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Standard Test Methods for Flexural Bond Strength of Masonry[1]

This standard is issued under the fixed designation E 518; 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.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope*

1.1 These test methods cover determination of the flexural bond strength of unreinforced masonry assemblages. Two procedures are provided:

1.1.1 *Test Method A*—Simply supported beam with third-point loading.

1.1.2 *Test Method B*—Simply supported beam with uniform loading.

~~1.2The values stated in SI units are to be regarded as the standard.~~

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

1.3 *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:*[2]

C 67 Test Methods for Sampling and Testing Brick and Structural Clay Tile

C 78 Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)

C 140 Test Methods for Sampling and Testing Concrete Masonry Units and Related Units

C 270 Specification for Mortar for Unit Masonry

C 778 Specification for Standard Sand

E 4 Practices for Force Verification of Testing Machines

E 72 Test Methods of Conducting Strength Tests of Panels for Building Construction

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

3. Significance and Use

3.1 These test methods are intended to provide simplified and economical means for gathering comparative research data on the flexural bond strength developed with different types of masonry units and mortar or for the purpose of checking job quality control (materials and workmanship).

NOTE 1—These test methods are not intended for use in establishing design stresses. For this purpose, Methods E 72 should be used.

4. Apparatus

4.1 *Testing Machine*, conforming to the requirements of Practices E 4.

4.2 *Test Method A*—The third-point loading method is illustrated in Fig. 1. ~~The load is applied by means of a loading apparatus similar to that described in Test Method C78.~~

~~4.3~~. *The minimum span between supports shall not be less than 2.5 multiplied by the average depth of the specimen. The distance between each support and the adjacent distributed point load shall be one-third of the span length ±3 mm (0.1 in.). Steel rods with a maximum diameter of 25 mm (1 in.) shall be used to support the specimen and apply the load. The steel rods shall extend over the full width of the specimen.*

NOTE 2—The loading apparatus is intended to be similar to that used in Test Method C 78 to reduce the need for redundant testing equipment.

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[1] These test methods are under the jurisdiction of ASTM Committee C15 on Manufactured Masonry Units and are the direct responsibility of Subcommittee C15.04 on Research.

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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* ~~, Vol 04.05~~.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.**

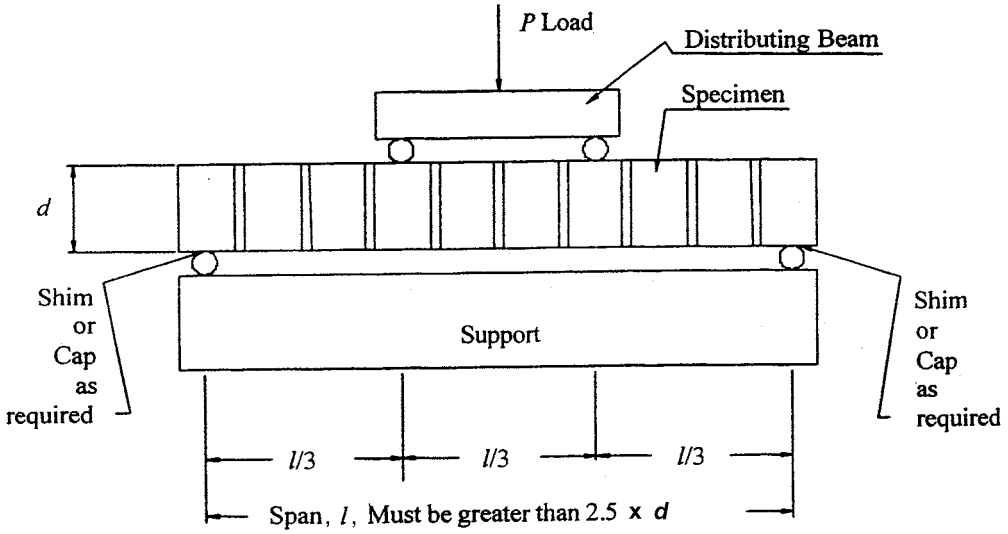

FIG. 1 The Third-Point Loading Method (Test Method A)

