Designation: C882/C882M – 23

Standard Test Method for Bond Strength of Bonding Systems Used With Concrete By Slant Shear[1]

This standard is issued under the fixed designation C882/C882M; 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 test method covers the determination of the bond strength of bonding systems for use with portland-cement concrete. This test method covers bonding hardened concrete to hardened or freshly-mixed concrete.

1.2 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.

1.3 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.

1.4 *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.* A specific hazard statement is given in Section 9. (**Warning**—Fresh hydraulic cementitious mixtures are caustic and may cause chemical burns to exposed skin and tissue upon prolonged exposure.[2])

1.5 *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:*[3]

C39/C39M Test Method for Compressive Strength of Cylindrical Concrete Specimens

C109/C109M Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50 mm] Cube Specimens)

C125 Terminology Relating to Concrete and Concrete Aggregates

C150/C150M Specification for Portland Cement

C192/C192M Practice for Making and Curing Concrete Test Specimens in the Laboratory

C470/C470M Specification for Molds for Forming Concrete Test Cylinders Vertically

C511 Specification for Mixing Rooms, Moist Cabinets, Moist Rooms, and Water Storage Tanks Used in the Testing of Hydraulic Cements and Concretes

C595/C595M Specification for Blended Hydraulic Cements

C617/C617M Practice for Capping Cylindrical Concrete Specimens

C881/C881M Specification for Epoxy-Resin-Base Bonding Systems for Concrete

C928/C928M Specification for Packaged, Dry, Rapid-Hardening Cementitious Materials for Concrete Repairs

C1059/C1059M Specification for Latex Agents for Bonding Fresh To Hardened Concrete

3. Terminology

3.1 *Definitions:*

3.1.1 For definitions of terms used in this specification, refer to Terminology C125.

3.2 *Definitions of Terms Specific to This Standard:*

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

[1] This test method 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] See Section on Safety Precautions, Manual of Aggregate and Concrete Testing, *Annual Book of ASTM Standards*, Vol 04.02.

[3] 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

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

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

3.2.4 *contact time, n*—specified time between when the bonding 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.

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

4. Summary of Test Method

4.1 The bond strength is determined by using the bonding material to bond together two equal sections of a 75 mm by 150 mm [3 in. by 6 in.] portland-cement mortar cylinder, each section of which has a diagonally cast bonding area at a 30° angle from the centerline of the cylindrical specimen. After suitable curing of the bonding system, the test is performed by loading the composite cylinder in compression and dividing the maximum load by the area of the bonded surface.

5. Significance and Use

5.1 The strength developed by a bonding system that joins two regions of concrete is its most important property.

6. Apparatus

6.1 *Apparatus to Mix Portland-Cement Mortar*—This apparatus shall be as described in Test Method C109/C109M, except for the sections on specimen molds, tamper, and testing machine.

6.2 *Specimen Molds*—The molds shall meet the requirements of Specification C470/C470M and be 75 mm ± 2 mm [3 in. ± 1⁄16 in.] in inside diameter and 150 mm ± 2 mm [6 in. ± 1⁄16 in.] in height.

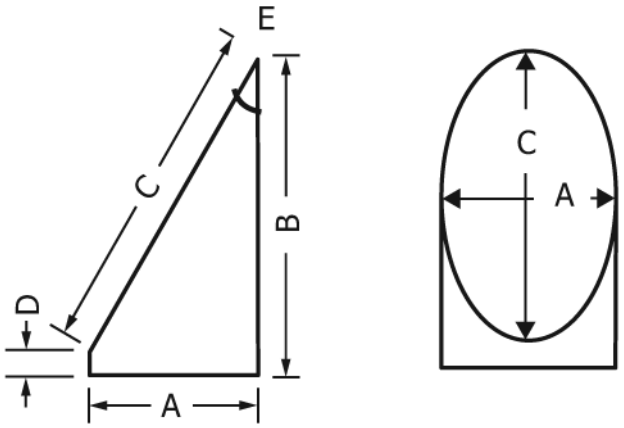
6.3 *Dummy Section*—A dummy section (Fig. 1) shall be machined of a hard material that is not attacked by portland-cement mortar. It shall fit the mold and be equal to half the volume of the cylinder, but at an angle of 30° from the vertical. Additional dummy sections can be made by casting an epoxy-resin mortar against the machined dummy section contained in a specimen mold. Due precautions, such as waxing, shall be taken to prevent the bonding of the epoxy-resin mortar to the machined dummy section or the mold.

