



Designation: C109/C109M – 23

Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 50 mm [2 in.] Cube Specimens)¹

This standard is issued under the fixed designation C109/C109M; 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 U.S. Department of Defense.

1. Scope*

1.1 This test method covers determination of the compressive strength of hydraulic cement mortars, using 50 mm [2 in.] cube specimens.

NOTE 1—Test Method C349 provides an alternative procedure for this determination (not to be used for acceptance tests).

1.2 This test method covers the application of the test using either SI or inch-pound 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 Values in SI units shall be obtained by measurement in SI units or by appropriate conversion, using the Rules for Conversion and Rounding given in IEEE/ASTM SI-10, of measurements made in other units.

1.4 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use. (Warning—Fresh hydraulic cementitious mixtures are caustic and may cause chemical burns to skin and tissue upon prolonged exposure.²)*

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 ASTM Standards:³

- C91/C91M Specification for Masonry Cement
- C114 Test Methods for Chemical Analysis of Hydraulic Cement
- C150/C150M Specification for Portland Cement
- C230/C230M Specification for Flow Table for Use in Tests of Hydraulic Cement
- C305 Practice for Mechanical Mixing of Hydraulic Cement Pastes and Mortars of Plastic Consistency
- C349 Test Method for Compressive Strength of Hydraulic-Cement Mortars (Using Portions of Prisms Broken in Flexure)
- C511 Specification for Mixing Rooms, Moist Cabinets, Moist Rooms, and Water Storage Tanks Used in the Testing of Hydraulic Cements and Concretes
- C595/C595M Specification for Blended Hydraulic Cements
- C618 Specification for Coal Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
- C670 Practice for Preparing Precision and Bias Statements for Test Methods for Construction Materials
- C778 Specification for Standard Sand
- C989/C989M Specification for Slag Cement for Use in Concrete and Mortars
- C1005 Specification for Reference Masses and Devices for Determining Mass and Volume for Use in Physical Testing of Hydraulic Cements
- C1157/C1157M Performance Specification for Hydraulic Cement
- C1328/C1328M Specification for Plastic (Stucco) Cement
- C1329/C1329M Specification for Mortar Cement
- C1437 Test Method for Flow of Hydraulic Cement Mortar
- E4 Practices for Force Calibration and Verification of Testing Machines

2.2 IEEE/ASTM Standard:³

- IEEE/ASTM SI-10 Standard for Use of the International System of Units (SI): The Modern Metric System

¹ This test method is under the jurisdiction of ASTM Committee C01 on Cement and is the direct responsibility of Subcommittee C01.27 on Strength.

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² See the section on Safety, Manual of Cement Testing, *Annual Book of ASTM Standards*, Vol 04.01.

³ 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



3. Summary of Test Method

3.1 The mortar used consists of 1 part cement and 2.75 parts of sand proportioned by mass. Portland, air-entraining portland, portland-limestone, or air-entraining portland-limestone cements are mixed at a specified water content. Water content for other cements is that sufficient to obtain a flow of 110 ± 5 in 25 drops of the flow table. The 50 mm [2 in.] test cubes are compacted by tamping in two layers. The cubes are cured one day in the molds and stripped and immersed in lime water until tested.

4. Significance and Use

4.1 This test method provides a means of determining the compressive strength of hydraulic cement and other mortars and results may be used to determine compliance with specifications. Further, this test method is referenced by numerous other specifications and test methods. Caution must be exercised in using the results of this test method to predict the strength of concretes.

5. Apparatus

5.1 *Weights and Weighing Devices*, shall conform to the requirements of Specification C1005. The weighing device shall be evaluated for precision and accuracy at a total load of 2000 g.

5.2 *Glass Graduates*, of suitable capacities (preferably large enough to measure the mixing water in a single operation) to deliver the indicated volume at 20 °C [68 °F]. The permissible variation shall be ± 2 mL. These graduates shall be subdivided to at least 5 mL, except that the graduation lines may be omitted for the lowest 10 mL for a 250 mL graduate and for the lowest 25 mL of a 500 mL graduate. The main graduation lines shall be circles and shall be numbered. The least graduations shall extend at least one seventh of the way around, and intermediate graduations shall extend at least one fifth of the way around.

