical, physical, and chemical properties; environmental durability; limitations; maintenance instructions; and general recommendations on storage, mixing, application, cleanup, and disposal of materials. Submit a mix design which includes the name and type of all ingredients, the mix ratios to be used, and the application rate for each material. Include in the submittal a chart showing the expected cure times (in minutes) at the corresponding temperatures between 40°F and 100°F (in 10°F increments) for the proposed system components.
- 4.1.2. **Certification of Compliance.** Provide a certificate of compliance from an independent laboratory stating the materials to be used meet the requirements of this specification. Furnish samples of the materials to be used as required by the Engineer.
- 4.1.3. **Safety Data Sheets.** Provide manufacturer's Safety Data Sheets (SDS) for all materials to be used on site and certification the materials conform to local, state, and federal environmental and worker's safety laws and regulations.
- 4.1.4. **Work Plan.** Submit a work plan for constructing the overlay including at least the following: proposed equipment, materials, and procedures for preparing the surface and placing the overlay; proposed removal and replacement of existing non-compatible deck repair materials; repair procedures for patching deteriorated areas and repairing cracks exposed by surface preparation; and an anticipated schedule for traffic control. The work plan must meet the approval of the manufacturer of the overlay system. Any deviations from the application prescribed by this specification must be approved.
- 4.1.5. **Technical Support Representative.** Submit name and qualifications of overlay system manufacturer's representative who will be on the jobsite at initiation of work. The Engineer may request the manufacturer's representative return to the jobsite to address issues that may arise during the work.

4.2. Handling of Materials.

Transport and store polymer materials in their original containers in accordance with the manufacturer's recommendations and requirements. Clearly mark containers by component and corresponding to sequence of work and include the following information on each container: name of product, name and address of manufacturer, mixing proportions and instructions, lot and batch numbers, date manufactured, and quantity contained.

Store all materials in a cool, dry location protected from all potential sources of contamination or moisture and in their original containers in accordance with the System Manufacturer's recommendation to ensure their preservation until used in the work. The shelf life for liquid materials stored out of direct sunlight and at

temperatures 80 °F and below must be at least 12 mon. Applicable fire codes may require special storage facilities for some components of the overlay system.

- 4.3. **Application.** When night work is necessary, no additional compensation will be provided for night placements of concrete. Provide sufficient lighting to make quality workmanship and adequate inspection possible during night placements. Lighting must be approved before operations begin.

- 4.3.1. **Trial Application.** Prior to constructing the overlay, conduct one or more trial applications on the prepared substrate to demonstrate proper initial set time and the effectiveness of the surface preparation, mixing, placing and finishing equipment proposed. Each trial application will be at least 10 ft. long and at the planned paving width and specified overlay thickness and on the deck to be overlaid. The locations of the trial applications are to be approved by the Engineer. As approved by the Engineer, successful trial applications may be retained as the final product.

If the cleaning practice, materials, installation, finishing and/or texturing are not acceptable, remove the failed trial application and reinstall the trial application at no additional cost to the Department until satisfactory results are obtained.

Conduct as many trial applications as necessary to demonstrate the ability to construct an acceptable trial overlay section and competency to perform the work. The installer, System Provider and proposed equipment and techniques may be rejected by the Engineer if not shown to be acceptable after 3 failed trial applications.

Perform bond strength test 24 hr. after the placement of the trial application in accordance with ASTM C 1583 to assure that the overlay adheres to the prepared surface. Report the average of 2 successful tests. Test cores must be drilled through the overlay and into the substrate a minimum of 0.5”.

The minimum bond strength on normal weight concrete substrates will be 250 psi with a concrete substrate failure area greater than 50% of the test area. Repair all bond strength test locations with polyester concrete in accordance with this specification.

- 4.3.2. **Surface Preparation.** Prepare surface by shot blasting in accordance with the requirements of Item 483, “Concrete Bridge Deck Surfacing.” Remove dirt, slurry, curing compound, laitance, and any other debonding material from the surface of the concrete. Keep vehicular traffic from shot blasted surface unless required by the overlay operation and approved by the Engineer. Clean concrete substrates that have contaminants that may interfere with the bonding or curing of the overlay prior to placing the overlay, at no additional cost to the Department. Apply primer and overlay only to clean and dry concrete substrate.

All steel surfaces that will be in contact with the overlay must be cleaned in accordance with SSPC-SP No. 10, Near-White Blast Cleaning, except that wet blasting methods are not allowed.

- 4.3.3. **Application of Primer.** Do not begin application of the primer until the substrate is visibly surface dry, free of water and moisture. ASTM D 4263 modified for 2 hr. may be used to verify dryness at the discretion of the Engineer in cases when surface dryness is difficult to determine.

The substrate surface temperature must be between 40-100°F at the time of primer and overlay placement. Night work may be required when temperatures cannot be met during the day.

Prior to applying the HMWM prime coat, ensure the area is completely dry and blown clean with oil-free compressed air.

