

An ACI Standard

# Specification for Type EM (Epoxy Multi-Layer) Polymer Overlay for Bridge and Parking Garage Decks

Reported by ACI Committee 548

ACI 548.8-19



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## **Specification for Type EM (Epoxy Multi-Layer) Polymer Overlay for Bridge and Parking Garage Decks**

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# Specification for Type EM (Epoxy Multi-Layer) Polymer Overlay for Bridge and Parking Garage Decks

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Reported by ACI Committee 548

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*This Specification covers epoxy multi-layer (EM) polymer overlay for bridge and parking garage decks. Type EM polymer overlay incorporates a low-modulus epoxy binder and selected aggregate to produce a flexible, skid-resistant, and low-permeability overlay. The overlay may be used for both new construction and rehabilitation of existing structures. The overlay is placed by applying the neat epoxy binder to the surface and broadcasting aggregate. This Specification includes the requirements for epoxy resin, aggregates, storage and handling, surface preparation, surface profile, mixing, placement, quality control and quality assurance.*

**Keywords:** bridge decks; epoxy; multi-layer; parking garage decks; polymer overlay; surface preparation; low permeability.

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**MANDATORY REQUIREMENTS CHECKLIST, p. 7****SUBMITTAL CHECKLIST, p. 7****SECTION 1—GENERAL****1.1—Scope**

**1.1.1** This Specification covers materials and procedures for constructing a multi-layer, low-permeability epoxy polymer (Type EM) overlay for new construction and rehabilitation of bridge and parking garage decks, using mechanical, semi-automated, and fully-automated methods. Type EM polymer overlay incorporates a low-modulus, epoxy binder and selected aggregate to produce a flexible, skid-resistant, and low-permeability overlay. This Specification includes requirements for epoxy resin components, aggregates, storage and handling, surface preparation, surface profile, mixing, placement, quality control, and quality assurance.

**1.1.2** This Specification supplements the contract documents and provides requirements for the contractor.

**1.1.3** This Specification governs for construction within its scope, except the contract documents govern if there is a conflict.

**1.1.4** This Specification governs if there is a conflict with its referenced standards.

**1.1.5** The Contractor is permitted to submit written alternatives to any provisions in the Specification.

**1.1.6** Do not use this Specification in conjunction with ACI 301 or ACI 350.5.

**1.1.7** Ignore provisions of the Specification that are not applicable to the Work.

**1.1.8** Values in this Specification are stated in inch-pound units. A companion specification in SI units is also available.

**1.1.9** The Notes to the Specifier are not part of this Specification.

**1.2—Interpretation**

**1.2.1** Unless otherwise explicitly stated, this Specification shall be interpreted using the following principles:

**1.2.1.1** Interpret this Specification consistent with the plain meaning of the words and terms used.

**1.2.1.2** Definitions provided in this Specification govern over the definitions of the same or similar words or terms found elsewhere.

**1.2.1.3** Whenever possible, interpret this Specification so that its provisions are in harmony and do not conflict.

**1.2.1.4** Headings are part of this Specification and are intended to identify the scope of the provision or sections that follow. If there is a difference in meaning or implication between the text of a provision and a heading, the meaning of the text governs.

**1.2.1.5** Where a provision of this Specification involves two or more items, conditions, requirements, or events

connected by the conjunctions “and” or “or,” interpret the conjunction as follows:

“and” indicates that all of the connected items, conditions, requirements, or events apply

“or” indicates that the connected items, conditions, requirements, or events apply singularly

**1.2.1.6** The use of the verbs “may” or “will” indicates that the Specification provision is for information to the contractor.

**1.2.1.7** The phrase “unless otherwise specified” means the specifier included an alternative to the default requirements in Contract Documents.

**1.2.1.8** The phrase “if specified” means the specifier may have included a requirement in Contract Documents for which there is no default requirements in this Specification.

**1.3—Definitions**

**broadcast**—to scatter over a wide area by hand or mechanical method.

**cure time**—time interval after mixing in which a polymer concrete system develops the required strength.

**fully automated**—metering, mixing of epoxy resin components with pumps and static mixing equipment and application of epoxy resin without the use of squeegees and broadcasting of aggregate

**gel time**—time interval after mixing that a liquid material exhibits a significant viscosity increase.

**mechanical**—mixing of epoxy resin components with drills and mixing paddles and spreading with squeegees and broadcasting of aggregate.

**semi-automated**—metering, mixing of epoxy resin components with pumps and static mixing equipment, and spreading of the epoxy resin with squeegees and broadcasting of aggregate.