4.3 *Test Method B*—The uniform loading method is illustrated in Fig. 2. ~~The load is applied by means of an air bag typically made of poly(vinyl chloride) 0.5 mm (0.02 in.) thick. The air bag shall be of any convenient thickness and shall have a contact area equal to that of the specimen. It shall be equipped with two valves for inflating and deflating the bag. The air bag shall be backed by a steel channel suspended from the cross head of the testing machine with a suitable stud welded to the web of the channel. The channel shall be an American Standard steel channel whose depth is equal to the width of the air bag. It is recommended that the air pressure in the bag be monitored during the test as a check against the test machine dial indicator.~~ . The minimum span between supports shall not be less than 2.5 multiplied by the average depth of the specimen. Uniformly distributed transverse load shall be applied by air pressure over the full surface of the specimen. The air bag reaction frame shall fully contact one surface of the air bag and shall be sufficiently stiff as to not measurably deflect during testing.

NOTE ~~2—When~~ 3—Air bags manufactured using 0.5 mm (0.02 in.) thick polyvinyl chloride have been successfully used with this test. When testing specimens constructed with a high bond-strength mortar, or whose thickness is greater than a nominal 100 mm (4 in.), the applied load required to fail the specimen may be such as to rupture the seams of the air bag. In such cases Test Method A is recommended.

5. Sampling and Testing

5.1 *Masonry Units*—Representative masonry units shall be sampled and tested in accordance with the following applicable methods: Test Methods C 67 for brick, or Test Methods C 140 for concrete masonry units. Minimum tests required shall be compressive strength, and initial rate of absorption for brick or absorption for concrete masonry units.

5.2 *Mortar*—One of the types of mortar in Specification C 270 shall be used, or the mortar shall conform to that specified for the construction. Sand sieve analysis shall be performed and recorded, except when ASTM C 778 standard sand is used. If ASTM C 778 standard sand is used, the record shall identify the sand as 20–30 sand, graded sand, or a blend of indicated proportions of each sand by weight.

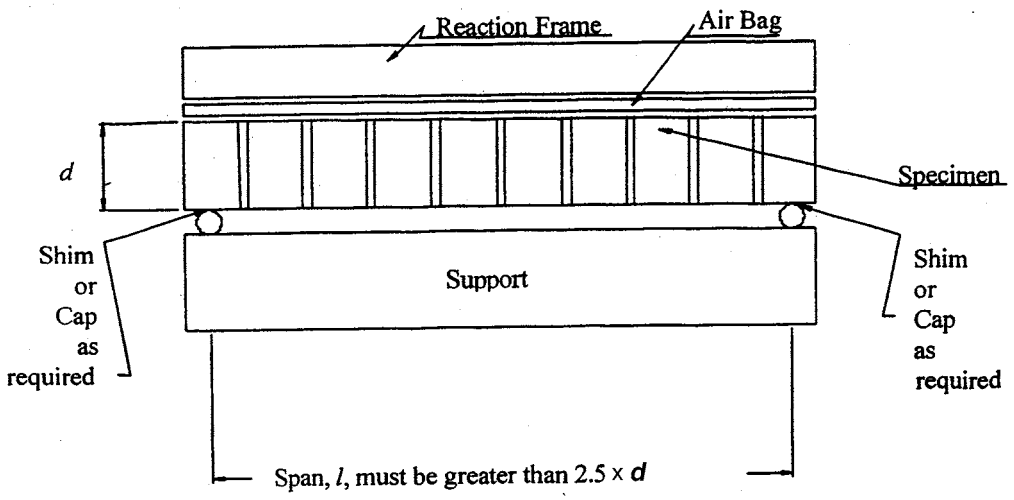

FIG. 2 The Uniform Loading Method (Test Method B)

