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

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1. Scope

1.1 This test method covers the determination of the bond strength of latex bonding systems for use with portland-cement concrete. This test method covers bonding hardened mortar specimens to freshly mixed mortar specimens.

1.2 The values stated in either inch-pound units or SI units are to be regarded separately as standard. Within the text, the SI units are shown in brackets. The values stated in each system are not exact equivalents, therefore, each system shall be used independently of the other. Combining values from the two systems may result in nonconformance with this test method.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

C 39 Test Method for Compressive Strength of Cylindrical Concrete Specimens[2]

C 109/C 109M Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or 50-mm Cube Specimens)[3]

C 150 Specification for Portland Cement[3]

C 192 Practice for Making and Curing Concrete Test Specimens in the Laboratory[2]

C 305 Practice for Mechanical Mixing of Hydraulic Cement Pastes and Mortars of Plastic Consistency[3]

C 617 Practice for Capping Cylindrical Concrete Specimens[2]

C 1059 Specification for Latex Agents for Bonding Fresh to Hardened Concrete[2]

3. Summary of Test Method

3.1 The bond strength is determined by using the latex system to bond a fresh mortar section of a 3 by 6 in. [75 by 150 mm] portland-cement mortar cylinder to a hardened half cylinder, that has a diagonally cast bonding area at an angle 30° from vertical. After suitable curing of the composite specimen, the bond stress is determined by testing the specimen in compression and computing the bond strength at the diagonal face.

4. Significance and Use

4.1 This test method can be used in measuring the effectiveness of latex systems in bonding fresh concrete to hardened concrete.

5. Apparatus

5.1 *Apparatus to Mix Portland-Cement Mortar*—This apparatus shall be as described in Practice C 305.

5.2 *Specimen Molds*—The molds shall be constructed in the form of right cylinders, 3 ± 1/16 in. [75 ± 2 mm] in inside diameter and 6 ± 1/16 in. [150 ± 2 mm] high. All molds shall be either selected or machined so that the maximum range of the differences in each of the dimensions of the group of molds is less than 1/64 in. [0.4 mm]. The molds shall be made of metal not attacked by portland-cement mortar. The side of the mold shall be sufficiently rigid to prevent spreading or warping. The molds shall be made watertight before use. A satisfactory material for this purpose is the paraffin-resin mixture described in Test Method C 109/C 109M.

5.3 *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 30° from 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.

5.4 *Tamping Rod*—The tamping rod shall be a round rod of brass or plastic, 3/8in. [10 mm] in diameter and approximately 12 in. [300 mm] long, having both ends rounded to hemispherical tips.

6. Half Cylinder Preparation

6.1 Laboratory conditions, materials, proportions, and procedures for mixing the portland-cement mortar shall be in

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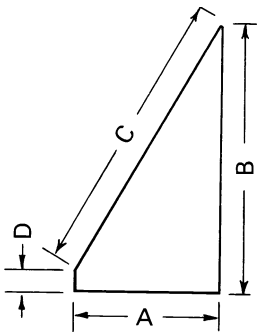
[2] *Annual Book of ASTM Standards,* Vol 04.02.

[3] *Annual Book of ASTM Standards,* Vol 04.01.

TABLE 1



Dimensions

	in.	mm
A—Diameter	3.000	75
B—Height	5.598	140
C—Slant height	6.000	150
D—Base height	0.402	10

FIG. 1 Dummy Section

accordance with Test Method C 109/C 109M and the cement shall conform to Specification C 150, Type III.

6.2 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 three layers of approximately equal volume. Rod each layer with 25 strokes of the tamping rod. Rod the bottom layer as deeply as possible. Distribute the strokes uniformly over the section and rod deeply enough to penetrate into any underlying layer. 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 C 192 for at least 28 days. Then dry the half cylinder in laboratory air for at least 7 days.

6.3 A 3 by 6-in. [75 by 150-mm] cylinder of the mortar shall have a compressive strength, when tested in accordance with 8.3, of at least 4500 psi [31 MPa] at 35-days age (28 days of curing in accordance with Practice C 192 and 7 days of ambient drying).

