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Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete[1]

This standard is issued under the fixed designation C881/C881M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope*

1.1 This specification covers two-component, epoxy-resin bonding systems for application to portland-cement concrete, which are able to cure under humid conditions and bond to damp surfaces.

1.2 This specification does not cover epoxy-resin-base bonding systems that have been modified by addition of components such as cement, fine aggregate, or fiber reinforcement. Additional testing may be required to meet applicable specifications for these applications.

1.3 This specification does not address the effects of creep on epoxy-resin-base bonding systems while under load or the potential for creep rupture. Additional testing is required for applications where creep and creep rupture are critical.

1.4 The text of this standard refers to notes and footnotes that provide explanatory material. These notes and footnotes (excluding those in tables and figures) shall not be considered as requirements of this standard.

1.5 *Units*—The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system are not necessarily exact equivalents; therefore, to ensure conformance with the standard, each system shall be used independently of the other, and values from the two systems shall not be combined.

1.6 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.* For specific hazards statements, see Section 9.

1.7 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C882/C882M Test Method for Bond Strength of Epoxy-Resin Systems Used With Concrete By Slant Shear
C884/C884M Test Method for Thermal Compatibility Between Concrete and an Epoxy-Resin Overlay
D570 Test Method for Water Absorption of Plastics
D638 Test Method for Tensile Properties of Plastics

[1] This specification is under the jurisdiction of ASTM Committee C09 on Concrete and Concrete Aggregates and is the direct responsibility of Subcommittee C09.25 on Organic Materials for Bonding.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

***A Summary of Changes section appears at the end of this standard**

D648 Test Method for Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position
D695 Test Method for Compressive Properties of Rigid Plastics
D2556 Test Method for Apparent Viscosity of Adhesives Having Shear-Rate-Dependent Flow Properties Using Rotational Viscometry
D2566 Test Method for Linear Shrinkage of Cured Thermosetting Casting Resins During Cure (Withdrawn 1993)[3]

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *binder, n*—the cementitious part of a grout, mortar, or concrete that binds the aggregate or filler into a cohesive mass.

3.1.2 *bonding system, n*—the product resulting from the combination of all the components supplied for use as a bonding material.

3.1.3 *component, n*—a constituent that is intended to be combined with one or more other constituents to form a bonding system.

3.1.4 *contact strength, n*—bond strength measured by slant shear after a specified contact and cure time.

3.1.5 *contact time, n*—specified time between when the epoxy system is applied and when the two segments are bonded together and still achieve a specified bond strength after a specified curing time and temperature.

3.1.6 *curing agent, n*—a substance that causes the conversion of a fluid resin system to a solid cured resin by means of a chemical reaction.

3.1.7 *epoxy equivalent, n*—the weight of resin containing one molecular weight of epoxy groups.

3.1.8 *epoxy resin, n*—a resin that contains or did contain epoxy groups principally responsible for its polymerization.

3.1.9 *filler, n*—a finely divided solid, predominantly passing the 75-µm [No. 200] sieve, that is used to improve certain properties of the bonding system or to reduce cost.

3.1.10 *formulator, n*—the agency responsible for preparing the separate components and for recommending the proportions to be used in preparing the final bonding system.

3.1.11 *lot or batch, n*—that quantity of manufactured material which has been subjected to the same unit chemical or physical processes intended to make the final product substantially uniform.

3.1.12 *manufacturer, n*—a producer of a basic constituent part of a component.

3.1.13 *reactive diluent, n*—a relatively free flowing liquid used to reduce the viscosity of the liquid resin or resin mixture, and which contains reactive groups that cause it to become an integral part of the cured resin.

3.1.14 *working (pot) life, n*—the time after mixing during which a bonding system or mixture containing it retains sufficient workability for proper use.

4. Classification

4.1 This specification provides for the classification of epoxy-resin bonding systems by type, grade, class, and color.

4.2 *Types*—Seven types of systems that are distinguished by the requirements of Table 1 are recognized:

4.2.1 *Type I*—For use in non-load bearing application for bonding hardened concrete to hardened concrete and other materials, and as a binder in epoxy mortars or epoxy concretes.

[3] The last approved version of this historical standard is referenced on www.astm.org.