**1.4—Reference standards****1.4.1 AASHTO Standards**

AASHTO T 277-15—Standard Method of Test for Electrical Indication of Concrete’s Ability to Resist Chloride Ion Penetration

**1.4.2 ASTM Standards**

ASTM C566-13—Standard Test Method for Total Evaporable Moisture Content of Aggregate by Drying

ASTM C579-01(2012)—Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing, and Polymer Concretes

ASTM C778-13—Standard Specification for Standard Sand

ASTM C881/C881M-15—Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete

ASTM C884/C884M-98(2010)—Standard Test Method for Thermal Compatibility between Concrete and an Epoxy Resin Overlay

ASTM C1202-12—Standard Test Method for Electrical Indication of Concrete’s Ability to Resist Chloride Ion Penetration

ASTM C1583/C1583M-13—Standard 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)

ASTM D638-14—Standard Test Method for Tensile Properties of Plastics

ASTM D3278-96(2011)—Standard Test Methods for Flash Point of Liquids by Small Scale Closed-Cup Apparatus

ASTM D4263-83(2012)—Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method

#### 1.4.3 SSPC standards

SSPC-SP 10/NACE No. 2—Near White Blast Cleaning

### 1.5—Submittals

**1.5.1** Submit a certificate of compliance and quality control test results verifying conformance to material specifications for each manufactured batch of epoxy resin components and aggregate lot. A lot or batch is a quantity of material manufactured at one time and placed into containers.

**1.5.2** Submit material manufacturer technical data sheet and product data sufficient for to the Architect/Engineer to evaluate the system, including in addition to all installation instructions and quality control procedures.

**1.5.3** Submit manufacturer material safety data sheets (SDS).

**1.5.4** Submit technical data sheet on patching material for Architect/Engineer to determine if it is compatible with the overlay.

### 1.6—Project conditions

**1.6.1 Cold weather limits**—Do not place overlay when the temperature of the existing substrate and polymer materials is below 50°F unless otherwise recommended by the material manufacturer and accepted by the Architect/Engineer.

**1.6.2 Hot weather limits**—Do not place overlay if 1 in.<sup>3</sup> job-site production samples have gel times of less than 10 minutes or if the broadcast aggregate does not penetrate the epoxy layer.

**1.6.3 Moisture limits**—Do not place overlay on surfaces unless they are moisture free when tested in accordance with **ASTM D4263** or per manufacturer recommendations.

### 1.7—Labeling, storage, and handling of materials

**1.7.1 Labeling**—Mark product containers with the following information:

- a. Name of manufacturer
- b. Manufacturer's product identification
- c. Material quantity
- d. Manufacturer's mixing instructions
- e. Warning for storage and handling
- f. Hazard information

**1.7.2 Storage**—Store epoxy resins, hardeners, and aggregate in an area that prevents them from getting wet. Store away from open flames and other sources of ignition. Store epoxy resins, hardeners, and aggregate at temperatures between 50 and 120°F unless otherwise recommended by the material manufacturer.

### 1.8—Quality assurance and quality control acceptance of work

Assure that the surface preparation, mixing, application, and curing of the overlay meet the specification requirements.

## SECTION 2—PRODUCTS

### 2.1—Epoxy binder

Multi-component epoxy binder shall meet the requirements listed in Tables 2.1a and 2.1b. All components used for physical testing shall be maintained at 73°F (±1°F) for a minimum of 24 hours before mixing, curing, or testing. Do not use epoxy systems containing solvents and unreactive diluents.

**Table 2.1a—Properties of mixed, uncured epoxy binder (material conditioned at 73°F [±1°F] and 50 percent [±5 percent] relative humidity)**

Property	Value	Test method
Viscosity	700 to 2500 cps	ASTM D2556 (No. 3 at 20 rpm, Brookfield RVT)
Gel time	15 to 45 minutes	ASTM C881/C881M (modified 70 mL)
Flash point	>199°F	ASTM D3278

**Table 2.1b—Mechanical properties of cured epoxy binder at 7 days (material and curing conditions at 73°F [±1°F] and 50 percent [±5 percent] relative humidity)**

Property	Value	Test method
Tensile strength	2 to 5 ksi	ASTM D638 Type 1
Tensile elongation	30 to 70 percent	ASTM D638 Type 1

### 2.2—Aggregate

Aggregate shall meet the gradation requirements in Table 2.2 and have hardness of 6 or higher on the Mohs hardness scale. Aggregate shall be angular, and consist of natural silica sand, basalt, bauxite, or other nonfriable aggregate, and shall contain less than 0.2 percent moisture when tested in accordance with **ASTM C566**.



