

**Specification for Type ES
(Epoxy Slurry) Polymer Overlay
for Bridge and Parking Garage Decks**

An ACI Standard

Reported by ACI Committee 548



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Specification for Type ES (Epoxy Slurry) Polymer Overlay for Bridge and Parking Garage Decks

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This Specification covers epoxy slurry (ES) overlay for bridge and parking garage decks. Type ES polymer overlay incorporates low-modulus epoxy-based slurry and selected aggregate to produce a flexible, skid-resistant, and water-resistant overlay. The overlay may be used for both new construction and rehabilitation. The overlay is placed by applying the polymer slurry to the surface and broadcasting aggregate. This Specification includes requirements for chemical components, aggregates, storage and handling, surface preparation, surface profile, mixing, placement, finishing, and quality control.

Keywords: aggregate; bridge decks; epoxy; mortar; overlays; parking garage decks; polymer; premixed; resin; slurry.

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SECTION 1—GENERAL

1.1—Scope

1.1.1 This Specification covers materials and procedures for constructing a polymer overlay for new construction and for repair and rehabilitation of bridge and parking garage decks. Type ES polymer overlay incorporates a low-modulus epoxy binder, filler, and selected aggregate to produce a flexible, skid-resistant, and water-resistant overlay. This Specification includes requirements for chemical components, aggregates, storage and handling, surface preparation, surface profile, mixing, placement, finishing, and quality control.

1.1.2 The provisions of this Specification shall govern unless otherwise specified in the Contract Documents.

1.1.3 Units—Values are stated in SI units.

1.2—Reference standards

1.2.1 *ASTM International standards*

C566-97(2004)	Test Method for Total Evaporable Moisture Content of Aggregate by Drying
C579-01(2006)	Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing, and Polymer Concretes
C778-06	Specification for Standard Sand
C881/C881M-02	Specification for Epoxy-Resin-Base Bonding Systems for Concrete
C884/C884M-98(2005)	Test Method for Thermal Compatibility between Concrete and an Epoxy-Resin Overlay
C1583-04	Test Method for Tensile Strength of Concrete Surfaces and the Bond Strength or Tensile Strength of Concrete Repair and Overlay Materials by Direct Tension (Pull-off Method)
D638-03	Test Method for Tensile Properties of Plastics
D2393-86	Standard Test Method for Viscosity of Epoxy Resins and Related Components*
D3278-96(2004) ^{e1}	Test Methods for Flash Point of Liquids by Small Scale Closed-Cup Apparatus
D4263-83(2005)	Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method

1.2.2 *SSPC standards*

SSPC-SP 10/NACE No. 2 Near White Metal Blasting

1.3—Reference organizations

Abbreviations for and complete names and addresses of organizations issuing documents referred to in this Specification are listed:

ASTM International
100 Barr Harbor Drive
West Conshohocken, PA 19428
www.astm.org

The Society for Protective Coatings (SSPC)
40 24th Street, 6th Floor
Pittsburgh, PA 15222-4656
www.sspc.org

1.4—Submittals

1.4.1 Submit a certificate of compliance and quality control test results, verifying conformance to material specifications in Section 2 for each manufactured batch of epoxy and lot of aggregate. A lot or batch is a quantity of material manufactured at one time and placed into containers.

1.4.2 Submit materials and product data sufficient for the Architect/Engineer to evaluate the system including all installation instructions and quality control procedures required to ensure an acceptable finished overlay.

1.5—Project conditions

1.5.1 Cold weather limits—Do not place overlay when the temperature of the deck or applicable surface and polymer materials is below 15 °C unless otherwise recommended by the material manufacturer and accepted by the Architect/Engineer.

1.5.2 Hot weather limits—Do not place overlay if the 70 mL job-site production samples have gel times less than 10 minutes or if the broadcast aggregate will not penetrate the epoxy layer.

1.5.3 Moisture limits—Do not place the overlay on surfaces unless they are moisture-free when tested in accordance with ASTM D4263.

