

**ACI 548.9-XX**

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

**An ACI Standard**

**Reported by ACI Committee 548**

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5 *This Specification covers epoxy slurry (ES) polymer overlay for bridge and parking garage decks. Type ES*  
6 *polymer overlay incorporates a low-modulus epoxy binder, fillers, and selected aggregate to produce a*  
7 *flexible, skid-resistant, and low-permeability overlay. The overlay may be used for both new construction*  
8 *and rehabilitation of existing structures. The overlay is placed by applying the mixed epoxy binder and*  
9 *filler to the surface and broadcasting aggregate. This Specification includes requirements for epoxy resin,*  
10 *fillers, aggregates, storage and handling, surface preparation, surface profile, mixing, placement, quality*  
11 *control, and quality assurance.*

12 **Keywords:** bridge decks; epoxy; low permeability; parking garage decks; polymer overlay; surface  
13 preparation; slurry.

14

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19 **1.1—Scope**

20 **PART 1—GENERAL**

21 **1.1.1** This specification covers materials and procedures for constructing a low-permeability epoxy

22 polymer slurry (Type ES) overlay at locations designated in Contract Documents pertaining to new

23 construction and rehabilitation of bridge and parking garage decks. Type ES polymer overlay incorporates

24 a low-modulus epoxy binder, fillers, and selected aggregate to produce a flexible, skid-resistant, and low-

25 permeability overlay. This specification includes requirements for epoxy resin components, fillers,

26 aggregates, storage and handling, surface preparation, surface profile, mixing, placement, quality control.

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1 **1.1.2** This Specification is incorporated by Contract Documents and provides requirements for the  
2 Contractor.-

3 **1.1.3** This Specification governs for construction within its scope, except project-specific Contract  
4 Documents govern if there is a conflict.

5 **1.1.4** This Specification governs if there is a conflict with referenced material and testing standards.

6 **1.1.5** The Contractor is permitted to submit written alternatives to any provisions in this Specification for  
7 consideration.

8 **1.1.6** Ignore provisions of the Specification that are not applicable to the Work.

9 **1.1.7** Values in this Specification are stated in inch-pound units. A companion specification in SI units is  
10 also available.

11 **1.1.8** The Notes to the Specifier are not part of this Specification.

## 12 **1.2—Interpretation**

13 **1.2.1** Unless otherwise explicitly stated, this Specification shall be interpreted using the following  
14 principles:

15 **1.2.1.1** Interpret this Specification consistent with the plain meaning of the words and terms used.

16 **1.2.1.2** Definitions provided in this Specification govern over the definitions of the same or similar words  
17 or terms found elsewhere.

18 **1.2.1.3** Whenever possible, interpret this Specification so that its provisions are in harmony and do not  
19 conflict.

20 **1.2.1.4** Headings are part of this Specification and are intended to identify the scope of the provision or  
21 sections that follow. If there is a difference in meaning or implication between the text of a provision and a  
22 heading, the meaning of the text governs.

23 **1.2.1.5** Footnotes are part of this Specification. The meaning of the provision text governs in the event of a  
24 difference in meaning or implication between the provision text and a footnote to that provision.

25 **1.2.1.6** Where a provision of this Specification involves two or more items, conditions, requirements, or  
26 events connected by the conjunctions “and” or “or,” interpret the conjunction as follows:

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

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1 “or” indicates that the connected items, conditions, requirements, or events apply singularly  
2 **1.2.1.7** The use of the verbs “may” or “will” indicates that the Specification provision is for information  
3 to the Contractor.

4 **1.2.1.8** The phrase “as indicated in Contract Documents” means the specifier included the provision  
5 requirements in the Contract Documents.

6 **1.2.1.9** The phrase “unless otherwise specified” means the specifier included an alternative to the default  
7 requirements in Contract Documents.

8 **1.2.1.10** The phrase “if specified” means the specifier may have included a requirement in Contract  
9 Documents for which there is no default requirements in this Specification.

### 10 **1.3—Definitions**

11 The following definitions shall govern in this Specification.

12 **accepted**—determined by the Architect/Engineer to be in compliance with Contract Documents.

13 **Architect/Engineer**—architect, engineer, architectural firm, engineering firm developing Contract  
14 Documents or administering Work under Contract Documents, or both.

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

16 **Contract Documents**—set of documents that form the basis of a contractual between an Owner and  
17 Contractor or design-builder; documents are defined by the contractual agreement, and can contain contract  
18 forms, contract conditions, specifications, drawings, addenda, and contract changes.

19 **Contractor**—person, firm, or entity under contract for construction of Work.