TABLE 1 Physical Requirements of Bonding Systems

Property	Type						
	I	II	III	IV	V	VI	VII
Viscosity, Pa·s [P]:							
Grade 1, max	2.0 [20]	2.0 [20]	2.0 [20]	2.0 [20]	2.0 [20]	. . .	. . .
Grade 2, min	2.0 [20]	2.0 [20]	2.0 [20]	2.0 [20]	2.0 [20]	. . .	. . .
Grade 2, max	10 [100]	10 [100]	10 [100]	10 [100]	10 [100]	. . .	. . .
Consistency, mm [in.]:							
Grade 3, max	6.0 [¼]	6.0 [¼]	6.0 [¼]	6.0 [¼]	6.0 [¼]	6.0 [¼]	6.0 [¼]
Gel Time, minutes, min	30[A]	30	30	30[A]	30	30	30
Bond Strength, min, MPa [psi]:							
Hardened Concrete to Hardened Concrete:							
2 days (moist cure)	7.0 [1000]	. . .	. . .	7.0 [1000]	. . .	7.0 [1000]	. . .
14 days (moist cure)	10.0 [1500]	. . .	10.0 [1500]	10.0 [1500]	. . .	. . .	7.0 [1000]
Freshly Mixed Concrete to Hardened Concrete:							
14 days	. . .	10.0 [1500]	. . .	. . .	10.0 [1500]	. . .	. . .
Absorption, 24 h, max, %	1	1	1	1	1	. . .	. . .
Heat Deflection Temperature, min, °C [°F]:							
7 days	. . .	. . .	. . .	50 [120]	50 [120]	. . .	. . .
14 days	. . .	. . .	. . .	. . .	. . .	50 [120]	50 [120]
Thermal Compatibility	. . .	. . .	passes test	. . .	. . .	. . .	. . .
Linear coefficient of shrinkage on cure, max	0.005	0.005	. . .	0.005	0.005	. . .	. . .
Compressive Yield Strength, min, MPa [psi]:							
24 h	. . .	. . .	. . .	. . .	. . .	14.0 [2000]	. . .
36 h	. . .	. . .	. . .	. . .	. . .	. . .	7.0 [1000]
48 h	. . .	. . .	. . .	. . .	. . .	40.0 [6000]	. . .
72 h	. . .	. . .	. . .	. . .	. . .	. . .	14.0 [2000]
7 days	55.0 [8000]	35.0 [5000]	. . .	70.0 [10 000]	55.0 [8000]	. . .	. . .
Compressive Modulus, MPa [psi]:							
min	1000 [150 000]	600 [90 000]	. . .	1400 [200 000]	1000 [150 000]	. . .	. . .
max	. . .	. . .	896 [130 000]	. . .	. . .	. . .	. . .
Tensile Strength, 7 days min, MPa [psi][B]	35.0 [5000]	14.0 [2000]	. . .	50.0 [7000]	40.0 [6000]	. . .	. . .
Elongation at Break, %, min[B]	1	1	30	1	1	. . .	. . .
Contact Strength, MPa [psi], min							
2 days	. . .	. . .	. . .	. . .	. . .	7.0 [1000]	. . .
14 days	. . .	. . .	. . .	. . .	. . .	. . .	7.0 [1000]

[A] Minimum gel time of 5 min when automated proportioning, mixing, and dispensing equipment are used.
[B] Not required for Viscosity Grade 3 Systems.

4.2.2 *Type II*—For use in non-load bearing applications for bonding freshly mixed concrete to hardened concrete.

4.2.3 *Type III*—For use in bonding skid-resistant materials to hardened concrete and as a binder in epoxy mortars or epoxy concretes used on traffic bearing surfaces (or surfaces subject to thermal or mechanical movements).

4.2.4 *Type IV*—For use in load bearing applications for bonding hardened concrete to hardened concrete and other materials and as a binder for epoxy mortars and concretes.

4.2.5 *Type V*—For use in load bearing applications for bonding freshly mixed concrete to hardened concrete.

4.2.6 *Type VI*—For bonding and sealing segmental precast elements, as in segment-by-segment erection, and for span-by-span erection when temporary post tensioning is applied.

4.2.7 *Type VII*—For use as a nonstress carrying sealer for segmental precast elements when temporary post tensioning is not applied as in span-by-span erection.

NOTE 1— Epoxy resin systems will adhere to a wide variety of materials, including wood, metals, masonry, and most plastics. Polyethylene, TFE-fluorocarbon, cellophane, and greased or waxed surfaces are among the few materials to which these systems will not adhere.

4.3 *Grades*—Three grades of systems are defined according to their flow characteristics and are distinguished by the viscosity and consistency requirements of Table 1.

4.3.1 *Grade 1*—Low viscosity.

4.3.2 *Grade 2*—Medium viscosity.

4.3.3 *Grade 3*—Non-sagging consistency.

4.4 *Classes*—Classes A, B, and C are defined for Types I through V, and Classes D, E, and F are defined for Types VI and VII, in accordance with the range of temperatures for which they are suitable (Note 2).

4.4.1 *Class A*—For use below 4°C [40°F] the lowest allowable temperature to be defined by the manufacturer of the product.

4.4.2 *Class B*—For use between 4 and 15°C [40 and 60°F].

4.4.3 *Class C*—For use above 15°C [60°F] the highest allowable temperature to be defined by the manufacturer of the product.

4.4.4 *Class D*—For use between 4 and 18°C [40 and 65°F] for Type VI and VII applications.

