



NEVADA DEPARTMENT OF TRANSPORTATION - RESEARCH SECTION

EXTERNAL PRODUCT/MATERIAL ACCEPTANCE CRITERIA  
QPL Section 496.02.01 – OVERLAY SYSTEM (POLYESTER)

**Category Description:** Polymer concrete to be used for overlay systems.  
**Primary Evaluating Section:** Materials

**Evaluation Criteria (adopted 03/12/2019):**

Requirement	Criteria	Test
Independent laboratory test results showing conformance to the criteria	Current criteria is attached	Pass/Fail
<b>If product passes screening for the above item, applicants may be invited for the next stage:</b>		
NDOT Field Testing	Product demonstrates satisfactory performance after the successful completion of a two-year field test (NDOT will select the date and location)	Pass/Fail

**Note:** Field test must cover two full winter seasons.

## SECTION 496 - POLYMER CONCRETE

### DESCRIPTION

**496.01.01 General.** This work consists of preparing concrete surfaces and placing a prime coat, premixed composition of polyester resin binder and dry aggregate, and sand.

### MATERIALS

**496.02.01 Certificates and Submittals.** Materials for polymer concrete shall be tested by a certified lab. Submit a certified copy of test results that are less than 1 year old for review and approval 30 days before polymer concrete placement. Identify all materials by source and type. Submit test reports for the polyester styrene resin binder and the high molecular weight methacrylate resin prime coat. The materials so tested and certified shall be of the same composition as the materials used on the project.

**496.02.02 Polymer Concrete.** The prime coat shall be a wax free, high molecular weight methacrylate resin conforming to the following requirements:

TEST	TEST METHOD	REQUIREMENT
Viscosity (b) @ 25 °C (77 °F), Pa·s (poises)	ASTM D2196 (a)	0.025 (0.25) Maximum
Specific Gravity @ 25 °C (77 °F)	ASTM D1475 (a)	0.90 Minimum
Flash Point, °C (°F)	ASTM D3278 (a)	82 (180) Minimum
Tack-Free Time @ 25 °C (77 °F), minutes	Calif. 551	400 Maximum
Bond Strength (c) @ 21 ± 1 °C (70 ± 2 °F), MPa (psi)	Calif. 551	3.5 (500) Minimum

- (a) Perform test before addition of the initiator.
- (b) Brookfield RVT with UL adaptor, 50 rpm.
- (c) PCC Saturated Surface-Dry Bond Strength at 24 hr.

The promoter/initiator system for the methacrylate resin shall consist of a metal drier and peroxide. If supplied separately from the resin, at no time shall the metal drier be mixed with or allowed to contact the peroxide directly. Do not store the containers in a manner that will allow leakage or spillage from one material to contact the container or material of the other.

Accompany each shipment of high molecular weight methacrylate resin, promoter, and initiator with a Material Safety Data Sheet.

Polymer concrete consists of polyester resin binder and dry aggregate.

Polyester resin binder shall be an unsaturated isophthalic polyester-styrene co-polymer and shall conform to the following requirements:

TEST	TEST METHOD	REQUIREMENT
Viscosity (b) @ 25 °C (77 °F), Pa·s (poises)	ASTM D2196 (a)	0.075 to 0.20 (0.75 to 2.0)
Specific Gravity @ 25 °C (77 °F)	ASTM D1475 (a)	1.05 to 1.10
Elongation (d), Type I at 11.5 mm/min., %	ASTM D638	35 Minimum
Tensile Strength (d), Type I at 11.5 mm/min., MPa (psi)	ASTM D638	17.5 (2,500) Minimum
Silane Coupler, % by mass of polyester-styrene resin	Calif. 551	1.0 Minimum
Styrene Content, % by mass, as volatiles	ASTM D2369 (a)	40 to 50
Bond Strength (c) @ 21 ± 1 °C (70 ± 2 °F), MPa (psi)	Calif. 551 or ASTM C679	3.5 (500) Minimum

- (a) Perform test before addition of the initiator.
- (b) Brookfield RVT, No. 1 Spindle, 20 rpm.
- (c) PCC Saturated Surface-Dry Bond Strength at 24 hr.
- (d) Thickness = 6.5 ± 1 mm. Sample Conditioning: 18hr/25 °C/50% + 5hr/70 °C according to ASTM D618.

