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# StandardTest 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)[1]

This standard is issued under the fixed designation C1583/C1583M; 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.

ε[1] NOTE—The designation was changed editorially to agree with the existing values statement in the Scope in March 2008.

## 1. Scope

1.1 This test method is suitable for both field and laboratory use to determine one or more of the following:

1.1.1 The near-surface tensile strength of the substrate as an indicator of the adequacy of surface preparation before application of a repair or overlay material.

1.1.2 The bond strength of a repair or an overlay material to the substrate.

1.1.3 The tensile strength of a repair or overlay material, or an adhesive used in repairs, after the material has been applied to a surface.

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 may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

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 the user 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:*[2]

C125 Terminology Relating to Concrete and Concrete Aggregates

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

C900 Test Method for Pullout Strength of Hardened Concrete

## 3. Terminology

3.1 *Definitions*—For definitions of terms used in this test method refer to Terminology C125 and ACI 503R[3].

## 4. Summary of Test Method

4.1 This test is performed on the surface of a prepared concrete base before application of a concrete repair or overlay material, or on the surface of a concrete repair or overlay material after the material has been applied to the prepared concrete surface.

4.2 The test specimen is formed by drilling a shallow core into and perpendicular to the surface of the substrate, and leaving the intact core attached to the concrete. A steel disk is bonded to the top surface of the test specimen.

4.3 A tensile load is applied to the steel disk until failure occurs. The failure load and the failure mode are recorded and the nominal tensile stress at failure is calculated.

## 5. Significance and Use

5.1 This test method determines the tensile strength of concrete near to the prepared surface, which can be used as an indicator of the adequacy of surface preparation before applying a repair or an overlay material.

5.2 When the test is performed on the surface of a repair or an overlay material, it determines the bond strength to the substrate or the tensile strength of either the overlay or substrate, whichever is weaker.

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

5.4 When the test is performed on the surface of a material applied to the substrate, the measured strength is controlled by

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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.

[3] ACI 503R-93 (Reapproved 1998), "Use of Epoxy Compounds with Concrete," American Concrete Institute (ACI), P.O. Box 9094, Farmington Hills, MI 48333.

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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.

## 6. Apparatus

6.1 *Core Drill,* for preparing test specimen.

6.2 *Core Barrel,* with diamond impregnated bits - nominally 50 mm [2.0 in.] inside diameter.

6.3 *Steel Disk,* nominally 50 mm [2.0 in.] diameter and at least 25 mm [1.0 in.] thick.

6.4 *Tensile Loading Device,* with a load-indicating system and nominal capacity of 22 k N (5,000 lbf) and capable of applying load at the specified rate. The loading device includes a tripod or bearing ring for distributing the force to the supporting surface.

6.4.1 Within the operating range, the indicated tensile force shall be within ± 2 % of the force measured by a calibrated testing machine or load cell. Verify the tensile loading device at least once a year and after repairs and adjustments.

NOTE 1—See Test Method C900 for suitable verification schemes.

6.4.2 A coupling device shall be used to connect the steel disk to the tensile loading device. The coupling device shall be designed to withstand the tensile load capacity without yielding, and to transmit the tensile force parallel to and in line with the axis of the cylindrical test specimen without imparting torsion or bending to the test specimen.

## 7. Materials

7.1 Epoxy adhesive material for bonding the steel disk to the test specimen. It shall be a fast-curing paste or gel meeting the requirements of Specification C881/C881M for Type IV, Grade 3, except that a shorter gel time is permitted.

## 8. Sampling

8.1 Three individual test results with similar failure modes shall be obtained for each test site.

8.2 The field test site shall be large enough so that all methods to be used in the full-scale repair or overlay operation, including surface preparation, are used for preparing test specimens. The test site shall be at least 1 by 1 m [3 by 3 ft]. It shall be selected to be representative of actual field conditions.

8.3 If concrete cover is less than 20 mm [¾ in.], do not locate test specimens directly over bars in the layer of reinforcement nearest to the surface.

NOTE 2—The location of reinforcement may be established using reinforcement locators or metal detectors. Follow the manufacturer's recommendations for proper operation of such devices.

8.4 The center-to-center distance of adjacent test specimens shall be at least two disk diameters. The distance from the center of a test specimen and a free edge of the test object shall be at least one disk diameter.

## 9. Preparation of Surface

9.1 *Preparation to Determine Tensile Strength of Substrate:*

9.1.1 Remove all surface contaminants and loose or deteriorated concrete to obtain a clean, undamaged surface.

9.1.2 Prepare the surface using the same method to be used in the full-scale repair or overlay.

9.1.3 The surface must be in the same condition regarding dryness and cleanliness as specified for the actual work.

9.2 *Preparation to Determine Bond or Tensile Strength of the Repair or Overlay Material:*

9.2.1 Prepare the surface in accordance with 9.1.

9.2.2 Apply and cure the repair or overlay material in accordance with specifications for the repair or overlay operation.

## 10. Preparation of Test Specimen

10.1 Using the coring equipment, drill a circular cut perpendicular to the surface. For tests of substrate concrete, drill to a depth of at least 10 mm [0.5 in.]. For tests of repair or overlay materials, drill to at least 10 mm [0.5 in.] below the concrete-overlay interface. The test specimen is left intact, attached to the substrate. Measure the diameter of the test specimen in two directions at right angles to each other. Record the average diameter to the nearest 0.2 mm [0.01 in.].

10.2 Remove any standing water; clean the surface of any debris from the drilling operation and allow to dry.

10.3 Attach the steel disk to the top of the test specimen using the epoxy adhesive. Ensure that the disk is centered with the test specimen and that the axis of the disk is parallel to the axis of the test specimen. Cure the epoxy adhesive following manufacturer's instructions (see Note 4). Do not allow the adhesive to run down the side of the test specimen into the annular cut; if this occurs, the specimen is not tested and another is prepared. At temperatures below 20°C [70°F], it is permitted to gently heat the steel disk to no more than 50°C [120°F] to facilitate spreading of the adhesive and to accelerate curing. The test specimen shall not be heated with a direct flame.

NOTE 3—Figs. 1 and 2 are schematics of the tests for determining tensile strength of the substrate and bond or tensile strength of the repair or overlay material, respectively. These schematics are not intended to indicate specific equipment designs.

NOTE 4—Guidance on applying and curing the epoxy adhesive may be found in ACI 503R.

## 11. Test Procedure

11.1 Attach the tensile loading device to the steel disk using the coupling device.

11.2 Apply the tensile load to the test specimen so that the force is parallel to and coincident with the axis of the specimen.

11.3 Apply the tensile load at a constant rate so that the tensile stress increases at a rate of 35 ± 15 kPa/s [5 ± 2 psi/s].

11.4 Record the failure load and the failure mode. Record the failure mode as *(a)* in the substrate, *(b)* at the bond line between the substrate and the repair or overlay material, *(c)* in the repair or overlay material, or *(d)* at the bond line between the repair or overlay material and the epoxy adhesive used to bond the steel disk. If failure occurs at the bond line between the steel disk and the epoxy adhesive, discard the test and

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