20 **submit**—provide to Architect/Engineer for review.

21 **submittal**—document and material provided to Architect/Engineer for review or acceptance.

22 **gel time**—time interval after mixing that a liquid material exhibits an increase in viscosity as determined  
23 by a specific test method.

24 **mechanical mixing**—mixing of epoxy resin components and fillers with drills and mixing paddles or  
25 mortar mixing equipment.

26 **testing agency**—organization responsible for performing material testing; not responsible for acceptance

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1 of test values.

2 **Work**—the entire construction or separately identifiable parts required to be furnished under Contract  
3 documents.

4 **1.4—Reference standards**

5 **1.4.1 ASTM Standards**

6 ASTM C566-19—Standard Test Method for Total Evaporable Moisture Content of Aggregate by Drying

7 ASTM C579-18—Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars,

8 Grouts, Monolithic Surfacing, and Polymer Concretes

9 ASTM C778-17—Standard Specification for Standard Sand

10 ASTM C881/C881M-20—Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete

11 ASTM C884/C884M-16—Standard Test Method for Thermal Compatibility between Concrete and an  
12 Epoxy Resin Overlay

13

14 ASTM C1583/C1583M-20—Standard Test Method for Tensile Strength of Concrete Surfaces and the Bond  
15 Strength or Tensile Strength of Concrete Repair and Overlay Materials by Direct Tension (Pull-off Method)

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

17 ASTM D2556-14(2018)—Standard Test Method for Apparent Viscosity of Adhesives Having Shear-Rate-  
18 Dependent Flow Properties Using Rotational Viscometer

19 ASTM D3278-20—Standard Test Methods for Flash Point of Liquids by Small Scale Closed- Cup  
20 Apparatus

21 ASTM D4263-83(2018)—Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet  
22 Method

23 **1.4.2 SSPC standards**

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

25 **1.5—Submittals**

26 **1.5.1** Submit a certificate of compliance and quality control test results verifying conformance to material

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1 specifications for each manufactured lot or batch of epoxy resin components, fillers, and aggregate. A lot  
2 or batch is a quantity of material manufactured at one time and placed into containers.

3 **1.5.2** Submit material and product data for the Architect/Engineer to evaluate the system, including all  
4 manufacturer installation instructions and quality control procedures.

5 **1.5.3** Submit manufacturer safety data sheets (SDS).

6  
7 **1.5.4** Submit Quality Control Plan for acceptance before the proposed start of Work. Unless otherwise  
8 specified, include the following information:

9 a) Key Personnel and contact information

10 b) Epoxy binder and filler production plant and plant location

11 c) Aggregate production plant and plant location

12 d) Name of the certified independent testing agency

13 e) All manufacturer certifications and test results

14 f) Description of acceptable environmental conditions for placing overlay

15 g) Cure time and time to open to traffic estimates for overlay as a function of temperature

16 h) Method for determining cure for opening to traffic

17 i) Procedures for storage of materials

18 j) Disposal and recycling of excess overlay materials and empty containers

19 k) Designate a Quality Control Manager with the authority to institute any action necessary for the  
20 successful operation of the Quality Control (QC) Plan; the QC Plan must be approved by Architect/Engineer  
21 prior to placing any overlay.

22 **1.6—Project conditions**

23 **1.6.1 Cold weather limits**—Do not place overlay when the temperature of the existing substrate or polymer  
24 materials is below 50°F unless otherwise recommended by the material manufacturer and accepted by the  
25 Architect/Engineer.

26 **1.6.2 Hot weather limits**—Do not place overlay if 1 in.3 job-site production samples have gel times of less



1 than 10 minutes or if the broadcast aggregate does not penetrate the epoxy slurry.

2 **1.6.3 Moisture limits**—Do not place overlay on surfaces unless they are moisture-free when tested in  
3 accordance with ASTM D4263 or in accordance with manufacturer recommendations.

4 **1.7—Delivery, storage, and handling of materials**

5 **1.7.1 Delivery of materials**—Use only materials delivered in sealed containers with labels legible, intact  
6 and with the following information.

7 a. Name of manufacturer

8 b. Manufacturer’s product identification

9 c. Manufacturer’s mixing instructions

10 d. Warning for-handling and toxicity

11 e.-Expiration date

12 **1.7.2 Storage**—Store epoxy resin, hardener, filler, and aggregate in an area that prevents them from getting  
13 wet. Store epoxy resin components away from open flames and other sources of ignition. Store epoxy resin,  
14 hardener, filler, and aggregate at temperatures between 50 and-100°F unless otherwise recommended by  
15 the material manufacturer.

