



Designation: E 1512 – 01

Standard Test Methods for Testing Bond Performance of Bonded Anchors¹

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1. Scope

1.1 These test methods cover instructions for making a variety of tests for the strength of the adhesive bond developed between a steel anchor and the surface of a hole in concrete or masonry (including masonry units and mortar joints) and for assessing the effects on such bond of a variety of factors including elevated temperature, fire, moisture, and freezing and thawing action. The specifier or manufacturer shall select those tests that are appropriate for the given anchoring system and intended application.

1.2 The adhesive-bonded anchor system refers to a smooth or deformed steel bar or threaded rod, set in a predrilled hole containing chemical bonding compounds. Loads are transferred mainly by the bond of the adhesive both to the anchor and the surrounding elements along the sides of the hole. For anchoring systems made of significantly different materials, these test methods shall be taken as a guideline.

1.3 This standard applies to all adhesives used to bond steel anchors or steel reinforcement bars (rebar) to concrete or masonry. These test methods apply to anchorages used in uncracked concrete or masonry. They do not apply to the use of the anchor in the concrete tension zone. The usual forces applied during the tests are in tension, shear, and under a combination of both tension and shear.

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

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 to determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:

C 666 Test Method for Resistance of Concrete to Rapid

Freezing and Thawing²

E 119 Test Methods for Fire Tests of Building Construction and Materials³

E 488 Test Method for Strength of Anchors in Concrete and Masonry Elements⁴

E 575 Practice for Reporting Data from Structural Tests of Building Constructions, Elements, Connections, and Assemblies⁴

3. Terminology

3.1 Definitions of Terms Specific to This Standard:

3.1.1 *baseline test*—restrained test conducted on anchors installed in the same test member and under the same installation method as a required environmental test for comparison purposes.

3.1.2 *bonded anchor*—a fastener placed in hardened concrete or masonry that derives its holding strength from a chemical compound placed between the wall of the hole and the embedded portion of the anchor.

4. Significance and Use

4.1 These test methods are intended to provide information from which applicable design data and specifications are derived for a given anchorage device and for qualifying anchors or anchorage devices.

4.2 These test methods shall be followed to ensure reproducibility of the test data.

5. General Requirements

5.1 The adhesive bonded anchors to be tested shall be representative of the product made available for typical field installations. The manufacturer shall provide information on physical, mechanical, and chemical properties of the anchor system. If required by a customer or approval agency, the testing laboratory shall verify, or have a specialized laboratory verify, the physical, mechanical, and chemical properties of the adhesive.

5.2 The installation equipment, instructions, and procedures shall be as specified by the manufacturer. If there are any

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

³ *Annual Book of ASTM Standards*, Vol 04.07.

⁴ *Annual Book of ASTM Standards*, Vol 04.11.

deviations from the manufacturer's instructions when testing commercial anchors, they shall be described in the report.

5.3 The structural members shall be as described in Test Method E 488.

5.4 The test and measuring equipment for performing static tension and shear tests, as well as dynamic tests, are described in Test Method E 488. For performing long-term creep tests, equipment that will sustain the required loads without distress shall be used.

6. Materials and Manufacture

6.1 The adhesive-bonded anchors shall be installed for use in accordance with written instructions of the manufacturer. An inert filler that does not affect the performance of the components, if specified by the manufacturer, shall be uniformly incorporated in one or both bonding components.

7. Procedure

7.1 This section presents the specific tests that shall be performed as required to evaluate the bonded anchor system. When evaluating bonded anchors in concrete, the concrete strength shall be 3000 ± 500 psi (20 ± 3 MPa) compressive strength, unless otherwise specified, using aggregate of river gravel or crushed rock. Cure the concrete for a minimum of 28 days. Condition the test member to $75^{\circ}\text{F} \pm 10^{\circ}\text{F}$ ($24^{\circ}\text{C} \pm 5^{\circ}\text{C}$) prior to anchor installations, unless otherwise specified. Masonry shall be permitted to be used as the test member.

7.2 Static Tests:

7.2.1 Perform tension and shear tests in accordance with Test Method E 488. All sizes are to be tested at both minimum and maximum embedments expected. Shear tests at the maximum embedment shall be permitted to be excluded if shear tests at a shallower embedment result in a steel failure. If there is a difference greater than 9 anchor diameters between these embedments additional intermediate embedments shall be tested. Clean holes and install anchors as specified by the manufacturer. Measure and record hole diameters and/or drill bit diameters. Install and cure anchors at $75^{\circ}\text{F} \pm 10^{\circ}\text{F}$ ($24^{\circ}\text{C} \pm 5^{\circ}\text{C}$).

