



Standard Test Methods for Strength of Power-Actuated Fasteners Installed in Structural Members¹

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1. Scope

1.1 These test methods describe procedures for determining the static axial tensile and shear strengths of power-actuated fasteners installed in structural members made of concrete, concrete masonry, and steel.

1.2 These test methods are intended for use with fasteners that are installed perpendicular to a plane surface of the structural member.

1.3 Tests for combined tension and shear, fatigue, dynamic, and torsional load resistance are not covered.

1.4 The values stated in metric (SI) units are to be regarded as standard. The inch-pound units 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 determine the applicability of regulatory limitations prior to use.* Specific hazard statements are given in Section 6.

2. Referenced Documents

2.1 ASTM Standards:

- E 4 Practices for Force Verification of Testing Machines²
- E 171 Specification for Standard Atmospheres for Conditioning and Testing Flexible Barrier Materials³
- E 575 Practice for Reporting Data from Structural Tests of Building Constructions, Elements, Connections, and Assemblies⁴
- E 631 Terminology of Building Constructions⁴

2.2 ANSI Standard:

- A10.3 Safety Requirements for Powder-Actuated Fastening Systems⁵

¹ These test methods are under the jurisdiction of ASTM Committee E-6 on Performance of Buildings and are the direct responsibility of Subcommittee E06.13 on Structural Performance of Connections in Building Construction.

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² *Annual Book of ASTM Standards*, Vol 03.01.

³ *Annual Book of ASTM Standards*, Vol 15.09.

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

⁵ Available from American National Standards Institute, 11 West 42nd Street, New York, NY 10036.

3. Terminology

3.1 Definitions of general terms may be found in Terminology E 631.

3.2 Descriptions of Terms Specific to This Standard:

3.2.1 *powder-actuated fastening system*—a system that uses explosive powder to embed the fastener in structural elements.

3.2.2 *power-actuated fastening system*—a system that uses explosive powder, gas combustion, or compressed air or other gas to embed the fastener in structural elements.

3.2.3 *drive pin*—a nail-like metal fastener designed to attach one material to another.

3.2.4 *threaded stud*—a round metal-wire fastener, with a pointed shank at one end and threads along the other end, designed to be used as a removable fastening or in conjunction with a threaded coupler.

3.2.5 *structural member*—an element of a structural system such as a beam, column, or truss.

3.2.6 *static load*—a load or series of loads that are supported by or are applied to a structure so gradually that forces caused by change in momentum of the load and structural elements are negligible and all parts of the system at any instant are essentially in equilibrium.

3.2.7 *tensile test*—a test in which a fastener is loaded axially in tension at a specified rate.

3.2.8 *shear test*—a test in which a force is applied perpendicularly to the axis of the fastener and parallel to the surface of the structural member.

3.2.9 *fastener spacing, s*—the distance between the longitudinal axes of two fasteners in the same plane. Also, distance between longitudinal axis of fastener and nearest edge of test-system supports (see *s* in Fig. 1).

3.2.10 *edge distance, c*—the distance from the longitudinal axis (center) of a fastener to the nearest edge of the structural member in which it is installed.

3.2.11 *embedment depth, h_{ef}* —the distance from the surface of the structural member to the installed end of the fastener including its point, if any.