**Table 2.2—Deck aggregate gradation**

Broadcast bridge deck aggregate gradation	
Mesh size	Percent passing
No. 4	100
No. 8	30 to 75
No. 16	0 to 5
No. 30	0 to 1
Broadcast parking deck aggregate gradation	
Mesh size	Percent passing
No. 8	100
No. 16	51 to 75
No. 20	14 to 50
No. 30	0 to 25
No. 40	0 to 2

**Table 2.3—Properties of Type EM polymer overlay (at 73°F [±1°F] and 50 percent [±5 percent] relative humidity)**

Property	Value	Test method
Compressive strength*	>1 ksi (3 hours) >5 ksi (24 hours)	ASTM C579, Method B
Thermal compatibility*	Pass	ASTM C884/C884M, Method B
Bond strength concrete†	250 psi	ASTM C1583/C1583M
Rapid chloride permeability test values at 28 days	100 coulombs maximum	ASTM C1202 AASHTO T 277

\*Samples should be made using 2.75 volume parts 20-30 sand per ASTM C778, No. 20 to No. 30 sieve to one volume part of mixed epoxy.

†The bond strength is a field test to determine the adequacy of surface preparation before the epoxy overlay application.

## 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**—Submit a surface preparation technique (size and flow of abrasive, forward speed, and number of passes of the blasting machine) that shall expose coarse aggregate. Remove all loose material to result in a dust-free surface before application. Use this quality control procedure (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 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 478 yd<sup>2</sup>, whichever is smaller for bridges, and 478 yd<sup>2</sup> for parking decks.

**3.1.2.2** At each test location selected by the Architect/Engineer, prepare a minimum surface area of 4 ft<sup>2</sup> using

the equipment and procedures proposed for project surface preparation.

**3.1.2.3** Prepare the surface and apply the overlay at 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, and 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/C1583M**, except that the tensile adhesion evaluation shall not be performed at surface temperatures above 80°F. For concrete surfaces, core drill through the test overlay to a depth of 0.5 in. (±0.125 in.) into the underlying concrete slab. For steel surfaces, core drill through the test overlay to the top of the steel interface. An evaluation shall be an average of three tests at each location within the quality control test location and have an average pull off strength of 250 psi.

**3.1.2.6** If the test results do not meet the required 250 psi average pull-off strength, check the surface preparation procedures, modify, repeat the surface preparation, and repeat the tests. If additional testing does not result in strength of 250 psi minimum, then Architect/Engineer shall make the decision on the placement of the overlay.

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

### 3.2—Surface preparation

**3.2.1 Concrete decks**—Prepare concrete surfaces using the approved surface preparation practice until the specified substrate surface conditions have been achieved. Prepared surface shall meet a minimum **ICRI 310.2R** CSP 5 condition unless otherwise recommended by the manufacturer.

**3.2.2 Steel decks**—Prepare steel surfaces according to SSPC-SP 10/NACE No. 2. Surface preparation shall result in minimum surface profiles of 4 mils unless otherwise specified. If flash rust appears, reblast the surface to **SSPC-SP 10/NACE No. 2**.

**3.2.3** Blasted surfaces shall be free of dust and other loose material that can inhibit bonding of the overlay.

**3.2.4** If the Architect/Engineer determines that the surface preparation is suspect redo with the accepted method.

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

### 3.3—Mixing epoxy binder

**3.3.1** Mix the epoxy components according to the manufacturer's instructions.

**3.3.2 Mechanical mixing**—For each mixed epoxy resin batch, the contractor shall maintain and provide to the Architect/Engineer records including, but not limited to, the following deck location, surface area and time of application.

a. Date and time each sample is poured

b. Deck location of where the sample was placed referenced by location and batch numbers

c. Gel time (70 mL sample) tested per **ASTM C881/C881M**

- d. Temperature of the air, deck surface, mixed polymer components, and aggregates
- e. Time to open to traffic

The contractor must record and maintain these records and provide the records to the Architect/Engineer.

**3.3.3 Semi-automated and fully-automated mixing**—Use equipment that continually meters, mixes, and dispenses the epoxy binder. Prior to commencement with semi-automated or fully-automated metering and mixing equipment and after any stop/start greater than 10 minutes, perform a ratio check of the two components by pouring each component into clear plastic graduated cups to verify that the variance of the ratios is no greater than  $\pm 5$  percent.

- a. Date and time of each application start and stop
- b. Gel time (2.4 fl oz. sample) tested per **ASTM C881/C881M**
- c. Temperature of the air, deck surface, mixed polymer components, and aggregates
- d. Time to open to traffic

### 3.4—Overlay application

The overlay application shall consist of two distinct steps: epoxy binder application and aggregate broadcasting.

