



# Standard Test Method for Expansion of Hydraulic Cement Mortar Bars Stored in Water<sup>1</sup>

This standard is issued under the fixed designation C 1038; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This test method covers the determination of the expansion of mortar bars made using hydraulic cement, of which sulfate is an integral part.

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

1.2 The values stated in SI units are to be regarded as the standard. Values in parentheses are for information only.

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:

C 109/C 109M Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or 50-mm Cube Specimens)<sup>2</sup>

C 230/C 230M Specification for Flow Table for Use in Tests of Hydraulic Cement<sup>2</sup>

C 305 Practice for Mechanical Mixing of Hydraulic Cement Pastes and Mortars of Plastic Consistency<sup>2</sup>

C 490 Practice for Use of Apparatus for the Determination of Length Change of Hardened Cement Paste, Mortar, and Concrete<sup>2</sup>

C 511 Specification for Moist Cabinets, Moist Rooms, and Water Storage Tanks Used in the Testing of Hydraulic Cements and Concretes<sup>2</sup>

C 778 Specification for Standard Sand<sup>2</sup>

C 1005 Specification for Reference Masses and Devices for Determining Mass and Volume for Use in the Physical Testing of Hydraulic Cements<sup>2</sup>

C 1437 Test Method for Flow of Hydraulic Cement Mortar<sup>2</sup>

D 1193 Specification for Reagent Water<sup>3</sup>

## 3. Significance and Use

3.1 This test method is used to determine the amount of expansion of a mortar bar when it is stored in water. The amount of mortar-bar expansion may relate to the amount of sulfate in the cement; expansion may become excessive when the cement contains too much sulfate.

3.2 Some cement specifications limit the amount of sulfate contained in hydraulic cement by requiring that the amount of expansion in water not exceed a specified value.

## 4. Apparatus

4.1 *Reference Masses and Mass-Determining Devices*, conforming to the requirements of Specification C 1005. Evaluate the device for precision and bias at a total load of 2 Kg.

4.2 *Glass Graduates, Molds, and Length Comparator*, conforming to the requirements of Specification C 490.

4.3 *Moist Cabinet or Room*, conforming to the requirements of Specification C 511.

4.4 *Mixer, Bowl, and Paddle*, conforming to the requirements of Practice C 305.

4.5 *Trowel and Tamper*, conforming to the requirements of Test Method C 109.

## 5. Temperature and Relative Humidity

5.1 *Molding Room, Dry Materials, and Mixing Water*—Maintain the temperature of the molding room, dry materials, and mixing water at  $23.0 \pm 4.0^\circ\text{C}$ , and maintain the relative humidity of the molding room at not less than 50 %.

## 6. Reagents and Materials

6.1 *Mixing Water*—Potable water is satisfactory for routine tests. For all cooperative tests and in case of dispute, use reagent water conforming to the numerical limits of Type III of Specification D 1193.

6.2 *Graded Sand*—Sand for making the test specimens shall conform to the requirements for graded standard sand in Specification C 778.

## 7. Procedure


7.1 *Number and Dimensions of Test Specimens*—Make four 25 by 25 by 285-mm, or 1 by 1 by 11¼-in. test specimens for each cement. The effective gage length of these specimens is 125 mm or 5 in. respectively.

<sup>1</sup> This test method is under the jurisdiction of ASTM Committee C01 on Cement and is the direct responsibility of Subcommittee C01.28 on Sulfate Content.

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<sup>2</sup> *Annual Book of ASTM Standards*, Vol 04.01.

<sup>3</sup> *Annual Book of ASTM Standards*, Vol 11.01.

 **C 1038**

NOTE 1—In routine tests, 25 by 25 by 160-mm, or 1 by 1 by 6¼-in. specimens may be used; however, in case of dispute, results obtained with 25 by 25 by 285-mm, or 1 by 1 by 11¼-in. specimens shall govern.

7.2 *Specimen Molds*—Prepare the specimen molds in accordance with the requirements of Specification C 490, except cover the interior surfaces of the mold 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 which will reduce the penetration of water into the specimen.

NOTE 2—TFE-fluorocarbon tape complies with the requirements for a mold release agent.

7.3 *Proportioning, Consistency, and Mixing of Mortar:*

7.3.1 The quantity of dry materials required to prepare four 25 by 25 by 285-mm or 1 by 1 by 11¼-in. specimens is 500 g of cement and 1375 g of graded sand. Use an amount of mixing water that produces a flow of  $110 \pm 5$  as determined by the flow table after 25 drops in 15 s as described in Test Method C 1437. Record the amount of water used to the nearest millilitre.

7.3.2 Mix the mortar in accordance with the procedure described in Practice C 305.

7.4 *Molding Test Specimens*—Immediately upon completion of mixing, remove the paddle and the bowl from the mixer and shake the excess mortar from the paddle into the bowl. Fill the mold in two layers, compacting each layer with the tamper. Work the mortar into the corners, around the gage studs, and along the surfaces of the mold with the tamper until a homogeneous specimen is obtained. After the top layer has been compacted, cut the mortar off flush with the top of the mold and smooth the surface with a few strokes of the trowel.

## 8. Storage of Test Specimens

8.1 *Initial Storage*—Immediately upon completion of molding, place the test specimens in the moist cabinet or moist room. Keep all test specimens in the molds in the moist cabinet or moist room for  $22.05 \pm 0.5$  h with upper surfaces exposed to the moist air but protected from dripping water. After this time, remove the specimens from the molds, properly identify, and place in water maintained at  $23.0 \pm 2.0$  °C for at least 30 min prior to making the initial measurement.

8.2 *Subsequent Storage*—After the initial measurement, store the test specimens in saturated lime water in a tank in the moist cabinet or moist room. Cover the specimens with at least 5-mm (¼-in.) of water during storage. Keep the storage water

clean by changing as necessary. Use a tank and lime water conforming to the requirements of Specification C 511.

## 9. Length Change Measurement

9.1 Remove the specimens from water storage, one at a time, and wipe only the gage studs with a damp cloth before measuring. Make length-comparator readings. The effective gage length of specimens is 250 mm or 10 in. for the standard mold size.

9.2 Make the first reading at the age of  $24 \text{ h} \pm 15 \text{ min}$  from the time the cement and water are mixed together. Make additional length-comparator readings at the age of 14 days.

NOTE 3—Additional information of value may be obtained by making length-comparator readings of the specimens at ages earlier and later than 14 days.

## 10. Calculation and Report

10.1 Calculate the change in length of the specimen at 24 h and at 14 days to the nearest 0.001 % of the effective gage length and report as the expansion of the specimen at that period. Report the average length of change of the four specimens to the nearest 0.001 %.

## 11. Precision and Bias

11.1 *Precision*—The following precision statements are applicable when replicate samples are made using the same portland cement at fixed water content.

11.1.1 The single-operator standard deviation has been found to be 0.00165 % for expansions between 0.0075 and 0.011 %. Therefore, results of two properly conducted tests by the same operator on the same material should not differ from each other by more than 0.005 %.

11.1.2 The multi-laboratory standard deviation has been found to be 0.00287 % for expansions between 0.0075 and 0.0115 %. Therefore, results of two properly conducted tests on the same material in two different laboratories should not differ from each by more than 0.008 %.

11.2 *Bias*—Since there is no accepted reference material suitable for determining the bias for the procedure in Test Method C 1038 for measuring the expansion of the bar specimens, no statement on bias is being made.

## 12. Keywords

12.1 hydraulic cement; mortar-bar expansion; sulfate; sulfate content

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