



## Standard Practice for Length Change of Cast, Drilled, or Sawed Specimens of Hydraulic-Cement Mortar and Concrete<sup>1</sup>

This standard is issued under the fixed designation C 341/C 341M; 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 practice covers the determination of the length changes of cast, drilled, or sawed specimens of hydraulic-cement mortar and concrete due to causes other than externally applied forces and temperature changes. It can be readily adapted, if desired, to studies of length change involving different schedules or environmental treatment than the standard procedures prescribed by this practice.

1.2 The values stated in either inch-pound units or SI units shall be regarded separately as standard. The units stated in each system may not be exact equivalents; therefore, each system must be used independently of the other, without combining in any way. The inch-pound units are shown in brackets.

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:<sup>2</sup>

- A 276 Specification for Stainless Steel Bars and Shapes
- C 31/C 31M Practice for Making and Curing Concrete Test Specimens in the Field
- C 42/C 42M Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
- C 157/C 157M Test Method for Length Change of Hardened Hydraulic-Cement, Mortar, and Concrete
- C 192/C 192M Practice for Making and Curing Concrete Test Specimens in the Laboratory
- C 490 Practice for Use of Apparatus for the Determination

<sup>1</sup> This practice is under the jurisdiction of ASTM Committee C09 on Concrete and Concrete Aggregates and is the direct responsibility of Subcommittee C09.68 on Volume Change.

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<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

of Length Change of Hardened Cement Paste, Mortar, and Concrete

C 666 Test Method for Resistance of Concrete to Rapid Freezing and Thawing

### 3. Terminology

#### 3.1 Definition

3.1.1 *length change, n*—an increase or decrease in a linear dimension of a test specimen, which has been caused to change by any factor other than externally applied forces and temperature changes.

### 4. Significance and Use

4.1 Measurements of length change permit assessment of the potential for volumetric expansion or contraction of cast, drilled, or sawed specimens of hydraulic-cement mortar, and concrete due to various causes other than externally applied forces and temperature changes. This practice is particularly useful for comparative evaluation of this potential in different mortar or concrete specimens.

### 5. Apparatus

5.1 *Length Comparator*—The length comparator shall generally conform to the requirements of Specification C 490, except that it shall be constructed to accommodate the specimens to be tested under this practice, which shall have gage lengths of 75 mm [3 in.] or more.

5.1.1 *Gage Studs in Ends of Specimens*—When the comparator is to be used to measure between gage studs in the ends of specimens, the gage length for computing percentage length change shall be considered to be the distance between the innermost ends of the gage studs, and the contact terminals of the comparator shall be plane, polished, heat-treated surfaces as described in Specification C 490. Fig. 3 of Specification C 490 shows one type of comparator that has been found suitable for such specimens. A horizontal comparator is desirable for specimens that are considered too large to be handled by the type of comparator illustrated in Fig. 3 of Specification C 490.

5.1.2 *Gage Studs on Sides of Specimen*—When the comparator is to be used to measure between gage studs on the sides of specimens, the contact terminals shall be conical,

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

heat-treated surfaces as shown in Fig. 1, which illustrates a type of comparator that has been found satisfactory for this type of specimen. In this case, the gage length shall be the distance between the reference points located in the exposed ends of the gage studs (see 5.2).

**5.2 Gage Studs**—Gage studs shall be Type 316 stainless steel, meeting Specification A 276.

**5.2.1 For Ends of Specimens**—Gage studs that are to be located in the ends of specimens shall have a rounded surface to provide point contact with the terminals of the comparator. The types of studs described in Specification C 490 are suitable for insertion in drilled holes. Spherical studs having a diameter of 6 to 10 mm [ $\frac{1}{4}$  to  $\frac{3}{8}$  in.], or studs that are sections of spheres of similar diameter, are suitable for cementing to the ends of specimens.

**5.2.2 For Sides of Specimens**—The exposed end of gage studs that are to be located on the sides of specimens shall have a plane surface with a diameter or diagonal of 10 to 13 mm [ $\frac{3}{8}$  to  $\frac{1}{2}$  in.]. For dry setting, the length of the stud shall be 13 to 16 mm [ $\frac{1}{2}$  to  $\frac{5}{8}$  in.]. Shorter lengths of stud, including plane disks, shall be satisfactory for studs that are to be cemented.

