Designation: E518/E518M – 15

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

This standard is issued under the fixed designation E518/E518M; 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 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.

1.2 These test methods cover the application of the tests using either inch-pound or SI units. The values stated in either SI units or inch-pound units are to be regarded separately as standard. Within the text, the inch-pound units are shown in brackets. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in nonconformance with the standard.

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]

C67 Test Methods for Sampling and Testing Brick and Structural Clay Tile

C78 Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)

C140 Test Methods for Sampling and Testing Concrete Masonry Units and Related Units

C270 Specification for Mortar for Unit Masonry

C778 Specification for Standard Sand

C1232 Terminology of Masonry

E4 Practices for Force Verification of Testing Machines

E72 Test Methods of Conducting Strength Tests of Panels for Building Construction

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

3. Terminology

3.1 For terms used in these test methods, refer to Terminology C1232.

4. Significance and Use

4.1 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 E72 should be used.

5. Apparatus

5.1 *Testing Machine,* conforming to the requirements of Practices E4.

5.2 *Test Method A*—The third-point loading method is illustrated in Fig. 1. 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 and shall have the same nominal diameter.

NOTE 2—The loading apparatus is intended to be similar to that used in Test Method C78 to reduce the need for redundant testing equipment.

5.3 *Test Method B*—The uniform loading method is illustrated in Fig. 2. 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 using an air bag 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 deflect more than the span divided by 600 during testing.

NOTE 3—Air bags manufactured using 0.5 mm [0.02 in.] thick

[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.

Current edition approved Dec. 1, 2015. Published January 2016. Originally approved in 1974. Last previous edition approved in 2010 as E518 – 10. DOI: 10.1520/E0518_E0518M-15.

[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**

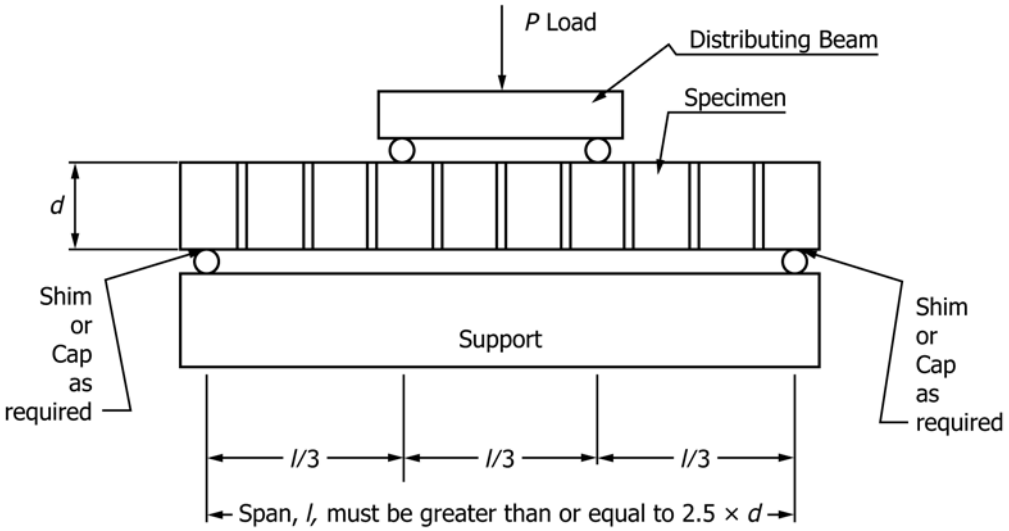

FIG. 1 The Third-Point Loading Method (Test Method A)