1.6—Labeling, storage, and handling of materials

1.6.1 *Labeling*

Mark product containers with the following information:

- Name of manufacturer;
- Manufacturer's product identification;
- Material quantity;
- Manufacturer's mixing instructions;
- Warning for storage and handling; and
- Hazard information.

1.6.2 Storage—Store epoxy resins and hardeners in an area that prevents them from getting wet. Store them away from open flames and other sources of ignition. Store epoxy resins and hardeners at temperatures between 15 and 45 °C unless otherwise recommended by the material manufacturer. Store aggregates in an area that prevents them from getting wet.

1.7—Safety

Heed all warnings on Material Safety Data Sheets and manufacturer's labels.

SECTION 2—PRODUCTS

2.1—Epoxy binder

Multi-component epoxy shall meet the requirements listed in **Tables 2.1** and **2.2**. All components used for physical testing shall be maintained at 23.0 ± 1.0 °C for a minimum of 24 hours before mixing, curing, or testing. Do not use epoxy systems containing solvents and unreactive diluents.

*This document has been withdrawn.

Table 2.1—Properties of mixed, uncured epoxy binder

Property	Value	Test method
Viscosity	700 to 2500 mPa·s	ASTM D2393 (No. 3 at 20 rpm, Brookfield RVT)
Gel time at 23 °C	15 to 45 minutes	ASTM C881/C881M (modified 70 mL)
Flash point	>93 °C	ASTM D3278

Table 2.2—Physical properties of cured epoxy binder

Property	Value	Test method
Tensile strength	12 to 34 MPa	ASTM D638 (Type I)
Tensile elongation	30 to 70%	ASTM D638 (Type I)
Modulus of elasticity, maximum	90 MPa	ASTM D638 (Type I)

Table 2.3—Deck aggregate gradation

Broadcast bridge deck aggregate gradation	
Mesh size	Percent passing
4.75 mm	100
2.36 mm	30 to 75
1.18 mm	0 to 5
600 µm	0 to 1
Broadcast parking deck aggregate gradation	
Mesh size	Percent passing
2.36 mm	100
1.18 mm	51 to 75
850 µm	14 to 50
600 µm	0 to 25
425 µm	0 to 2

Table 2.4—Properties of Type ES polymer overlay

Property	Value	Test method
Compressive strength*	>7 MPa (3 hours) >34 MPa (24 hours)	ASTM C579, Method B
Thermal compatibility*	Pass	ASTM C884/C884M, Method B
Bond strength, minimum	1.7 MPa	ASTM C1583

*Samples should be made using 2.75 volume parts 20-30 sand per ASTM C778, 850 to 600 µm sieve to one volume part of mixed epoxy.

2.2—Aggregate

Aggregate shall meet the gradation requirements in Table 2.3 and have a hardness of six or higher on the Mohs hardness scale. Aggregate shall be angular and consist of natural silica sand, basalt, or other nonfriable aggregate and shall contain less than 0.2% moisture when tested in accordance with ASTM C566.

2.3—Polymer overlay slurry

Type ES polymer overlay slurry shall meet the requirements of Table 2.4.

SECTION 3—EXECUTION

3.1—Procedure qualification

3.1.1 Equipment—Remove deteriorated concrete, grease, dirt, oil, and other contaminants that inhibit bond of the overlay with blasters using steel shot or grit abrasives.

3.1.2 Quality-control procedure qualification—Specify a surface preparation technique (size, flow of abrasive, forward speed, number of passes of the blasting machine) that shall expose coarse aggregate and ensure adhesion of the overlay to the substrate. Remove all loose material to result in a dust-free surface before application. Use this quality-control procedure (Sections 3.1.2.1 through 3.1.2.6) to determine that the materials, batching, mixing, placing, and curing procedures provide the required adhesion of the overlay to the substrate.

3.1.2.1 Test locations will be designated for quality-control tests to evaluate the range of surface conditions on the area to be overlaid, including areas with deck repairs, if any. The Architect/Engineer shall designate one test location to be evaluated for each span or 400 m², whichever is smaller, for bridges, and 400 m² for parking decks.