**5.3 Drying Room and Controls**—A drying room and controls as described in Test Method C 157/C 157M shall be used for storing specimens in air.

## 6. Sampling

**6.1** Samples of drilled or sawed hydraulic cement mortar or concrete shall be obtained in accordance with the section on Sampling of Test Method C 42/C 42M.

**6.2** Samples of field cast hydraulic cement mortar or concrete shall be cast in accordance with Practice C 31/C 31M.

**6.3** Constituent materials for concrete or mortar specimens made in the laboratory for use in this practice shall be sampled using applicable standard methods.

**6.3.1** The specimens for use in this practice prepared from the constituent materials in the laboratory shall be cast prisms or cylinders made and cured in accordance with the applicable requirements of Practice C 192/C 192M and Practice C 490.

## 7. Test Specimens

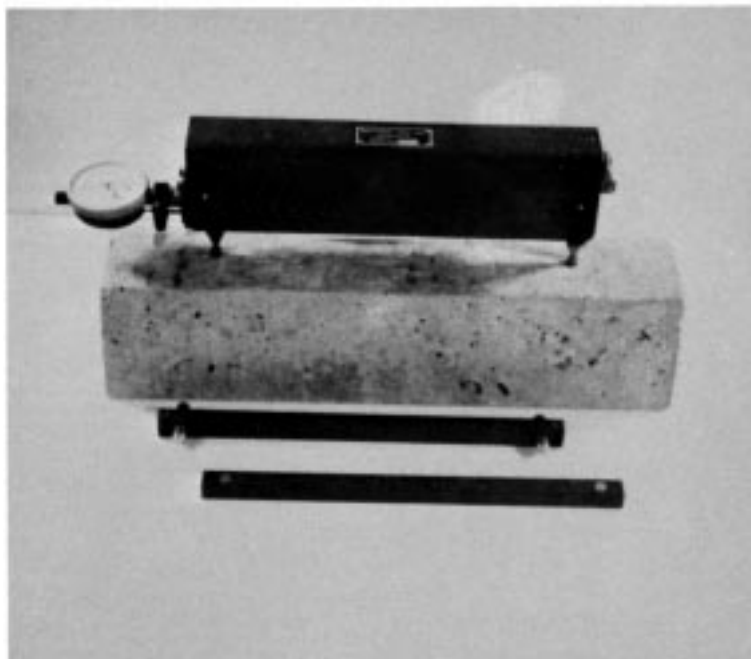
**7.1** Test specimen geometry shall be either cylindrical or rectangular prisms. Specimens shall be either cast from freshly mixed materials or drilled or sawn from existing concrete or mortar structures. Specimens shall be free from reinforcing steel, visible cracks, or other structural defects. They shall be of any size but specimens that are to be compared shall not differ in their cross-sectional dimensions by more than 10 % or in length by more than 20 % (Note 1). The gage length shall be at least six times the maximum nominal size of the coarse aggregate but not less than 75 mm [3 in.], and that the minimum cross-sectional dimension be at least three times the maximum nominal size of the coarse aggregate but not less than 50 mm [2 in.]. When the gage studs are to be located on the sides of the specimen, the over-all length of the specimen shall exceed the gage length by at least 50 mm [2 in.].

**NOTE 1**—Specimens used for length change measurements during freeze thaw resistance testing as described in Test Method C 666 should follow the dimensional requirements of that method.

## 8. Setting Gage Studs

**8.1** Gage studs shall either be cast in place, dry-set or cemented in drilled holes, or cemented directly to the surface of the specimen.

**8.2 Drilling Holes**—For gage studs that are to be cemented, holes shall be drilled (Note 2) only slightly larger than the studs. For gage studs that are to be dry-set, holes shall be drilled about 0.1 mm [0.005 in.] smaller in diameter than the studs. In the case of small specimens, take care that the



**FIG. 1** Type of Suitable Extensometer for Measurement of Length Change of Specimens Having Gage Studs on Sides



specimens are not damaged by the drilling operation. The location and depth of holes shall be as given in 8.2.1 and 8.2.2.

NOTE 2—Carbide-tipped masonry drills have been found most suitable for this purpose.

