Designation: C 341 – 96

Standard Test Method for Length Change of Drilled or Sawed Specimens of Hydraulic-Cement Mortar and Concrete[1]

This standard is issued under the fixed designation C 341; 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 the length changes of 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 test method.

1.2 The values stated in inch-pound units are to be regarded as 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:*

A 276 Specification for Stainless Steel Bars and Shapes[2]

C 42 Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete[3]

C 157 Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete[3]

C 490 Practice for Use of Apparatus for the Determination of Length Change of Hardened Cement Paste, Mortar, and Concrete[4]

3. Terminology

3.1 *Definition of Term*—The term "length change," as used here, is defined as 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 drilled or sawed specimens of hydraulic-cement mortar, and concrete due to various causes other than externally applied forces and temperature changes. This test method 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 should be constructed to accommodate the specimens to be tested under this test method, which may have gage lengths of 3 in. (75 mm) 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 which has been found suitable for such specimens. A horizontal comparator may be 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, 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

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[2] *Annual Book of ASTM Standards*, Vol 01.05.

[3] *Annual Book of ASTM Standards*, Vol 04.02.

[4] *Annual Book of ASTM Standards*, Vol 04.01.

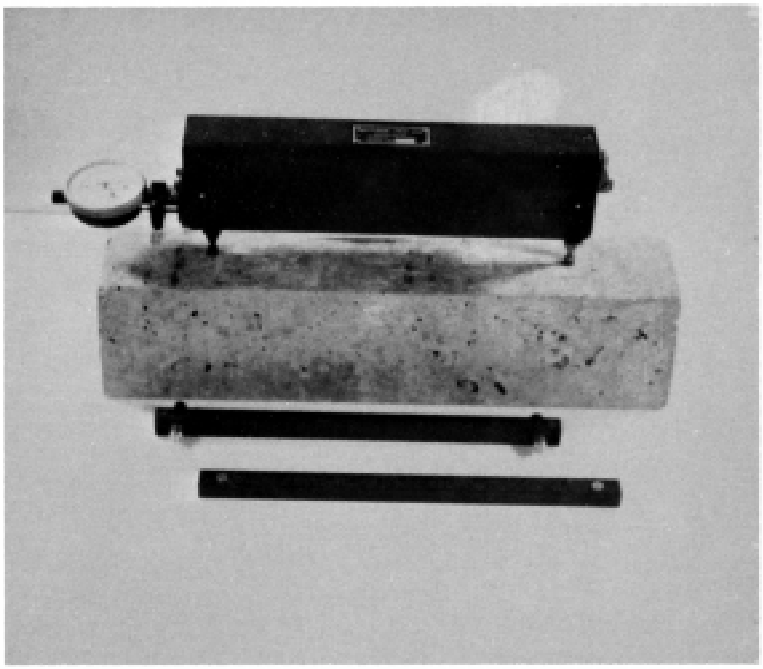

FIG. 1 Type of Suitable Extensometer for Measurement of Length Change of Specimens Having Gage Studs on Sides

for insertion in drilled holes. Spherical studs having a diameter of ¼ to ⅜ in. (6 to 10 mm), 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 ⅜ to ½ in. (10 to 13 mm). For dry setting, the length of the stud shall be ½ to ⅝ in. (13 to 16 mm). Shorter lengths of stud, including plane disks, may 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 shall be used for storing specimens in air.

6. Sampling

6.1 Samples shall be obtained in accordance with the section on Sampling of Test Method C 42.

7. Test Specimens

7.1 Test specimens shall be either cores or rectangular prisms that have been drilled or sawed from existing concrete or mortar structures and are free from reinforcing steel, visible cracks, or other structural defects. They may be of any size but specimens that are to be compared should not differ in their cross-sectional dimensions by more than 10 % or in length by more than 20 %. The gage length shall be at least six times the maximum nominal size of the coarse aggregate but not less than 3 in. (75 mm), and that the minimum cross-sectional dimension be at least three times the maximum nominal size of the coarse aggregate but not less than 2 in. (50 mm). 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 2 in. (50 mm).

8. Setting Gage Studs

8.1 Gage studs may either be 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 should be drilled (Note 1) only slightly larger than the studs. For gage studs that are to be dry-set, holes should be drilled about 0.005 in. (0.1 mm) smaller in diameter than the studs. In the case of small specimens, take care that the 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 1—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 should be such that the gage studs will project from ⅛ in. to 3⁄16 in. (3 to 5 mm) 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 should be at least 1 in. (approximately 25 mm) from the end of the specimen. The depth of the holes should preferably be such that the top surfaces of the gage studs can be set about 0.1 in. (3 mm) 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

should be stable and effective in either a wet or dry environment and at temperatures up to 250°F (121°C). The following cementing materials have been found satisfactory:

8.3.1.1 *Epoxy Resin*—Epoxy resins for this purpose should cure at room temperatures. Holes should 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 250°F (121°C) 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 should 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 0.005 in. (0.1 mm) 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*—Establish a reference point on each gage stud located on the side of a specimen by drilling a hole (approximately 1 mm in diameter) with a No. 56 American Standard Twist drill 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 should be as nearly equal to the mean gage length of the comparator as practicable. Remove burred edges from the reference point holes.

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 73.4 ± 3.0°F (23.0 ± 1.7°C), except that during the last 1 h of immersion immediately before making any measurement for length maintain the temperature at 73.4 ± 1.0°F (23.0 ± 0.5°C). 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.

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 73.4 ± 3.0°F (23.0 ± 1.7°C). 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 73.4 ± 1.0°F (23.0 ± 0.5°C) for a period of at least 30 min.

11.3 *Air Storage*—Store the specimens in circulating air maintained at a temperature of 73.4 ± 2.0°F (23.0 ± 1.1°C) and a relative humidity of 50 ± 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 ± 30 mL/24 h from the atmometer referenced in 5.3 or 13 ± 5 mL/24 h from a 400-mL Griffin low-form beaker filled initially to ¾ in. (20 mm) 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 ± 4 % while the specimens are at a temperature of 73.4 ± 2.0°F (23.0 ± 1.1°C).

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, reported as percent increase or decrease in linear dimension to the nearest 0.001 %, 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. Precision and Bias

13.1 Data necessary to determine precision and bias are not available at this time.