16 **1.7.3 Handling of materials**—Handle all materials in a way to avoid breaking container seals.

17 **1.8—Safety**

18 Follow all material safety warnings on SDS and manufacturer’s labels.

19 **1.9—Quality assurance**

20 1.9.1 *Quality Control Plan*—Verify Contractor follows Quality Control Plan.

21

22 **2.1—Epoxy binder**

23 **PART 2—PRODUCTS**

24 **2.1.1** Multi-component epoxy binder shall meet the requirements listed in Tables 2.1a and 2.1b. All  
25 components used for physical testing shall be maintained at 73°F (±2°F) for a minimum of 24 hours before  
26 mixing, curing, or testing. Do not use epoxy systems containing solvents and unreactive diluents.

27 **Table 2.1a—Properties of mixed, uncured epoxy binder (material conditioned at 73**

1 ±2°F} and 50 ±5 % relative humidity)

Property	Value	Test method
Viscosity	700 to 2500 cP	ASTM D2556 (No. 3 at 20 rpm, Brookfield RVT)
Gel time	15 to 45 minutes	ASTM C881/C88M (modified 60 mL)
Flash point	>199°F	ASTM D3278

2 **Table 2.1b—Mechanical properties of cured epoxy binder at 7 days (material and curing**  
3 **conditions at 73±2°F and 50 ±5 % relative humidity)**

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

4 **2.2—Fillers**

5 2.2.1 Filler components and gradation will vary from manufacturer to manufacturer and will be specified  
6 by the epoxy slurry manufacturer.

7 **2.3—Aggregate**

8 2.3.1 Aggregate shall meet the gradation requirements in Table 2.2 and have hardness of 6 or higher on the  
9 Mohs hardness scale. Aggregate shall be angular, consist of natural silica sand, basalt, bauxite, or other  
10 nonfriable aggregate, and shall contain less than 0.2 percent moisture when tested in accordance with  
11 ASTM C566.

12 **Table 2.2—Broadcast aggregate gradation**

Bridge deck aggregate gradation	
Sieve size	Percent passing
4.75 mm (No. 4)	100
2.36 mm (No. 8)	30 to 75
1.18 mm (No. 16)	0 to 5
600 µm (No. 30)	0 to 1

13

14

Parking garage deck aggregate gradation	
Sieve size	Percent passing
2.36 mm (No. 8)	100
1.18 mm (No. 16)	51 to 75
850 μm (No. 20)	14 to 50
600 μm (No. 30)	0 to 25
425 μm (No. 40)	0 to 2

1

2 **2.4—Polymer overlay**

3 2.4.1 Type ES polymer overlay shall meet the requirements of Table 2.3. All specimens used for Physical  
4 testing shall be maintained at 73°F (±2°F) for a minimum of 24 hours before testing.

5 **Table 2.3—Properties of Type ES polymer overlay (at 73±2°F and 50±5**  
6 **% relative humidity)**

7

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 to concrete†	250 psi	ASTM C1583/C1583M

12 \*Specimens are made using 2.75 parts by volume 20-30 sand conforming to ASTM C778, to one part by  
13 volume of mixed epoxy.

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

16

17 **PART 3—EXECUTION**

18 **3.1—Procedure qualification**

19 **3.1.1 Equipment**—Remove deteriorated concrete, grease, dirt, oil, and other contaminants that might inhibit  
20 bond of the overlay with blasters using steel shot or grit abrasives.

21 **3.1.2 Procedure qualification**—Submit a surface preparation method (size and flow of abrasive, forward  
22 speed, and number of passes of the blasting machine) that shall expose coarse aggregate. Remove all loose  
23 material to result in a dust-free surface before application. Use this quality control procedure (3.1.2.1  
24 through 3.1.2.6) to determine the materials, batching, mixing, placing, and curing procedures provide the

1 required adhesion of the polymer overlay to the substrate.

2 **3.1.2.1 Prepared surface**—Test locations will be designated for quality control to evaluate the range of  
3 surface conditions on the area to be overlaid, including areas with deck repairs if any. The  
4 Architect/Engineer will designate one test location to be evaluated for each span or 478 yd<sup>2</sup>, whichever is  
5 smaller for bridges, and 478 yd<sup>2</sup> for parking decks.

6 **3.1.2.2** At each test location selected by the Architect/Engineer, prepare a surface area of at least 4 ft<sup>2</sup> using  
7 the equipment and procedures proposed for project surface preparation. The surface profile of the prepared  
8 test area shall be in accordance with 3.2.

9 **3.1.2.3** Prepare the surface and apply the polymer overlay at designated quality control test locations.

