Designation: C 1019 – 09

Standard Test Method for Sampling and Testing Grout[1]

This standard is issued under the fixed designation C 1019; 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 procedures for both field and laboratory sampling and compression testing of grout used in masonry construction. Grout for masonry is specified under Specification C 476.

NOTE 1—The testing agency performing this test method should be evaluated in accordance with Practice C 1093.

1.2 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered 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]

C 39/C 39M Test Method for Compressive Strength of Cylindrical Concrete Specimens

C 143/C 143M Test Method for Slump of Hydraulic-Cement Concrete

C 476 Specification for Grout for Masonry

C 511 Specification for Mixing Rooms, Moist Cabinets, Moist Rooms, and Water Storage Tanks Used in the Testing of Hydraulic Cements and Concretes

C 617 Practice for Capping Cylindrical Concrete Specimens

C 1064/C 1064M Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete

C 1093 Practice for Accreditation of Testing Agencies for Masonry

C 1611/C 1611M Test Method for Slump Flow of Self-Consolidating Concrete

3. Significance and Use

3.1 Grout used in masonry is a fluid mixture of cementitious materials and aggregate with a high water content for ease of placement.

3.1.1 During construction, grout is placed within or between absorptive masonry units. Excess water must be removed from grout specimens in order to provide compressive strength test results more nearly indicative of the grout strength in the wall. In this test method, molds are made from masonry units having the same absorption and moisture content characteristics as those being used in the construction.

3.2 This test method is used to either help select grout proportions by comparing test values or as a quality control test for uniformity of grout preparation during construction.

3.3 The physical exposure condition and curing of the grout are not exactly reproduced, but this test method does subject the grout specimens to absorption conditions similar to those experienced by grout in the wall.

NOTE 2—Test results of grout specimens taken from a wall should not be compared to test results obtained with this test method.

4. Apparatus

4.1 *Maximum-Minimum Thermometer*.

4.2 *Straightedge*, a steel straightedge not less than 6 in. (152.4 mm) long and not less than 1/16 in. (1.6 mm) in thickness.

4.3 *Tamping Rod*, a nonabsorbent rod, either round or square in cross section nominally 5/8 in. (15.9 mm) in dimension with ends rounded to hemispherical tips of the same diameter. The rod shall be a minimum length of 12 in. (304.8 mm).

4.4 *Nonabsorbent Blocks and Spacers*, nonabsorbent, rigid squares and rectangles with side dimensions so as to achieve the desired grout specimen side dimensions and of sufficient quantity or thickness to yield the desired grout specimen height, as shown in Fig. 1, Fig. 2, and Fig. 3.

[1] This test method is under the jurisdiction of ASTM Committee C12 on Mortars and Grouts for Unit Masonry and is the direct responsibility of Subcommittee C12.02 on Research and Methods of Test.

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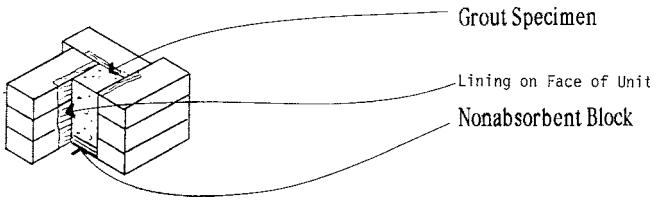
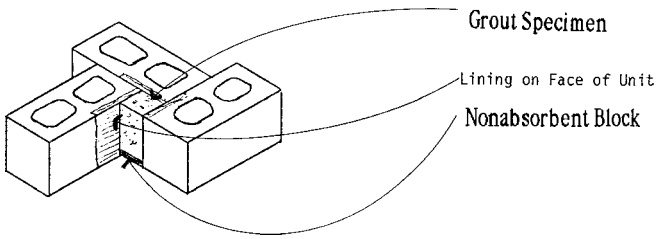
[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

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



NOTE—Front masonry unit stack not shown to allow view of specimen.