6.4 *Tamping Rod*—A 10-mm [3⁄8-in.] diameter tamping rod, as described in Practice C192/C192M.

6.5 *Apparatus for Mixing Epoxy-Resin Bonding System*—A glass, plastic, or metal container of approximately 0.1 L [3 oz] capacity shall be used to hand-mix the bonding system. A tongue depressor or wooden stick of similar dimensions shall be used as a paddle.

6.6 *Testing Machine*—The testing machine shall be as described in Test Method C39/C39M.

6.7 *Moist Room*—The moist room shall conform to the requirements of Specification C511.



	Dimensions	
	mm	in.
A—Diameter	75 ± 2	[3.00 ± 0.08]
B—Height	140 ± 2	[5.60 ± 0.08]
C—Slant height	150 ± 2	[6.00 ± 0.08]
D—Base height	10 ± 2	[0.40 ± 0.08]
E-Slant angle	0.52 ± .026 rad	[30° ± 1.5°]

FIG. 1 Dummy Section

6.8 *Temperature-Conditioning Chambers*—Rooms or chambers in which the temperature is maintained appropriate to the class of the resin system being tested, in accordance with Specification C881/C881M.

7. Materials

7.1 *Portland Cement Mortar Specimens* Laboratory conditions, materials, proportions, and procedures for mixing the portland-cement mortar shall be in accordance with Test Method C109/C109M. A cement complying with Specification C150/C150M or a Type IL cement complying with Specification C595/C595M shall be used. The Type of cement used shall be reported.

7.1.1 Lightly oil the dummy section and the cylinder mold. Position the dummy section in the mold with the slant side up. Place the portland-cement mortar in the mold in two layers of approximately equal volume. Rod each layer with 25 strokes of the tamping rod. Distribute the strokes uniformly over the section and rod deeply enough to penetrate into any underlying layer. Rod the bottom layer as deeply as possible. Strike off the surface of the top layer with the trowel, and cover the specimen and mold with a glass or metal plate. Cure the mortar half-cylinder in accordance with Practice C192/C192M for at least 28 days. Then dry the half-cylinder in laboratory air for at least 7 days. As an alternative, a complete 75 by 150 mm [3 by 6-in.] cylinder shall be cast, cured for at least 28 days, and saw-cut at an angle of 30°.

7.1.2 A 75 mm by 150mm [3 in. by 6 in.] cylinder of the mortar shall have a compressive strength, when tested in accordance with 12.3, of at least 31 MPa [4500 psi] at 28-days age.

NOTE 1—Calculations for bond strength are determined based on the elliptical bonding surface of the cut cylinder. For an angle of 30° from the vertical this corresponds to exactly twice the surface area of the base of the assembled cylinder. Use of mortar with the minimum compressive strength listed in 7.1.2 will only provide a qualitative pass/fail result for

bond strengths exceeding approximately 13 MPa [1900 psi]. If quantitative results are desired it is recommended the mortar compressive strength of the mortar exceed the anticipated bond strength by a factor of 2.5 or more.

7.2 *Bonding System*—The bonding systems covered by this test method shall be furnished in two or more components for combining immediately prior to use in accordance with the written instructions of the manufacturer.

7.3 *Polyethylene Film*—Film thickness of 100 µm [4 mil] cut into 150 mm × 500 mm [6 in. × 30 in.] sections.

7.4 *Masking Tape.*

7.5 *Paraffin Wax.*

8. Specimen Preparation

8.1 Lightly oil the dummy section and the cylinder mold. Position the dummy section in the mold with the slant side up.

8.2 Place the portland-cement mortar in the mold in two layers of approximately equal volume. Rod each layer with 25 strokes of the tamping rod. Distribute the strokes uniformly over the section and rod deeply enough to penetrate into any underlying layer. Rod the bottom layer as deeply as possible. Strike off the surface of the top layer with the trowel, and cover the specimen and mold with a nonabsorbent plate or lid.