8.2.1 *For Gage Studs in Ends of Specimen*—Drill holes in the ends of a specimen so that their longitudinal axes coincide with the longitudinal axis of the specimen. The depth of the holes shall be such that the gage studs will project from 3 to 5 mm [ $\frac{1}{8}$  in. to  $\frac{3}{16}$  in.] beyond the ends of the specimen.

8.2.2 *For Gage Studs in Sides of Specimen*—Drill a pair of holes in each of two opposite sides of the specimen to compensate for warping and to provide a better average for length change. Position both pairs of holes in a plane containing the longitudinal axis of the specimen and space to conform to the length of the comparator. The center of each hole shall be at least 25 mm [1 in.] from the end of the specimen. The depth of the holes shall preferably be such that the top surfaces of the gage studs can be set about 3 mm [0.1 in.] below the surface of the specimen.

### 8.3 Cementing Methods:

8.3.1 *Studs Set in Holes*—Position gage studs in holes at the depth specified in 8.2.1 or 8.2.2, as appropriate, with the exposed end parallel to the surface of the specimen in the case of studs having plane end surfaces. The cementing material shall be stable and effective in either a wet or dry environment and at temperatures up to 120°C [250°F]. The following cementing materials have been found satisfactory:

8.3.1.1 *Epoxy Resin*—Epoxy resins for this purpose shall cure at room temperatures. Holes shall be free of loose particles and visually dry to ensure good bond.

8.3.1.2 *Portland-Cement Paste*—Use a thick paste of Type III Portland cement. Moisten each hole with about 5 mL of water, cement the studs in place after the water has been absorbed, and moist-cure the paste for approximately 24 h.

8.3.1.3 *Other Cementing Media*—Sulfur and Rose metal have also proven satisfactory.

8.3.2 *Studs Cemented to Surface*—An epoxy resin system that sets at room temperature and does not soften at a temperature of 120°C [250°F] is the most satisfactory material for cementing studs to the surface of a specimen. To ensure good bond, it is essential that the surface be clean. Acid etching followed by flushing with water and drying is a satisfactory preparation of the surface for bonding. The locations of the studs on the specimen are the same as those prescribed for drilled holes in 8.2.1 and 8.2.2. The exposed end surface of each stud having a plane end surface shall be parallel to the surface of the specimen.

8.4 *Dry-Setting Method*—Drive the gage studs to the depth specified in 8.2.1 or 8.2.2, as appropriate, into holes that are approximately 0.1 mm [0.005 in.] smaller in diameter than the gage studs, being careful not to deform the exposed ends of the gage studs during the driving operation.

8.5 *Reference Points on Gage Studs*—On each gage stud located on the side of a specimen, establish a reference point by drilling a hole approximately 1 mm in diameter (see Note 3) in the end of the stud to a depth sufficient to provide clearance between the bottom of the hole and the point of the comparator, as shown in Fig. 1. A template (Fig. 1) will aid in spacing the

holes at proper gage length, which shall be as nearly equal to the mean gage length of the comparator as practicable. Remove burred edges from the reference point holes.

NOTE 3—A No. 56 American Standard Twist Drill or other bit suitable to drill a hole approximately 1 mm or 0.046 in. in diameter is suitable for this purpose.

## 9. Determination of Gage Length of Specimens

9.1 Determine the gage length of each specimen to an accuracy of 1 %. In the case of specimens having gage studs on the sides, determine the gage length by direct measurement between the reference points with a suitable scale. Determine the gage length of specimens having gage studs in the ends by first measuring the distance between the ends of the gage studs with suitable calipers and subtracting the lengths of the two gage studs.

## 10. Conditioning of Specimens for Measurement of Base Length

10.1 Prior to the initial measurement for length, condition specimens by immersion in lime-saturated water.

10.2 Maintain the temperature of the conditioning water at  $23 \pm 2^\circ\text{C}$  [ $73.5 \pm 3.5^\circ\text{F}$ ], except that during the last 1 h of immersion immediately before making any measurement for length maintain the temperature at  $23.0 \pm 0.5^\circ\text{C}$  [ $73.4 \pm 1.0^\circ\text{F}$ ] (Note 4). When measuring for length, remove the specimens from water one at a time, wipe with a damp cloth, and immediately measure for length using the comparator specified in 5.1. Make length measurements at 7-day intervals and continue conditioning until the change in length over a 7-day period is less than 0.001 %. Use the length measurement that determines that this criterion is met as the basis for calculating length change occurring during the air or water storage period.