FIG. 1 Grout Mold (Units 6 in. (152.4 mm) or Less in Height, 2¼ in. (57.2 mm) High Brick Shown)



NOTE—Front masonry unit not shown to allow view of specimen.

FIG. 2 Grout Mold (Units Greater than 6 in. (152.4 mm) High, 8 in. (203.2 mm) High Concrete Masonry Unit Shown)

NOTE 3—Nonabsorbent blocks may be of plastic, wood, or other nonabsorbent material. Certain species of wood contain sugars which cause retardation of cement. In order to prevent this from occurring, new wooden blocks shall be soaked in limewater for 24 h, sealed with varnish or wax, or covered with an impermeable material prior to use.

4.5 *Panels and plates*, pieces of ¾ in. (19 mm) plywood with dimensions as needed to contain units and grout specimens. Soak in limewater for 24 h, seal with varnish or wax, or cover with an impermeable material prior to use. A nonabsorbant material of equivalent stiffness to the plywood is permitted.

PROCEDURES

5. Test Specimens

5.1 Each grout specimen shall have a square cross-section, 3 in. (76 mm) or larger on the sides and twice as high as its width. Dimensional tolerances shall be within 5 % of the width selected.

5.2 Test at least three specimens at each age specified.

NOTE 4—Frequency of sampling and age of test is to be determined by the specifier of this test method and is usually found in the construction documents.

6. Grout Specimen Molds

6.1 *Molds from Masonry Units*:

6.1.1 Select a level location where the molds remain undisturbed for up to 48 h.

NOTE 5—The location of specimen construction should be protected and as free from perceptible vibration as possible.

6.1.2 The construction of the mold shall simulate the in-situ construction. If the grout is placed between two different types of masonry units, both types shall be used to construct the mold.

6.1.3 Form a space with a square cross-section, 3 in. (76 mm) or larger on each side and twice as high as its width, by stacking masonry units of the same type and moisture condition as those being used in the construction. The surface of the unit in contact with the grout specimen shall not have been previously used to mold specimens. Place nonabsorbent blocks, cut to proper size and of the proper thickness or quantity, at the bottom of the space to achieve the necessary height of specimen. Tolerance on space and specimen dimensions shall be within 5 % of the specimen width. See Fig. 1, Fig. 2, and Fig. 3 and accompanying notes.

6.1.4 Line the masonry surfaces that will be in contact with the grout specimen with a thin, permeable material to prevent bond to the masonry units. New lining material shall be used for each specimen.

NOTE 6—The lining, such as paper towel, is used to aid in stripping the grout specimen from the mold. Proper installation of the lining prevents irregularly sized specimens and varying test results.

6.1.5 Brace units to prevent displacement during grouting and curing.

6.2 *Alternative Methods*—Alternative methods of forming the specimens shall be used only with the approval of the specifier. Such approval shall be based on comparative testing of grout specimens constructed from molds as described in 6.1 and the alternative method. Approval shall be limited to a single specimen shape, method of forming, masonry units used, and grout mix. A conversion factor based on comparative testing of a minimum of ten pairs of specimens shall be used to modify results from alternative methods.

NOTE 7—Other methods of obtaining grout specimens and specimens of different geometry have been employed in grout testing, but are not described in this test method. Other methods used to obtain grout specimens include: drilling grout-filled cores of regular units; filling cores of masonry units specifically manufactured to provide grout specimens; filling compartments in slotted corrugated cardboard boxes specifically manufactured to provide grout specimens; and forming specimens from different sized masonry units of the same or similar material.

Since test results vary with methods of forming the specimen, specimen geometry, and grout mix, comparative test results between specimens made with molds described in 6.1 and specimens made with alternative methods are required and confined to a single specimen shape, method of forming, masonry units used, and grout mix.

7. Sampling Grout

7.1 *Size of Sample*—Grout samples to be used for slump and compressive strength tests shall be a minimum of ½ ft^3 (0.014 m^3).