4.4.5 *Class E*—For use between 15 and 30°C [60 and 80°F] for Type VI and VII applications.

4.4.6 *Class F*—For use above 25°C [75°F] for Type VI and VII applications, the highest allowable temperature to be defined by the manufacturer of the product.

NOTE 2—The temperature in question is usually that of the surface of the hardened concrete to which the bonding system is to be applied. This temperature may be considerably different from that of the air. Where unusual curing rates are desired it is possible to use a class of bonding agent at a temperature other than that for which it is normally intended. For example, a Class A system will cure rapidly at room temperature.

4.5 *Color*—Epoxy resin systems are normally unpigmented, but they can be colored or darkened. If a specific color is desired, it should be so stated by the purchaser.

5. Ordering Information

5.1 The purchaser shall specify the type, grade, class, and color of bonding system desired and the size of units in which the components shall be furnished. Special requirements regarding filling of either the components or the final bonding system should be stated. The product furnished under this specification is intended to be resistant to moisture and therefore should be suitable for either indoor or outdoor exposure.

5.2 The purchaser may specify a minimum gel time of 5 min for Types I and IV when automatic proportioning, mixing, and dispensing equipment are used.

6. Materials and Manufacture

6.1 The systems covered by this specification shall be furnished in two components for combining immediately prior to use in accordance with written instructions of the formulator. Component A shall contain an epoxy resin with or without a reactive diluent. Component B shall contain one or more curing agents, which on mixing with Component A shall cause the mixture to

harden. A suitable inert filler may be uniformly incorporated in one or both components. The filler shall be either nonsettling or readily dispersible in any component in which it is incorporated. All systems shall cure under humid conditions, and bond to damp surfaces.

7. Chemical Composition

7.1 The epoxy resin constituent of Component A shall have an epoxy equivalent of 155 to 275.

8. Physical Properties

8.1 A mixture of Components A and B in the proportions recommended by the formulator shall conform to the properties prescribed in Table 1.

9. Safety Hazards

9.1 **Warning—**~~Caution:~~Epoxy resins contain irritants, especially to the skin, eyes, and respiratory system. Persons handling these materials shall use appropriate protective clothing, including rubber or plastic gloves. If an epoxy resin should contact the skin, it shall be removed immediately with a dry cloth or paper towel, and the area of contact washed thoroughly with soap and water. Solvents shall *not* be used, because they carry the irritant into the skin. Cured epoxy resins are innocuous.

10. Sampling

10.1 Take a representative sample of each of the two components from a well-blended lot prior to packaging or by withdrawing samples from no fewer than 5% of the containers comprising the lot or shipment. Unless the samples of the same component taken from containers show visual evidence of variability, they may be combined into a single composite sample. In place of the foregoing, packaged materials may be sampled by a random selection of containers of each component from each lot, provided such a procedure is acceptable to the purchaser.

11. Test Methods

11.1 *Consistency*—Test Method to Determine the Consistency of an Epoxy Resin System.

11.1.1 *Scope*—This test provides a method for determining the consistency of Grade 3 epoxy resin systems.

11.1.2 *Significance and Use*—This test method is used to determine compliance with the requirements of the specification.

11.1.3 *Apparatus:*

11.1.3.1 *Paper Cup*—Approximately 0.100L [approximately 3 oz.] unwaxed paper cup.

11.1.3.2 *Mixing Blade*—Ordinary wooden tongue depressor or stick of similar size.

11.1.3.3 *Glass Panel.*

11.1.4 *Conditioning*—Condition the individual components and any equipment with which they will come in contact to the following temperatures: Class A, 0 ± 1°C [32 ± 2°F]; Class B, 10 ± 1°C [50 ± 2°F]; Class C, 23 ± 1°C [73 ± 2°F], Class D, 18 ± 1°C [65 ± 2°F]; Class E, 27 ± 1°C [80 ± 2°F]; Class F, 32 ± 1°C [90 ± 2°F] or to the temperature at which the material will be used (Note 2).

11.1.5 *Procedure*—Prepare approximately 30 cm^3 of the bonding system. Weigh the necessary amounts of the components to an accuracy of 1% into a single, approximately 100-cm^3 [3-oz], unwaxed paper cup. Mix immediately with a wooden tongue depressor or stick of similar size. Note the time at which mixing begins. Mix for 3 min, taking care to scrape the side and bottom of the cup periodically. Immediately apply about 2 cm^3 of the mixture to a glass panel. Form a semicylindrical bead of the bonding system by drawing the applicator blade through the sample in a straight line with the panel horizontal. Immediately raise the panel to a position inclined at no greater than 10° from vertical and with the bead horizontal. Maintain the panel and sample at their original temperature until the bonding system has cured, as determined by an inability to indent it appreciably with a pencil point or fingernail. Determine the consistency by measuring the flow of the lower edge of the bead from its original position at three points along its length.