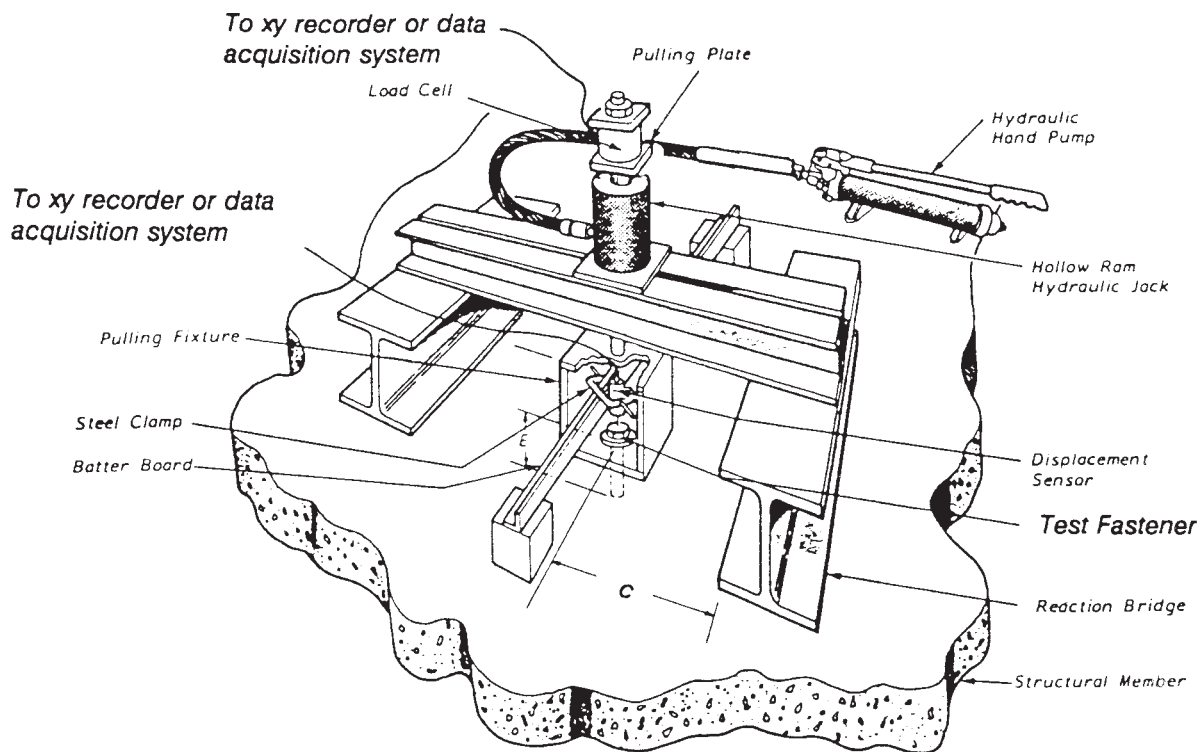


FIG. 1 Typical Static Tension Test Arrangement

3.2.12 *displacement*—movement of a fastener relative to the structural member. In tensile tests, displacement is measured along the axis of the fastener; in shear tests it is measured in the direction of the applied load perpendicular to the axis of the fastener.

4. Significance and Use

4.1 These test methods are intended to measure the anchoring capability and shear resistance of power-actuated fasteners to provide information from which applicable design values are to be derived for use in structural applications, such as in members of concrete, concrete masonry, and steel.

5. Apparatus

5.1 *Equipment*—Any system suitable for applying tensile and shear forces shall be used, provided the requirements for rate of loading in 9.4 are met, and the instrumentation is capable of measuring the forces to an accuracy within $\pm 2\%$ of the applied force, when calibrated in accordance with Practices E 4. The device shall be of sufficient capacity to prevent yielding of its various components and shall ensure that the applied tensile forces remain parallel to the axes of the fasteners and that the applied shear forces remain parallel to the surface of the structural member during testing. Load cells shall be used for laboratory testing. If pressure gages are used for field testing, they shall be calibrated immediately prior to use.

5.1.1 *Tensile Test*—A system suitable for applying tensile forces is shown in Fig. 1 for a single fastener specimen. The test system supports shall be of sufficient size to prevent failure of the surrounding structural member. The loading rod shall be of a size to develop the ultimate strength of the fastener

hardware with minimal elongation and shall be attached to the fastener by means of a connector that will minimize the direct transfer of bending forces through the connection. When displacements are measured, dial gages or a linear variable differential transformer (LVDT) shall be mounted in a manner so as to ensure accurate displacement measurement.

5.1.2 *Shear Test:*

5.1.2.1 A system suitable for applying shear forces is shown in Fig. 2 for a single fastener specimen. The components of the test fixture shall be of sufficient size and strength to prevent yielding during application of the ultimate test load. The test system support shall be of sufficient size to prevent local failure of the structural member in the bearing contact area. When displacements are measured, dial gages or a linear variable differential transformer (LVDT) shall be mounted in a manner so as to ensure accurate displacement measurement.

5.1.2.2 The thickness of the shear fixture in the immediate vicinity of the test fastener shall be approximately equal to the fastener diameter at the point of intersection of the fastener and the base material unless otherwise specified. The hole in the shear fixture designed to accommodate the fastener shall have a diameter that is 0.5 ± 0.1 mm (0.020 ± 0.004 in.) greater than that of the fastener tested. The initial shape of the hole in the shear fixture shall correspond to that of the fastener cross section and shall be maintained throughout all tests. Worn or deformed holes shall be repaired. When required, insert sleeves shall be installed in the shear plate to meet these requirements, provided they do not increase deformation of the anchorage under load.

5.2 *Optional Displacement Measurements*— Displacement or deformation measurements are not required to derive design data for a given fastening system.

