



## Standard Test Method for Expansion of Portland 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 from portland cement, of which sulfate is an integral part. This test method applies only to portland cements.

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 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 Weights and Weighing Devices for Use in the Physical Testing of Hydraulic Cements<sup>2</sup>

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

#### 2.2 National Standard of Canada:

CAN 3-A5-M83 Portland Cements<sup>4</sup>

### 3. Significance and Use

3.1 This test method, when applied to portland cement containing calcium sulfate, determines the amount of expansion of a mortar bar when it is stored in water. The amount of mortar bar expansion is related to the amount of calcium

sulfate in the cement; expansion becomes excessive when the cement contains too much calcium sulfate.

3.2 When desired, cement specifications may limit the amount of calcium sulfate contained in a portland cement by requiring that the amount of expansion in water not exceed a specified value.

NOTE 1—An expansion limit of 0.020 % in fourteen days of water immersion is in use in Canadian Standards document CAN 3-A5-M83.

### 4. Apparatus

4.1 *Weights and Weighing Devices*, conforming to the requirements of Specification C 1005. The weighing device shall be evaluated for precision and accuracy 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 Humidity

5.1 *Molding Room, Dry Materials, and Mixing Water*—The temperature of the molding room, dry materials, and mixing water shall be maintained between 20 and 28°C (68 and 82.4°F) and the relative humidity of the molding room shall not be 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, reagent water conforming to Type III B of Specification D 1193 shall be used.

6.2 *Graded Sand*—The graded 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 (1 by 1 by 11¼-in.) test specimens for each cement.

NOTE 2—In routine tests, 25 by 25 by 160-mm (1 by 1 by 6¼-in.) specimens may be used; however, in case of dispute, results obtained with 25 by 25 by 285-mm (1 by 1 by 11¼-in.) specimens shall govern.

<sup>1</sup> This test method is under the jurisdiction of ASTM Committee C-1 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.

<sup>4</sup> Available from Canada Standards Association, 178 Rexdale Blvd., Rexdale, Ontario Canada M9W 143.

7.2 *Specimen Molds*—Prepare the specimen molds in accordance with the requirements of Specification C 490, 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 which will inhibit the penetration of water into the specimen.

NOTE 3—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 (1 by 1 by 11¼-in.) specimens is 500 g of cement and 1375 g of graded sand. The amount of mixing water is 243 mL for all non-air-entraining portland cements and 230 mL for all air-entraining portland cements.

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 to 23 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  $23 \pm 2^\circ\text{C}$  ( $73.4 \pm 3.6^\circ\text{F}$ ) 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. The specimens shall be covered

with at least 5-mm (¼-in.) of water during storage. Keep the storage water clean by changing as necessary.

## 9. Length Measurement

9.1 Remove the specimens from water storage, one at a time, and wipe with a damp cloth before measuring. Measure the specimens for length by means of the length comparator.

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. Measure the specimens again at the age of 14 days.

NOTE 4—Additional information of value may be obtained by making measurements of the specimens at ages earlier and later than 14 days.

## 10. Calculation and Report

10.1 Calculate the difference 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 of the four specimens.

## 11. Precision and Bias

11.1 *Precision*—The following precision statements are applicable when replica samples are made using the same cement.

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 calcium sulfate; hydraulic cement; sulfate content

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