Designation: E3121/E3121M – 17

Standard Test Methods for Field Testing of Anchors in Concrete or Masonry[1]

This standard is issued under the fixed designation E3121/E3121M; 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 These test methods cover procedures for static tensile and shear testing of post-installed and cast-in-place anchorage systems in members made of concrete or members made of solid, hollow, or grout-filled masonry and related materials. Tests may be made to determine the ultimate load or to apply a proof load to verify proper installation. Proof load tests performed in the confined condition to verify proper installation shall not be used to develop design values. Only those tests required by the specifying authority need to be performed.

1.2 These test methods are intended for use with such anchorage devices designed to be installed perpendicular to a plane surface of the member.

1.3 Seismic, fatigue, shock, combined tension, and shear and torsion testing are not covered in the methods described herein. If these tests are required, refer to Test Methods E488/E488M for equipment and procedures.

1.4 Both inch-pound and SI units are provided in this standard. The testing may be performed in either system and reported in the system used and converted to the other. However, anchor diameters, threads, and related test equipment shall be in accordance with either inch-pound or SI provisions.

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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.6 *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:*[2]

E4 Practices for Force Verification of Testing Machines

E488/E488M Test Methods for Strength of Anchors in Concrete Elements

E575 Practice for Reporting Data from Structural Tests of Building Constructions, Elements, Connections, and Assemblies

E631 Terminology of Building Constructions

E2265 Terminology for Anchors and Fasteners in Concrete and Masonry

3. Terminology

3.1 For definitions of general terms used in these test methods related to building construction, refer to Terminology E631, and for definitions of terms related to anchoring, refer to Terminology E2265.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *cast-in-place anchor, n*—an anchor that is installed prior to the placement of base material and that derives its holding power from plates, lugs, or other protrusions.

3.2.1.1 *Discussion*—Examples include, headed anchor bolts, specialty inserts, anchor channels, metal straps, and similar embedded items.

3.2.2 *confined test condition, n*—test configuration in which the reaction forces from the test equipment are transferred to the member surface in close proximity to the anchor element.

3.2.3 *Manufacturer's Printed Installation Instructions (MPII), n*—instructions for correct anchor installation under all covered installation conditions as approved and supplied in product packaging by the manufacturer of the anchor system.

3.2.4 *member, n*—the base material in which the anchor is installed and which resists forces from the anchor.

3.2.5 *post-installed anchor, n*—an anchor that is installed after the placement and hardening of base material.

[1] These test methods are under the jurisdiction of ASTM Committee E06 on Performance of Buildings and is the direct responsibility of Subcommittee E06.13 on Structural Performance of Connections in Building Construction.

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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.

3.2.5.1 *Discussion*—Examples include, expansion, undercut, screw, grouted, and adhesive anchors.

3.2.6 *proof load, n*—a test load applied to an anchor for a specified duration, if applicable, to verify proper installation.

3.2.7 *unconfined test condition, n*—test configuration in which the reactions from the test equipment are spaced a suitable distance from the anchor to allow unrestricted development of a conical fracture surface.

3.3 *Symbols:*

3.3.1 *c*—edge distance, measured from centerline of anchor to edge of member or test frame support, in. [mm].

3.3.2 *d*—nominal anchor diameter, in. [mm].

3.3.3 d_{hole}—diameter of drilled borehole in member, in. [mm].

3.3.4 $d_{opening}$—diameter of hole in confining plate for confined tension tests, in. [mm].

3.3.5 *F*—maximum test load, lbf [kN].

3.3.6 *h*—thickness of the member, in. [mm].

3.3.7 h_{ef}—effective depth of embedment of an anchor, in. [mm].

3.3.8 *n*—number of test specimens.

3.3.9 *s*—anchor spacing measured centerline to centerline, in. [mm].

3.3.10 t_{pl}—thickness of confining plate for tension tests, ≥d, in. [mm].

4. Significance and Use

4.1 These test methods are intended to provide data from which applicable performance and design data can be determined for a given anchorage device used in a member of concrete, solid, hollow, or grout-filled masonry, and related materials and for qualifying anchors or anchorage systems. Tests performed in the confined condition shall not be used to develop design values. Proof load tests shall not result in damage to properly installed anchors.