Mix and apply primer in accordance with the System Provider's recommendations. Apply primer within 5 min. of mixing initiator and resin at a rate of approximately 90-100 ft²/gal or as otherwise recommended by the System Provider. Apply primer by flooding and uniformly spreading to completely cover all surfaces to receive overlay, including any adjacent vertical surfaces. Care should be taken to avoid heavy application that results in excess puddling. Remove or distribute excess material to meet the recommended application rate. Reapply primer to any areas that appear visibly dry prior to overlay placement.

- 4.3.4. **Application of Polyester Concrete.** Mix and apply the polyester concrete in accordance with the System Provider's recommendations. Place concrete only when the air or substrate temperature is between 40°F and 100°F and the polyester concrete temperature is between 40°F and 100°F.
- Apply polyester concrete after 15 min. and within 2 hr. of placing the primer. Place the polyester concrete prior to gelling or within 15 min. following addition of the initiator, whichever occurs first, or as recommended by the System Provider.
- The polyester concrete mixture must have an initial set time of ≥ 30 min. and ≤ 90 min., when the in-place polyester concrete cannot be deformed by pressing with a finger. An initial set of less than 20 min. will be cause for rejection at the Engineer's discretion. If the initial set is not within 90 min., remove and replace the material at no additional cost.
- Consolidate and finish the polyester concrete using placement equipment as defined herein to strike off the polyester concrete to the required grade and cross-section as shown in the Plans.
- Place the polyester overlay at a profile necessary to meet the desired grade and cross-section as shown in the Plans with a minimum thickness of $\frac{3}{4}$ in. Termination edges of the overlay may require application and finishing by hand trowel due to obstructions such as a curb. Isolate expansion joints prior to overlaying or saw within four hr. after overlay placement, as approved by the Engineer.
- Provide sufficient labor and equipment for proportioning, mixing, placing, and finishing concrete overlay at a rate of at least 40 ft. of finished overlay per hr.
- 4.3.5. **Application of Abrasive Sand Finish.** Apply the abrasive finish sand evenly on the finished overlay surface at a rate of at least 2.2 lbs/yd² by broadcasting, immediately after the overlay placement before gelling. Adjust rate of application as necessary to ensure complete coverage.
- 4.4. **Curing.** Cure overlay sufficiently before being subjected to loads or traffic of any nature that may damage the overlay. Cure time is dependent on ambient and substrate temperatures and also initiator/accelerator levels used at the time of mixing. The overlay is considered cured to a traffic ready state after 4 hr. following finishing or as approved by manufacturer and the Engineer. Methods to validate traffic ready state in less than 4 hr. may be submitted by the manufacturer for approval. A Schmidt hammer reading of not less than 25 on a properly calibrated Schmidt hammer is an acceptable method to validate traffic ready state.
- 4.5. **Surface and Thickness Requirements.** Variable thickness overlay placement may be required to account for variations in substrate profile to meet the desired grade and cross-section as shown in the Plans.
- Contractor is responsible for the ride quality of the finished surface. Acceptance criteria as defined in Article 422.4.10, "Defective Work," will be used and enforced for this work.
- Correct any surfaces which fail to conform to the specified tolerance by diamond grinding. Do not diamond grind until at least 24 hr. after placement of the overlay.
- If the Engineer determines that the minimum thickness has not been attained, apply an additional layer, at least $\frac{1}{4}$ " thick, after the overlay has cured for a minimum of 4 hr., and applied as recommended by the System Provider and approved by the Engineer at no additional cost to the State.
- To ensure adequate pavement friction, the completed overlay surface must be free of any smooth or glassy areas such as those resulting from insufficient quantities of abrasive finish sand. Repair any such surface defects as recommended by the System Provider and approved by the Engineer.
- Fill surface cracks in sound, bounded polyester concrete overlays with properly catalyzed HMWM primer material.

- 4.6. **Grooving.** When indicated on the plans, groove surface in accordance with Article 422.4.11., "Final Surface Texture."

5. MEASUREMENT

Polyester polymer concrete overlay will be measured by the square yard of surface overlaid using the dimensions shown on the plans. Overlay is a plans quantity measurement item. The quantity to be paid is the quantity shown in the proposal, unless modified by Article 9.2., "Plans Quantity Measurement." Additional measurements or calculations will be made if adjustments of quantities are required.

6. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Polyester Polymer Concrete Overlay" of the specified depth.

Payment for "Polyester Polymer Concrete Overlay" is full compensation for: surface preparation, surface cleaning; surface preparation testing; presence of overlay system manufacturer's representative at initiation of the work and as requested; furnishing and applying primer, polyester polymer concrete overlay, and surface friction sand; grooving when indicated on the plans; repairing damaged or marred overlay surfaces; and all materials, labor, tools, equipment, and incidentals.

Repair of deteriorated concrete below the level of scarification will be paid for in accordance with Item 429, "Concrete Structure Repair."