

SPECIAL SPECIFICATION**4190****Multiple-Layer Polymer Concrete Overlay**

- 1. Description.** Prepare deck surfaces, and furnish and apply multiple-layer polymer concrete overlay on bridge structures.
- 2. Materials.** Provide only new materials that meet all material requirements.
 - A. Aggregate.** Use an angular-shaped aggregate. Use aggregates that are non-friable, non-polishing, clean, kiln-dried to a maximum moisture content of 0.2% by weight, and free of dirt, clay, asphalt, and other organic materials. Furnish aggregates from sources that conform to the requirements shown in Table 1. Supply mechanically crushed gravel or stone aggregates that meet the definitions in Tex-100-E. The Engineer will designate the plant or the quarry as the sampling location. Samples must be from materials produced for the project. The Engineer will perform Los Angeles abrasion and magnesium sulfate soundness tests. Perform all other aggregate quality tests listed in Table 1. Document all test results and provide the results to the Engineer. The Engineer may perform tests on independent or split samples to verify Contractor test results. SAC requirements apply to all aggregates used in all courses. Blending is not allowed. The SAC for sources on the Department's Aggregate Quality Monitoring Program (AQMP) is listed in the BRSQC.
 - B.** All aggregate materials retained in the #8 sieve must have at least ± 2 mechanically fractured faces. Use aggregate that conforms to the gradation specified in Table 1. Determine aggregate gradations based on the washed sieve analysis given in Tex-200-F, Part II.

Table 1
Aggregate Quality Requirements

| Property | | Test Method | Requirement | |
|---|------------------------|------------------------|-------------------------|-------------------------|
| Coarse Aggregate | | | | |
| SAC | | AQMP | A | |
| Deleterious material, %, max | | Tex-217-F, Part I | 1.0 | |
| Decantation, %, max | | Tex-406-A, Part I | 1.0 | |
| Los Angeles abrasion, %, max | | Tex-410-A | 30 | |
| Magnesium sulfate soundness, 5 cycles, %, max | | Tex-411-A | 20 | |
| Coarse aggregate angularity, 2 crushed faces, %, min | | Tex 460-A, Part I | 95 ¹ | |
| 1. Only applies to crushed gravel. | | | | |
| Aggregate Gradation | | | | |
| | Sieve No. 4 | Sieve No. 8 | Sieve No. 16 | Sieve No. 30 |
| % by weight passing sieve | 100% | 30-75% | 0-5% | 0-1% |

- C. Resin (Binder).** Use a 2-component, 100% solid, 100% reactive polymer compound that is free of volatile solvents. Formulate the polymer to volumetric mixing proportions such as 1 part “A” to 1 part “B” according to the manufacturer's recommendations. Establish and submit infrared spectrum for each polymer component at time of testing. The resin (neat) and the polymer overlay system (composite consisting of resin and aggregate) must comply with the property requirements specified in Table 2.

Table 2
Requirements for Resin and Polymer Overlay System

| Property | Requirement* | Test Method |
|--|-------------------------|-------------|
| Viscosity (neat) | 7-70 poises | Tex-614-J |
| Gel time (neat) | 15 min. minimum | Tex-614-J |
| Compressive strength at 5 hr. (composite) | 1,000 psi minimum | Tex-618-J |
| Compressive strength at 48 hr. (composite) | 5,000 psi minimum | Tex-618-J |
| Tensile strength at 7 days (neat) | 1,800-5,000 psi | Tex-618-J |
| Resilience at 48 hr (neat) | 70% minimum | Tex-618-J |
| Elongation at 7 days (neat) | 30-100% | Tex-618-J |
| Permeability to chloride ion at 28 days (neat) | 100 coulombs maximum | ASTM C1202 |
| Shore D hardness (neat) | 60-70 | ASTM D2240 |
| Absorption at 24 hr. (neat) | 1% maximum | ASTM D570 |

| | | |
|---|----------------------------|--|
| Thermal compatibility (composite) | No delamination of overlay | ASTM C 884 with modifications; one cycle is 8 hr. at 60°C followed by 16 hr. at -21°C. Determine results after 9 cycles. |
| *Values are based on composite specimens or neat samples cured or aged and tested at 24°C (75°F). | | |