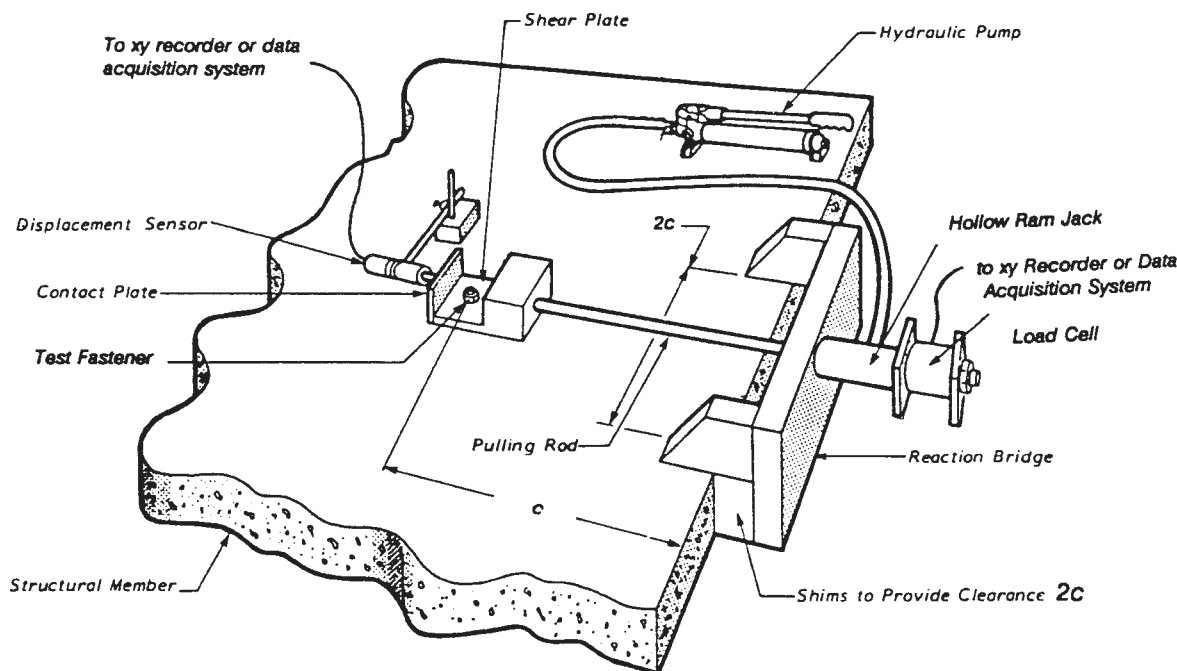


FIG. 2 Typical Static Shear Test Arrangement

5.2.1 *Tension Test* (see Fig. 1)—Dial gages, having a smallest division of not more than 0.025 mm (0.001 in.), or any suitable measurement devices or calibrated sensors of at least comparable accuracy and sensitivity, such as an LVDT, shall be used to measure displacement of the fastening system relative to the structural member. The instruments shall be positioned to measure the vertical movement of the fastener with respect to points on the structural member, at a minimum distance of 40 mm (1.6 in.) from the center of the test fastener. The instruments shall be mounted on the fastener specimen or loading rod at a distance not more than 100 mm (4.0 in.) from the structural member surface, in order to minimize extraneous movements (hardware elongation) in the displacement measurements.

5.2.2 *Tests of a Group of Fasteners*— Only one set of instruments is required for a group of fasteners tested as a closely spaced cluster. The displacement to be used for the evaluation of the findings is the average deformation indicated by all instruments mounted symmetrically equidistant from the center of the cluster.

5.2.3 *Shear Test* (see Fig. 2)—A single dial gage, having a smallest division of not more than 0.025 mm (0.001 in.) or any suitable measurement device, such as an LVDT, or calibrated sensor of at least comparable accuracy and sensitivity shall be used to measure the displacement of the fastening system relative to the structural member. The instrument shall be positioned to measure displacement in the direction of the applied force. The displacement sensor shall be placed on the structural member to allow the sensing element to be in direct contact with the fastener or be attached directly to the fastener. For tests on clusters of fasteners, the instrument shall lie in a plane through the axis of the shear loading rod or plate. An extension of the axis of the shear fixture shall pass through the centroid of the cluster of fasteners.

6. Hazards

6.1 Take precaution to ensure that people are not injured and that test equipment, instrumentation, and the building, its components, and its finish are not damaged prior to, during, or after load application, by any unexpected release of potential strain energy accumulated during testing.

6.2 All operators of powder-actuated tools used for the installation of test specimens shall be licensed by the manufacturer. Operators shall comply with ANSI Standard A 10.3 requirements and local safety requirements.

7. Test Specimens

7.1 *Fastening System*—The fastening system shall be representative of the type and lot to be used in field construction and shall include all accessory hardware normally required.

7.2 *Fastener Installation*—The fasteners shall be installed using the manufacturer's installation instructions and tools or, where specific deviation is justified, in accordance with accepted field methods or to meet the requirements of the tests.

7.3 *Fastener Placement*—All fasteners (types, sizes, embedment depths) to be used in a given installation shall either be tested individually or in groups of two or more at the intended spacing. Fasteners shall be installed at distances equal to or greater than those specified in Table 1 to preclude influences from adjacent fasteners or edges during testing. These distances are not to be considered minimum distances. Tests shall be performed to determine minimum spacing and edge distances.

7.4 *Structural Member*—The structural member in which the fastener is to be installed shall be representative of the materials and configuration intended for field use. Concrete or masonry structural members do not have to be reinforced with steel (Note 1).