3.1.2.2 At each test location selected by the Architect/Engineer, prepare a minimum surface area of 0.4 m² using the equipment and procedures proposed for project surface preparation.

3.1.2.3 Prepare the surface and apply the overlay to designated quality-control test locations.

3.1.2.4 Apply overlays at quality-control test locations at the same thickness and with the same materials, equipment, personnel, timing, sequence of operations, and curing period that will be used on the project.

3.1.2.5 Evaluate the test overlays using the procedure described in ASTM C1583, except that the tensile adhesion evaluation shall not be performed at surface temperatures above 27 °C. Core through the test overlay to a depth of 10 ± 3 mm into the underlying concrete slab. An evaluation shall be an average of three tests at each location within the quality-control test location and have an average minimum pulloff strength of 1.7 MPa.

3.1.2.6 If the test results do not meet the required 1.7 MPa average pulloff strength, check the surface preparation procedures and repeat the tests. If the test results still do not meet the required 1.7 MPa average pulloff strength, check the manufacturer's batching, mixing, placing, and curing requirements, and repeat the test until the required pulloff strength is achieved.

3.1.3 Quality control of surface preparation—Surfaces prepared for overlay application shall have the same surface profile as accepted test areas in Section 3.1.2.

3.2—Surface preparation

3.2.1 Concrete decks—Prepare the overlay area using the approved surface preparation until the specified substrate conditions have been achieved.

3.2.2 Steel decks—Prepare steel surfaces according to SSPC-SP 10/NACE No. 2, resulting in minimum surface profiles of 0.1 mm. If flash rust appears, reblast the surface to SSPC-SP 10/NACE No. 2 specifications.

3.2.3 Blasted surface shall be free of dust and other loose material that can interfere with the bonding of the overlay.

3.2.4 If the Architect/Engineer determines that there has been a deviation from the accepted surface preparation procedure, prepare the suspect areas using the accepted method or verify surface preparation in suspect areas using ASTM C1583 procedure.

3.2.5 Obtain inspection and acceptance by the Architect/Engineer of patching and surface preparation before placement of the overlay.

3.3—Mixing epoxy binder

3.3.1 Mix the epoxy binder according to the manufacturer's instructions.

3.3.2 When continuous mixing is specified, use equipment that continually meters, mixes, and dispenses the epoxy binder.

3.3.3 Thoroughly blend the epoxy components with a mechanical mixer to a uniform, homogeneous mixture. Add aggregate and mix in a small plaster or mortar mixer. Use equipment with an adequate mixing capacity to allow placement and finishing operations to proceed continuously and be completed before the overlay becomes tack-free at the area of the next placement.

3.4—Overlay application

The overlay application consists of two distinct steps: 1) epoxy slurry placement; and 2) aggregate broadcasting. Priming may be required by the epoxy manufacturer before the placement of the slurry.

3.4.1 Do not place polymer overlay on hydraulic cement concrete less than 28 days of age unless specified otherwise. Polymer overlay shall not be placed on magnesium phosphate cement concrete.

3.4.2 Polymer overlays shall not be placed over crack repair materials that will affect the bonding or curing of the overlay.

3.4.3 No visible moisture shall be present on the surface of the concrete at the time of polymer overlay application. Use a plastic sheet left taped in place according to ASTM D4263 (modified to a minimum of 2 hours) to identify moisture in the overlay area.

3.4.4 *Priming*—Mix the epoxy components according to the manufacturer's instructions. Use squeegees or paint rollers to apply the binder to achieve a uniform coverage per the manufacturer's recommendations.

3.4.5 *Epoxy slurry placement*—Time between priming and overlay placement shall be per manufacturer's recommendations. Use a self- or hand-advanced vibrating screed or gauge rakes to apply the overlay. Adjust the screed to the desired depth of the overlay. Apply epoxy slurry at a minimum thickness of 6 mm or to the thickness as shown on the plans.

3.4.6 *Aggregate broadcasting*—Immediately after placement of the epoxy slurry and while the epoxy is still fluid, broadcast aggregate onto the surface until a dry layer of aggregate is present over the entire surface.