The silane coupler shall be an organosilane ester, gammamethacryloxy-propyltrimethoxysilane. The promoter shall be compatible with suitable methyl ethyl ketone peroxide (MEKP) and cumene hydroperoxide (CHP) initiators.

Obtain materials for polymer concrete from one of the sources listed in the QPL.

Accompany each shipment of polyester styrene resin with a Material Safety Data Sheet.

Aggregate shall conform to the following gradation requirements when tested according to Test Method Nev. T206.

Sieve Size	Percent Passing by Mass
3/8 Inch .....	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 retained on the No. 8 sieve shall have a maximum of 45% fractured faces as determined by Test Method No. Calif. 205. Aggregate passing the No. 8 sieve shall consist of natural sand only.

Aggregate absorption shall not exceed 1.5% as determined by Test Method No. Calif. 206 or 207, as applicable.

The moisture content of the aggregate, as determined by Test Method No. Nev. T112 (Method A), shall not exceed 50% of the aggregate absorption capacity at the time of mixing with the resin.

The pre-bagged aggregate may be furnished in two or more sizes. The combined proportions of each size shall meet the above requirements.

Provide a mix design detailing the description and quantity of polyester resin, aggregates, promoter, and accelerant required to produce an acceptable product. Include certified lab testing results for the individual materials and the following properties of the cured polymer concrete:

1. Unit Weight (lb/ft<sup>3</sup>) per Test Method No. Nev. T435 modified to use a disposable container.
2. Tensile Strength (psi) per ASTM C1583 modified as approved, or ACI 503R - Appendix A of the ACI Manual of Concrete Practice.

Include the ambient and surface temperature limitations for batching and placement of the polymer concrete within the restrictions of Subsection 496.03.04.

Submit the mix design for approval a minimum of 20 days prior to the trial batch placement. Do not place trial batch until the mix design is approved in writing.

Provide 1 five-gallon bucket of blended coarse and fine aggregates conforming to the gradation and enough resin and catalyst to prepare lab samples.

## CONSTRUCTION

**496.03.01 General.** Before placing polymer concrete, furnish the following:

1. Skilled technical service relating to application of materials, including a representative present during the trial batch and initial full-production placement of polymer concrete.
2. Health and safety training for personnel who are to handle the materials. In addition, provide a soap and water wash station for the workers at the job site.
3. Submit proposed locations of the longitudinal and transverse joints for approval. Place longitudinal joints on lane lines.

**496.03.02 Trial Batches.** The materials used in the trial batches shall be the same as those used in the mix design. If at any time different materials are to be used, a new mix design and trial batches will be required.

When the polymer concrete will be used for an overlay application, place one or more trial batches on a previously constructed concrete base to demonstrate the effectiveness of the proposed mixing, placing, and finishing equipment. Each trial batch shall be 12 feet wide, at least 12 feet long, and the same thickness as the overlay to be constructed.

Place trial batches under similar conditions anticipated to be encountered during placement of the permanent overlay.

Adjustments to the approved mix design may be made by the technical service representative with approval.

As necessary, remove and dispose of the concrete base and materials used in the trial batches according to Subsection 107.14.

**496.03.03 Bridge Deck Preparation.** After removal of bituminous surfacing and before deck preparation, repair bridge decks as provided for in Subsection 502.03.15. After repairs are complete, scarify the bridge deck by shot blasting. Use of scabblers, milling machines, or sand blasting will be at the discretion of the Engineer. If shot blasting is utilized, use a 75 hp minimum self-propelled machine equipped with vacuum recovery.

The scarifying procedure shall produce a uniform rough texture, removing concrete and exposing the coarse aggregate to a depth not to exceed 1/4 inch. The prepared surface shall be sound and clean.

Adequately isolate expansion joints and weakened plane joints before overlaying or saw them by approved methods within 4 hours after overlay placement. The exact time of sawing will be determined.

Immediately before applying the prime coat, sweep the surface clean with compressed air to remove accumulated dust and loose material.

**496.03.04 Concrete Placement.** Before applying the prime coat, the concrete area to receive the prime coat shall be dry when tested according to ASTM D4263. The concrete surface temperature shall be between 50 °F and 100 °F during application of the prime coat and polymer concrete. If necessary, propose methods to heat or cool the concrete surface for approval.

