

Standard Test Methods for Compressive Strength of Masonry Prisms

1. Scope

1.1 These test methods cover two compression tests of masonry prisms:

1.1.1 *Method A*—For determining comparative data on the compressive strength of masonry built in the laboratory with either different masonry units or mortar types, or both.

1.1.2 *Method B*—For determining the compressive strength of masonry built at the job site with the same materials and workmanship to be used, or being used, in a particular structure.

NOTE 1—Method B is intended to establish the compressive strength of a particular set of materials by a preconstruction evaluation or to evaluate quality of materials and workmanship during construction.

1.2 Test specimens for both test methods are short compression prisms: the influence of slenderness ratio is taken into account either by proportions of the fabricated specimens or by the application of a correction factor.

1.3 The values stated in SI units are to be considered as the primary standard units.

1.4 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:*

C 67 Methods of Sampling and Testing Brick and Structural Clay Tile

C 140 Methods of Sampling and Testing Concrete Masonry Units

C 144 Specification for Aggregate for Masonry Mortar

C 270 Specification for Mortar for Unit Masonry

C 476 Specification for Grout for Masonry

E 4 Practices for Load Verification of Testing Machines

E 6 Terminology Relating to Methods of Mechanical Testing

E 105 Practice for Probability Sampling of Materials

E 111 Test Method for Young's Modulus, Tangent Modulus, and Chord Modulus

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

E 631 Terminology of Building Constructions

3. Terminology

3.1 *Definitions*—For definitions and terminology used in these test methods, refer to Terminology E 6 and E 631.

4. Apparatus

4.1 The testing machine shall conform to the requirements given in Practices E 4.

4.2 The upper bearing shall be a spherically seated, hardened metal block firmly attached at the center of the upper head of the machine. The center of the sphere shall lie at the center of the surface held in its spherical seat, but shall be free to turn in any direction, and its perimeter shall have at least 6-mm (1/4-in.) clearance from the head to allow for specimens whose bearing surfaces are not exactly parallel. The diameter of the bearing surface shall be at least 125 mm (5 in.). A hardened metal bearing block shall be used beneath the specimen to minimize wear of the lower platen of the machine. The bearing block surfaces intended for contact with the specimen should have a hardness not less than 60 HRC (620 HB). These surfaces shall not depart from plane surfaces by more than 0.003 mm (0.0001 in.) in any 150-mm (6-in.) dimension. When the bearing area of the spherical bearing block is not sufficient to cover the area of the specimen, a steel plate with surfaces machined to true planes within ± 0.003 mm (0.0001 in.), and with a thickness equal to at least one half of the distance from the edge of the spherical bearing to the most distant corner shall be placed between the spherical bearing block and the capped specimen.

5. Test Specimen

5.1 *Sampling and Testing of Masonry Units:*

5.1.1 Select representative masonry units and test for percent void area for hollow clay masonry and average net area for hollow concrete masonry and compressive strength in accordance with the following applicable ASTM methods:

Masonry Units	ASTM Designation
Building and race brick	C 67
Sandlime brick	C 140
Concrete brick	C 140
Concrete block	C 140
Structural clay tile	C 67

5.1.2 Select random samples of masonry unit test specimens in accordance with Recommended Practice E 105.

5.2 *Sampling and Testing of Mortar*—Unless otherwise specified, use one of the types of mortar as specified in Specifications C 270 or C 476. Determine the compressive strength of the mortar in accordance with Test Method C 109 except the sand shall conform to Specification C 144. After moist curing in the molds for 24 h release the cubes and store in the same

CRD-C 643-01

atmosphere as the prisms as specified in 5.5. Determine and record the following minimum physical properties of the mortar:

5.2.1 Compressive strength (minimum three cubes) and

5.2.2 Sand-sieve analysis.

5.3 *Sampling and Testing of Grout:*

5.3.1 Use one of the types of grout as specified in Specification C 476, and the materials shall conform to the requirements of that specification.

5.3.2 *Fine Grout*—Mold a minimum of three 50-mm (2-in.) cubes from a sample of the fine grout and test in the same manner as prescribed in 5.2, except moist cure cubes 48 h before releasing from molds.

