REVISION OF SECTION 519
THIN BONDED OVERLAY (POLYESTER CONCRETE)

Section 519 is hereby added to the Standard Specifications as follows:

DESCRIPTION

519.01 This work consists of furnishing and placing a polyester concrete overlay system with a 3/4 inch minimum thickness on an existing concrete bridge deck for the purpose of improving skid resistance and sealing the concrete surface. The surface of the concrete shall be prepared and the overlay system shall be placed in accordance with these specifications. The Contractor shall install an overlay system with all components provided through a single system provider with documented experience successfully supplying 5 projects of similar size and scope within the past 5 years. This work also includes patching of Class 1, Class 2 and Class 3 removal areas using polyester concrete material.

QUALIFICATION OF CONTRACTOR

519.02 The Contractor shall submit documentation that confirms his having a minimum of five years of experience in the use and application of deck structural concrete placed to established grade using similar equipment specified herein. During the last 5 year period, the Contractor shall have conducted at least 10 successful projects placing structural concrete (bridge decks or concrete pavement) to established grade. The Contractor shall also submit documentation that confirms having a minimum of five years of experience in the use and application of the specified polyester concrete material and the Contractor shall retain the services of a system provider's representative with said experience as required in Subsection 519.04 (e) of these Special Provisions.

MATERIALS

519.03 The Contractor shall submit a Certified Test Report of the all the materials associated with the polyester concrete overlay in accordance with subsection 106.13 and accompanied by certified test reports from independent accredited laboratories.

The polyester concrete shall consist of polyester resin binder and aggregate as specified below. It shall also include a compatible primer which when mixed with other specified ingredients and applied as specified herein, is capable of producing a polyester concrete meeting the requirements of this specification.

(a) Polyester Resin Binder

Table 519-1
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 (0.075 to 0.20 Pa) 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 must be performed before adding initiator.		

Polyester resin binder shall have the following properties:

(1) Be an unsaturated isophthalic polyester-styrene co-polymer. The resin content shall be 12% +/- 1% of the weight of the dry aggregate.
(2) Contain at least 1 percent by weight gamma-methacryloxypropyltrimethoxysilane, an organosilane ester silane coupler.
(3) Be used with a promoter that is compatible with suitable methyl ethyl ketone peroxide and cumene hydroperoxide initiators.
(4) Have the values for the material properties shown in Table 519-1:

Accelerators or inhibitor may be required to achieve proper setting time of polyester concrete. They shall be used as recommended by the overlay system provider.

(b) High Molecular Weight Methacrylate Primer

Table 519-2
HIGH MOLECULAR WEIGHT METHACRYLATE RESIN PROPERTIES (tested yearly)

Property	Test Method	Value
Viscosity*	ASTM D 2196	4.0×10^{-5} psi (0.025 Pa) 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)	California Test 551, part 5**	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		

Primer for the concrete surface shall be a wax-free low odor, high-molecular-weight methacrylate prime coat, and consist of a resin, initiator and promoter. The prime coat shall conform to Table 519-2.

Initiator 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.

(c) Aggregates

Table 519-3
AGGREGATE GRADATION

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

Aggregate for polyester concrete shall have the following properties (verified by yearly testing):

(1) Have not more than 45 percent crushed particles retained on the No. 8 sieve when tested in accordance with AASHTO Test Method T335.
(2) Provide fine aggregate consisting of natural sand.
(3) Have a weighted-average aggregate absorption of no more than 1.0 percent when tested under AASHTO Test Methods T84 and T85.
(4) 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.
(5) Comply with the requirements for the aggregate gradation shown in Table 519-3:

Sand for abrasive sand finish shall have the following properties:

(1) Be commercial-quality blast sand.
(2) 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.
(3) Have an average absorption of not more than 1 percent when tested under AASHTO Test Method T85.

