



Standard Test Method for Length Change of Hydraulic-Cement Mortars Exposed to a Sulfate Solution¹

This standard is issued under the fixed designation C1012/C1012M; 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 This test method covers the determination of length change of mortar bars immersed in a sulfate solution. Mortar bars made using mortar described in Test Method C109/C109M are cured until they attain a compressive strength of 20.0 ± 1.0 MPa [3000 ± 150 psi], as measured using cubes made of the same mortar, before the bars are immersed.

1.2 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 non-conformance 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

- C109/C109M Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens)
- C114 Test Methods for Chemical Analysis of Hydraulic Cement
- C150 Specification for Portland Cement
- C157/C157M Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete
- C215 Test Method for Fundamental Transverse, Longitudinal, and Torsional Resonant Frequencies of Concrete Specimens
- C305 Practice for Mechanical Mixing of Hydraulic Cement

Pastes and Mortars of Plastic Consistency

- C348 Test Method for Flexural Strength of Hydraulic-Cement Mortars
 - C349 Test Method for Compressive Strength of Hydraulic-Cement Mortars (Using Portions of Prisms Broken in Flexure)
 - C452 Test Method for Potential Expansion of Portland-Cement Mortars Exposed to Sulfate
 - C490 Practice for Use of Apparatus for the Determination of Length Change of Hardened Cement Paste, Mortar, and Concrete
 - C511 Specification for Mixing Rooms, Moist Cabinets, Moist Rooms, and Water Storage Tanks Used in the Testing of Hydraulic Cements and Concretes
 - C595 Specification for Blended Hydraulic Cements
 - C597 Test Method for Pulse Velocity Through Concrete
 - C618 Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
 - C684 Test Method for Making, Accelerated Curing, and Testing Concrete Compression Test Specimens
 - C778 Specification for Standard Sand
 - C917 Test Method for Evaluation of Cement Strength Uniformity From a Single Source
 - C989 Specification for Slag Cement for Use in Concrete and Mortars
 - D1193 Specification for Reagent Water
 - E18 Test Methods for Rockwell Hardness of Metallic Materials
- ### 2.2 American Concrete Institute Reports:
- ACI C201-2R-01 Guide to Durable Concrete³

3. Significance and Use

3.1 This test method provides a means of assessing the sulfate resistance of mortars made using portland cement, blends of portland cement with pozzolans or slags, and blended hydraulic cements. Method C452 is suitable for evaluating portland cements but not blended cements or blends of portland cement with pozzolans or slags.

3.2 The standard exposure solution used in this test method, unless otherwise directed, contains 352 moles of Na_2SO_4 per

¹ This test method is under the jurisdiction of ASTM Committee C01 on Cement and is the direct responsibility of Subcommittee C01.29 on Sulfate Resistance.

Current edition approved Dec. 15, 2009. Published January 2010. Originally approved in 1984. Last previous edition approved in 2004 as C1012-04. DOI: 10.1520/C1012_C1012M-09.

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.

³ Available from American Concrete Institute (ACI), P.O. Box 9094, Farmington Hills, MI 48333-9094, <http://www.concrete.org>.

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

m³ [50 g/L]. Other sulfate concentrations or other sulfates such as MgSO₄ may be used to simulate the environmental exposure of interest. Further discussion of these and other technical issues is given in the Appendix.

4. Apparatus

4.1 *Mixer*, conforming to the requirements of Practice C305.

4.2 *Cube Molds*, conforming to the requirements of Test Method C109/C109M.

4.3 *Bar Molds*, conforming to the requirements of Specification C490.

4.4 *Comparator*, conforming to the requirements of Specification C490.

4.5 *Containers*—The containers in which the bars are immersed shall be corrosion resistant such as plastic, glass, or ceramic. Support the bars so that no end or side of a bar rests against the container. Seal the container with a lid so that the sulfate solution cannot evaporate.

4.6 *Curing Tank*, conforming to the requirements of Test Method C684.

5. Reagents and Materials

5.1 *Purity of Reagents*—USP or technical grade chemicals may be used, provided it is established that any reagent used is of sufficiently high purity to permit its use without lessening the accuracy of the determination. When tests are made that are expected to produce results that are close to an acceptance-rejection value, it is recommended that reagent grade chemicals be used. Such chemicals shall conform to the specifications of the Committee on Analytical Reagents for the American Chemical Society where such specifications are available.⁴

5.2 *Purity of Water*—Unless otherwise indicated, references to water shall be understood to mean reagent water conforming to Type IV of Specification D1193.