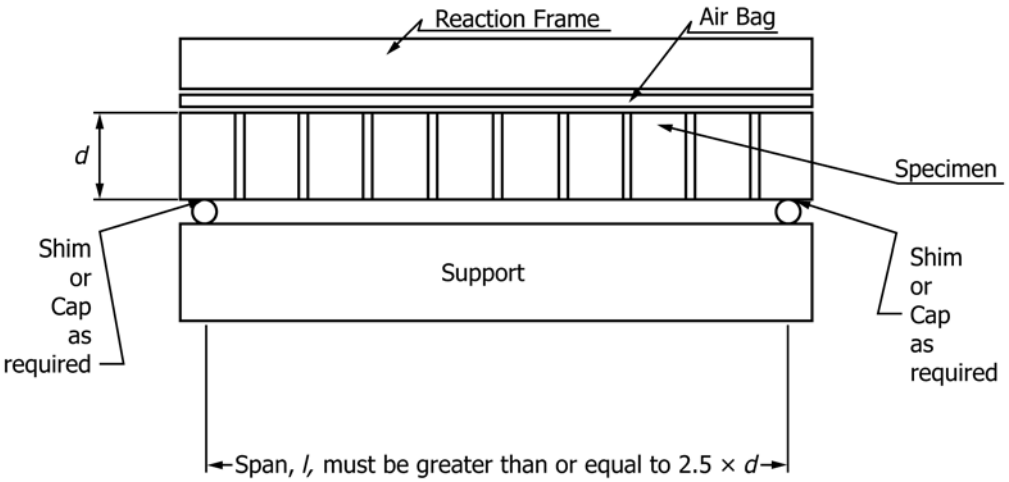

FIG. 2 The Uniform Loading Method (Test Method B)

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.

6. Sampling and Testing

6.1 *Masonry Units*—Representative masonry units shall be sampled and tested in accordance with the following applicable methods: Test Methods C67 for brick, or Test Methods C140 for concrete masonry units. Minimum tests required shall be compressive strength, and initial rate of absorption for brick or absorption for concrete masonry units.

6.2 *Mortar*—One of the types of mortar in Specification C270 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 C778 standard sand is used. If ASTM C778 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.

6.2.1 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 C270, 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 8. The following physical properties of the mortar shall be determined and recorded:

6.2.2 Compressive strength (average of three cubes),

6.2.3 Initial flow (laboratory-mixed mortar only),

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

7. Test Specimens

7.1 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.

7.2 Applicable portions of the following procedures shall be observed:

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

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

7.2.3 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 4).

7.2.4 Repeat steps 7.2.2 and 7.2.3 until the prisms are the required number of courses high. Tool or otherwise finish the joints as specified.

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

8. Handling and Curing Conditions

8.1 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.

8.1.1 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.

