



Standard Test Method for Potential Volume Change of Cement-Aggregate Combinations¹

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1. Scope

1.1 This test method covers the determination of the potential expansion of cement-aggregate combinations by measuring the linear expansion developed by the combinations in mortar bars subjected to variations of temperature and water saturation during storage under prescribed conditions of test.

1.2 *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.*

1.3 The values stated in SI units are to be regarded as standard.

2. Referenced Documents

2.1 ASTM Standards:

C 109/C109M Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens)²

C 150 Specification for Portland Cement²

C 227 Test Method for Potential Alkali Reactivity of Cement-Aggregate Combinations (Mortar-Bar Method)³

C 305 Practice for Mechanical Mixing of Hydraulic Cement Pastes and Mortars of Plastic Consistency²

C 490 Practice for Use of Apparatus for the Determination of Length Change of Hardened Cement Paste, Mortar, and Concrete³

C 856 Practice for Petrographic Examination of Hardened Concrete³

E 11 Specification for Wire-Cloth Sieves for Testing Purposes⁴

3. Significance and Use

3.1 This test method has been found to produce significant expansions of cement-aggregate combinations when the cement in some cases has a very low alkali content, and in other

cases, where the aggregate is presumptively nonreactive with alkalis. It has been suggested that the test method measures interactions of phenomena possibly including microcracking effects that are in some cases physical and perhaps in other cases chemical.

3.2 No acceptance limits for expansion of cement-aggregate combinations applicable either to cement or aggregate have been developed or should be established.

3.3 This test method is intended primarily for use by those interested in research on aggregates that are found in parts of Oklahoma, Kansas, Nebraska, and Iowa.⁵

4. Apparatus

4.1 The apparatus shall conform to Test Method C 227 except as follows:

4.2 *Containers*—Containers for storing the specimens shall be of corrosion-resistant material, and the inside dimensions shall be approximately 32 by 89 by 310 mm. They shall be so constructed that when used for storing specimens, the loss of moisture is prevented by a tight-fitting cover or by sealing, or by both. The capacity of the containers shall be such that not more than 315 mL of water are required to immerse completely three mortar specimens supported 13 mm above the bottom of the container. Provision shall be made for supporting the specimens 13 mm above the bottom of the container in such manner that the weight of the specimens is not supported by the gage studs, and the specimens are kept vertical, spaced uniformly, and free from contact with the walls of the container.

NOTE 1—Removable corrosion-resistant 0.3 to 0.9-mm sheet metal spacers have been found to be satisfactory to space and support the specimens. The top spacer is a rectangular strip (28 mm in width and 86 mm in length to fit into the interior cross-sectional dimension of the container. The strip is perforated along the longitudinal center line with

⁵ For additional information refer to: Conrow, A. D., "Studies of Abnormal Expansion of Portland Cement Concrete," *Proceedings*, Am. Soc. Testing Mats., ASTEA, Vol 52, 1952, p. 1205; and "Final Report on Cooperative Tests of Proposed Tentative Method of Test for Potential Volume Change of Cement-Aggregate Combinations, and Proposed Tentative Method of Test for Potential Abnormal Expansion of Cement-Aggregate Combinations," by Subcommittee II-b, ASTM Committee C-9, *Proceedings*, ASTEA, Am. Soc. Testing Mats., Vol 54, 1954; and Hadley, David W., "Field and Laboratory Study of the Reactivity of Sand—Gravel Aggregates," *Journal of the PCA Research and Development Laboratories*, Vol 10 No. 1, 1968, pp.17–13; also *Research Bulletin 221*, R and D Laboratories of the PCA, Skokie, IL, 1968.

¹ This test method is under the jurisdiction of ASTM Committee C-9 on Concrete and Concrete Aggregates and is the direct responsibility of Subcommittee C09.26 on Chemical Reactions of Materials.

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² *Annual Book of ASTM Standards*, Vol 04.01.

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

⁴ *Annual Book of ASTM Standards*, Vol 14.02.

three holes of a size to permit insertion of the gage studs at the ends of the specimens. The hole for the center specimen is placed at the center of the strip, and the centers of the other hole are placed 28 mm to either side of the center. The bottom spacer is the same except for an added length of 13 mm at each end that are turned at right angles to the face of the strip to form legs to support spacers 13 mm above the bottom of the container.

5. Temperature and Humidity

5.1 The temperature of the dry materials, water, molding room, and moist cabinet and the humidity of the laboratory and moist cabinet shall conform to Test Method C 227 (see also Section 8).

