Designation: C 321 – 00 (Reapproved 2005)

Standard Test Method for Bond Strength of Chemical-Resistant Mortars[1]

This standard is issued under the fixed designation C 321; 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 This test method covers the determination of the bond strength between chemical-resistant mortars and chemical-resistant brick.

1.2 *This standard does not purport to address all of the safety problems, 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 279 Specification for Chemical-Resistant Masonry Units
C 287 Specification for Chemical-Resistant Sulfur Mortar
C 904 Terminology Relating to Chemical-Resistant Nonmetallic Materials
E 4 Practices for Force Verification of Testing Machines

3. Terminology

3.1 *Definitions*—For definitions of terms used in this test method, see Terminology C 904.

4. Significance and Use

4.1 This test offers a method of determining the bond strength between chemical-resistant mortars and chemical-resistant brick. The results obtained by this test method should be used as a guide in, but not as the sole basis for, selection of a chemical-resistant material for a particular application. If failure is within the brick, then the result reported shall be stated as a minimum bond strength and it shall be noted that the brick broke.

5. Apparatus

5.1 *Equipment*, capable of weighing materials or specimens to ±0.3 % accuracy.

5.2 *Equipment for Mixing Materials*, consisting of a container of suitable size, preferably made of corrosion-resistant metal, or a porcelain enameled pan, and a strong, sturdy spatula or trowel.

5.3 *Equipment for Melting Sulfur*, consisting of a container of suitable size, preferably made of corrosion-resistant metal, and a heater for melting the sulfur mortar. Also required is a laboratory mixer capable of operating at a speed sufficient to lift the aggregate but without beating air into the melt.

5.4 *Testing Machine*, of the universal type, in which the load is applied hydraulically, mechanically, or electromechanically at a constant but adjustable rate of crosshead movement. The machine shall conform to Practices E 4.

5.5 *Guide for Marking Brick*, of the type shown in Fig. 1.

5.6 *Special Test Fixture*, consisting of two units of the type shown in Fig. 2.

5.7 *Apparatus for Preparation of Mortar Joint by Casting*, of the type shown in Fig. 3.

5.8 *Brick*, as defined in 1.1. See Specification C 279.

6. Temperature

6.1 The standard temperature of the laboratory equipment and materials shall be 73 ± 4°F (23 ± 2°C).

7. Number of Specimens

7.1 A minimum of six crossed-brick test specimens shall be prepared.

8. Preparation of Crossed-Brick Test Specimens

8.1 With mortars designed for a trowel-type application, apply the mortar over the area on the brick that is marked for the joint. The amount of mortar applied shall be 25 to 50 % in excess of the required amount to ensure a full joint. Place one of the brick, mortared side up, on a flat level surface. Then place two blocks on each side of the joint area of the bottom brick. The height of the blocks must be uniform and is dependent on the thickness of the mortar joint desired and the height of the brick; for example, if a ⅛-in. (3.2-mm) thick joint

[1] This test method is under the jurisdiction of ASTM Committee C03 on Chemical-Resistant Nonmetallic Materials and is the direct responsibility of Subcommittee C03.01 on Mortars and Carbon Brick.

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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.

