Designation: C1012/C1012M – 24

Standard Test Method for Length Change of Hydraulic-Cement Mortars Exposed to a Sulfate Solution[1]

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 MPa ± 1.0 MPa [3000 psi ± 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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.4 *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:*[2]

C109/C109M Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 50 mm [2 in.] Cube Specimens)

C114 Test Methods for Chemical Analysis of Hydraulic Cement

C150/C150M 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/C490M 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/C595M Specification for Blended Hydraulic Cements

C597 Test Method for Ultrasonic Pulse Velocity Through Concrete

C618 Specification for Coal Ash and Raw or Calcined Natural Pozzolan for Use in Concrete

C778 Specification for Standard Sand

C917/C917M Test Method for Evaluation of Variability of Cement from a Single Source Based on Strength

C989/C989M Specification for Slag Cement for Use in Concrete and Mortars

C1157/C1157M Performance Specification for Hydraulic Cement

D1193 Specification for Reagent Water

E18 Test Methods for Rockwell Hardness of Metallic Materials

E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods

[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.

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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**

E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

2.2 *American Concrete Institute Reports:*
ACI C201-2R-01 Guide to Durable Concrete[3]

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. Test 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 m^3(50 g/L). Other sulfate concentrations or other sulfates such as $MgSO_4$ 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/C490M.

4.4 *Comparator,* conforming to the requirements of Specification C490/C490M.

4.5 *Containers*—The containers in which the bars are immersed in the sulfate solution 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 *Initial Curing Container*—The container and the risers in which the specimens are to be cured shall be corrosion and heat resistant such as plastic, glass, or ceramic. The container shall be of a size that permits the storage of the specimens, so that no end or side of a bar or cube rests against the container. The lid on the container shall be air tight, so that the water cannot evaporate. More than one container may be required for the initial curing of a complete set of bars and cube specimens.

4.7 *Oven*—A convection oven with temperature control maintaining 35 °C ± 3 °C (95 °F ± 5 °F).

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* (Na_2SO_4)—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 Na_2SO_4 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 °C ± 2.0 °C [73.5 °F ± 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 in. by 1 in. by 11 ¼ in. (volume of 184 mL [11.25 $in.^3$]), this is 645 mL to 830 mL of solution per mortar bar in the storage container. For mortar bars 25 mm by 25 mm by 285 mm (volume 178 mL), this is 625 mL 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/C490M.

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 Specification C150/C150M cements and 0.460 for all air-entraining Specification C150/C150M cements. Use a water-cement ratio by mass of 0.485 for non-air-entraining Specification C595/C595M or C1157/C1157M cements. For mixtures consisting of a Specification C150/C150M, C595/C595M, or C1157/C1157M cement and a pozzolan or slag cement, use a water-cementitious materials ratio that develops

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

[4] *ACS Reagent Chemicals, Specifications and Procedures for Reagents and Standard-Grade Reference Materials*, American Chemical Society, Washington, DC. For suggestions on the testing of reagents not listed by the American Chemical Society, see *Analar 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.