9. Procedure

9.1 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,

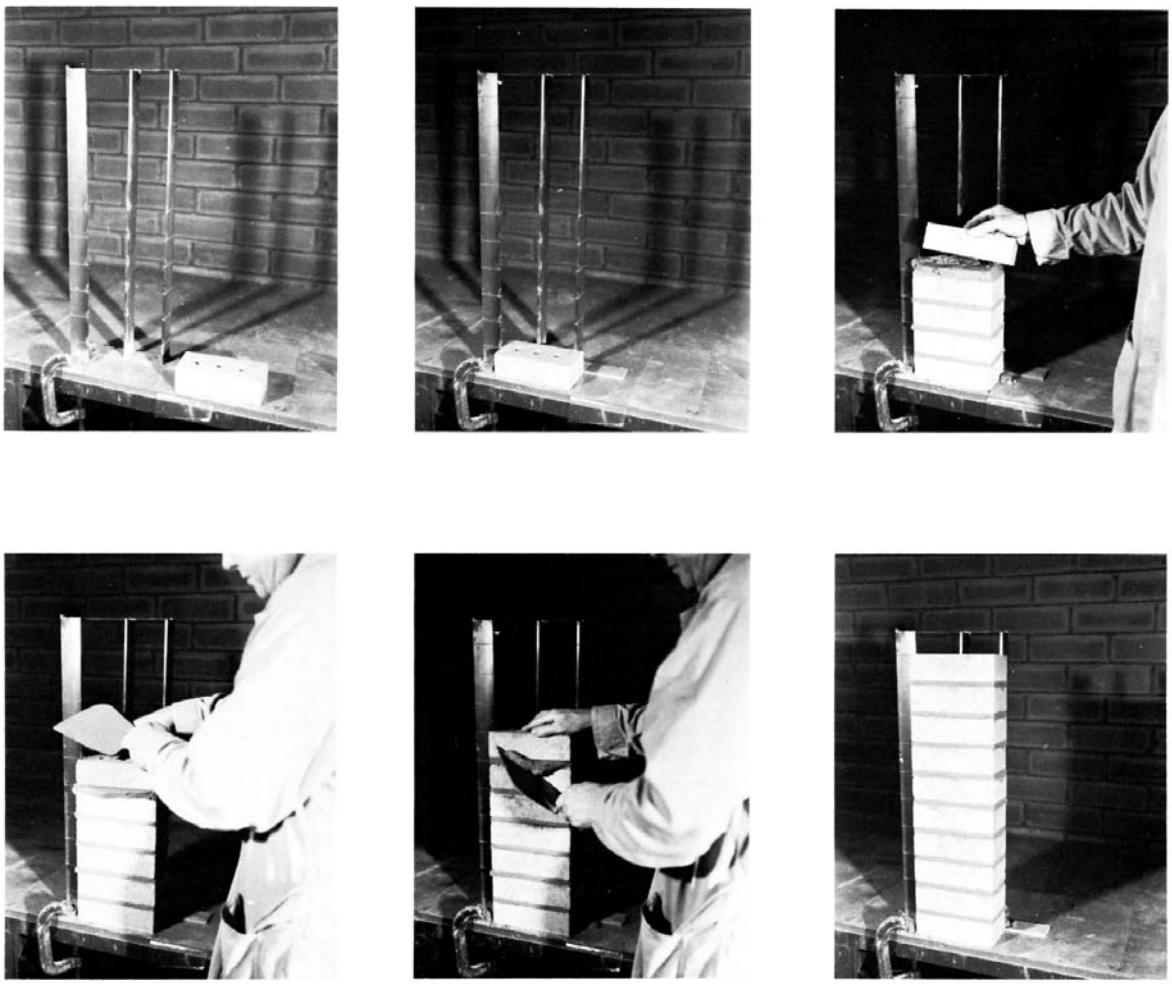

FIG. 3 Use of a Jig to Align One Face of a Prism to a Plane

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.

9.2 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.

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

10. Calculation

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

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

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

where:

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

10.1.2 For Test Method B, with uniform loading:

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

where the terms are the same as those described in 10.1.1.

10.2 For specimens built with hollow masonry units (less than 75 % net area), calculate the net area modulus of rupture as follows (See Note 5):

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

$$R = \frac{(0.167\,P + 0.125\,P_s)l}{S} \quad (3)$$

where:

S = section modulus of actual net bedded area, mm^3 [$in.^3$].

10.2.2 For Test Method B, with uniform loading:

$$R = \frac{0.125\,(P + P_s)l}{S} \quad (4)$$

where S is the same as in 10.2.1.

NOTE 5—The equations for determining the modulus of rupture values in 10.1 and 10.2 assume that the location of the failure plane occurs at the mid-span of the specimen. Where the failure location is other than mid-span, the use of these equations for determining the modulus of rupture will not be entirely accurate. Where a more precise assessment of the specimens' modulus of rupture values is deemed appropriate, a more thorough analysis using accepted engineering mechanics should be employed.

10.3 If the failure occurs in a joint outside of the middle third of the span length for Method A, discard the test results.

11. Report

11.1 The report shall be prepared in conformance with Practice E575 and shall include the following:

11.1.1 Identification number,
11.1.2 Average width of specimen to the nearest 1.0 mm [0.05 in.],
11.1.3 Average depth of specimen to the nearest 1.0 mm [0.05 in.],
11.1.4 Weight of specimen, N [lbf],
11.1.5 Method of applying load (Method A or B),
11.1.6 Maximum applied load, N [lbf],
11.1.7 Individual and average gross or net area moduli of rupture calculated to the nearest MPa [psi]; standard deviation; and coefficient of variation.
11.1.8 Curing history and age of specimen,
11.1.9 Defects in specimen,
11.1.10 Description of failure,
11.1.11 Type and mix design of mortar,
11.1.12 Compressive strength of mortar, kPa [psi],
11.1.13 Initial flow of mortar as used (laboratory-mixed mortar only),
11.1.14 Water retention of mortar (laboratory-mixed mortar only),
11.1.15 Physical properties of masonry units, and
11.1.16 Sketch or photograph of masonry unit showing core configuration and mortar bedded area, full or face shell.
11.1.17 Results of the sand sieve analysis or, if ASTM C778 sand is used, identify which of the defined sands were used.

12. Precision and Bias

12.1 No statement is made either on the precision or on the bias of these test methods due to the variety of materials and combinations of materials involved. Sufficient test data for all materials and combinations of materials are not presently available to permit the development of precision and bias statements.

13. Keywords

13.1 flexural bond strength; masonry units; mortar; simply supported beam; stack bonded prism; third point loading; uniform load

SUMMARY OF CHANGES

Committee C15 has identified the location of selected changes to this standard since the last issue (E518 – 10) that may impact the use of this standard. (December 1, 2015)

(1) Added Terminology C1232 to Section 2.

(2) Added Section 3 to include a terminology reference.