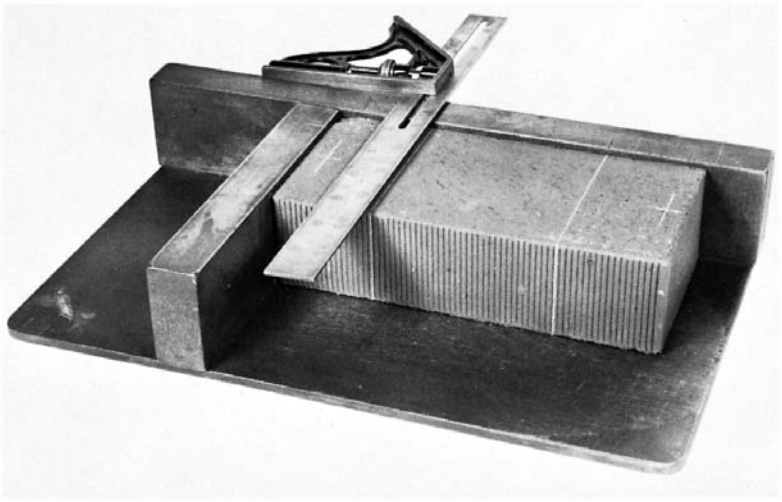


FIG. 1 Guide for Marking Brick

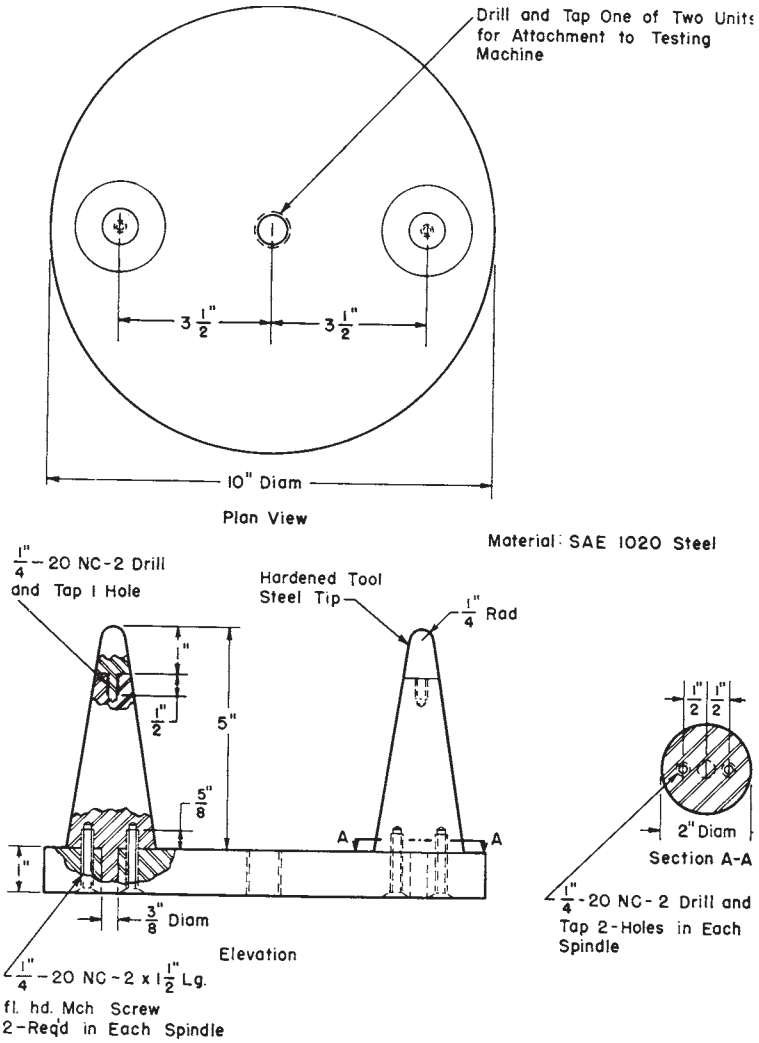
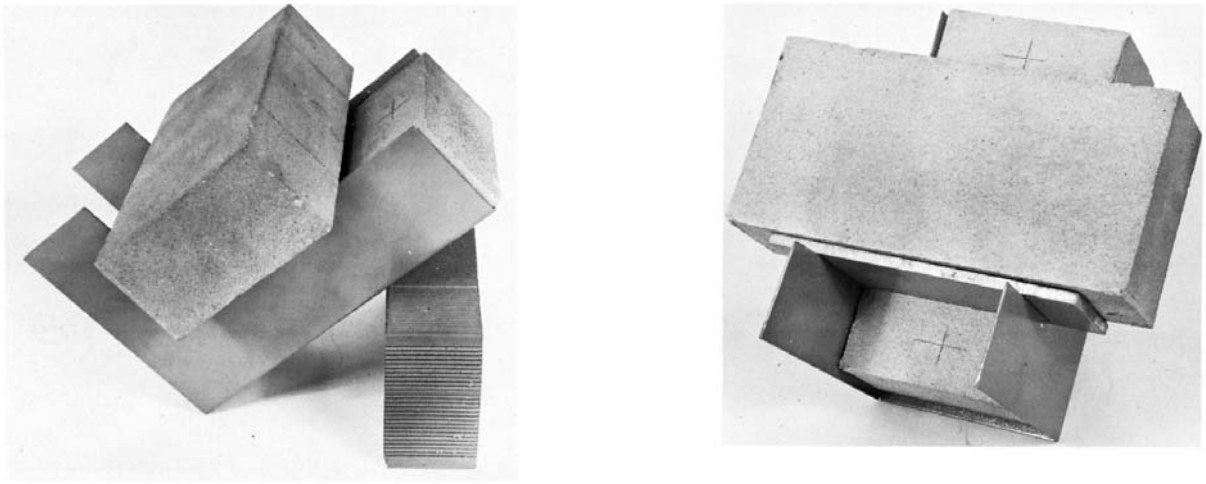


FIG. 2 Special Test Fixture

is desired and the height of the brick laying flat is 3⅜ in. (85.7 mm), then the blocks should be 3½ in. (88.9 mm) in height in order to provide the desired joint thickness. It is suggested that the blocks be made of wood or rigid plastic. Mortar shall be trowelled onto the marked area of the second brick. The amount of mortar applied shall be 10 to 25 % in excess of the



(*a*) Side View. (*b*) Rear View.

FIG. 3 Apparatus for Preparation of Mortar Joint by Casting

required amount to ensure a full joint. Place the second brick on top of the bottom brick as shown in Fig. 3. Compress the top brick until its ends are firmly against the side blocks. At the same time, align the two brick-mortar contacts as parallel surfaces. Strike off the excess mortar that has been squeezed from all sides of the joint. Remove the blocks, taking care not to disturb the joint area. Normally, with chemical-resistant mortars, the joint thickness does not exceed ⅛ in. Allow the mortar to set for a minimum of 24 h or longer if recommended by the mortar manufacturer before handling the specimens.

