



Designation: C227 – 03

Standard Test Method for Potential Alkali Reactivity of Cement-Aggregate Combinations (Mortar-Bar Method)¹

This standard is issued under the fixed designation C227; 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.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope

1.1 This test method covers the determination of the susceptibility of cement-aggregate combinations to expansive reactions involving hydroxyl ions associated with the alkalis (sodium and potassium) by measurement of the increase (or decrease) in length of mortar bars containing the combination during storage under prescribed conditions of test.

1.2 Alkalis participating in the expansive reactions usually are derived from the cement; under some circumstances they may be derived from other constituents of the concrete or from external sources. Two types of alkali reactivity of aggregates are recognized: (1) an alkali-silica reaction involving certain siliceous rocks, minerals, and natural or artificial glasses and (2) an alkali-carbonate reaction involving dolomite in certain calcitic dolomites and dolomitic limestones (see Standard C294). The method is not recommended as a means to detect the latter reaction because expansions produced in the mortar-bar test by the alkali-carbonate reaction (see Test Method C586) are generally much less than those produced by the alkali-silica reaction for combinations having equally harmful effects in service.

1.3 The values stated in SI units are to be regarded as standard. The non-SI values, shown in parentheses, are for informational purposes only.

1.4 *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 This test method is under the jurisdiction of ASTM Committee C09 on Concrete and Concrete Aggregates and is the direct responsibility of Subcommittee C09.26 on Chemical Reactions of Materials.

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2. Referenced Documents

2.1 ASTM Standards:²

- C33 Specification for Concrete Aggregates
- C109/C109M Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens)
- C289 Test Method for Potential Alkali-Silica Reactivity of Aggregates (Chemical Method)
- C294 Descriptive Nomenclature for Constituents of Concrete Aggregates
- C295 Guide for Petrographic Examination of Aggregates for Concrete
- C305 Practice for Mechanical Mixing of Hydraulic Cement Pastes and Mortars of Plastic Consistency
- C490 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
- C586 Test Method for Potential Alkali Reactivity of Carbonate Rocks as Concrete Aggregates (Rock-Cylinder Method)
- C856 Practice for Petrographic Examination of Hardened Concrete
- C1437 Test Method for Flow of Hydraulic Cement Mortar
- E11 Specification for Woven Wire Test Sieve Cloth and Test Sieves

² 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.

3. Significance and Use

3.1 Data correlating the results of tests performed using this test method with performance of cement-aggregate combinations in concrete in service, results of petrographic examination of aggregates (Guide C295), and results of tests for potential reactivity of aggregates by chemical methods have been published in Test Method C289 and should be consulted in connection with the use of results of tests performed using this test method as the basis for conclusions and recommendations concerning the use of cement-aggregate combinations in concrete.

3.2 The results of tests performed using this method furnish information on the likelihood that a cement-aggregate combination is potentially capable of harmful alkali-silica reactivity with consequent deleterious expansion of concrete. Criteria to determine potential deleterious alkali-silica reactivity of cement-aggregate combinations from the results of this test method have been given in the Appendix of Specification C33.

3.3 Insignificant expansion may result when potentially deleteriously reactive siliceous rocks are present in comparatively high proportion even when a high-alkali cement is used. This may occur because the alkali-silica reaction products are characterized by an alkali to silica ratio that is so low as to minimize uptake of water and swelling, or because of alkali leaching from the bars (see section on containers). Dolomitic aggregates that are deleteriously affected by the alkali-carbonate reaction when employed as coarse aggregate in concrete may not produce notable expansion in this test method. Also, significant expansion may occur rarely in the test for reasons other than alkali-aggregate reaction, particularly the presence of sulfates in the aggregate that produce a sulfate attack upon the cement paste, ferrous sulfides (pyrite, marcasite, or pyrrhotite) that oxidize and hydrate with the release of sulfate, and materials such as free lime (CaO) or free magnesia (MgO) in the cement or aggregate that progressively hydrate and carbonate.

3.4 When expansions in excess of those given in the Appendix of Specification C33 are shown in results of tests performed using this test method, it is strongly recommended that supplementary information be developed to confirm that the expansion is actually due to alkali reactivity. Sources of such supplementary information include: (1) petrographic examination of the aggregate to determine if known reactive constituents are present; (2) examination of the specimens after tests to identify the products of alkali reactivity; and (3) tests of the aggregate for potential reactivity by chemical methods (Test Method C289).

3.5 When it has been concluded from the results of tests performed using this test method and supplementary information as outlined that a given cement-aggregate combination should be considered potentially deleteriously reactive, additional studies may be appropriate to develop information on the potential reactivity of other combinations containing the same cement with other aggregates, the same aggregate with other cements, or the same cement-aggregate combination with a mineral admixture.

4. Apparatus

4.1 The apparatus shall conform to Specification C490, except as follows:

4.2 *Sieves*—Square hole, woven-wire cloth sieves, shall conform to Specification E11.

4.3 *Mixer, Paddle, and Mixing Bowl*—Mixer, paddle, and mixing bowl shall conform to the requirements of Method C305, except that the clearance between the lower end of the paddle and the bottom of the bowl shall be 5 to 6 mm (0.20 to 0.24 in.) .

4.4 *Tamper and Trowel*—The tamper and trowel shall conform to Test Method C109/C109M.

4.5 *Containers*—Covered containers for storing the test specimens shall be constructed of material that is resistant to corrosion under the test conditions. The wall thickness of the container and cover shall be less than 6 mm ($\frac{3}{16}$ in.) to reduce the insulating effect and provide a rapid heat transfer for the initial 14-day test period. The cover shall be constructed in a manner to maintain a tight seal between the cover and top of the container wall (Note 1). The container shall be arranged to provide every surface of each specimen with approximately an equal exposure to an absorbent wicking material. The specimens shall not be in direct contact with the wicking material but every surface shall be within 30 mm (1¼ in.) or less of the the wicking. A typical arrangement of such a container is shown in Fig. 1 (Note 2). The inner sides and the center core of the containers are to be lined with an absorbent material, such as blotting or filter paper, to act as a wick and to ensure that the atmosphere in the container is quickly saturated with water vapor when it is sealed after the specimens are placed therein (Note 2). The wicking liners will extend into the top of the water in the bottom of the container and above the tops of the specimens. Make provisions to support the bars in a vertical position with the lower end of the bars approximately 25 mm (1 in.) above the surface of the water in the containers. The weight of the specimens shall not be supported on the metal gage studs. A supporting rack shall be provided to ensure that the specimens do not touch the wicking material or each other. The supporting rack shall be constructed of brass wire or other material that is resistant to corrosion under the test conditions and shall not act as a vapor barrier but provide free movement of vapors within the container. Provisions shall be made to prevent water from splashing and dripping onto the specimens (Notes 3-5). If required to prevent the growth of mold on the wicking, add a suitable fungicide to the water in the container. The container size and internal arrangement of the specimens and wicking may be varied at the users discretion, providing expansion data for all specimens can be shown to be equivalent to that developed with the container herein described.

NOTE 1—This seal may be achieved by a double wrap of vinyl tape 38 mm (1½ in.) or greater in width, overlaying the lid and container wall along its full circumference.

NOTE 2—A covered container that has been found acceptable for this purpose is sold by the United States Plastic Corp., 1390 Neubrecht Rd., Lima, OH 45801, as a PVC plating, photo, and chemical tank, stock No. 10062, 6-in. diameter x 17 in. high, with cover.

NOTE 3—The shape and spacing of the center wicking material may be maintained during the test by the use of rubber bands or hardware cloth.

NOTE 4—If concern exists for adequately preventing dripping or