7.2 *Procedure*—The procedures used in sampling shall include the use of precautions that will assist in obtaining samples that are representative of the nature and condition of the grout. After the final slump adjustment has been made, sample grout as the grout is being placed.

7.2.1 *Field Sampling*—Collect two or more portions taken at regularly spaced intervals during the discharge of the middle portion of the batch. The elapsed time between obtaining the first and final portions of the sample shall be not more than 15 min.

7.2.2 *Laboratory Sampling*—The entire mixed batch of grout is the sample.

NOTE 8—The field technician sampling, making, and curing specimens for acceptance testing should be certified (American Concrete Institute

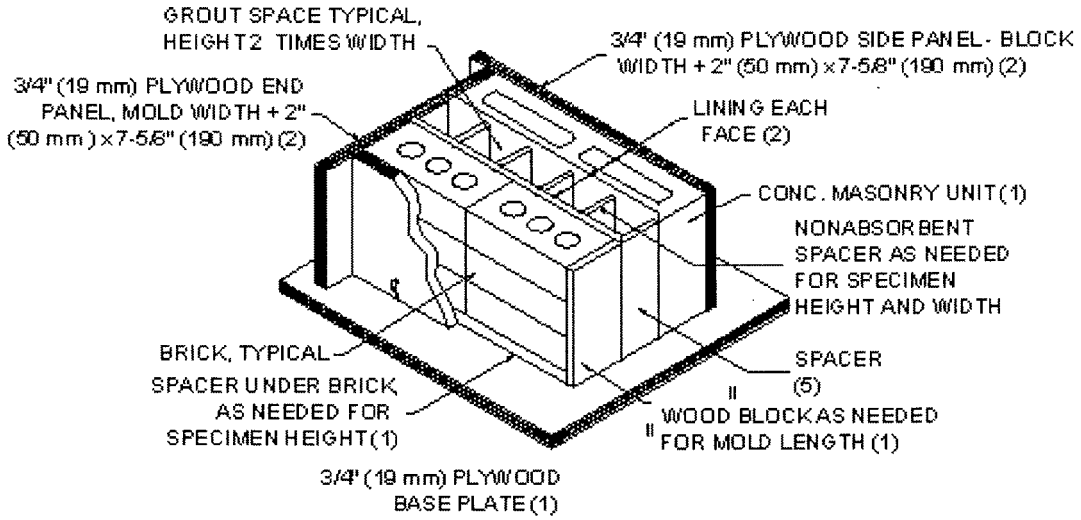


FIG. 3 Grout Mold with Brick and Concrete Masonry Units

Field Testing Technician—Grade I, National Concrete Masonry Association Masonry Testing Technician, or equivalent). Equivalent certification programs should include both written and performance examinations.

7.3 Place the grout sample in a non-absorptive container and cover the top to protect the sample from the sun, wind, and any other sources of rapid evaporation and from contamination. Transport the grout sample to the mold location. Remix the sample with a shovel or trowel to ensure uniformity prior to filling molds. Keep remaining grout sample protected until used to fill any depression in the sample due to initial water loss.

8. Temperature and Slump Test

8.1 Measure and record the temperature of the grout sample in accordance with Test Method C 1064/C 1064M.

8.2 Begin filling the slump cone within 5 min of obtaining the final portion of the sample.

8.3 For all grout except self-consolidating grout, measure and record the slump in accordance with the requirements of Test Method C 143/C 143M.

8.4 For self-consolidating grout, measure and record the slump flow in accordance with the requirements of Test Method C 1611/C 1611M and visual stability index (VSI) in accordance with the requirements of Test Method C 1611/C 1611M, Appendix X1.

9. Compressive Test Specimen

9.1 If grout from the slump or slump flow test is used for the compressive test specimens, remix the sample. Begin filling the compressive strength molds within 15 min of obtaining the final portion of the sample.