8.2 With sulfur mortars to be applied by casting, mount the brick in a special jig as shown in Fig. 3. Mask any open points to prevent leakage. Prepare sulfur mortar in accordance with Specification C 287. Pour the molten mortar into the joint cavity provided by this assembly. Allow 15 min for the mortar to set before handling the specimens.

9. Conditioning Brick

9.1 *Drying*—Dry the test brick in a ventilated oven at 230 to 239°F (110 to 115°C) for not less than 24 h and until two successive weighings at intervals of 2 h show an increment of not greater than 0.2 % of the last previously determined weight of the specimen. Cool the brick to 73 ± 4°F before applying the mortar. (Note 1) Mark the brick as shown in Fig. 1, to ensure that the crossed bricks will be at right angles to each other and centered one on the other when the specimen is assembled. At the same time, mark the contact points for the load test in the special test fixture (see 12.1).

NOTE 1—Brick to be used with hydraulic cements shall not be dried.

10. Preparation of Mortar

10.1 For mortars to be applied by troweling, prepare a 1200 to 1500-g sample of mortar, mixing it in the proper proportions and in the manner specified by the manufacturer of the materials. If the proportions so specified are by volume, weigh the materials and report the corresponding proportions by weight.

10.2 For sulfur mortars to be applied by casting, prepare samples in accordance with 7.1.1 of Specification C 287.

11. Conditioning Test Specimens

11.1 Condition the specimens, except those of sulfur and hydraulic cement mortars, for seven days at 73 ± 4°F (23 ± 2°C). Other conditioning temperatures are acceptable, provided they are reported with the test data. In the case of sulfur mortars, test the samples after 48 h. The conditioning time and temperature may be varied to establish time-temperature-strength relationship or to conform with intended service. Store specimens made with hydraulic cement mortars for 14 days in a moist cabinet at 73 ± 4°F (23 ± 2°C) and at a relative humidity of not less than 90 %.

11.2 Take care in handling the specimens to avoid abuse, such as lifting the unit by the top brick, or stacking specimens one on another.

12. Procedure

12.1 Mount the test specimen in the special test fixture as shown in Fig. 2 and Fig. 4. Place the specimen on the support points of the bottom head in such a manner that the specimen is balanced. The marked contact points on the bottom surface of the top brick must match the support points of the bottom test head. Position the apparatus to match the contact points of the top head with the marked contact points on the top surface of the bottom brick.

12.2 With the cross-head movement of 0.20 to 0.25 in./min (5 to 6.4 mm/min) when the machine is running without load, apply load until failure and record the maximum load applied.

12.3 Inspect the joint after testing and note whether the failure was in the mortar, between the mortar and the brick, or in the brick, and the relative areas involved. This will indicate which is the greater, cohesion within the mortar or adhesion between the mortar and brick or within the brick.

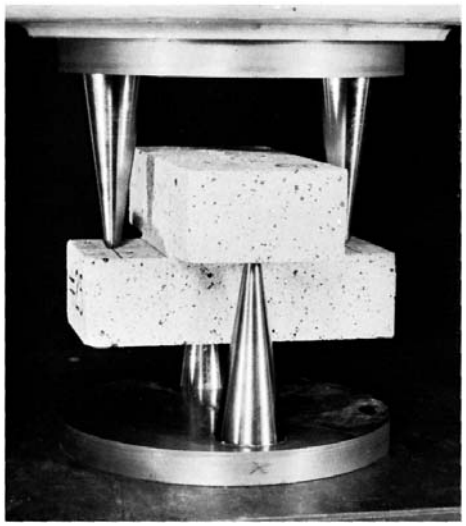


FIG. 4 Cross-Brick Specimen Mounted on Special Fixture

13. Calculation

13.1 Calculate the bond strength as follows:

$$A = L/J$$

where:

A = bond strength, psi (or MPa),
L = maximum load applied, lbf (or N), and
J = area of joint, in.^{2}(or mm^2).

14. Report

14.1 The report shall include the following:

14.1.1 Identification of mortar tested and the proportions of the mortar by weight,

14.1.2 Identification of brick used, including brand, type, and surface,

14.1.3 Age of specimen at time of test,

14.1.4 Average bond strength,

14.1.5 Standard deviation,

14.1.6 Number of specimens tested,

14.1.7 Any variation from the standard procedure, and

14.1.8 Type of failure, that is, cohesive, adhesive, or failure of the brick.

15. Precision and Bias

15.1 Precision and bias for this test method have not been established.

15.2 Test specimens that are manifestly faulty should be rejected and not considered in determining the bond strength of the mortar.

15.3 If any bond strength value differs from the mean by more than 15 %, the farthest value from the mean shall be rejected and the mean recalculated. If any value still differs from the new mean by more than 15 %, the farthest value shall again be rejected and the mean recalculated. If any value remains 15 % from the mean, the test shall be rerun.

15.4 If less than four values remain, the test shall be rerun.

16. Keywords

16.1 adhesion; bond; bond strength; brick; chemical-resistant brick; chemical-resistant mortar; cohesion; mortar