10 **3.1.2.4** Apply polymer overlay at quality control test locations at the same thickness and with the same  
11 materials, equipment, personnel, timing, sequence of operations, and curing period that will be used on the  
12 project.

13 **3.1.2.5** Evaluate the test polymer overlay using the procedure described in ASTM C1583/C1583M, except  
14 that the tensile adhesion evaluation shall not be performed at surface temperatures above 80°F. For concrete  
15 surfaces, core drill through the test polymer overlay to a depth of 0.5-±0.1 in. into the underlying concrete  
16 slab. For steel surfaces, core drill through the test polymer overlay to the top of the steel interface. An  
17 evaluation shall be an average of three tests at each location within the quality control test location and have  
18 an average pull off strength of at least 250 psi.

19 **3.1.2.6** If the test results do not meet the required 250 psi minimum average pull-off strength, check the  
20 surface preparation procedures, modify, repeat the surface preparation, and repeat the tests. If additional  
21 testing does not result in an average pull-off strength of at least 250 psi, then the Architect/Engineer will  
22 make the decision on the placement of the polymer overlay.

23 **3.1.3 Quality control of surface preparation**—Surfaces prepared for polymer overlay application shall have  
24 the same surface profile as accepted test areas in 3.1.2.

## 25 **3.2—Surface preparation**

26 **3.2.1 Concrete decks**—Prepare concrete surfaces using the accepted surface preparation practice in 3.1.2  
27 until the specified substrate surface conditions have been achieved. Unless otherwise specified, the prepared  
28 surface shall have a profile equivalent to CSP 5, as defined in ICRI 310.2R, or rougher.

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1 **3.2.2 Steel decks**—Prepare steel surfaces according to SSPC-SP 10/NACE No. 2. Unless otherwise  
2 specified, surface preparation shall result in minimum surface profiles of 4 mils. If rust appears, reblast the  
3 surface according to SSPC-SP 10/NACE No. 2.

4 **3.2.3** Prepared surfaces shall be free of dust and other loose materials that can inhibit bond of the polymer  
5 overlay.

6 **3.2.4** Obtain inspection and acceptance by the Architect/Engineer of surface preparation operations before  
7 placement of the polymer overlay.

### 8 **3.3—Mixing epoxy primer and slurry**

9 **3.3.1** Mix the epoxy primer and epoxy slurry components according to the manufacturer’s instructions.

10 **3.3.2 Mechanical mixing**—For each mixed epoxy primer and slurry batch, the contractor must record,  
11 maintain, and provide to the Architect/Engineer the following records including, but not limited to:

- 12 a. Date and time each batch of epoxy primer and slurry is poured
- 13 b. Deck location of where the batch was placed referenced by locations and batch numbers
- 14 c. Gel time (60 mL sample) tested per ASTM C881/C881M
- 15 d. Temperature of the air, deck surface, mixed epoxy primer and epoxy binder.
- 16 e. Time to open to traffic

### 17 **3.4—Overlay application**

18 Epoxy primer shall be applied if recommended by the manufacturer. The overlay application shall consist  
19 of two distinct steps: epoxy slurry application and aggregate broadcasting.

20 **3.4.1** Do not place polymer overlay on hydraulic cement concrete less than 28 days of age, unless otherwise  
21 specified.

22 **3.4.2** Do not place polymer overlay on magnesium phosphate cement concrete.

23 **3.4.3** Do not place polymer overlay over crack repair materials that will affect the bond or the curing of the  
24 overlay.

25 **3.4.4** No visible moisture shall be present on the prepared substrate surface at the time of overlay  
26 application. Use a plastic sheet taped in place according to ASTM D4263 to indicate presence of moisture  
27 in the overlay area. The sheet needs to remain in place for at least 2 h, rather than 16 h as required by ASTM

1 D4263, before checking for moisture.

2 **3.4.5** Apply the polymer overlay within 24 hours of surface preparation. If polymer overlay is not applied  
3 within 24 hours, repeat surface preparation. Traffic shall not be allowed on the accepted prepared surface  
4 until polymer overlay has been applied.

5 **3.4.6 *Primer application***—Apply the epoxy primer using notched squeegees to a uniform coverage rate of  
6 not more than 40 ft<sup>2</sup>/gal.

7 **3.4.7 *Epoxy slurry application***—Time between priming and epoxy slurry overlay placement shall be before  
8 epoxy primer begins to gel or according to the manufacturer’s recommendation. Use a self-advanced or  
9 hand-advanced vibrating screed or gauge rakes to apply the epoxy slurry. Adjust the screed or gauge rake  
10 to obtain the specified overlay thickness. Unless otherwise specified, epoxy overlay thickness shall be at  
11 least 1/4 in.