5.3.3 *Coarse Grout*—Mold a minimum of three 75 by 150-mm (3 by 6-in.) cylinders from a sample of the coarse grout and moist cure for 48 h before releasing from molds. Cap and test them in compression in accordance with applicable provisions of Test Method C 39.

5.4 *Masonry Prisms:*

5.4.1 *Method A*—Build and test a minimum of three prism specimens for each combination of variables. Each test prism shall be a single-wythe specimen laid in stack bond, with a height-to-thickness ratio of not less than two nor more than five. The mortar joints shall be 10 mm (3/4 in.) in thickness. Spread a full bed of mortar on each solid masonry unit and allow no furrowing of the mortar bed. Fully bed the face shells of hollow masonry units with mortar. Strike mortar joints flush with the face of the masonry without tooling. The length of the prism shall be greater than its thickness.

5.4.2 *Method B*—Build and test a minimum of three prisms using the materials and workmanship being used in the structure. In constructing the prisms, the mortar bedding, the thickness and tooling of the joints, the grouting, the condition of the units, and the bonding arrangement shall be in so far as possible the same as being used in the structure, except that no structural reinforcement shall be included in the test specimen; however, metal ties may be used. Prisms shall contain no grout unless all hollow cells and spaces in the actual wall construction are to be grouted.

5.4.2.1 The thickness of the prisms shall be the same as the thickness of the masonry part of the wall in the structure. The length of the prism shall be equal to or greater than the thickness of the prism. The height of the prism shall be at least twice the thickness, contain at least two mortar joints, and be a minimum of 380 mm (15 in.). Where prisms composed of 200-mm (8-in.) high units are to be tested, and where the compression testing equipment will not accommodate three full units in height, the configuration shown in Fig. 1 may be used.

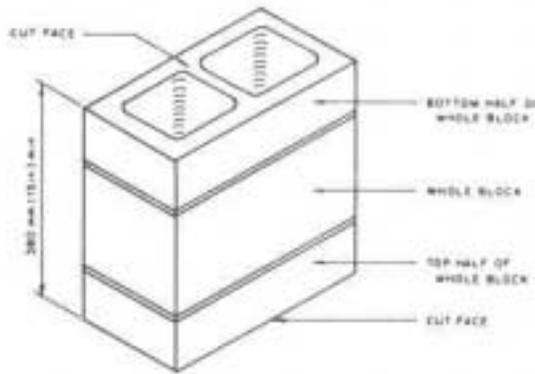


Fig. 1. Masonry Prism Construction for 200-mm (8-in.) High Units

5.5 Handling and Curing Conditions:

5.5.1 *Method A*—Generally, cures all prisms for 28 days. However, lesser periods of time may be used provided the relation between that period and the 28-day strength of the masonry is established by a suitable statistical method (Recommended Practice E 105) (Note 2). Cure the prisms together with the corresponding mortar and grout specimens in laboratory air maintained at a temperature of $24 \pm 8 \text{ }^\circ\text{C}$ ($75 \pm 15 \text{ }^\circ\text{F}$), with a relative humidity between 30 and 70 %, and free of drafts. These environmental conditions will not require, generally, special air-conditioning equipment. Make a continuous graphical record of temperatures and humidity to detect unusual dryness or excessive moisture together with unusual fluctuations of temperature.

NOTE 2—A preferred method of determining the relation between the strengths of 28-day prisms and those cured for shorter periods of time is to build three additional prisms to be tested after curing the shorter time. Such a procedure is especially recommended for Method B and should be done in advance of start of construction if the prisms built and tested during construction are for the purpose of job control of materials and workmanship and the construction schedule requires a curing period of less than 28 days.

5.5.2 *Method B*—Build prisms made during construction at the job site in a place where they will not be disturbed and will be subjected to air conditions similar to that of the walls they represent. After 48 h, place a 20-mm (3/4-in.) plywood board cut the same size as the prisms on the top and bottom and wire or strap tightly to prevent joints from being disturbed while the prisms are being transported to the laboratory for testing. Protect the prisms and transport them in such a manner as not to break the bond between mortar and units.