3. Equipment.

- A. Surface Cleaning Equipment.** Equip all surface preparation equipment with oil traps, and provide compressed air that is free of oil and moisture. Use abrasive blasting equipment that is capable of providing Steel Structures Painting Council SSPC-SP10 (near white metal) finish with a minimum 4 mil. anchor profile.
- B. Tensile Adhesion Test Equipment.** Provide all equipment to perform tensile adhesion test prescribed in ACI 503R-Appendix A. Thoroughly clean the test equipment to avoid contamination of prepared surfaces.
- C. Overlay Application Equipment.** All equipment must be suitable for mixing and placement of the overlay system components determined by the manufacturer of the overlay system. Application equipment must include at least the following automated (mechanical) equipment: a polymer mixer, an aggregate spreader, and a self-propelled sweeper broom or vacuum truck.

The polymer mixer must feature positive displacement volumetric metering pumps that allow for verification of polymer component mix ratios. Polymer components held within the mixer must be stored in temperature-controlled reservoirs capable of maintaining the components at the optimum temperature range determined by the manufacturer of the overlay system. The aggregate spreader must be capable of uniformly applying the aggregate so that 100% of the polymer material placed is covered to excess. The aggregate must be dropped vertically such that the level of the polymer is not unduly disturbed.

Do not apply overlay by hand except in isolated areas of the deck where automated equipment cannot be used unless hand application is approved by the Engineer. Hand application equipment must include at least the following: calibrated containers, a paddle-type mixer, squeegees or rollers, and a broom.

4. Construction.

- A. Contractor Submittals.** Submit to the Engineer the following documentation, and obtain approval before work commences.
 - 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.

2. **Certification of Compliance.** Provide a certificate of compliance from an independent nationally recognized laboratory stating that the materials to be used meet the requirements of this specification. Furnish samples of the materials to be used as required by the Engineer.
 3. **Material Safety Data Sheets.** Provide manufacturer's Material Safety Data Sheets (MSDS) for all materials to be used on site and certification that the materials conform to local, state, and federal environmental and worker's safety laws and regulations.
 4. **Work Plan.** Submit a work plan for constructing the overlay including at least the following: proposed equipment, materials, and procedures for placing the overlay; a sketch showing the deck surface divided into segments that will be covered by each polymer batch and identifying any hand application areas; and an anticipated schedule for traffic control. The work plan must meet the approval of the manufacturer of the polymer overlay system. Any deviations from the application prescribed by this specification must be approved by the Engineer.
 5. **Technical Support Representative.** Submit name and qualifications of manufacturer's representative who will be on the job site at all times from initial surface cleaning until traffic is opened on the overlay surfaces. The manufacturer's representative makes recommendations directly to the Engineer on the acceptability of every phase of the operation, including but not limited to equipment use, surface preparation, interpretation of test results, mixing of overlay components, overlay application, and suitability of finished overlay for opening to traffic.
- B. Handling of Materials.** Transport and store polymer materials in their original containers inside a clean, dry, and temperature-controlled facility that is maintained at a temperature range determined by the manufacturer of the overlay system. Clearly mark containers as "Part A - Contains Resin" or "Part B - Contains Curing Agent," 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. Maintain a copy of the MSDS prominently displayed with the materials at all times. Store aggregates in a clean and moisture-free atmosphere that is protected from all potential sources of contamination.
- C. Surface Cleaning.** Clean the entire steel deck surface using approved blasting equipment to provide a Steel Structures Painting Council SSPC-SP10 (near white metal) finish with a minimum 4 mil. anchor profile and remove any potentially detrimental materials that, in the opinion of the overlay system manufacturer's representative or the Engineer, would prevent proper bonding to or curing of the overlay material. Use approved hand-held equipment only in areas that shot-blasting equipment cannot reach. Conduct all hand-held cleaning operations before shot-blasting whenever possible and practical.

Cleaning operations are inspected and accepted before placing any course of the overlay. Remove any contamination of the deck or intermediate courses after initial cleaning. Apply the first course of the overlay immediately after cleaning, and place all courses of the overlay within 7 days of cleaning. Apply each course with minimal

handling to keep air out of the final epoxy mixture. Significant air bubbles can cause the epoxy to be too permeable and allow moisture intrusion onto the steel deck resulting in detrimental corrosion.

