Designation: ~~A944 – 10 (Reapproved 2015)~~ A944 – 22

Standard Test Method for Comparing Bond Strength of Steel Reinforcing Bars to Concrete Using Beam-End Specimens[1]

This standard is issued under the fixed designation A944; 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~~ Scope*

1.1 This test method describes procedures to establish the relative bond strength of steel reinforcing bars in concrete.

1.2 This test method is intended to determine the effects of surface preparation or condition (such as bar coatings) on the bond strength of deformed steel reinforcing bars (of sizes ranging from No. ~~10~~3 to No. ~~36~~11 [No. ~~3~~10 to No. ~~11~~)36]) to concrete.

1.3 The bond strengths obtained using this test method are not directly applicable to the design of reinforced concrete members.

NOTE 1—The bond strengths obtained using this test method are generally higher than obtained in development or splice tests using beams with the same embedment lengths. The results obtained using this test method should only be used for comparisons with results for other reinforcing bars tested using this method.

1.4 The values stated in inch-pound units are to be regarded as standard. The values given in brackets are mathematical conversions to SI units that are provided for information only and are not considered 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~~ safety, health, and ~~health~~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]

~~A775/A775M Specification for Epoxy-Coated Steel Reinforcing Bars~~
C192/C192M Practice for Making and Curing Concrete Test Specimens in the Laboratory
E4 Practices for Force Calibration and Verification of Testing Machines
E575 Practice for Reporting Data from Structural Tests of Building Constructions, Elements, Connections, and Assemblies

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

[1] 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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[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.

***A Summary of Changes section appears at the end of this standard**

3.1.1 *bond strength, n*—maximum measured load in a tensile bond test of a steel reinforcing bar.

3.1.2 *bonded length, n*—the length of the test bar that is in contact with concrete.

3.1.3 *concrete cover, n*—minimum distance between the surface of the test bar and the top or bottom of the test specimen.

3.1.4 *embedment length, n*—the distance from the surface of the concrete test specimen to the installed end of the steel reinforcing bar. This equals the sum of the lead length and the bonded length.

3.1.5 *lead length, n*—the length of the test bar that is not in contact with concrete but is between the surface of the concrete test specimen and the bonded length.

3.1.6 *relative rib area, n*—ratio of the projected rib area normal to bar axis to the product of the nominal bar perimeter and the center-to-center rib spacing.

3.2 *Symbols:*

C_{bc} = Concrete cover, ~~mm [in.].~~in. [mm].

d_b = Nominal diameter of reinforcing bar, ~~mm [in.].~~in. [mm].

~~l~~ℓ_e = Embedment length, ~~mm [in.].~~in. [mm].

4. Apparatus

4.1 *Equipment*—A schematic of a suitable testing system is shown in Fig. 1. The loading system shall be capable of measuring the forces to an accuracy within ±2 % of the applied load, when 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~~force remains parallel to the axis of the steel reinforcing bar during testing.

4.2 *Compression Reaction Plate*—The compression reaction plate shall be placed a minimum clear distance equal to 0.9 ~~l~~times the embedment length (ℓ_e) measured from the center of the test bar to the edge of the reaction plate.

4.3 *Bar Displacement Measurements*—Displacements of the loaded and free ends of the steel reinforcing bar shall be measured