NOTE 4—Specimens used for length change measurements during freeze thaw resistance testing as described in Test Method C 666 should follow the conditioning of that method.

## 11. Storage of Specimens

11.1 After measurement at the end of the conditioning period, store the specimens as described in either 11.2 or 11.3, unless another condition of storage is specified.

11.2 *Water Storage*—Immerse specimens in lime-saturated water at  $23 \pm 2^\circ\text{C}$  [ $73.5 \pm 3.5^\circ\text{F}$ ]. Take observations of the length of each specimen after 1, 2, 4, 8, 16, 32, and 64 weeks unless otherwise specified. Make these observations immediately after the specimens have been subjected to storage in water at  $23.0 \pm 0.5^\circ\text{C}$  [ $73.4 \pm 1.0^\circ\text{F}$ ] for a period of at least 1 h. When measuring for length, remove the specimens from water one at a time, wipe with a damp cloth, and immediately measure for length using the comparator specified in 5.1.

11.3 *Air Storage*—Store the specimens in circulating air maintained at a temperature of  $23 \pm 2^\circ\text{C}$  [ $73.5 \pm 3.5^\circ\text{F}$ ] and a relative humidity of  $50 \pm 4\%$  unless some other condition of storage is specified. See 5.3 for reference to a suitable drying room. The air movement past all specimens shall be such that the rate of evaporation is  $77 \pm 30$  mL/24 h from the atmometer referenced in 5.3 or  $13 \pm 5$  mL/24 h from a 400-mL Griffin low-form beaker filled initially to 20 mm [ $\frac{3}{4}$  in.] from the top.



Unless otherwise specified, measure specimens for length at weekly intervals and continue them in air storage until their change in length over a 7-day period is less than 0.001 %. Preferably, make these observations in a room maintained at a relative humidity of  $50 \pm 4$  % while the specimens are at a temperature of  $23 \pm 2^\circ\text{C}$  [ $73.5 \pm 3.5^\circ\text{F}$ ].

## 12. Report

12.1 Report the following information:

12.1.1 Sources of specimen in terms of the structure and particular location in the structure from which the specimen was obtained,

12.1.2 Dimensions of the test specimen,

12.1.3 Maximum size and mineral character of aggregate in concrete,

12.1.4 Description of conditioning, either by indication that the type of conditioning outlined in Section 10 was followed, or by giving details of any procedure not conforming to that condition. In either case, give the total length of the conditioning period,

12.1.5 Description of the storage condition, either by indicating that the type of storage outlined in Section 11 was followed or by giving details of any procedure not conforming to that condition,

12.1.6 Total length of the period of storage, exclusive of the conditioning period, up to each length measurement,

12.1.7 Length change data, measured in accordance with the Procedure for Calculating Length Change in Test Method C 157/C 157M and typically reported to 0.001 %, except the gage length is defined in terms of Section 9 above, based on the initial measurement made at the end of the conditioning period,

12.1.8 Any condition or characteristic of the concrete of interest to the study, and

12.1.9 Any other pertinent information.

## 13. Keywords

13.1 comparator; concrete; conditioning; length change; mortar

## SUMMARY OF CHANGES

Committee C09 has identified the location of selected changes to this practice since the last issue, C 341 – 03, that may impact the use of this practice. (Approved December 1, 2003)

- (1) Eliminated erroneous references to this standard as a test method throughout.
- (2) Improved the description of test specimens in Section 7.
- (3) Provided for cast in place gage studs in Section 8.
- (4) Revised paragraph 8.5 to clarify wording and to allow any type of drill bit that can produce a hole approximately 1 mm or 0.046 in. in diameter by inserting Note 3 and renumbering subsequent notes.

- (5) Clarified paragraph 11.2 water storage so that the temperature conditioning and handling of the specimens is the same process as is used for the initial measurement.
- (6) Changed paragraph 12.7 to better reflect this document as a practice rather than a test method.

Committee C09 has identified the location of selected changes to this practice since the last issue, C 341 – 96, that may impact the use of this practice. (Approved July 10, 2003)

- (1) Revised title and scope to reflect change from Test Method to Practice.
- (2) Converted to dual unit standard (SI and inch-pound units).

- (3) Allowed cast specimens, as well as cored and sawed specimens.

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