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## Standard Test Method for Evaluating Bond Strength for ~~15.2 mm (0.6 in.)~~ 0.600-in. [15.24-mm] Diameter Prestressing Steel Prestressing Strand, Grade 270 [1860], Uncoated, Used in Prestressed Ground Anchors<sup>1</sup>

This standard is issued under the fixed designation A981/A981M; 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 approval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

### 1. Scope

~~1.1 This test method describes procedures to establish the relative bond strength of 15.2 mm (0.6 in.) diameter, Grade 270 prestressing steel strand in cement grout as used in prestressed ground anchors for the purpose of evaluating the effects of manufacturing practices on bond strength.~~

~~1.2 The bond strength values obtained shall not be used to design the bond length of ground anchors that depend on field conditions.~~

~~1.3 This test method is not intended to be used as a bond test for pretensioned concrete applications.~~

~~1.4 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.~~

1.1 This test method describes procedures to establish the relative bond strength of 0.600-in. [15.24-mm] diameter, Grade 270 [1860] steel prestressing strand in cement grout as used in prestressed ground anchors for the purpose of evaluating the effects of manufacturing practices on bond strength.

1.2 The bond strength values obtained are not intended to be used to design the bond length of ground anchors that depend on field conditions.

1.3 This test method is not intended to be used as a bond test for prestressed concrete applications.

1.4 The values stated in either inch-pound or SI units are to be regarded as standard. Within the text, the SI units are shown in brackets. 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.

*1.5 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:*<sup>2</sup>

A416/A416M Specification for Steel Strand, Uncoated Seven-Wire for Prestressed Concrete

C150 Specification for Portland Cement

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

C1019 Test Method for Sampling and Testing Grout

E4 Practices for Force Verification of Testing Machines

### 3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *bond strength*—maximum measured load in a pull test on a ~~15.2 mm (0.6 in.)~~ 0.600-in. [15.24-mm] diameter prestressing steel prestressing strand embedded in cement grout.

<sup>1</sup> This test method is under the jurisdiction of ASTM Committee A01 on Steel, Stainless Steel and Related Alloys and is the direct responsibility of Subcommittee A01.05 on Steel Reinforcement.

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<sup>2</sup> 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.

3.1.2 *bonded length*—the length of the test strand that is in contact with the cement grout.

#### 4. Apparatus

4.1 *Equipment*—A suitable tensile testing machine or load frame shall be used. The loading system shall be calibrated in accordance with Practices E4. The test system shall have sufficient capacity to prevent yielding of its various components and shall ensure that the applied tensile load remains parallel to the axis of the prestressing steel prestressing strand during testing.

4.2 *Strand Displacement Measurements*—Displacements of the free end of the prestressing steel prestressing strand shall be measured with respect to the loaded surface of the test specimen using suitable measurement devices. Dial gages having the smallest division of not more than  $25\ \mu\text{m}$  (0.001 in.) 0.001 in. [25  $\mu\text{m}$ ] or linear variable differential transformers (LVDTs) with equal or superior accuracy are examples of satisfactory devices.

#### 5. Test Specimen—Strand Bond Test Specimen

5.1 *Prestressing Steel Strand*—shall be 15.2 mm (0.6 in.) diameter, Grade 270 and comply with Specification Steel Prestressing Strand—Strand shall be 0.600-in. [15.24-mm] diameter, Grade 270 [1860] and comply with Specification A416/A416M and shall be cut from standard production coils prior to packaging. The surface of the test samples shall not be wiped or cleaned in order to preserve their original condition. Minimum recommended sample length is 750 mm (30 in.) 30 in. [750 mm].