NOTE 2—Example materials that have been used for the purpose of a nonabsorbent plate or lid are plastic, glass, or metal.

8.3 Cure the mortar half-cylinder in accordance with Practice C192/C192Mfor at least 28 days. Then dry the half-cylinder in laboratory air for at least 7 days. As an alternative, a complete 75 mm by 150 mm [3 in. by 6 in.] cylinder shall be cast, cured for at least 28 days, and saw-cut at an angle of 0.52 rad ± 0.026 rad [30° ± 1.5°]. Then air dry the saw-cut half-cylinders in laboratory environment for at least 7 days.

9. Hazards

9.1 **Warning—**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 shall be 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 samples in accordance with Specification C881/C881M.

11. Test Specimens

11.1 A test result is the average of three replicate specimens having the same testing conditions.

11.2 *Conditioning:*

11.2.1 *Types I, III, IV, VI, and VII Systems, defined in Specification C881/C881M*—Condition the resin system components, the mortar sections, and all equipment that will contact the resin to the temperatures specified in Specification C881/C881M.

11.2.1.1 Prepare the test specimens and make provision for maintaining them at the appropriate temperature during the entire cure time. Prepare the surface to be bonded by sandblasting and dry brushing to remove all loose surface material.

11.2.1.2 Use mortar sections and assemblies that have been soaked in water for 24 h. Place the face of the mortar sections to be bonded on an absorbent material for 10 min prior to applying the adhesive. For assembled test specimens, remove all water by shaking. Allow to air dry for 15 min.

11.2.2 *Type II and Type V Systems defined in Specification C881/C881M*—Because Type II and Type V resins are appropriate for use only at temperatures that permit strength gain of the freshly prepared concrete, only the conditioning temperature for a Class C resin, 23 °C ± 1 °C [73 °F ± 2 °F], need be provided. Prepare the test specimens and make provision for maintaining them at 23 °C ± 1 °C [73 °F ± 2 °F] during the entire cure time. Prepare the surface to be bonded by sandblasting and dry brushing to remove all loose surface material.

11.2.3 *Other Systems*—Systems not requiring compliance with Specification C881/C881M are conditioned as follows:

11.2.3.1 *Latex, Type I (Redispersible) and Type II (Non-redispersible) defined in Specification C1059/C1059M*—Condition test specimens, bonding materials, and all equipment that will contact the bonding materials to 23 °C ± 1 °C [73 °F ± 2 °F]. Prepare the diagonal face of the half cylinder by sand blasting to expose the aggregate and dry brushing to remove all loose surface material or by cutting a whole cylinder with a diamond sawblade as stated in 8.3 and rinsing with water. Keep the prepared surface damp until the bonding system has been applied.

11.2.3.2 *Packaged Cementitious Repair Materials defined in Specification C928/C928M*—Condition test specimens in accordance with 11.2.2

11.2.3.3 *Bonding Materials for Use on Dry Surfaces*—Condition bonding system components, the mortar sections, and all equipment that will contact the adhesive to 23 °C ± 1 °C [73 °F ± 2 °F] and relative humidity (RH) of 50% ± 5%. Maintain test specimens at the required temperature and relative humidity during the entire cure time. Prepare the surface to be bonded by sandblasting and dry brushing to remove all loose surface material or by cutting a whole cylinder with a diamond sawblade as stated in 8.3 and rinsing with water.

11.3 *Specimen Preparation:*

11.3.1 Measure and record the lengths of the minor axis and major axis of the elliptical bonding surface for calculating the bond strength. These are depicted as “A” and “C” in Fig. 1.

11.3.2 *Type I, III, IV, VI, and VII, Grade 2 or 3 Systems defined in Specification C881/C881M*—Two mortar sections will be needed for each test specimen. Wrap 100 µm [4 mil] of polyethylene film 150 mm by 500 mm [6 in. by 20 in.] around one section of each pair, even with the base and secure with masking tape. Thoroughly mix the components of the bonding system in the proportions recommended by the formulator. A mixing time of 3 min should suffice. Support the film-wrapped mortar section so that the prepared bonding surface is horizontal.