3.5—Curing

3.5.1 If a nonadhering plastic cover is placed over the wet polymer overlay during curing to protect it from adverse

weather conditions, remove the plastic cover after the surface is tack-free.

3.6—Excess aggregate removal

Remove all excess aggregate from the surface after the overlay has cured.

3.7—Joints

Maintain expansion joints in the concrete surface to be overlaid during the overlay application. When a joint must be sawcut into the overlay, perform the cut as soon as the overlay can support the sawing equipment without damaging the overlay. Sawcut joints within 12 hours of overlay placement.

3.8—Open to traffic

Do not open to traffic until the finished overlay is hard enough to not permanently deform under traffic.

NOTES TO SPECIFIER

General notes

G1. ACI Specification 548.9M is intended to be used by reference or incorporation in its entirety in the Project Specification. Do not copy individual Parts, Sections, Articles, or Paragraphs into the Project Specification, because taking them out of context may change their meaning.

G2. If Sections or Parts of ACI Specification 548.9M are copied into the Project Specification or any other document, do not refer to them as an ACI specification, because the specification has been altered.

G3. A statement such as the following will serve to make ACI Specification 548.9M a part of the Project Specification: "Work on (Project Title) shall conform to all requirements of ACI 548.9M published by the American Concrete Institute, Farmington Hills, Michigan, except as modified by these Contract Documents."

G4. Each technical Section of ACI Specification 548.9M is written in the three-part Section format of the Construction Specifications Institute, as adapted for ACI requirements. The language is imperative and terse.

G5. The Specification is written to the Contractor. When a provision of this Specification requires action by Contractor, the verb "shall" is used. If Contractor is allowed to exercise an option when limited alternatives are available, the phrasing "either...or..." is used. Statements provided in the Specification as information to Contractor use the verbs "may" or "will." Informational statements typically identify activities or options that "will be taken" or "may be taken" by Owner or Architect/Engineer.

FOREWORD TO CHECKLISTS

F1. This Foreword is included for explanatory purposes only; it does not form a part of ACI Specification 548.9M.

F2. ACI Specification 548.9M may be referenced by the Specifier in the Project Specification for any building project, together with supplementary requirements for the specific project. Responsibilities for project participants must be defined in the Project Specification. ACI Specification 548.9M cannot and does not address responsibilities for any project participant other than the Contractor.

F3. Checklists do not form a part of ACI Specification 548.9M. Checklists assist the Specifier in selecting and specifying project requirements in the Project Specification.

F4. The Mandatory Requirements Checklist indicates work requirements regarding specific qualities, procedures, materials, and performance criteria that are not defined in ACI Specification 548.9M.

F5. The Submittals Checklist identifies Specifier choices for information or data to be provided by the Contractor before, during, or after construction.

F6. Recommended references—Documents and publications that are referenced in the Checklists of ACI Specification 548.9M are listed. These references provide guidance to the

specifier and are not considered to be part of ACI Specification 548.9M.

ICRI Standards

Guideline No. 03732, “Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays”

International Concrete Repair Institute (ICRI)
3166 South River Road
Suite 132
Des Plaines, IL 60018
www.icri.org

MANDATORY REQUIREMENTS CHECKLIST

Section/Part/Article	Notes to Architect/Engineer
1.1	Specify scope of the planned overlay.
1.2	Review applicability of cited references.
1.4	Submit certificate of compliance, quality control test results, and material samples.
3.1.3	Form comparison of concrete surface textures, use ICRI Guideline No. 03732; for steel surfaces, use SSPC-SP 10/NACE No. 2.

SUBMITTALS CHECKLIST

Section/Part/Article	Notes to Architect/Engineer
1.4.1	Certificate of compliance
1.4.2	Materials and product data
1.7	Material Safety Data Sheets



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The committees, as well as ACI as a whole, operate under a consensus format, which assures all participants the right to have their views considered. Committee activities include the development of building codes and specifications; analysis of research and development results; presentation of construction and repair techniques; and education.

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Members are encouraged to participate in committee activities that relate to their specific areas of interest. For more information, contact ACI.

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