(d) Composite system

COMPOSITE PROPERTIES
Table 519-4- Tested every 2 years

Polyester Concrete		
Property	**Test Method**	**Requirement**
PPC Saturated Surface Dry Bond Strength	CT 551*	500 psi minimum at 24 hrs and 70F (without primer, at 12% resin content by weight of the dry aggregate, on Saturated Surface Dry Specimen)
Abrasion Resistance	CT 550*	<2g weight loss (at 12% resin content by weight of the dry aggregate)
Modulus of Elasticity	ASTM C 469	1,000,000 psi to 1,500,000psi (at 12% resin content by weight of the dry aggregate)

* Copies of California Test 550 and 551 are available from the Engineer.

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REVISION OF SECTION 519
THIN BONDED OVERLAY (POLYESTER CONCRETE)

CONSTRUCTION REQUIREMENTS

519.04 The overlay system shall be applied in accordance with these specifications at the locations indicated on the plans. The quantities and rates shown are for typical situations only. Exact quantities and rates shall be as recommended by the system provider and approved by the Engineer.

(a) *Trial Application.* Prior to constructing the overlay, one or more trial overlays shall be placed on a previously constructed concrete base to determine the initial set time and to demonstrate the effectiveness of the mixing, placing, and finishing equipment proposed. The set time can be determined when the in place PPC cannot be deformed by pressing with a finger, indicating that the resin binder is no longer in a liquid state. Each overlay shall be 12 feet wide, at least 6 feet long and the same thickness as the specified overlay. The trial overlay shall be tined as per Subsection subsection 519.04 (f). Conditions during the construction of the trial overlays and equipment used shall be similar to those to be used for construction of the overlay. The location of the trial overlays shall be approved by the Engineer.

The number of trial overlay sections required shall be as many as necessary for the Contractor to demonstrate the ability to construct an acceptable trial overlay section and competency in ability to perform the work. The cost of the construction and removal of the concrete base surfaces for the trial sections will not be measured and paid for separately, but shall be included in the work. Removed trial sections shall be properly disposed of off-site by the Contractor.

A vertical axis pull bond test shall be performed in accordance to ACI 503R-30 after 24 hours. The test result shall be the average of three tests, drilled a minimum of 0.25" but no greater than 0.50" below the bond line, with a strength greater than 250 psi and a failure area greater than 50% failure in the substrate concrete of the test surface area. An acceptable result assures that the overlay adheres to the prepared surface and the installation may proceed.

(b) *Equipment.* All equipment for cleaning the existing concrete surface and mixing and applying the overlay system shall be in accordance with the system provider's recommendations as approved by the Engineer prior to commencement of any work.

MIXING EQUIPMENT

A. Use a continuous mixer to mix polyester concrete for large area applications over with quantities of 2000 cubic feet per contract. The continuous mixer must:
   1. Employ an auger screw/chute device.
   2. 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.
   3. Have a visible readout gage that displays volumes of aggregate and resin being recorded.
   4. Produce a satisfactory mix consistently during the entire placement.
   5. Provide certification that equipment has been calibrated within 90 days by a CT 109 test (copies available from the engineer) or a method approved by the engineer.

B. Polyester concrete may be mixed in mechanical mixers of appropriate size for proposed batches, as approved by the system provider, for smaller area applications of less than 2000 cubic feet per contract.

FINISHING EQUIPMENT

Consolidate and finish the overlay to the required grade and cross section using finishing equipment.

A. Finishing equipment for polyester concrete contracts with a quantity of 2000 cubic feet or more shall:
    1. Use self-propelled slip-form paving machine which is modified or specifically built to effectively place the PPC overlay in a manner that meets the objectives and requirements of the project. The paving machine shall:
        a. Employ a vibrating pan to consolidate and finish the PPC.
        b. Be fitted with hydraulically controlled grade automation to establish the finished profile. The automation shall be fitted with substrate grade averaging devices on both sides of the new placement; the device shall average 15 ft in front and behind the automation sensors. It is acceptable to match grade when placing lanes adjacent to previously placed PPC.
        c. Have sufficient engine power and weight to provide adequate vibration of the finishing pan while maintaining consistent forward placement speed.

        The installer shall furnish a documented history of the use of this paving machine to successfully place Polyester Polymer Concrete overlays on major bridge projects acceptable to the authority.

B. Finishing equipment for polyester concrete contracts with a quantity less than 2000 cubic feet may:
    1. Use finishing equipment as specified in Finishing Equipment Section A above.
    2. Use vibratory-type mechanical screed riding on preset forms/rails.