7.3 Dynamic Tests:

7.3.1 *Fatigue Tests*—Perform fatigue tests in accordance with Test Method E 488.

7.3.2 *Seismic Tests*—Perform seismic tests in accordance with Test Method E 488.

7.4 Environmental Tests:

7.4.1 The tests given in Sections 7.4.3-7.4.8 are designed to determine the effect of loading and environmental influences on the bond strength of the adhesive. To ensure bond failure, use steel of sufficiently high strength to prevent steel failure of the anchor. To provide comparative standardized data, anchors shall be $\frac{1}{2}$ "-13 UNC Threaded Rod, unless otherwise specified (12 mm), and be embedded 4.5 ± 0.1 inches (115 ± 2.5 mm). Test anchors of other diameters when specified by the purchaser or manufacturer. Install and cure all anchors at $75^{\circ}\text{F} \pm 10^{\circ}\text{F}$ ($24^{\circ}\text{C} \pm 5^{\circ}\text{C}$), unless specified otherwise. Install and cure anchors according to the manufacturers instructions, unless directed otherwise.

7.4.2 The tests given in Sections 7.4.3-7.4.8 shall be conducted as restrained tests or unrestrained tests, unless the

section in question requires a specific test. A restrained test is defined as a test conducted in accordance with Test Method E 488 except that the test equipment support clearance requirements of E 488 do not apply. The reaction base shall be approximately equal to the drilled hole diameter for the anchor to preclude concrete or masonry failure, but allow bond failure. An unrestrained test is defined as a test conducted in accordance with Test Method E 488. If the environmental tests are conducted as restrained tests, baseline tests are required for comparison purposes. Baseline tests are defined as restrained tests conducted on three $\frac{1}{2}$ -inch (12 mm) anchors embedded 4.5 ± 0.1 inches (115 ± 2.5 mm) in the same base material using the same installation method as the required environmental test. If the environmental tests are conducted as unrestrained test, baseline tests are not required.

7.4.3 *Test on Short-term Effect of Fire*—The purpose of this test is to determine anchor performance when subjected to the temperatures and times given in the fire-temperature curve in Test Method E 119. This test shall be conducted in the unrestrained mode. Install and test a minimum of three anchors. Use a test member that is sufficiently large (36" square (1 m square)) to give realistic concrete or masonry response to the fire temperature exposure in the vicinity of the test anchor. Condition the test member in accordance with Test Method E 119 under the "Protection and Conditioning of Test Specimen" section. A typical set-up is shown in Fig. 1. During testing, subject the anchors to a constant tension load. This load shall be the allowable load for the anchor as determined in Section 7.2, or other load as specified by the manufacturer. Maintain the load as the fire temperature is increased in accordance with the Test Method E 119 time-temperature curve. Record temperature and displacement readings at 1-minute increments until failure occurs.

7.4.4 *Radiation Test*—Perform these tests where the radiation resistance of the adhesive is required. The tests shall be conducted as restrained tests, or unrestrained tests. If testing is conducted in the restrained mode, baseline tests are required. Install and test a minimum of three anchors. Expose the test specimens to a minimum gamma radiation level of 2×10^7 rads. Conduct tension tests and compare the irradiated anchor results to the baseline test results if the radiation tests were conducted in the restrained mode. Compare the irradiated anchor results to the results determined in Section 7.2 for the same size anchor if the radiation tests were conducted in the unrestrained mode. Upon completion of the tests, the testing agency shall be responsible for safely disposing of the test samples in accordance with applicable regulations.

7.4.5 *Tests on Effect of Freezing and Thawing Conditions*—The tests shall be conducted as restrained tests, or unrestrained tests. If testing is conducted in the restrained mode, baseline tests are required. Install and test a minimum of three anchors. Freezing-and-thawing resistant concrete shall be used as an option. Cover the surface of the test member, within a minimum 3-inch (76 mm) radius from the center of the test anchor, with tap water, maintaining a minimum of $\frac{1}{2}$ -inch (12 mm) depth throughout the test. Load each anchor with a constant tension load equal to at least 40 % of the ultimate load capacity of the baseline tests for restrained tests, or 40 % of the