Use edge forms for placement of prime coat and polymer concrete that is not constrained by existing concrete or existing polymer concrete. Use forms that are leak-proof, preventing loss of prime coat or polyester resin. Remove polyester concrete that exhibits resin leaking. Slip form paving with no edge constraints may require up to 4 inches of the polymer concrete to be removed on each side of the pass. Construct longitudinal joints parallel to the roadway alignment. Construct vertical joints perpendicular to the deck surface. Saw cut vertical joints that are not perpendicular to the deck surface.

Apply the prime coat to the surface prior to placement of polymer concrete.

Apply the prime coat at an approximate rate of 0.09 gal/yd<sup>2</sup>. Flood concrete surfaces with the prime coat allowing penetration into the concrete and filling of all cracks. Redistribute the applied prime coat in cracks by squeegees or brooms. Do not over-apply the prime coat, including ponding or runoff. A noticeable increase in viscosity prior to placement will be cause for rejection. If the primed surface becomes contaminated or if there is a failure of the material, clean the contaminated or failed area by abrasive blasting and re-prime. Do not allow traffic on the primed surface.

Mix polymer concrete in mechanically operated mixers. Use a sufficient amount of initiator in the polymer concrete to produce set times between 30 and 120 minutes after placement. Determine set times according to Test Method No. Calif. 551. Accelerators or inhibitors may be required to achieve proper set times and shall be used as recommended by the resin supplier.

Initiate and thoroughly blend the resin binder before introduction of aggregate to the binder. Mix the polymer concrete for a sufficient amount of time to produce a homogeneous mixture without entrapping air in the mixture.

Place and finish polymer concrete before gelling or within 15 minutes following addition of the initiator, whichever occurs first. Discard polymer concrete not placed within this time.

Samples will be obtained from both the trial batch and production paving. The samples will be tested for tensile strength performed by a modified version of ASTM C1583 or ACI 503R - Appendix A of the ACI Manual of Concrete Practice, for density by a modified version of Test Method No. Nev. T435, and for polyester resin content and gradation by a modified version of Test Method No. Nev.T761.

Use finishing equipment that strikes off the polymer concrete to the established grade, cross section, and nominal depth. Equipment shall include sufficient vibrators to consolidate the overlay material and bring a thin layer of resin to the surface.

Embed abrasive sand in the thin layer of resin on the polymer concrete surface. The sand shall be commercial quality blast sand, conforming to the absorption capacity and moisture content requirements of polymer concrete aggregate specified herein. Provide sand such that 95% shall pass the No. 8 sieve and 95% shall be retained on the No. 20 sieve. Apply the sand finish by mechanical means immediately after overlay strike-off. Broadcast sand uniformly onto the surface before gelling occurs at a minimum rate of 2.0 lb/yd<sup>2</sup> and as necessary to cover the entire surface resulting in no visible polyester resin.

Texture the sanded polymer concrete surface with a mechanical spring steel tining device which will form grooves perpendicular to the centerline of the bridge. Do not perform tining too early, where by the grooves may close up. Make tines of rectangular cross section and of sufficient thickness and resilience to result in grooves spaced 3/4 inch on center, 3/32 to 1/8 inch wide, and 1/8 to 3/16 inch deep in the finished concrete pavement.

Construct grooves continuously to within 12 to 15 inches of the deck edge, parapets, gutters, or barrier rail on each side of the bridge deck. Terminate grooves a maximum of 12 inches from expansion joints or devices imbedded in the pavement, such as metal joints, access plates, etc. Line up the grooves across construction joints or stopping points to produce grooves that are continuous across the entire surface.

Tine at a speed which keeps up with placement of polymer concrete overlay.

Leave a 3/4-inch gap between each tine strip to prevent overlapping the tined surface and producing a weak surface area.

Maintain the tining device clean and free of debris to ensure uniform groove dimensions.

Perform tining when the concrete has sufficiently set to prevent the material from settling and closing the grooves. Do not attempt to tine polymer concrete which has fully set, whereas the tining operation may lift aggregate out of, tear, or causing excessive roughness to the polymer concrete surface.

If polymer concrete has hardened before tining is performed, apply a grooved finish to the polymer concrete surface. Perform grooving using diamond blades, mounted on a multi-blade arbor on a self-propelled machine which is designed for grooving concrete pavement. Provide a machine with a depth control device which will detect variations in the pavement surface and adjust the cutting head height to maintain the depth of groove specified. Use a machine that uses guides to control alignment and a functioning water recovery system.