5.3 *Specimen Molds*, for the 50 mm [2 in.] cube specimens shall be tight fitting. The molds shall have not more than three cube compartments and shall be separable into not more than two parts. The parts of the molds when assembled shall be positively held together. The molds shall be made of hard metal not attacked by the cement mortar. For new molds the Rockwell hardness number of the metal shall be not less than 55 HRB. The sides of the molds shall be sufficiently rigid to

prevent spreading or warping. The interior faces of the molds shall be plane surfaces and shall conform to the tolerances of Table 1.

5.3.1 Cube molds shall be checked for conformance to the design and dimensional requirements of this test method at least every 2 ½ years.

5.4 *Mixer, Bowl, and Paddle*, an electrically driven mechanical mixer of the type equipped with paddle and mixing bowl, as specified in Practice C305.

5.5 *Flow Table and Flow Mold*, conforming to the requirements of Specification C230/C230M.

5.6 *Tamper*, a nonabsorptive, nonabrasive, nonbrittle material such as a rubber compound having a Shore A durometer hardness of 80 ± 10 or seasoned oak wood rendered nonabsorptive by immersion for 15 min in paraffin at approximately 200 °C [392 °F], shall have a cross section of $13 \text{ mm} \pm 1.6 \text{ mm}$ by $25 \text{ mm} \pm 1.6 \text{ mm}$ [0.5 in. $\pm$ 0.06 in. by 1 in. $\pm$ 0.06 in.] and a length of 120 mm to 150 mm [5 in. to 6 in.]. The tamping face shall be flat and at right angles to the length of the tamper.

5.6.1 Tampers shall be checked for conformance to the design and dimensional requirements of this test method at least every six months.

NOTE 2—Each day that the tamper is used a visual inspection should confirm that the end is flat and at a right angle to the long axis of the tamper. Rounded or peeling tampers should not be allowed for use.

5.7 *Trowel*, having a steel blade 100 mm to 150 mm [4 in. to 6 in.] in length, with straight edges.

5.8 *Moist Cabinet or Room*, conforming to the requirements of Specification C511.

5.9 *Testing Machine*, either the hydraulic or the screw type, with sufficient opening between the upper bearing surface and the lower bearing surface of the machine to permit the use of verifying apparatus. The load applied to the test specimen shall be indicated with an accuracy of ± 1.0 %. If the load applied by the compression machine is registered on a dial, the dial shall be provided with a graduated scale that can be read to at least the nearest 0.1 % of the full scale load (Note 3). The dial shall be readable within 1 % of the indicated load at any given load level within the loading range. In no case shall the loading range of a dial be considered to include loads below the value that is 100 times the smallest change of load that can be read on the scale. The scale shall be provided with a graduation line equal to zero and so numbered. The dial pointer shall be of

TABLE 1 Permissible Variations of Specimen Molds

Parameter	50 mm Cube Molds		2 in. Cube Molds	
	New	In Use	New	In Use
Planeness of sides	<0.025 mm	<0.05 mm	<0.001 in.	<0.002 in.
Distance between opposite sides	50 mm $\pm$ 0.13 mm	50 mm $\pm$ 0.50 mm	2 in. $\pm$ 0.005 in.	2 in. $\pm$ 0.02 in.
Height of each compartment	50 mm + 0.25 mm to – 0.13 mm	50 mm + 0.25 mm to – 0.38 mm	2 in. + 0.01 in. to – 0.005 in.	2 in. + 0.01 in. to – 0.015 in.
Angle between adjacent faces ^A	90° $\pm$ 0.5°	90° $\pm$ 0.5°	90° $\pm$ 0.5°	90° $\pm$ 0.5°

^A Measured at points slightly removed from the intersection. Measured separately for each compartment between all the interior faces and the adjacent face and between interior faces and top and bottom planes of the mold.