6. Selection and Preparation of Materials

6.1 *Selection of Aggregate*—Materials proposed for use as fine aggregate in concrete shall be processed as described in the section on preparation of aggregate with a minimum of crushing. Materials proposed for use as coarse aggregate in concrete shall be processed by crushing to produce as nearly as practical a graded product from which a sample can be obtained. The sample shall have a grading as prescribed in the section on preparation of aggregate and be representative of the composition of the coarse aggregate as proposed for use.

6.1.1 When there is reason to expect the coarser sized particles of crushed material to have a different composition than the finer sizes, and the difference might significantly affect expansion due to reaction with alkalis, the coarser sizes shall be tested in a manner to that employed in testing the finer sizes.

6.1.2 Coarse aggregate crushed to sand size may give accentuated expansion, owing to the increased surface exposed upon crushing. Therefore, if coarse aggregate tested by this method produces an excessive amount of expansion, the material shall not be classed as objectionably reactive with alkali unless tests of concrete specimens confirm the findings of the tests of the mortar.

6.2 *Preparation of Aggregate*—Fine and coarse aggregates to which this test method is applied shall be graded in accordance with the requirements prescribed in Table 1 unless specified otherwise. Aggregates in which sufficient quantities of the sizes specified in Table 1 do not exist shall be crushed until the required material has been produced. In the case of aggregates containing insufficient amounts of one or more of the larger sizes listed in Table 1, and if no larger material is available for crushing, the first size in which sufficient material is available shall contain the cumulative percentage of material down to that size as determined from the grading specified in Table 1. When such procedures are required, special note shall be made thereof in the test report. After the aggregate has been separated into the various sieve sizes, each size shall be washed with a water spray over the sieve to remove adhering dust and

fine particles from the aggregate. The sieve splits shall then be dried and recombined in the quantity required for one batch of mortar to the grading prescribed in Table 1.

6.3 *Selection of Cement*—Cement for use in tests made for reasons other than to determine performance of cement-aggregate combinations performance shall conform to the requirements of Specification C 150 (Note 2). Cement for use in this test method shall be passed through an 850- μ m sieve to remove lumps before use.

NOTE 2—It is recommended that each aggregate subjected to this method be used with both high and low-alkali portland cements; other combinations with pozzolans or ground blast-furnace slag, for example, may be used. A low-alkali portland cement is defined in Specification C 150 as one containing not more than 0.60 % alkalis ($\text{Na}_2\text{O} + 0.658 \text{K}_2\text{O}$). Cements of alkali contents as low and as high as can be obtained should be used.

7. Preparation of Test Specimens

7.1 *Number of Test Specimens*—Three test specimens shall be made from one batch for each cement-aggregate combination.

7.2 *Preparation of Molds*—Prepare the molds in accordance with Specification C 490.

7.3 *Proportioning of Mortar*—The proportions of dry materials of the test mortar shall be 1 part cement to 2.25 parts graded aggregate by mass. The quantities of dry materials to be mixed at one time in the batch or mortar for making three specimens shall be 500 g of cement and 1125 g of aggregate. The amount of mixing water shall be enough to produce a flow of 100 to 115 % determined in accordance with Test Method C 109.

7.4 *Mixing of Mortar*—Mix the mortar in accordance with Practice C 305.

7.5 *Molding of Test Specimens*—Mold the test specimens in accordance with Test Method C 227.

8. Storage and Measurement of Test Specimens

8.1 *Initial Storage*—After the mold has been filled, place it immediately in the moist closet or moist room. Specimens shall remain in the molds in the moist closet or moist room for 24 ± 2 h.

8.2 *Subsequent Storage and Measurement:*

8.2.1 At 24 ± 2 h after molding, remove the specimens from the molds and place them immediately on end in the container. Introduce into the container enough distilled water, not exceeding 315 mL, at a temperature of $23.0 \pm 1.7^\circ\text{C}$, to cover the specimens by at least 13 mm, and place the cover on the container. Place the container in storage at $23.0 \pm 1.7^\circ\text{C}$ for 24 ± 2 h, then remove the specimens from the container, taking care that no more water is lost from the container than is necessary, and take a comparator reading of the specimens. When the reading is made, the specimen, comparator, and reference bar shall be at a temperature of $23.0 \pm 1.7^\circ\text{C}$. Take this reading as the base or starting reading.

8.2.2 Return the specimens to the same container and water in which they were placed previously, adding more distilled water, if necessary, to cover the specimens. Seal the cover to the container, return the container to the same storage conditions as before, and allow it to remain in storage until the specimens are 28 days old. At this age take a comparator

TABLE 1 Grading Requirements

Sieve Size ^A		Mass %
Passing	Retained	
4.75 mm	2.36 mm	10
2.36 mm	1.18 mm	25
1.18 mm	600 μ m	25
600 μ m	300 μ m	25
300 μ m	150 μ m	15

^A Detailed requirements for these sieves are given in Specification E 11.