Designation: C 342 – 97

An American National Standard

Standard Test Method for Potential Volume Change of Cement-Aggregate Combinations[1]

This standard is issued under the fixed designation C 342; 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 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 Cement[2]

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 Consistency[2]

C 490 Practice for Use of Apparatus for the Determination of Length Change of Hardened Cement Paste, Mortar, and Concrete[3]

C 856 Practice for Petrographic Examination of Hardened Concrete[3]

E 11 Specification for Wire-Cloth Sieves for Testing Purposes[4]

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 alkalies. 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

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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.

[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.

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 alkalies, 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.

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 µm	25
600 µm	300 µm	25
300 µm	150 µm	15

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

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-µm 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 % alkalies ($Na_2O + 0.658 K_2O$). 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 ± 1.7°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 ± 1.7°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± 1.7°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 reading in accordance with the procedure given above for obtaining the base or starting reading. Immediately thereafter, return the specimens to the container, seal it again, and place it in storage at 55.0 ± 1.7°C for 7 days. After this period of time, reduce the temperature to 23.0 ± 1.7°C and store the container at this temperature for 24 ± 2 h. Then take a comparator reading of each specimen in accordance with the procedure described above, but do not return the specimens to the container.

8.2.3 Pending later use in the test, set the containers and water aside and mark the containers in such a way that the specimens removed from each can be returned later. Place the specimens in a drying oven maintained at 55.0 ± 1.7°C for a period of 7 days. After this, cool the specimens in a desiccator to 23.0 ± 1.7°C for 24 ± 2 h, and take a comparator reading. Then return the specimens to the container and water in which they were stored earlier and store the container at 23.0 ± 1.7°C. During this storage time take a comparator reading of each specimen in accordance with the procedure described above, at the following intervals:

8.2.3.1 Twenty-four hours after return to the container following drying.

8.2.3.2 Seven days after return to the container following drying,

8.2.3.3 Twenty-eight days after return to the container following drying, and

8.2.3.4 At 28-day intervals until the specimens are 52 weeks of age.

9. Calculation

9.1 Calculate the difference in comparator reading of the specimens after the initial 24-h storage in water and the comparator reading determined by any subsequent measurement to the nearest 0.001 % of the effective gage length, and record as the expansion of the specimen during that period. Indicate a contraction (negative expansion) by prefixing a minus sign to the percentage expansion reported. Report the average of the expansions of the three specimens of a given cement-aggregate combination to the nearest 0.01 % as the expansion for the combination at a given period.

10. Examination at End of Test

10.1 After the final length-change measurements have been made, test each specimen for warping and examine it.

10.1.1 *Warping*—Determine the warping, if any, that each specimen has manifested during the test period by placing the specimen on a plane surface and measuring the maximum separation between the specimen and the surface. Place the specimen so that its ends curve down to the reference surface and make the measurement to the nearest 0.25 mm.

10.1.2 *Examination*:

10.1.2.1 Items to be noted in the examination include: (*1*) Presence, location, and type of pattern of cracking; (*2*) Appearance of surfaces, surface mottling; and (*3*) Surficial deposits or exudations, their nature, thickness, and continuity.

10.1.2.2 When it is believed that additional features of noteworthy importance are likely to be revealed thereby, a further examination of the interior of the specimen may be made, preferably by a petrographer in accordance with the applicable provisions of Practice C 856. In such cases, the presence of gel-filled pores and fissures, evidence of reaction with aggregate particles of specific types and the nature of such evidence, and the properties of the reaction products are among the items to be noted.

11. Report

11.1 The report shall include the following:

11.1.1 Type and source of aggregate,

11.1.2 Type and source of portland cement,

11.1.3 Chemical analysis of the cement including alkali content as percent potassium oxide (K_2O), sodium oxide (Na_2O), and calculated Na_2O equivalent,

11.1.4 Grading of the aggregate if not that given in Table 1,

11.1.5 Type, source, proportions, and chemical analysis, including K_2O and Na_2O, of any pozzolans or blast-furnace slags employed in the tests,

11.1.6 Average length change in percentage at each reading of the specimens,

11.1.7 Any relevant information concerning preparation of the aggregates,

11.1.8 Any significant features revealed by examination of the specimens during and after test, and

11.1.9 Amount of mixing water, expressed as percent of cement by mass.

12. Precision and Bias

12.1 *Precision*—Studies of the precision of this test method yielded results that indicated that when this test is properly conducted all specimens will have values for expansion within 0.003 % of the average, except that if the average exceeds 0.020 %, the values of all specimens should be within 15 % of the average.

12.2 *Bias*—Since there is no accepted reference material, no statement on bias is being made.

13. Keywords

13.1 concrete; Conrow test; expansion; mortar; volume change