Do not allow traffic (construction or otherwise) onto any portion of the deck that has been shot-blasted, or onto any area where all coats have not been placed and allowed to fully cure.

- D. Tensile Adhesion Testing.** Conduct tensile adhesion tests in accordance with the test method prescribed in ACI 503R, Appendix A to determine the cleaning practice (size of shot, flow of shot, forward speed of shot-blast machine, and number of passes) necessary to provide an acceptable surface for overlay application.

One tensile adhesion test result is the average of 3 pull-off tests conducted over a 1-ft. by 3-ft test site prepared with at least 2 layers of polymer overlay. Install test site overlays with the same materials, equipment, personnel, timing, sequence of operations, and curing period before opening to traffic that will be used for the installation of the final overlay. Surfaces with tension adhesion test results demonstrating average tensile bond strengths of at least 250 lbs. per sq. in. are considered acceptable for overlay application.

Conduct 1 tensile adhesion test for each span or each 200 sq. yd. representative area of deck surface, whichever is smaller. Test site locations are determined by the Engineer for each representative area of deck. The cleaning practice, materials, and installation procedure are approved if one passing tensile adhesion test result (from 3 pull-off tests) is obtained for each representative area. The Contractor must remove test overlays, make necessary adjustments to the surfaces, re-overlay, and retest all failed representative test areas at no additional cost to the Department until satisfactory test results are obtained from all representative areas before final overlay application.

In addition to representative area tests, the Department may require additional tensile adhesion tests be performed on areas inaccessible to shot-blasting equipment or automated application equipment.

- E. Application of Polymer Overlay.** Remove all loose aggregate, and attain approval from the Engineer before placement of each polymer overlay course. Do not place polymer overlay materials when weather or surface conditions prevent the material from being properly handled, placed, and cured in accordance with the overlay system manufacturer's written recommendations and within the specified requirements of traffic control. Do not apply polymer overlay if the ambient air temperature is expected to drop below the overlay system manufacturer's recommended application temperature range within 8 hr. after application or if the gel time is expected to drop below 10 min.. All polymer and aggregate components must have a minimum material temperature determined by the overlay system manufacturer at time of application and must remain within the temperature range recommended by the overlay system manufacturer throughout the entire application.

After the polymer mixture has been prepared for the polymer overlay, apply it immediately and uniformly to the bridge deck surface using approved polymer distribution equipment. Do not exceed the pot life of overlay materials. Apply the dry

aggregate using approved aggregate spreader at rate recommended by the overlay system manufacturer to achieve complete coverage while the polymer is still tacky.

Cure each course of overlay until vacuuming or sweeping can be conducted without tearing or otherwise damaging the overlay surface. No equipment or traffic of any kind is allowed on any overlay surface course until it has fully cured. Overlay application equipment only is allowed to drive on fully cured intermediate courses during the overlay application if planking or similar precautions ensure that the deck surface is not contaminated or otherwise damaged.

Repair any intermediate courses in which the treated surface is damaged, contaminated, or does not receive adequate aggregate before gelling to create an intermediate surface compatible with the next overlay course as determined by the overlay system manufacturer at no additional cost to the Department. If the final polymer overlay surface is damaged or marred, repair damaged areas in accordance with the overlay system manufacturer's recommendations at no additional cost to the Department.

The minimum finished overlay thickness is 1/4 in. measured from the highest point on the deck surface to the top surface of the polymer (not the peaks of the aggregate). Apply the polymer with aggregates in multiple courses (minimum of two) as prescribed by the overlay system manufacturer but at rates no less than specified in Table 3. Stagger and overlap longitudinal joints between successive courses so that no ridges form.

**Table 3
Polymer and Aggregate Application Rates**

| Course | Polymer (Gal./100 Sq. Ft) | Aggregate (Lb./Sq. Yd.) |
|--------|------------------------------|----------------------------|
| 1 | Not less than 2.5 | > 10 |
| 2 | Not less than 5.0 | > 14 |

Protect all bridge deck expansion joints from intrusion of polymer overlay materials. Within 12 hr. of application and before opening the overlay surface to traffic, remove overlay over all expansion joints. Removal may be accomplished by scoring the overlay before gelling, by saw cutting after curing, or by other method approved by the overlay system manufacturer.