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

5. Apparatus

5.1 *Equipment*—Calibrated electronic load cells or hydraulic ram and pressure gauge systems calibrated together as a system shall be used. This equipment shall be capable of measuring the forces to an accuracy within ±2 % of the calibrated capacity, when calibrated in accordance with Practices E4. For tests which require displacement measurements, use either manually read dial gauges or electronic displacement measuring devices with accuracy of ±0.001 in. [0.025 mm]. The instrument(s) shall be positioned to measure movement of the anchor in the direction of the applied load in such a way that the instrument is not influenced during the test by movement or failure of the anchor or member. If load and corresponding displacement measurements are required, the number of data points recorded shall be selected based on the expected ultimate capacity of the anchor and shall be sufficient to accurately show the load-displacement behavior. The test fixture(s) shall be of sufficient capacity to prevent yielding of its various components and shall ensure that the applied tension loads remain parallel to and centered on the anchors and that the applied shear loads remain parallel to the surface of the member during testing.

5.1.1 *Tension Test*—An example of a typical system for applying tension pull-out forces to a single anchor is shown in Fig. 1A, Fig. 1B, and Fig. 1C. The test system support(s) shall be of sufficient size to prevent local crushing or failure of the surrounding member. Tests may be performed as confined or unconfined (see 6.3 and definitions) as specified. The loading rod shall be of sufficient size and strength to develop the ultimate strength of the anchor at a stress level less than its yield strength. A loading shoe may be used as shown in Fig. 1A or the loading rod may be directly coupled to the anchor as shown in Fig. 1B. If a loading shoe is used, it should be of sufficient thickness to prevent yielding during loading. The thickness should be at least equal to the nominal size of the anchor. Appropriate linkages or fixtures, such as ball and socket spherical device, shall be included in the load path to minimize the direct transfer of bending stress to the anchor due to misalignment of the loading system. For confined tests, a sheet of tetrafluoroethylene (TFE), polytetrafluoroethylene (PTFE), fluorinated ethylene propylene (FEP), or perfluoroalkoxy (PFA) of 0.020 ± 0.004 in. [0.5 ± 0.1 mm] thickness shall be placed between the loading plate and the surface of the member.

5.1.2 *Shear Test*—An example of a typical system for applying shear force to a single anchor is shown in Fig. 2. The thickness of the shear loading plate in the immediate vicinity of the test anchor shall be equal to the nominal bolt diameter to be tested unless another diameter is specified, with a tolerance of –1⁄16 in., +1⁄8 in. [–1.5 mm, + 3.0 mm]. The edges of the shear loading plate shall be chamfered or have a radius to prevent digging into the surface of the member. The hole in the shear loading plate shall have a diameter 0.06 in. ± 0.03 in. [1.5 mm ± 0.75 mm] greater than the test anchor. The initial shape of the hole in the shear loading plate shall correspond to that of the anchor cross section and shall be maintained throughout all tests. Worn or deformed holes shall be repaired. Hardened insert sleeves of the required diameter may be periodically installed in the shear loading plate to meet these requirements. A sheet of tetrafluoroethylene (TFE), polytetrafluoroethylene (PTFE), fluorinated ethylene propylene (FEP), or perfluoroalkoxy (PFA) of 0.020 ± 0.004 in. [0.5 ± 0.1 mm] thickness and corresponding to the area required according to Table 1 shall be placed between the shear loading plate and the surface of the member.

5.1.3 *Anchor Displacement Measurement*—For anchor tests that require displacement measurements, the displacement measurements shall be made using LVDT device(s), dial gauges, or equivalent.