9.2 For all grout except self-consolidating grout, fill the mold with grout in two layers of approximately equal depth. Rod each layer 15 times with the tamping rod. Rod the bottom layer through its depth. Slightly overfill the mold. Rod the second layer with the tamping rod penetrating ½ in. (12.7 mm) into the lower layer. Distribute the strokes uniformly over the cross section of the mold.

9.3 For self-consolidating grout, fill the mold with grout in one layer and do not rod.

9.4 Strike off the top surface of the specimen with a straightedge to produce a flat surface that is even with the top edge of the mold and that has no depressions or projections larger than ⅛ in. (3.2 mm). Cover immediately with a damp absorbent material such as cloth or paper towel. Keep the top surface of the specimens damp by wetting the absorbent material and covering with a nonabsorbent, nonreactive material to retain the moisture. Do not disturb the specimens.

9.5 Within 30 min after filling the mold, add sufficient grout without rodding to fill the depression caused by initial water loss. Strike off the top surface of the specimen with a straightedge to produce a flat surface that is even with the top edge of the mold. Cover immediately with a damp absorbent material such as cloth or paper towel. Keep the top surface of the specimen damp by wetting the absorbent material and covering with a nonabsorbent, nonreactive material. Do not disturb the specimen until the molds are removed.

NOTE 9—The viscosity of self-consolidating grout changes with time. Thus the depression may require filling prior to the thirty minute limit.

9.6 Protect the specimens from freezing and variations in temperature. Store an indicating maximum-minimum thermometer with the specimens and record the maximum and minimum temperatures experienced prior to the time the specimens are placed in the final curing environment.

NOTE 10—If storage temperatures are less than 60°F (15.6°C) or greater than 80°F (26.7°C) as shown by the thermometer, the resulting compressive strength will likely be affected.

10. Transportation, Curing, and Testing of the Specimens

10.1 Remove the molds between 24 and 48 h after making the specimens.

10.2 Within 30 min after removing the molds, place specimens in a protective container and keep specimens damp.

10.3 Transport field specimens to the laboratory within 8 h after mold removal.

10.4 Within 8 h after mold removal, place in a moist room, moist cabinet, or water storage tank conforming to Specification C 511. Store there until day of testing.

10.5 Store there until day of testing. Keep specimen damp until tested.

10.6 Cap the specimens in accordance with the applicable requirements of Practice C 617.

NOTE 11—Practice C 617 refers to capping cylindrical specimens; therefore, the alignment devices may need to be modified to ensure proper use with the rectangular prism specimens of this method. All other sections of Practice C 617 are applicable.

10.7 Measure and record the width of each face at mid-height. Measure and record the height of each face at mid-width. Measure and record the amount out of plumb at mid-width of each face.

10.8 Test the specimens in a damp condition in accordance with the applicable requirements of Test Method C 39/C 39M.

11. Calculations

11.1 Determine the average cross-sectional area by measuring the width of each face at its mid-height, calculating the average width of opposite faces, and multiplying the averages.

11.2 For specimens from molds of masonry units, calculate the compressive strength by dividing the maximum load by the average cross-sectional area and express the result to the nearest 10 psi (50 kPa).

11.3 For specimens from alternative methods of forming, calculate a conversion factor between the results obtained from comparative testing by dividing the average compressive strength of the specimens formed in accordance with 6.1 by the average compressive strength of the specimens formed by the alternative method. Calculate the average corrected compressive strength by dividing the maximum load by the average cross-sectional area and multiplying the result by the conversion factor. Express the result to the nearest 10 psi (50 kPa).

NOTE 12—The coefficient of variation of test results of specimens formed by the alternative method should be less than or equal to that of the specimens formed in accordance with 6.1.