(c) *Surface Preparation.* The surface of concrete substrate shall be prepared for application of the overlay by *shotblasting* in order to remove all existing grease, slurry, oils, paint, dirt, striping, cure compound, membrane or any other contaminants that could interfere with the proper adhesion of the overlay system.

Existing bridge decks shall be rehabilitated prior to the application of the polyester concrete overlay as shown in the plans and as determined in the field. Spalled and delaminated areas of the deck shall be removed down to sound concrete in accordance with Special Provision 202 – Removal of Portions of Present Structure.

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Prior to applying the overlay, the Contractor shall patch the Class 1, Class 2 and Class 3 removal areas with polyester concrete. To provide a uniform overlay thickness, the patching shall be struck off flush with the top of existing deck surface, prior to placing the polyester overlay.

The final surface shall adhere to the following requirements:

i. The areas to be overlaid shall be shotblasted (or abrasive sandblasted in the event that the shotblaster cannot access the area to be prepared).
ii. Loose particles of abrasive or shotblasting shall be removed prior to the overlay placement, by magnets and compressed air and vacuuming such that no trapped shot remains. Power washing will not be allowed.
iii. The areas to be overlaid areas shall be blown off with compressed air just prior to placement of the primer and must be completely dry.

1. Shotblast Cleaning: The required method of cleaning is shotblasting. This cleaning shall not commence until all work involving the repair of the concrete deck surface has been completed and the deck is dry. All contaminants shall be picked up and stored in the vacuum unit and no dust shall be created during the blasting operation that will obstruct the view of motorists in adjacent roadways. The travel speed and/or number of passes of the shotblasting unit shall be adjusted so as to result in all weak or loose surface mortar being removed and the aggregates of the concrete being exposed, as well as a visible change in the concrete color. Cleaned surfaces shall not be exposed to vehicular traffic other than required. If the deck becomes contaminated before placing the overlay, the Contractor shall abrasive blast-clean the contaminated areas to the satisfaction of the Engineer at no additional cost. Following completion of shotblast cleaning, any loose shot or other particles shall be removed from the deck prior to the application of the overlay. The shotblast cleaning or other approved method will not be measured and paid for separately, but shall be included in the work.

(d) *Acceptability of Surface Preparation.* Acceptability of the surface preparation may be determined by the Engineer, and may include the use of a vertical axis pull bond test. Test shall be performed by the Contractor in accordance to ACI 503R-30:

1. This test consists of bonding a 2 inch diameter sandblasted steel disk to the prepared substrate by using a fast setting epoxy, and pulling it from the substrate by applying a vertical force.
2. The number of tests needed will be determined by the Engineer; however, normally one test will be carried out for approximately each 1000 square feet of overlay area.
3. Substrate preparation will not be approved unless at least 90% of the bonded steel disk surface has retained substrate concrete exceeding 1/4 inches in depth.
4. At the discretion of the Engineer, the pull-out test may be carried out on the polymer overlay. At a minimum, one pull-out test shall be performed on each bridge. For bridges

with deck areas greater than 25,000 square feet, additional test shall be performed at a frequency of one test per 25,000 square feet of additional deck area, rounded up.

5. The minimum acceptable bond strength on normal weight concrete shall be 250 psi with a failure area greater than 50% failure in the substrate concrete of the test surface area.
6. The Contractor shall repair all bond test locations with polymer overlay in accordance with this specification.

(e) *Application of Overlay*. The Contractor shall submit the proposed system to the Engineer for approval at least 15 days prior to the delivery of resin and/or aggregate to the project. Two copies of the System provider's material information, written installation instructions, material safety data sheets and independent test results shall be included in the submittal for approval.

After the exposed surfaces have been prepared, primer coat shall be applied in accordance with the system provider's recommendations. The concrete surface temperature shall be from 40 to 100°F. The polyester concrete shall be applied after 15 minutes and within 2 hours after the prime coat has been applied. The polyester concrete shall be placed prior to gelling and 15 minutes following addition of initiator, whichever occurs first. The test time allowed for placement may be modified if recommended by the system provider's representative and approved by the Engineer.