12 **3.4.8 *Aggregate broadcast***—While the epoxy slurry is still fluid, broadcast aggregate onto the surface until  
13 a dry layer of aggregate is present over the entire surface. If wet spots develop, immediately broadcast  
14 additional aggregate until a dry surface is reestablished.

### 15 **3.5—Curing**

16 **3.5.1** If a non-adhering plastic cover is placed over the wet polymer overlay during curing to protect it from  
17 adverse weather conditions, remove the plastic cover after the polymer overlay has cured in accordance  
18 with manufacturer’s recommendations.

### 19 **3.6—Excess aggregate removal**

20 3.6.1 Remove all excess aggregate from the surface after the polymer overlay has cured in accordance with  
21 manufacturer’s recommendations.

### 22 **3.7—Joints**

23 **3.7.1** Maintain expansion joints in the concrete surface to be overlaid during polymer overlay application.  
24 If a joint must be saw-cut into the polymer overlay, perform the cut as soon as the polymer overlay can  
25 support the sawing equipment without damaging the polymer overlay. Saw cut joints within 12 hours of  
26 overlay placement.

### 27 **3.8—Open to traffic**

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

1 polymer overlay.

2 **NOTES TO SPECIFIER**

3 **General notes**

4 **G1.** ACI Specification 548.9 is to be used by reference in the Project Specification. Do not copy individual  
5 sections, parts, articles, or paragraphs into the Project Specification because taking them out of context may  
6 change their meaning.

7 **G2.** If sections or parts of ACI Specification 548.9 are copied into the Project Specification or any other  
8 document, do not refer to them as an ACI specification.

9 **G3.** A statement such as the following will serve to make ACI Specification 548.9 a part of the Project  
10 Specification:

11 “Work on (Project Title) shall conform to all requirements of ACI (SPEC-548.9-21, Type ES (Epoxy  
12 Slurry) Polymer Overlay for Bridge and Parking Garage Decks—Specification) published by the American  
13 Concrete Institute, Farmington Hills, Michigan, except as modified by these Contract Documents.”

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

17 **G5.** If ACI Specification 548.9 is referenced in Contract Documents along with another ACI specification  
18 that contains overlapping provisions, identify which requirements are in conflict and state in Contract  
19 Documents which requirements govern.

20 **Foreword to checklists**

21 **F1.** This foreword is included for explanatory purposes only; it is not a part of ACI Specification 548.9.

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

26 **F3.** Checklists do not form a part of ACI Specification 548.9. Checklists assist the specifier in selecting and  
27 specifying project requirements in the Project Specification.

28 **F4.** The Mandatory Requirements Checklist indicates work requirements regarding specific qualities,  
29 procedures, materials, and performance criteria that are not defined in ACI Specification 548.9. The  
30 specifier must include these requirements in the Project Specification.

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1 **F5.** The Optional Requirements Checklist identifies specifier alternatives or additions. The checklist  
 2 identifies the sections, parts, and articles of ACI Specification 548.9 and the action required or available to  
 3 the specifier. The specifier should review each of the items in the checklist and make adjustments to the  
 4 needs of a particular project by including those selected alternatives or additions as mandatory requirements  
 5 in the Project Specification.

6 **F6.** *Cited references*—Documents and publications that are referenced in the checklists of ACI  
 7 Specification 548.9 are listed below. These references provide guidance to the specifier and are not  
 8 considered to be part of ACI Specification 548.9.

9 *International Concrete Repair Institute*

10 ICRI 310.2R-2013—Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and  
 11 Polymer Overlays and Concrete Repair

12  
 13

14 **MANDATORY REQUIREMENTS CHECKLIST**

15

Section/Part/Article	Notes to Architect/Engineer
1.1	Specify scope of the planned overlay.
3.1.2.1 Test locations for surface	Specify test locations to determine surface condition.

16

17 **OPTIONAL CHECKLIST**

18

Section/Part/Article	Notes to Architect/Engineer
1.5.4 Quality control plan	Specify exceptions or additions to list of items in the quality control plan
1.6.1 Minimum application	Specify alternative minimum temperature.

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3.2.1 Prepared concrete	Specify an alternative minimum surface profile to ICRI 310.2R CSP5-condition.
3.2.2 Prepared steel surface	Specify an alternative minimum surface profile.
3.4.1 Hydraulic cement	Specify alternative minimum age of the concrete substrate for overlay application.
3.4.7 Overlay thickness	Specify alternative value of overlay thickness.

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