Designation: C1857/C1857M – 19

Standard Test Method for Evaluating the Adhesion (Pull-Off) Strength of Concrete Repair and Overlay Mortar[1]

This standard is issued under the fixed designation C1857/C1857M; 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 is suitable for laboratory use to determine one or more of the following:

1.1.1 The bond strength of a repair or an overlay material to a specific concrete substrate.

1.1.2 The tensile strength of a repair or overlay material after the material has been applied to the concrete substrate.

1.1.3 The change in bond strength when applying a bonding agent or other bond modifying treatment to the concrete substrate.

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. Some values have only SI units because the inch-pound equivalents are not used in practice.

1.2.1 If required results obtained from another standard are not reported in the same system of units as used by this test method, it is permitted to convert those results using the conversion factors found in the SI Quick Reference Guide.[2]

1.3 The text of this test method 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 test method.

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. (***Warning—***Fresh hydraulic cementitious mixtures are caustic and may cause chemical burns to skin and tissue upon prolonged exposure.)*[3]

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:*[4]

C125 Terminology Relating to Concrete and Concrete Aggregates

C191 Test Methods for Time of Setting of Hydraulic Cement by Vicat Needle

C305 Practice for Mechanical Mixing of Hydraulic Cement Pastes and Mortars of Plastic Consistency

C702/C702M Practice for Reducing Samples of Aggregate to Testing Size

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

C900 Test Method for Pullout Strength of Hardened Concrete

C1107/C1107M Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)

C1583/C1583M 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)

E4 Practices for Force Verification of Testing Machines

E74 Practices for Calibration and Verification for Force-Measuring Instruments

2.2 *ISO Standards:*[5]

ISO 13007-2 Ceramic Tiles - Grouts And Adhesives - Part 2: Test Methods For Adhesives

[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.

Current edition approved Dec. 1, 2019. Published March 2020. DOI: 10.1520/C1857_C1857M-19.

[2] Annex A in Form and Style for ASTM Standards, www.astm.org.

[3] Section on Safety Precautions, Manual of Aggregate and Concrete Testing, *Annual Book of ASTM Standards*, Vol. 4.02.

[4] 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.

[5] Available from International Organization for Standardization (ISO), ISO Central Secretariat, BIBC II, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, http://www.iso.org.

3. Terminology

3.1 *Definitions:*

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

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *burn-in layer, n*—a thin layer of repair material that is applied forcibly with a trowel so as to push the material into the pores of the substrate.

3.2.2 *scrub coat, n*—a slurry applied to a concrete substrate to enhance the bonding of a repair material to the substrate.

3.2.3 *standard concrete panel, n*—a panel of concrete with a specified thickness, moisture content, water absorption rate and tensile strength as defined in ISO 13007-2.

3.2.3.1 *Discussion*—Mixture proportions and instructions for manufacture of the standard panel are also included in ISO 13007-2.

3.2.4 *puck, n*—the cylindrical specimen formed by casting the repair or overlay material into the cavity of the flexible mask.

4. Summary of Test Method

4.1 This test method is performed by pulling off a puck of concrete repair or overlay material after it has been applied to a standard concrete panel

4.2 The test specimen or puck is formed by placing the material to be evaluated inside the cavities of a flexible mask that is laid on the standard concrete panel.

NOTE 1—As the puck is small in size, bond interface stresses due to puck shrinkage are also small. For this reason, the test method would not be a good predictor of bond failures caused by shrinkage stresses within the repair material.

4.3 A rigid disk is adhered to the puck with a suitable adhesive.

4.4 A tensile load is applied to the rigid disk at a constant stress rate until failure occurs. Normally, this is accomplished with a tensile loading device capable of applying a load at a specified rate. The failure load and the failure mode are recorded and the nominal tensile stress at failure is calculated.

4.5 This method is similar to Test Method C1583/C1583M but differs in that this method requires the use of a standard concrete panel and does not require partial-depth coring of the concrete panel.

5. Significance and Use

5.1 When the test is performed on the repair or overlay material, the result is the bond strength to the concrete panel or the tensile strength of either the overlay or concrete panel, whichever is weaker.

5.2 The measured strength is controlled by the failure mechanism requiring the least stress. Thus, it is not possible to know beforehand which strength will be measured by the test. For this reason, the failure mode has to be reported for each individual test result, and tests results are averaged only if the same failure mode occurs. Alternatively, one can infer that the bond strength is greater than the failure stress if the bond does not fail during the test.

5.3 The method may also be used to evaluate the performance of bonding agents.

5.4 This test method is designed to evaluate bond strengths in the laboratory and to standardize conditions that permit comparison of results between laboratories. It is not intended to determine bond strength for field applications as results obtained are only applicable to the standard substrate.

6. Apparatus

6.1 *Rigid Disk,* steel or aluminum cylindrical disk at least 50 mm [2.0 in.] diameter with thickness as follows.

6.1.1 *Steel Disk,* the thickness of a rigid disk made from steel shall be at least 50 % of the diameter of the disk.

6.1.2 *Aluminum Disk,* the thickness of a rigid disk made from aluminum shall be at least 60 % of the diameter of the disk.

6.2 *Tensile Loading Device,* with a load-indicating system capable of applying a concentric load to the disk at the specified rate. The loading device must couple to the disk and align to apply tension normal to the test surface. The device shall be capable of measuring the load to the nearest 0.1 kN [20 lbs] and capturing the peak load.

NOTE 2—The tensile loading device is also referred to as a "pull-off tester."

6.2.1 Within the operating range, the indicated tensile force shall be within ±2 % of the force measured by a calibrated testing machine or load cell that has been verified in accordance with Practices E4 or E74.

6.2.2 Verify the tensile loading device at least once a year and after repairs and adjustments.

NOTE 3—See Test Method C900 for suitable verification schemes.

6.2.3 Use a coupling device to connect the disk to the tensile loading device. The spherical coupling device shall be able to withstand the tensile load capacity without yielding, and transmit the tensile force in line with the axis of the puck without imparting torsion or bending to the puck.

6.3 Flexible, non-absorptive mask with 16 circular cavities. Mask is nominally 6 mm [0.25 in.] thick and of similar lateral dimensions to the standard concrete panel. The diameter of the cavities shall not be less than the diameter of the rigid disk to be used and can be up to 2 mm [0.08 in.] greater than the disk diameter. Mask cavities shall be at least 25 mm [1 in.] from the panel edges and the clear distance between cavities shall be at least 40 mm [1.6 in.].

NOTE 4—Rubber and silicone have been used to make suitable masks. The diameter of the cavity is required to be equal to or up to 2 mm [0.08 in.] larger than the diameter of the rigid disk to facilitate centering when the disk is bonded to the puck.

7. Materials

7.1 Standard concrete panel as defined in ISO 13007-2.

7.2 Repair or overlay material prepared in accordance with the manufacturer's instructions.

7.3 Rapid curing adhesive material for bonding the rigid disk to the puck capable of providing adequate strength to preclude failure between the disk and puck.