If the Contractor does not have 5 years of experience with the system as outlined in 519.02, the Contractor shall arrange for a qualified representative of the system provider (with 5 years of documented experience with polyester concrete) to be on site throughout the duration of the project to ensure proper construction of the polyester concrete. If the Contractor has 5 years of experience, the qualified representative shall be on site throughout the placement of the first two (2) bridge overlay placements, at a minimum, and shall be available as requested by the Engineer. The technical representative shall be completely competent in all aspects of the work, including all materials to install the polyester concrete properly. The technical representative shall be available on the site to facilitate the installation of polyester concrete. This includes, but not limited to, surface preparation, polyester concrete application and polyester concrete cure.

Application of the overlay shall not begin until the concrete deck is completely surface dry in accordance with ASTM D4263. Methods shown in this specification are typical of general installations and shall be per System provider's recommendations or as follows:

1. *Prime coat Application:*
   Prior to placing prime coat, the exposed surfaces shall be dry and blown clean with oil-free compressed air. Exposed surfaces shall be protected from precipitation and heavy dew during and after the application of the prime coat.

   After the exposed surfaces have been prepared and allowed to dry, primer coat shall be applied in accordance with the system provider's recommendations. The concrete surface temperature shall be from 40 to 100 °F. HMWM primer shall be placed within 5 minutes of mixing at approximately 90sf/gal or the rate recommended by the System Provider. Primer coat shall be uniformly spread to completely cover surfaces to be overlaid. Avoid puddling and re-prime any areas that appear dry from absorbing the material.

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2. *Polyester Concrete Application:*
The Polyester resin binder shall be initiated and blended completely. Aggregate shall be added and mixed for at least two minutes, when using a mechanical mixer.

The polyester concrete shall be applied after 15 minutes and within 2 hours after the prime coat has been applied. The polyester concrete shall be placed prior to gelling or 15 minutes following addition of initiator, whichever occurs first, or within a more restrictive range if recommended by the system provider.

Prior to polyester concrete placement, the surface temperature of the area to receive polyester concrete shall be a minimum of 40 °F and a maximum of 100 °F. Night work may be required when temperatures cannot be met during the day.

The resin binder content shall be 12% +/- 1% by weight of the dry aggregate. Polyester concrete must have an initial set time of at least 30 minutes and at most 120 minutes when tested using an initial-setting time Gillmore needle under ASTM C 266. The set time can be determined in the field when the in place PPC cannot be deformed by pressing with a finger, indicating that the resin binder is no longer in a liquid state. If the initial set is not within 30-120 minutes, the material must be removed and replaced.

The overlay shall be consolidated and finished to the required grade and cross section using a vibratory-type mechanical screed riding on preset forms/rails or through the use of a PPC paver. Although the screed or paver should yield a finished surface, additional finishing may be necessary. PPC shall be finished as necessary through traditional concrete finishing methods, producing a slight resin bleed indicating complete consolidation of aggregates.

A surface friction sand finish of at least 2.2 lbs per square yard shall be broadcast onto the glossy surface immediately after finishing and before resin gelling occurs. To ensure adequate pavement friction, the completed PPC overlay surface shall be free of any smooth or "glassy" areas such as those resulting from insufficient quantities of surface aggregate. Any such surface defects shall be repaired by the Contractor in the manner recommended by the System Provider and approved by the Engineer at no additional cost.

The overlay shall be longitudinally tined. Tining shall produce grooves of 1/8 inch by 1/8 inch spaced at ¾ - 1" inch apart. Tining grooves shall be neat in appearance and uniform in depth. Tining devices shall be maintained clean and free from encrusted mortar, polyester resin, sand and polyester concrete to ensure uniform groove thickness.

Unless indicated on the plans, tining shall run parallel with the direction of traffic and shall extend across the entire applied deck surface except for 1' next to the curb. The tining shall not be performed too early whereby the grooves may close up, or too late whereby the grooves are of inadequate depth.

Surface smoothness must vary at most 1/4" inch from the lower edge of a 12 foot long straightedge placed in any direction. Diamond grinding may be required to remediate any deficiencies at no additional cost.