12. Report

12.1 For all specimens, the report shall include the following:

12.1.1 Grout mix design,

12.1.2 Grout slump for all grouts except self-consolidating grout,

12.1.3 Slump flow and visual stability index (VSI) value of the grout for self-consolidating grout,

12.1.4 Description of the specimens—dimensions, amount out of plumb in percent,

TABLE 1 Statistics of Laboratory-Prepared Specimens

Number of Specimens	Mean, psi (MPa)	Standard Deviation, psi (MPa)	Coefficient of Variation, %
5	3784 (26.1)	306 (2.11)	8.1
5	2494 (17.2)	220 (1.52)	8.8
5	3178 (21.9)	634 (4.37)	20.0
6	5480 (37.8)	899 (6.2)	16.4
10	5350 (36.9)	826 (5.7)	15.4
12	3872 (26.7)	333 (2.30)	8.6

TABLE 2 Statistics of Field-Prepared Specimens

Number of Specimens	Mean, psi (MPa)	Standard Deviation, psi (MPa)	Coefficient of Variation, %
3	3583 (24.7)	118 (0.81)	3.3
6	5455 (37.6)	324 (2.23)	5.9
6	3992 (27.5)	228 (1.57)	5.7

12.1.5 Curing history, including initial temperature, maximum and minimum temperatures, and age of specimens when transported to laboratory and when tested,

12.1.6 Maximum load and compressive strength of each specimen, average compressive strength of the specimens, and standard deviation, and

12.1.7 Description of failure.

12.2 For specimens from molds of masonry units, additionally report the following:

12.2.1 Type and number of units used to form mold for specimens.

12.3 For specimens from alternative methods of forming, additionally report the following:

12.3.1 Description of the method used,

12.3.2 Conversion factor used to account for differences in method of forming and reference to supporting documentation of conversion factor determination, if not based on results included in this test report, and

12.3.3 Average corrected compressive strength.

12.3.4 Coefficient of variation of the compressive strengths of the specimens formed in accordance with 6.1 and the alternative method for those tests from which the conversion factor is determined.

13. Precision and Bias

13.1 *General:*

13.1.1 The masonry units used to form the mold have different absorption rates and will remove slightly different amounts of water from each specimen. Thus the standard deviation for this test method is higher than that using a nonabsorbent mold.

13.1.2 The standard deviation from field specimens of grout will be higher than that for laboratory specimens. There is less control of grout ingredients, conditions of units for mold construction, and initial curing environment in field-prepared specimens.

13.2 Limited test data are available for analysis at this time. A more detailed statement will be provided later. The following summary of available data is provided for review.

13.2.1 *Laboratory Specimens*—The coefficients of variation for a series of three laboratory prepared specimens ranged from 5.8 % with a mean value of 6452 psi (44.45 MPa) to 24.6 % with a mean value of 1373 psi (9.47 MPa) averaging 14.4 %. The standard deviation ranged from 211 psi (1.46 MPa) to 505 psi (3.48 MPa). Tests with a larger number of specimens had the characteristics found in Table 1.

13.2.2 *Field Specimens*—Test reports from one project show the characteristics found in Table 2.

14. Keywords

14.1 cementitious; compressive strength; grout; masonry units

SUMMARY OF CHANGES

Committee C12 has identified the location of selected changes to this standard since the last issue (C 1019 – 08a) that may impact the use of this standard. (Approved Jan. 1, 2009.)

(*1*) Note 10 on storage temperatures was added to 9.6.

Committee C12 has identified the location of selected changes to this standard since the last issue (C 1019 – 08) that may impact the use of this standard. (Approved Aug. 1, 2008.)

(*1*) Note 9 on self-consolidating grout was added to 9.5.
(*2*) Section 6 and Note 7 were revised to provide requirements on the use of alternative methods of forming specimens.
(*3*) Subsection 11.3 and Note 12 were added.
(*4*) Subsection 12.1 was revised to report results, coefficients of variation, and information on the alternative means of forming specimens.

Committee C12 has identified the location of selected changes to this standard since the last issue (C 1019 – 07) that may impact the use of this standard. (Approved Feb. 1, 2008.)

(*1*) Use of new lining materials was added to 6.1.4.
(*2*) Protection of the grout sample was added to 7.3.