Designation: C596 – 09ε1

Standard Test Method for Drying Shrinkage of Mortar Containing Hydraulic Cement[1]

This standard is issued under the fixed designation C596; 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.

ε[1] NOTE—Corrected research report footnote in Section 4 editorially in June 2015.

1. Scope*

1.1 This test method determines the change in length on drying of mortar bars containing hydraulic cement and graded standard sand.

1.2 The values stated in SI units are to be regarded as standard. When combined standards are referenced, the selection of measurement system is at the user's discretion subject to the requirements of the referenced 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.* **Warning—***Fresh hydraulic cementitious mixtures are caustic and may cause chemical burns to skin and tissue upon prolonged exposure).*[2]

2. Referenced Documents

2.1 *ASTM Standards:*[3]

C157/C157M Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete

C219 Terminology Relating to Hydraulic Cement

C305 Practice for Mechanical Mixing of Hydraulic Cement Pastes and Mortars of Plastic Consistency

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

C778 Specification for Standard Sand

C1005 Specification for Reference Masses and Devices for Determining Mass and Volume for Use in the Physical Testing of Hydraulic Cements

C1437 Test Method for Flow of Hydraulic Cement Mortar

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

3. Terminology

3.1 The term "drying shrinkage" is defined as the decrease in length of the test specimen, where the decrease is caused by any factor other than externally applied forces under stated conditions of temperature, relative humidity and evaporation rate in the environment; the term includes the net effect of a variety of phenomena tending to bring about both increases and decreases in length during the period in which the test specimens under consideration are stored in the environment and in which a number of processes, including hydration of the cement, are taking place at a variety of rates.

3.2 Other terms used in this test method are defined in Terminology C219.

4. Significance and Use

4.1 This test method establishes a selected set of conditions of temperature, relative humidity and rate of evaporation of the environment to which a mortar specimen of stated composition shall be subjected for a specified period of time during which its change in length is determined and designated "drying shrinkage".

4.2 The drying shrinkage of mortar as determined by this test method has a linear relation to the drying shrinkage of concrete made with the same cement and exposed to the same

[1] This test method is under the jurisdiction of ASTM Committee C01 on Cement and is the direct responsibility of Subcommittee C01.31 on Volume Change.

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[2] Section on Safety, *Manual of Cement Testing, Annual Book of Standards,* Vol 04.01.

[3] 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**

drying conditions.[4] Hence this test method may be used when it is desired to develop data on the effect of a hydraulic cement on the drying shrinkage of concrete made with that cement.

5. Apparatus

5.1 *Weighing Devices and Weights*—Weighing devices and weights used in determining the mass of materials for mortar mixtures shall conform to the requirements of Specification C1005.

5.2 *Glass Graduates*—Glass graduates of suitable capacities shall conform to the requirements of Specification C1005.

5.3 *Molds*—Molds shall conform to the requirements of Practice C490/C490M for mortars.

5.4 *Trowel*—The trowel shall have a straight-edged steel blade 100 to 150 mm in length.

5.5 *Tamper*—The tamper shall conform to the requirements of Test Method C157/C157M.

5.6 *Demolding Apparatus*—The demolding apparatus shall conform to the requirements of Test Method C157/C157M.

5.7 *Length Comparator*—The length comparator shall conform to the requirements of Practice C490/C490M.

6. Temperature and Humidity

6.1 *Laboratory*—The temperature of the laboratory, dry materials, and mixing water, and the relative humidity of the air in the laboratory shall conform to the requirements of Specification C511.

6.2 *Moist Storage Facility*—The temperature and humidity of the air in the moist storage facility shall conform to the requirements of Specification C511.

6.3 *Drying Room and Controls*—The drying room and controls shall conform to the requirements of Test Method C157/C157M.

7. Graded Standard Sand

7.1 The graded standard sand shall conform to Specification C778.

8. Number of Test Specimens

8.1 Make at least four test specimens (Note 1).

NOTE 1—Although the number of test specimens may consist of four specimens from a single batch of mortar, it is preferable that twelve specimens be made with four specimens being made from each of three batches, with each batch being made on a different day.

[4] Data pertaining to the relation of the drying shrinkage of mortar test specimens and of the drying shrinkage of concrete test specimens as affected by the cement under specified laboratory test conditions, may be found in RR:C01-0120, available from ASTM Headquarters; in a report of the California Division of Highways. "Significance of the Test for Contraction of Mortar in Air with Respect to Performance of Cements in Concrete," Oct. 18, 1961; and in the paper by Mardulier, F. J., Schneider, A. M., and Stockett, A. L., "An Analysis of Drying Shrinkage. Data for Portland Cement Mortar and Concrete," *Journal of Materials,* JMLSA, Am. Soc. Testing Mats., Vol 2, No. 4, 1967, pp. 829–842. A relevant paper by H. T. Arni entitled "The Significance of the Correlation Coefficient for Analyzing Engineering Data" was published in *Materials Research and Standards,* MTRSA, Am. Soc. Testing Mats., Vol. 11, No. 5, 1971, pp. 16–19.

9. Preparation of Molds

9.1 Prepare the specimen molds as required by Practice C490/C490M.

10. Preparation of Test Specimens

10.1 *Mortar Proportions*—A batch of mortar shall consist of 750 g of cement, 1500 g of graded standard sand, and an amount of mixing water sufficient to produce a flow of 110 ± 5 %. The flow shall be determined in conformance with the procedure as described in Test Method C1437.

10.2 *Mixing Mortar*—Mix the mortar in a mechanical mixer as required by Practice C305.

10.3 *Molding of Specimens*—Mold the specimens as required by Test Method C157/C157M.

11. Curing, Storage, and Taking Comparator Readings of Test Specimens

11.1 Cure, store, and take comparator readings of the test specimens as required by Test Method C157/C157M, except as follows:

11.1.1 Moist cure the specimens in the molds for 24 h ± 30 min. If the strength of the specimens is insufficient to allow proper removal from the mold at 24 h, moist cure in the mold for 48 h ± 30 min.

11.1.2 Remove the specimens from the molds and cure in lime-saturated water for 48 h. If the specimens have been moist cured in the mold for 48 h, cure in lime-saturated water for 24 h.

11.1.3 At the age of 72 h ± 30 min remove the specimens from water, wipe with damp cloth and immediately obtain a length comparator reading for each specimen. Then place the specimens in air storage for 25 days. Obtain a length comparator reading for each specimen after 4, 11, 18, and 25 days of air storage.

12. Calculation

12.1 Calculate the length change of each specimen at each age of air drying by subtracting the initial comparator reading, taken after removal from water storage, from the comparator reading taken at each age of air drying and express as millionths and as the percent of the effective gage length. Do not prefix a shrinkage value with a minus sign.

12.2 Report the average change in unit length, expressed as millionths, and as a percent of the effective gage length of four specimens from the same batch of mortar as the drying shrinkage of the mortar. If any one test specimen is manifestly faulty, discard it. If more than one test specimen is discarded, do not report the results and repeat the test on a new batch of mortar. If more than one batch of mortar has been tested, report the average result of the individual batches. When the experimenter is clearly aware that a gross deviation from prescribed experimental procedure has taken place, discard the resultant observation, whether or not it agrees with the rest of the data and without recourse to statistical tests for outliers.

NOTE 2—An approximation of ultimate drying shrinkage of mortar may be determined by plotting the shrinkage values as a function of the reciprocal of the time. The time includes the moist curing period. An