5.5.2.1 After prisms are delivered to the laboratory, cure them as provided in 5.5.1. Cure prisms in laboratory air until they are 28 days old. Use 7-day tests provided the relationship between the 7-day and 28-day strengths of the masonry assemblage has been previously established for the materials used.

6. Procedure

6.1 *Capping Test Specimens*—Cap the ends of the prisms in the same manner as set forth for capping the units in either Methods C 67 or C 140.

6.2 *Specimen Measurements*—Determine the length and thickness of the prism to the nearest 0.3 mm (0.01 in.) by averaging three measurements taken at the center and quarter points of the height of the specimen. Measure the height of the specimen including caps to the nearest 3 mm (0.1 in.).

6.3 *Placing the Specimen*—Place the plain (lower) bearing block, with its hardened face up, on the table or platen of the testing machine directly under the spherically seated (upper) bearing block. Wipe clean the bearing faces of the upper and lower bearing blocks and of the test specimen and place the test specimen on the lower bearing block. Carefully align both centroid axes of the specimen with the center of thrust of the spherically seated block. As the spherically seated block is brought to bear on the specimen, rotate its movable portion gently by hand so that uniform seating is obtained.

6.4 *Rate of Loading*—Apply the load, up to one half of the expected maximum load, at any convenient rate, after which adjust the controls of the machine so that the remaining load is applied at a uniform rate in not less than 1 nor more than 2 min.

6.5 *Determination of Young's Modulus*—When stipulated, determine Young's modulus in accordance with Test Method E 111. Follow the designated method to the greatest extent possible.

6.6 *Observations*—During the course of the test, note the loading at which the first cracking sounds are heard. Note whether a stethoscope or other instrument is used for hearing. If observed, note the load corresponding to the appearance of the first crack either in the unit itself or spalling of the mortar joint, or both. Upon increasing the load to a maximum sustained by the prism, describe the mode of failure as fully as possible. In the cases of walls with two or more wythes, apply suitable sensitive gages transversely across the collar joint at the midheight of the specimen to detect the formation of cracks in the plane of the collar joint. (Bonded wire gages have been found to be suitable for these measurements.)

NOTE 3—The measurements of transverse strains across collar joints in double- or multi-wythe walls are essential to determine whether a plane of weakness exists along a continuous vertical joint such as a collar joint which can develop significant tensile strains indicating potential premature cracking.

7. Report

7.1 The report shall be prepared in conformance with Practice E 575 and shall include the following:

CRD-C 643-01

7.1.1 The compressive strength and other specified physical properties of masonry units, including the name and address of the manufacturer and his unit designation number or name,

7.1.2 The compressive strength and other specified physical properties of the mortar and grout, a sand-sieve analysis, and other specified physical properties of the constituent materials, including the name and address of the manufacturer of each constituent material, and his material designation number or name.

7.1.3 Brief description of specimen fabrication including method of bonding, joint thickness, and prism dimensions.

7.1.4 Age of prism at time of test.

7.1.5 Maximum load for each prism in pounds-force (or newtons).

7.1.6 Cross-sectional area of each specimen in Square millimetres (or Square inches). The gross area shall be used for solid masonry prisms and the net area for prisms build with hollow units not solidly grouted.

7.1.7 Compressive strength of each prism calculated to the nearest 70 kPa (10 psi).

7.1.8 Average compressive strength, standard deviation, and coefficient of variation of the sample.

7.1.9 When required, the stress-strain curve for each prism, determined in accordance with applicable provisions of Test Method E 111, shall be plotted. The secant modulus of elasticity shall be reported for suitable values of stress and strain. In the case of double-wythe walls. the compressive stress versus the transverse strain measured across the collar joint shall also be plotted.

7.1.10 A full description of the mode of failure. Whenever useful clarification will result, use photographs, and

7.1.11 Unusual defects in either specimens or caps shall be noted, including causes, when known, of unusual test results.

8. Precision and Bias

8.1 No statement is made either on the precision or on the bias of these test methods due to the variety of material 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.

9. Keywords

9.1 compressive loading; masonry assemblies; masonry prisms