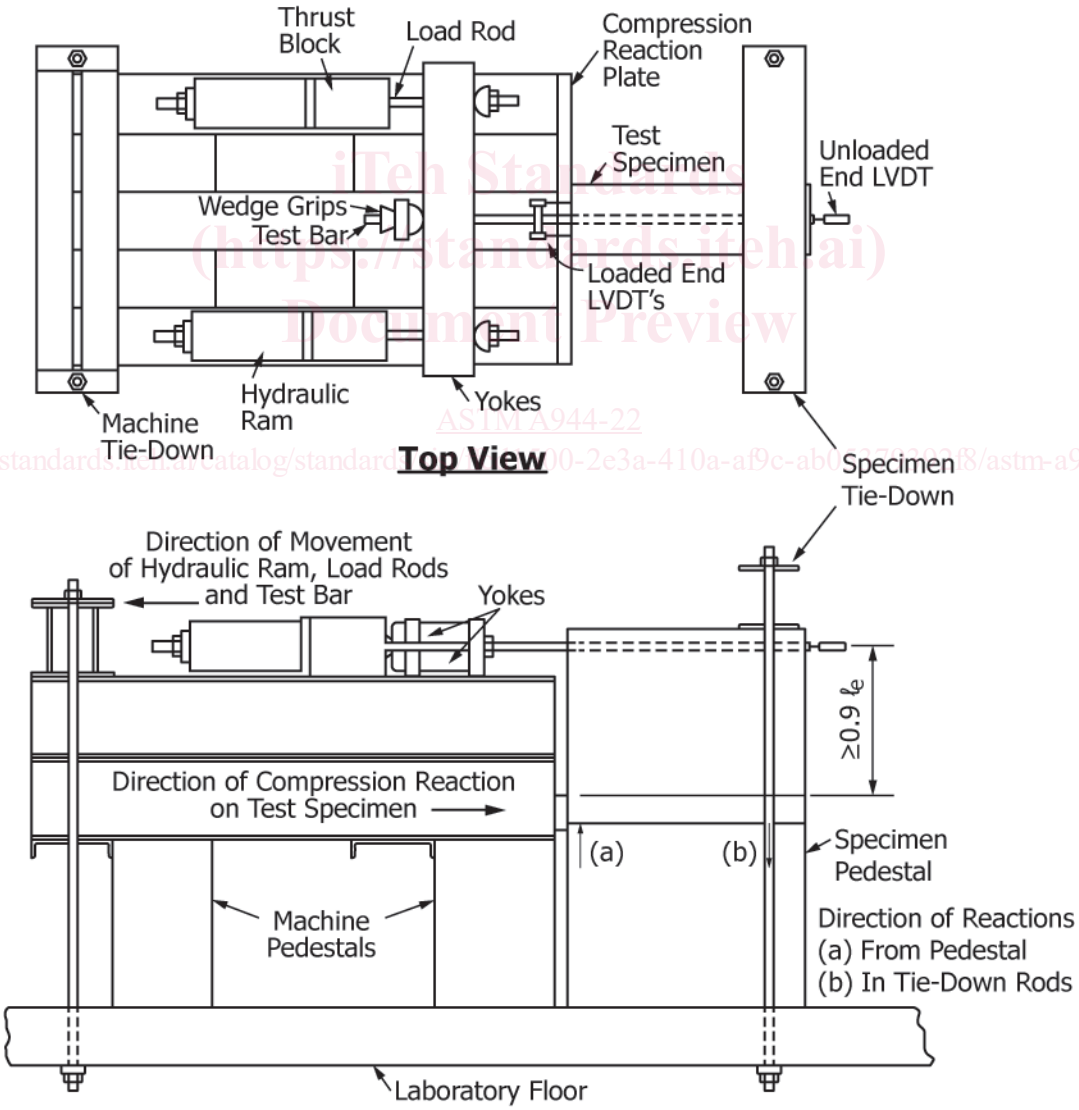

FIG. 1 Schematic of Test Apparatus

with respect to the loaded and free surfaces, respectively, of the concrete using suitable measurement devices. Dial gages having the smallest division of not more than ~~25 µm [0.001 in.]~~ 0.001 in. [25 µm] or linear variable differential transformers (LVDTs) with equal or superior accuracy are examples of satisfactory devices.

5. Test Specimen

5.1 *Beam-End Specimen*—The test specimen shall consist of the test bar cast in ~~a block of~~ reinforced concrete ~~600 ± 25 mm [24 ± 1 in.]~~24 in. ± 1 in. [600 mm ± 25 mm] long by d_b + ~~200~~8 ± ~~13~~½ ~~mm~~in. [d_b + ~~8~~200 ± ~~½ in.~~]13 mm] wide by a minimum of d_b + C_{bc} + ~~l~~ℓ_e + ~~60~~2½ ~~mm~~in. [d_b + C_{bc} + ~~l~~ℓ_e + ~~260~~½ ~~in.~~]mm] high. A typical test specimen shown in casting position is illustrated in Fig. 2. Specimens are inverted prior to testing. The specimen shall be reinforced by four closed stirrups oriented parallel to the sides of the specimen and two flexural steel reinforcing bars parallel to the test bar, as shown in Fig. 2. Transverse steel reinforcing bars similar to those illustrated in Fig. 2 may be used to aid in fabrication and testing. The test bar shall extend from the front surface a distance that is compatible with the test system. Two polyvinyl chloride (PVC) pipes shall be used as bond breakers to control the bonded length of the bar and to avoid a localized cone-type failure of the concrete at the loaded end of the specimen. The PVC pipes shall be sized so as to minimize the gap between the test bar and pipe wall, and the gap between the PVC pipe and test bar shall be caulked or otherwise sealed to prevent concrete from flowing into the pipes. The free end of the test bar shall butt against a hollow steel conduit or other device to provide access to the free end for measuring slip during the test; alternatively, access to the free end of the test bar shall be provided without the hollow steel conduit by extending the interior PVC pipe and test bar to the end of the specimen. All specimens in a test series shall use the same method to provide access to the free end of the bar. The closed stirrups shall be fabricated from Grade ~~420~~60 [Grade ~~60~~]420] No. ~~10~~3 [No. ~~3~~]10] bars for test bars up to and including No. ~~25~~8 [No. ~~8~~]25] and No. ~~13~~4 [No. ~~4~~]13] bars for test bars larger than No. ~~25~~8 [No. ~~8~~].25]. The two flexural steel reinforcing bars shall be selected so as to provide a total area not less than that of the test bar.