7. Preparation of Composite Specimens

7.1 A test shall consist of three (3) bonded 3-in. diameter by 6-in. high specimens made by applying a bonding latex or latex slurry to the diagonal faces of the hardened half cylinders, that are contained in the molds. Then, fill the molds with mortar using the procedure in 7.4. The mortar mixture shall be made in accordance with Test Method C 109/C 109M. 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 with a diamond sawblade and rinsing with water. Keep the prepared surface damp until the bonding system has been applied. Apply the latex bonding agent using the procedure in 7.2 or 7.3 depending on the type of latex used as defined in Specification C 1059.

7.2 *Type I Latices*—Brush the latex onto the diagonal face at the manufacturer's recommended coverage rate.

7.3 *Type II Latices*—Prepare a cement and latex slurry by mixing Specification C 150, Type I portland cement or the cement to be used on a particular project with the latex. (Approximately 50 mL of latex to 100 g of cement.) Apply the slurry to the diagonal face, the coverage rate, if specified, shall be used.

7.4 Place the half cylinder in a mold and support it so that the bonding surface is horizontal. Within 10 min after applying the bonding agent, place a ½ in. [15 mm] thick layer of the freshly mixed mortar over the coated surface and consolidate the mortar by using a tamping rod, trying not to disturb the bonding material. Add additional mortar as the cylinder is returned to a vertical position. Fully fill and rod ten times being sure not to disturb the bonding surface. Strike off the top of the cylinder with a trowel and cover the test specimen with a glass or metal plate.

8. Curing and Testing

8.1 Cure test specimens in laboratory air, 73 ± 3°F [23 ± 2°C] and a RH of 50 ± 4 % until time of demolding. Demold specimens on the seventh day and test on the 14th day. After removing molds, tests of Type I latices shall be done by curing the specimens, after demolding, in the laboratory air. Tests of Type II latices shall be done by curing the specimens, after demolding, in a saturated lime water, as described in Practice C 192.

8.2 *Capping*—Prepare specimens in accordance with Practice C 617.

8.3 *Strength Testing*—Test the specimens in compression in accordance with Test Method C 39. Except as noted, tests of Type I latex shall be done by curing the specimens in air.

9. Calculation

9.1 Calculate the nominal bond strength of the latex bonding system by dividing the load carried by the specimen at failure by the area of the bonded surface. (Note 1.) Reduce the area of the bonded surface by that of any large voids, other than entrained air, found in the bond on inspection after the test. Report the results to the nearest 10 psi [0.1 MPa].

NOTE 1—The area of the elliptical bonding surface of the test cylinders specified in this test method is 14.13 in.^{2} {9116 mm^2]. The actual area shall be based on measuring the lengths of the two axes (a and b) of the elliptical surface and substituting into the formula for the area of an ellipse [0.7854 a b].

10. Report

10.1 Report the following information:

10.1.1 Identification,

10.1.2 Bond strength,

10.1.3 Bonding area,

10.1.4 Number and total area of voids in the bond,

10.1.5 Type and position of the fracture (in the bonding material, in the mortar, or in the interface between them), and

10.1.6 Defects in either the specimen or the cap.

11. Precision and Bias

11.1 *Single Operator Precision*—The single operator within laboratory standard deviations ranged from 9 to 145 psi, coefficients of variation ranged from 1.7 to 19.6 %.

11.1.1 Therefore, the results of two properly conducted tests from the same operator should not differ from each other by more than 406 psi.

11.1.2 For each individual laboratory, standard deviations ranged from 95 to 520 psi; coefficients of variation ranged from 19 to 64 %.

11.1.3 Therefore, the results of two properly conducted tests conducted by two different laboratories should not differ by more than 1456 psi.

11.2 *Bias*—The bias of this test method has not been determined.

12. Keywords

12.1 adhesives; bonding agents; bond strength; concrete bonding; latex; shear bond