All working deck joints shall be extended through the overlay. Working joints shall be sealed according to the details in the plans.

Curing. The Contractor shall allow the overlay to cure sufficiently before subjecting it to loads or traffic of any nature that may damage the overlay. Cure time depends upon the ambient and deck temperatures. The overlay shall be considered cured to a firm, hard state when 4 hours have passed OR a minimum reading of 25 on a properly calibrated Schmidt hammer.

(f) *Repair of Surface Defects*. The repair materials and finishing methods for surface defects in the overlay shall be identical to those used for the application of the overlay. All surface defects shall be repaired to the satisfaction of the Engineer before acceptance of the work is made.

SUBMITTALS

519.05 The Contractor shall submit the product data sheet, installation instructions, System Provider qualifications, Contractor qualifications, Contractor polyester concrete specific qualifications OR System Provider technical representative qualifications, certificates of compliance with laboratory testing for each property in Section 519.03, placement plan and any other relevant documents for the selected protection - system at least 15 days before the first application of the product. The submittal is for approval and shall be directed to the Engineer.

(a) *System Provider Qualifications* includes at a minimum:

- 5 successful projects of similar size and scope in the past 5 years
- Date, quantities, reference name and contact information for owner representative

(b) *Contractor Qualifications* includes at a minimum:

- 10 successful projects placing concrete as specified in section 519.02 in the past 5 years
- Date, quantities, reference name and contact information for owner representative

(c) *Polyester Concrete Contractor Qualifications and System Provider Technical Representative Qualifications* includes at a minimum:

- 5 successful projects placing polyester concrete in the past 5 years
- Date, quantities, reference name and contact information for owner representative

(d) *The Placement Plan* includes at a minimum:

- Schedule of overlay work and testing for each bridge
- Staging plan describing overlay placement sequence including:
    - Paving widths
    - Anticipated paving lengths
    - Paving directions
    - Location of proposed trial overlay(s)
- Description of equipment used for:
    - Surface preparation including grinding and shot blasting
    - Applying HMWM resin
    - Measuring, mixing, placing, and finishing the polyester concrete overlay
    - Applying sand
    - Method of protecting and finishing inlets and bridge drains

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- Method for isolating expansion joints including pourable joints at the abutment and over the piers
- Method for measuring and maintaining overlay thickness and profile.
- Tining plan showing tining locations and describing methods that will be used for hand tining. Mainline tining shall be automated with the finisher.
- Cure time for polyester concrete
- Storage and handling of HMWM resin and polyester concrete components
- Procedure for disposal of excess HMWM resin, polyester concrete, and containers
- Procedure for cleanup of mixing and placement equipment

METHOD OF MEASUREMENT

519.06 Furnished overlay material will be measured by the actual volume of polyester concrete material complete-in-place. The volume shall include material used for patching unsound concrete and deck rehabilitation as directed by the Engineer. Any additional quantities in excess of the plan thickness as required for profile adjustments shall be included in the Contractor's submittal and approved by the Engineer prior to placement.

Overlay placement will not be measured, but shall be the quantities specified in the plans for the final surface. Quantities for placement of patching areas will not be measured and paid for separately, but shall be included in the work.

Trial application(s) will not be measured and paid for separately, but shall be included in the work.

BASIS OF PAYMENT

509.07 Thin Bonded Polyester Concrete Overlay will be paid at the unit price bid as follows:

Payment will be made under:

Pay Item	**Pay Unit**
Furnish Thin Bonded Overlay (Polyester Concrete)	Cubic Foot
Place Thin Bonded Overlay (Polyester Concrete)	Square Yard

Payment for Furnish Thin Bonded Overlay (Polyester Concrete) shall include all costs required to furnish the polyester concrete material to the project site and dispose of any unused overlay material.

Payment for Place Thin Bonded Overlay (Polyester Concrete) will be full compensation for all labor, equipment, and all incidentals necessary to prepare the concrete surface and complete the overlay placement including prime coat and polyester concrete. Costs for placement of polyester concrete material in spalled and deck removal areas where specified shall be included in the work.