Do not open the final course to traffic without the approval of the Engineer. Do not allow construction traffic on the final course until it has cured sufficiently to prevent damage by wheel loads. Minimum curing periods are specified in Table 4 (Temperatures listed are those of material components at time overlay is applied).

**Table 4
Minimum Curing Times for Overlay Courses**

| Course | 60-64°F | 65-69°F | 70-74°F | 75-79°F | 80-84°F | 85-89°F |
|--|---------|---------|---------|---------|---------|---------|
| 1 | 4 hr. | 3 hr. | 2.5 hr. | 2 hr. | 1.5 hr. | 1 hr. |
| 2* | 6.5 hr. | 5 hr. | 4 hr. | 3 hr. | 3 hr. | 3 hr. |
| * Cure Course 2 for 8 hr. if the air temperature falls below 60°F during curing. | | | | | | |

For each batch of polymer overlay mixture applied, maintain and provide to the Engineer records including but not limited to the following:

- Batch numbers and sizes,
- Location of batches as placed on deck, referenced by station,
- Batch time,
- Gel time (2 oz. sample),
- Temperature of the air, deck surface, mixed polymer components, and aggregates,
- Loose aggregate removal time, and
- Time opened to traffic (if applicable).

F. Performance Requirements. Meet the performance requirements in Table 5.

**Table 5
Performance Characteristic Requirements**

| Property | Requirement* |
|--|--------------|
| Adhesive strength | 250 psi. |
| Skid resistance (SN50S, average) | 25 minimum |
| Delamination | 2% maximum |
| Raveling/weathering | 5% maximum |
| * These requirements are derived from industry performance standards and not from any safety requirements. | |

G. Performance Evaluation Procedures. The Department conducts performance evaluations for each lane width, 0.1-mile segment of multiple-layer polymer concrete overlay applied in the contract. The Contractor may be present during these evaluations.

1. **Adhesive Strength.** The Department may direct the Contractor to perform tensile adhesion tests in accordance with ACI 503R-Appendix A using equipment provided by the Contractor to evaluate the bond between the multiple-layer polymer concrete overlay and the concrete surface of the existing deck. Initial performance tests and all subsequent tests resulting in a failure to meet performance characteristic requirements are provided at no additional expense to the Department.
2. **Skid Resistance.** The Department evaluates each segment for skid resistance in accordance with ASTM E274, SN05S [50 mph], unless shorter segments are needed to address site-specific conditions.
3. **Delamination.** The Department visually evaluates each segment for areas where the multiple-layer polymer concrete overlay has debonded from the underlying concrete surface, and determines the percentage of debonded surface based on the area of the segment.
4. **Raveling/Weathering.** The Department visually evaluates each segment for areas where the multiple-layer polymer concrete overlay has worn away from the underlying concrete surface due to either dislodging of aggregates (raveling) or loss

of resin (weathering), and determines the percentage of raveled or weathered surface based on the area of the segment.

- H. Initial Performance Requirements.** After construction is complete, the Engineer conducts a visual evaluation. The Engineer may use the visual evaluation as the basis for written acceptance. If required, for portions of multiple-layer polymer concrete overlay that do not appear to meet the performance requirements, the Department will conduct an initial performance evaluation for any performance requirement in question in accordance with Article 4.G, "Performance Evaluation Procedures." For multiple-layer polymer concrete overlay not meeting performance requirements, repair or replace until reevaluation shows that the multiple-layer polymer concrete overlay meets performance requirements.
- I. Written Acceptance.** The Department provides written acceptance after the Contractor meets the initial performance requirements. This written acceptance includes project information and the location, length, and date of acceptance for each accepted segment.
- 5. Measurement.** Multiple-layer polymer concrete overlay will be measured by the square yard of bridge deck surface area, measured in place.
- 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 "Multiple-Layer Polymer Concrete Overlay." This price is full compensation for: surface preparation; presence of overlay system manufacturer's representative at the work site during all planning, phasing and placement activities; furnishing and applying multiple-layer polymer concrete overlay courses; testing; maintaining and providing batch records; adhering to safety precautions; and all materials, labor, tools, equipment, and incidentals.