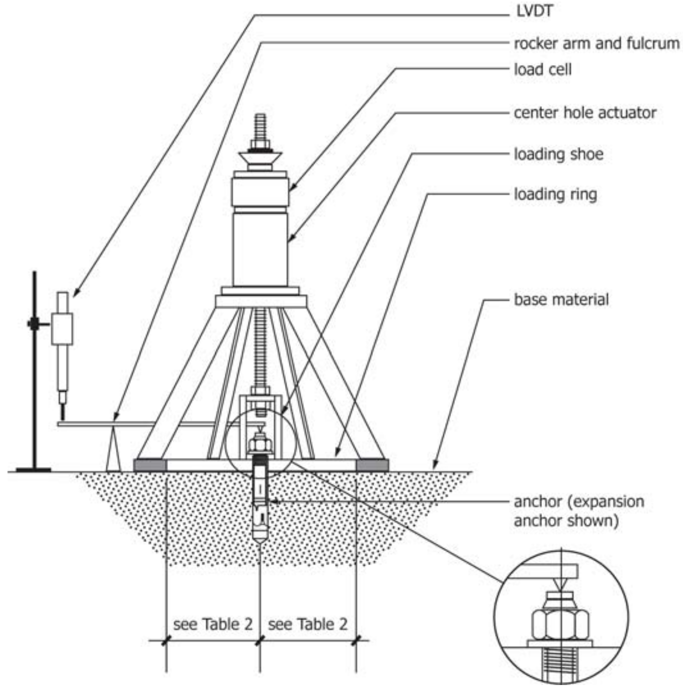

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FIG. 1 A Typical Example of Unconfined Tension Test Setup–Displacement Measurement from Top of Anchor

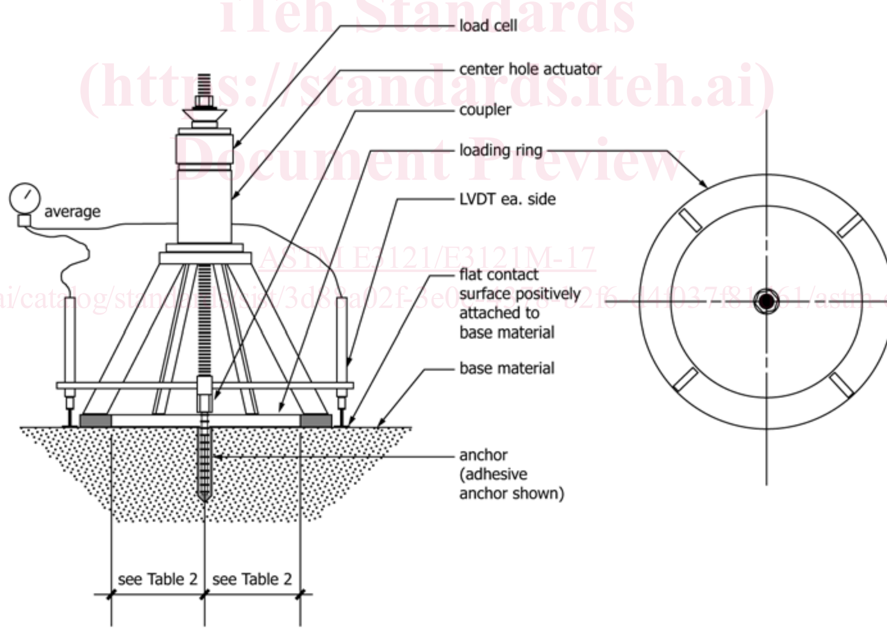

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FIG. 1 B Typical Example of Unconfined Tension Test Setup–Displacement Measurement with Dual LVDTs *(continued)*

5.1.3.1 *Tension Test:*

(1) Single Anchor—The displacement measuring device(s) shall be positioned to measure the vertical movement of the anchors with respect to points on the member in such a way that the device is not influenced during the test by deflection or failure of the anchor or member as shown in Fig. 1A, Fig. 1B, and Fig. 1C.

(2) Group of Anchors—Displacement measurements shall be made on all anchors or group of anchors tested simultaneously except that only one set of instruments needs to be used for a group of anchors tested as a closely spaced cluster. Displacement measurements as described in 5.1.3 include components of deformation not directly associated with displacement of the anchor relative to the member. Include components of deformation such as elastic elongation of the loading rod anchor stem, deformation of the loading plate, sleeves, shims, attachment hardware, and local member material. Deduct all of the elongations from these sources from the