5.2.1 Mortar for prism fabrication shall be mixed to a workable consistency. The compressive strength, initial flow, and water retention of the mortar shall be determined in accordance with the requirements of Specification C 270, except that the cubes molded for the compressive strength test, after moist curing in the molds for 24 h, shall be released and stored in the same atmosphere as the prisms as specified in Section 7. The following physical properties of the mortar shall be determined and recorded:

5.2.2 Compressive strength (average of three cubes),

5.2.3 Initial flow (laboratory-mixed mortar only),

5.2.4 Flow after suction (water retention) (laboratory-mixed mortar only).

6. Test Specimens

6.1 A minimum of five test specimens shall be constructed as stack-bonded prisms, at least 460 mm (18 in.) high with mortar joints 10 ± 1.5 mm (⅜ ± 1⁄16 in.) in thickness. The number of courses in each specimen shall be such as to permit locating supports and loading points midway between joints for Test Method A tests (4, 7, 10, 13, or 16 courses, depending on face heights of units), and to provide for a span-to-depth ratio that exceeds 2.5. When the test is for the purpose of determining the quality of materials and workmanship during construction, the specimens shall be constructed at the site by the masons involved, utilizing the materials on the site and the same masonry construction techniques.

6.2 Applicable portions of the following procedures shall be observed:

6.2.1 Set units on a firm, flat surface without the use of mortar, leaving not less than 50-mm (2-in.) spaces between stretchers.

6.2.2 Place a full or face shell mortar bed (in accordance with job specification) on all units without furrowing.

6.2.3 Immediately place the next course of units on the mortar bed and tap each unit to level. Align at least one vertical face of each prism to a plane using a level or other means. (~~Note 3~~Note 4).

6.2.4 Repeat steps 6.2.2 and 6.2.3 until the prisms are the required number of courses high. Tool or otherwise finish the joints as specified.

NOTE ~~3—A~~ 4—A convenient method of aligning one face is to use a jig as illustrated in Fig. 3.

7. Handling and Curing Conditions

7.1 Unless otherwise specified, all prisms shall be cured for 28 days. The prisms together with corresponding mortar cubes shall be cured in laboratory air maintained at a temperature of 24 ± 8°C (75 ± 15°F), with a relative humidity between 30 and 70 %, and free of drafts. These environmental conditions generally will not require special air-conditioning equipment. A continuous graphical record of temperature and humidity will suffice to detect unusual dryness or excessive moisture, together with unusual fluctuations of temperature.

7.1.1 Where prisms are made during construction at the job site, they shall be constructed in a place where they will not be disturbed, but will be subjected to air conditions similar to those in the masonry structure.

8. Procedure

8.1 Place the test specimen horizontally on its supports as a simply supported beam. If full contact is not obtained between the specimen and the load-applying blocks and supports, compressible shims or a bed of gypsum capping material shall be used to level and seat the specimen thereby ensuring the uniform application of load. If compressible shims are used, they shall be made of leather or similar compressible material of uniform-thickness, not less than 6 mm (¼ in.) thick, 25 to 50 mm (1 to 2 in.) in width, and shall extend across the full width of the specimen.

8.2 Apply the load at a uniform rate of travel of the moving head such that the total load is applied in not less than 1 nor more than 3 min.

8.3 Record the maximum applied load in Newtons (pounds) as P and the location of the break.

9. Calculation

9.1 For specimens built with solid masonry units (75 % or more net area), calculate the gross area modulus of rupture as follows (See Note 5):

9.1.1 For Test Method A, with third-point loading:

$$R = \frac{(P + 0.75\,P_s)l}{bd^2} \tag{1}$$

where:

R = gross area modulus of rupture, MPa (or psi),
P = maximum applied load indicated by the testing machine, N (or lbf),
P_s = weight of specimen, N (or lbf),
l = span, mm (or in.),
b = average width of specimen, mm (or in.), and
d = average depth of specimen, mm (or in.).