Cut grooves perpendicular to the centerline of the bridge. Run grooves continuously to not less than 12 inches nor more than 15 inches from the deck edge, parapet, gutters, or barrier rail on each side of the bridge deck. Terminate grooves a maximum of 12 inches from expansion joints or devices imbedded in the pavement, such as metal joints, access plates, etc. Line up the grooves across construction joints or stopping points to produce grooves that are continuous across the entire surface.

Make grooves of rectangular cross section and of sufficient thickness and resilience to result in grooves spaced 3/4 inch on center, 3/32 to 1/8 inch wide, and 1/8 to 3/16 inch deep in the finished concrete surface.

Protect the finished polymer concrete overlay from moisture, equipment, and public traffic for not less than 4 hours after finishing.

Do not contaminate concrete surfaces during clean-up of tools and equipment. Do not dump or spill polymer concrete materials or cleaning solvents in areas that will cause environmental or fire hazards.

Provide the necessary equipment and supplies for conducting pull off tests on the completed polymer concrete overlay. Perform pull off tests according to ACI 503R - Appendix A of the ACI Manual of Concrete Practice or ASTM C1583. Perform tests at a frequency of one test per every 60 yd<sup>2</sup> of deck surface. Acceptable pull off test shall exhibit cohesive failure (Type A failure) within existing material below the prime coat. Pull off tests that fail in the prime coat (Type B failure) are acceptable if a minimum of 250 psi is obtained. Newly placed polymer concrete that fails (Type C failure) with a strength of less than 500 psi is deemed unacceptable and shall be removed and replaced. Prime and patch test holes with polymer concrete immediately after testing.

When the polymer concrete wearing surface is indicated not to be covered with bituminous surfacing or other surfacing, the polymer concrete in each travel lane shall be uniform, shall have a Skid Number (SN) of not less than 55, and shall conform to Subsection 502.03.16. Test the finished surface of the polymer concrete for the specified SN according to ASTM E274. Grind or groove, parallel to the centerline, any portions of surfaces that do not meet the above requirements according to Subsection 502.03.16 until the finished surface requirements are met.

When the bridge deck and approach slab concrete are indicated to be covered by bituminous surfacing or other surfacing 1 inch or more in thickness, the surface of the concrete shall not vary more than 0.3 inch from the lower edge of a 12-foot straightedge laid in any direction. Remove high areas in the hardened surface according to Subsection 502.03.16. Correct high areas in the plantmix bituminous surface according to Subsection 402.03.05 and 403.03.04 to meet the aforementioned surface tolerances. Perform removal by abrasive means.

After required grinding by abrasive means has been performed, the surface of the concrete shall not be smooth or polished but shall have a satisfactory surface texture. Produce ground areas of uniform texture and of neat and approximately rectangular patterns which extend laterally to the nearest lane line and longitudinally so that the grinding begins and ends at lines normal to the centerline.

**METHOD OF MEASUREMENT**

~~406.04.01 Measurement. Polymer concrete aggregate will be measured by the pound for furnishing the placed polymer concrete aggregate. Mass will be determined by sack count of verified sack masses.~~

~~Polymer concrete resin will be measured by the pound for furnishing the placed polyester styrene resin binder. Mass will be determined by container count of verified container masses.~~

~~The quantities of polymer concrete aggregate and resin shown on the estimate and proposal are based on the nominal thickness shown on the plans with an estimated mixture of 125 pounds of aggregate and 17.5 pounds of resin per cubic foot of completed polymer concrete. The actual pay quantities will be adjusted and based on the approved mix formula and quantities used.~~

~~Materials used in the trial batches or the trial overlays will not be measured for payment.~~

~~Bridge deck preparation and concrete placement will be measured by the square yard for preparing the bridge deck surface, furnishing and placing the prime coat, placing the polymer concrete, and furnishing and placing sand.~~

**BASIS OF PAYMENT**

~~406.05.01 Payment. The accepted quantities, measured as provided above, will be paid for at the contract price per unit of measurement for the pay items listed below that are shown in the proposal. Payment will be full compensation for the work prescribed in this Section.~~

Payment will be made under:

Pay Item	Pay Unit
Bridge Deck Preparation and Concrete Placement .....	Square Yard
Polymer Concrete Aggregate .....	Pound
Polymer Concrete Resin .....	Pound