5.2 *Strand Bond Test Specimen*—The test specimen shall consist of the prestressing steel strand embedded in cement grout and centered inside a steel pipe, 125 mm (5 in.) O.D. with a 3 mm (0.125 in.) wall, 450 mm (18 in.) long with a 150 by 150 by 6 mm (6 by 6 by 0.25 in.) base plate welded, or otherwise leakproof connected to one end of the steel pipe. Other mold designs, including reusable molds, shall be permissible, provided that the dimensions and confinement in regard to circumferential stress provided for the grout body are the same. A hole in the base plate shall allow the strand to pass through. A 50 mm (2 in.) long debonding tube shall be positioned on the strand above the base plate and the strand shall protrude at least  $50 \pm 10$  mm ( $2 \pm 0.5$  in.) from the top of the grouted steel tube. A typical test specimen is illustrated in Fig. 1. Test Specimen Fabrication—The test specimen shall consist of the steel prestressing strand embedded in cement grout and centered inside a steel pipe, 5-in. [125-mm] O.D. with a 0.125-in. [3-mm] thick wall, 18-in. [450-mm] long with a 6 by 6 by 0.25 in. [150 by 150 by 6 mm] base plate welded to one end of the steel pipe, or otherwise attached with a leakproof connection. Other mold designs, including reusable molds, shall be permitted, provided that the dimensions and confinement in regard to circumferential stress provided for the grout body are the same. A 0.625-in. [16-mm] diameter hole shall be provided in the base plate to allow the strand to pass through. A 2-in. [50-mm] long debonding tube (Note 1) shall be positioned on the strand above the base plate and the strand shall protrude at least  $2 \pm 0.5$  in. [50  $\pm$  10 mm] from the top of the grouted steel tube. A typical test specimen is illustrated in Fig. 1.

NOTE 1—Polyethylene, trademark Styrofoam,<sup>3</sup> or similar material are commonly used for this purpose.

5.3 *Test Specimen Preparation*—The untensioned strand specimensample shall be installed and centered inside the steel pipe as shown in Fig. 1. A sealing agent shall be applied around the hole in the base plate to prevent leakage of grout from the sample during casting.

5.3.1 The grout shall be made solely from fresh portland cement conforming to Specification C150, Type I with a water/cement ratio of 0.45. Water shall be potable. The cement shall be added to the water. Mixing of the grout shall continue until the grout is free of lumps and undispersed cement. The grout then shall be poured into the steel tube to completely fill it., Type I with a water/cement ratio of 0.45, by weight. Water shall be potable. The cement shall be added to the water. Mixing of the grout shall continue until the grout is free of lumps and undispersed cement. The grout then shall be poured into the steel tube to completely fill it. Six 2 by 2 by 2 in. [50 by 50 by 50 mm] test cubes shall be cast at the same time from the same batch of grout.

5.4 *Test Specimen Conditioning*—The test specimen including the grout test cubes, shall be cured according to Specification C511 at a  $23.74 \pm 1.7^\circ\text{C}$  ( $74.3^\circ\text{F}$  [ $23 \pm 3^\circ\text{F}$ ],  $1.7^\circ\text{C}$ ) temperature and minimum 95 percent% relative humidity until the grout strength, as determined according to Test Method C1019 on at least two  $502$  by  $502$  by  $50$  mm ( $22$  in. [50 by 250 by 2 in.] 50 mm] test cubes, has reached a compressive strength of  $243500$  to  $28$  MPa ( $35004000$  psi [24 to 4000 psi] 28 MPa] The seal around the hole in the base plate may be removed once the grout has set.

5.5 The loss in height of the cured test cylinder because of grout bleed or drainage of water, or both, through the interstices of the seven-wire strand shall not be more than  $13$  mm ( $0.5$  in.) than  $0.5$  in. [13 mm]. Test cylinders with a height loss of more than  $13$  mm ( $0.5$  in.)  $0.5$  in. [13 mm] shall be discarded and new test cylinders prepared using a more thorough mixing of the grout or sealing the interstices of the seven-wire strand, or both, within the  $50$  mm ( $2$  in.)  $2$ -in. [50-mm] wide tape bond-breaker zone shown in Fig. 1. However, tests performed successfully on test cylinders shorter than the allowed minimum length, shall be deemed acceptable.

#### 6. Pull Test

6.1 *Pull Test Setup*—With the test specimen supported with its base plate on the table of the testing machine or load frame, the free strand protruding from the base plate shall be gripped by the jaws of the testing machine or load frame with a minimum of  $300$  mm ( $12$  in.) 12 in. [300 mm] of free strand in between the base plate and the jaws.

<sup>3</sup> Styrofoam is a registered trademark of The Dow Chemical Company.