**3.4.1** Do not place overlay on hydraulic cement concrete less than 28 days of age unless otherwise specified.

**3.4.2** Do not place overlay on magnesium phosphate cement concrete.

**3.4.3** Do not place overlay over crack repair materials that will affect the bonding or the curing of the overlay.

**3.4.4** No visible moisture shall be present on the prepared substrate surface at the time of 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.

**3.4.5** Apply the first layer of the overlay within 24 hours of surface preparation. If first layer is not applied in 24 hours repeat surface preparation. To avoid contamination, traffic shall not be allowed on the accepted prepared surface until all layers of polymer overlay have been applied.

**3.4.6 Epoxy binder application**—Apply the first layer of the epoxy binder to achieve a uniform coverage rate of 40 ft<sup>2</sup>/gal. minimum. using notched squeegees. For manual resin mixing applications, Contractor shall establish a measured surface grid area and report the gallons used to cover the area. For semi-automated and fully automated mixing applications, the Contractor shall report the binder gallons mixed and the total surface covered every 4 hours.

**3.4.7 Aggregate broadcast**—While the epoxy binder is still fluid, broadcast aggregate onto the surface until a dry layer of aggregate is present over the entire surface. If wet spots develop, immediately broadcast additional aggregate until a dry surface is reestablished.

**3.4.8** After the first layer of the overlay has cured, remove all excess unbonded aggregate.

**3.4.9** Achieve the specified overlay thickness by applying multiple layers of resin binder and aggregate. Repeat the application for subsequent layers with coverage rates of at least 20 ft<sup>2</sup>/gal. of epoxy binder using notched squeegees and broad-

cast aggregate until a dry layer of aggregate is present over the entire surface. The Architect/Engineer will specify the required number of applications and total overlay thickness.

### 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 overlay application. When a joint must be saw-cut into the overlay, perform the cut as soon as the overlay can support the sawing equipment without damaging the overlay. Saw-cut joints within 12 hours of overlay placement.

### 3.8—Open to traffic

Do not open to traffic until vehicle tires will not cause a depression or permanently deform the finished overlay.

## NOTES TO SPECIFIER (nonmandatory)

### General notes

**G1.** ACI Specification 548.8 is to be used by reference or incorporation in its entirety in the Project Specification. Do not copy individual sections, parts, 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 548.8 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 548.8 a part of the Project Specification:

“Work on (Project Title) shall conform to all requirements of ACI 548.8, Specification for Type EM (Epoxy Multi-Layer) Polymer Overlay for Bridge and Parking Garage Decks, published by the American Concrete Institute, Farmington Hills, Michigan, except as modified by these Contract Documents.”

**G4.** Each technical section of ACI Specification 548.8 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.** If ACI Specification 548.8 is used with another ACI specification that contains overlapping provisions, identify which requirements are in conflict and state in Contract Documents which requirements control.

**Foreword to checklists**

**F1.** This Foreword is included for explanatory purposes only; it does not form a part of Specification ACI 548.8.

**F2.** ACI Specification 548.8 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. The ACI Specification cannot and does not address responsibilities for any project participant other than the Contractor.

**F3.** Checklists do not form a part of ACI Specification 548.8. Checklists assist the Specifier in selecting and specifying project requirements in the Project Specification.

**F4.** The Specifier shall make adjustments to the needs of a particular project by reviewing each of the items in the checklists and including the items the Specifier selects as mandatory requirements in the Project Specification.

**F5.** The Mandatory Requirements Checklist indicates work requirements regarding specific qualities, procedures,

materials, and performance criteria that are not defined in ACI Specification 548.8.

**F6.** The Submittal Checklist identifies Specifier choices for information or data to be provided by the Contractor before, during, or after construction.

**F7. Recommended references**—Documents and publications that are referenced in the Checklists of ACI Specification 548.8 are listed. These references provide guidance to the Specifier and are not considered to be part of ACI Specification 548.8.

*International Concrete Repair Institute (ICRI)*

Guideline No. 310.2R-2013, “Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays and concrete repair”

*Society for Protective Coatings (SSPC)*

SSPC-SP 10/NACE No. 2—Near White Blast Cleaning





**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	For comparison of concrete surface textures, use ICRI Guideline No. 310.2R-2013, CSP 5; for steel surfaces, use SSPC-SP 10/NACE No. 2.
3.4.9	Specify number of applications to achieve overlay thickness

**SUBMITTAL CHECKLIST**

Section/Part/Article	Notes to Architect/Engineer
1.5.1	Certificate of compliance
1.5.2	Materials and product data
1.5.3	Materials Safety Data Sheets
1.5.4	Patching material product data







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