NOTE 2—Alternatively, the interior PVC pipe may be extended to the back of the specimen.

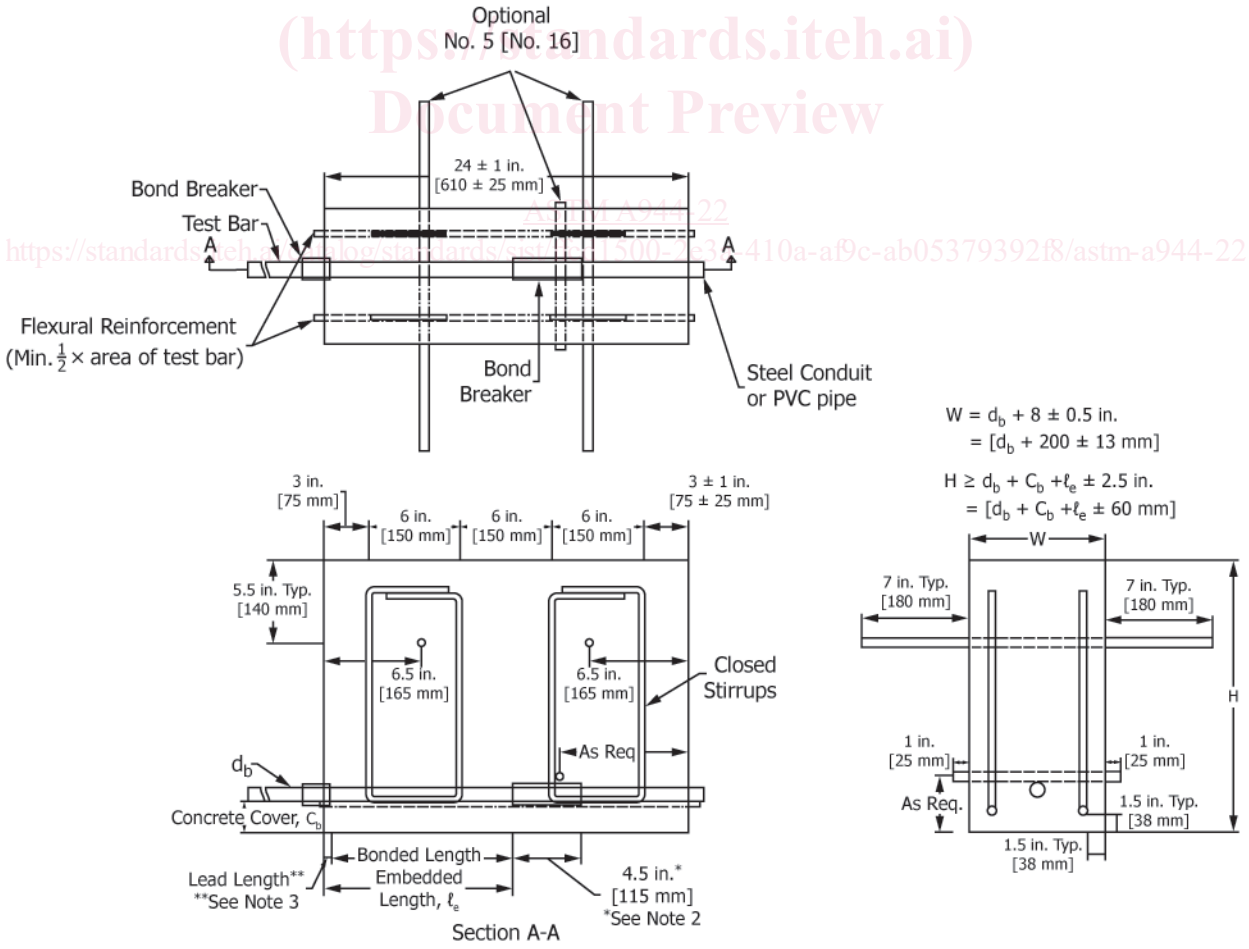

FIG. 2 Beam-End Test Specimens in Casting Position