5.3 *Sodium Sulfate (Na₂SO₄)*—Check the water content by loss on ignition each time the solution is prepared. Any anhydrous or hydrated sodium sulfate may be used if the water content of the salt is checked by loss on ignition and proper corrections made to account for the specified sulfate concentration.

5.4 *Sulfate Solution*—Each litre of solution shall contain 50.0 g of Na₂SO₄ dissolved in 900 mL of water, and shall be diluted with additional distilled or deionized water to obtain 1.0 L of solution. Mix the solution on the day before use, cover, and store at 23.0 ± 2.0 °C [73.5 ± 3.5 °F]. Determine the pH of the solution before use; reject the solution if the pH range is outside 6.0 to 8.0. Maintain the volume proportion of sulfate solution to mortar bars in a storage container at 4.0 ± 0.5 volumes of solution to 1 volume of mortar bars. For mortar bars 1 by 1 by 11¼ in. (volume of 184 mL [11.25 in.³]), this is

645 to 830 mL of solution per mortar bar in the storage container. For mortar bars 25 by 25 by 285 mm (volume 178 mL), this is 625 to 800 mL of solution per mortar bar in the storage container.

5.5 *Materials*:

5.5.1 *Graded Standard Sand*, as specified in Specification C778.

5.5.2 *Stainless Steel Gauge Studs*, as specified in Specification C490.

6. Hazards

6.1 **Warning**—Fresh hydraulic cementitious mixtures are caustic and may cause chemical burns to skin and tissue upon prolonged exposure.⁵

7. Preparing Mortars

7.1 Make mortars as described in Test Method C109/C109M, that is, 1 part cement to 2.75 parts of sand by mass. Use a water-cement ratio by mass of 0.485 for all non-air-entraining portland cements and 0.460 for all air-entraining portland cements. Use a water-cement ratio by mass of 0.485 for non-air-entraining portland-pozzolan (IP) and portland-blast furnace slag (IS) cements. For blends of portland cement with a pozzolan or slag, use a water-cement ratio that develops a flow within ±5 of that of the portland-cement mortar at a water-cement ratio of 0.485.

8. Specimen Molds

8.1 Prepare the specimen molds in accordance with the requirements of Specification C490 except the interior surfaces of the mold shall be covered with a release agent. A release agent will be acceptable if it serves as a parting agent without affecting the setting of the cement and without leaving any residue that will inhibit the penetration of water into the specimen.

NOTE 1—TFE-fluorocarbon tape complies with the requirements for a mold release agent.

9. Procedure

9.1 *Molding and Initial Curing of Specimens*—Mold the test bars in accordance with Test Method C157/C157M. Mold the cubes in accordance with Test Method C109/C109M. A set of specimens to test one cement consists of 6 bars and up to 21 cubes (Note 2). Immediately after molding, cover the molds with a rigid steel, glass, or plastic plate, seal the plate to the mold so as to be watertight, and place the mold in the curing tank in water at 35 ± 3 °C [95 ± 5 °F] for 23½ h ± 30 min, as in Test Method C684, Procedure A (Warm-Water Method). Place the sealed molds in the curing tank with the bottom of the bars as cast down, that is, in the same relative position in which the bars were cast. At 23½ h ± 30 min, remove molds from tank and demold the specimens.

NOTE 2—The set of cubes consists of 21 cubes to be tested as described herein when significant information on the strength development rate is not available. When information is available (as for example, from the use

⁴ *Reagent Chemicals, American Chemical Society Specifications*, American Chemical Society, Washington, DC. For Suggestions on the testing of reagents not listed by the American Chemical Society, see *Annual Standards for Laboratory Chemicals*, BDH Ltd., Poole, Dorset, U.K., and the *United States Pharmacopeia and National Formulary*, U.S. Pharmacopeial Convention, Inc. (USPC), Rockville, MD.

⁵ See *Manual of Cement Testing*, Section on Safety, *Annual Book of ASTM Standards*, Vol 04.01.