Designation: C 227 – 97a

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

This standard is issued under the fixed designation C 227; 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 alkalies (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 Alkalies 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 C 294). 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 C 586) 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.*

2. Referenced Documents

2.1 *ASTM Standards:*

C 33 Specification for Concrete Aggregates[2]

C 109/C 109M Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or 50-mm Cube Specimens)[3]

C 289 Test Method for Potential Reactivity of Aggregates (Chemical Method)[2]

C 294 Descriptive Nomenclature for Constituents of Natural Mineral Aggregates[2]

C 295 Guide for Petrographic Examination of Aggregates for Concrete[2]

C 305 Practice for Mechanical Mixing of Hydraulic Cement Pastes and Mortars of Plastic Consistency[3]

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

C 511 Specification for Moist Cabinets, Moist Rooms, and Water Storage Tanks Used in Testing of Hydraulic Cements and Concretes[3]

C 586 Test Method for Potential Alkali Reactivity of Carbonate Rocks for Concrete Aggregates (Rock Cylinder Method)[2]

C 856 Practice for Petrographic Examination of Hardened Concrete[2]

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

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 C 295), and results of tests for potential reactivity of aggregates by chemical methods have been published in Test Method C 289 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 C 33.

3.3 Insignificant expansion may result when potentially

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

Current edition approved Nov. 10, 1997. Published October 1998. Originally published as C 227 – 50 T. Last previous edition C 227 – 97.

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

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

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

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 course 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 C 33 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 C 289).

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 C 490, except as follows:

4.2 *Sieves*—Square hole, woven-wire cloth sieves, shall conform to Specification E 11.

4.3 *Mixer, Paddle, and Mixing Bowl*— Mixer, paddle, and mixing bowl shall conform to the requirements of Method C 305, 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 C 109.

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 (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 paper 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

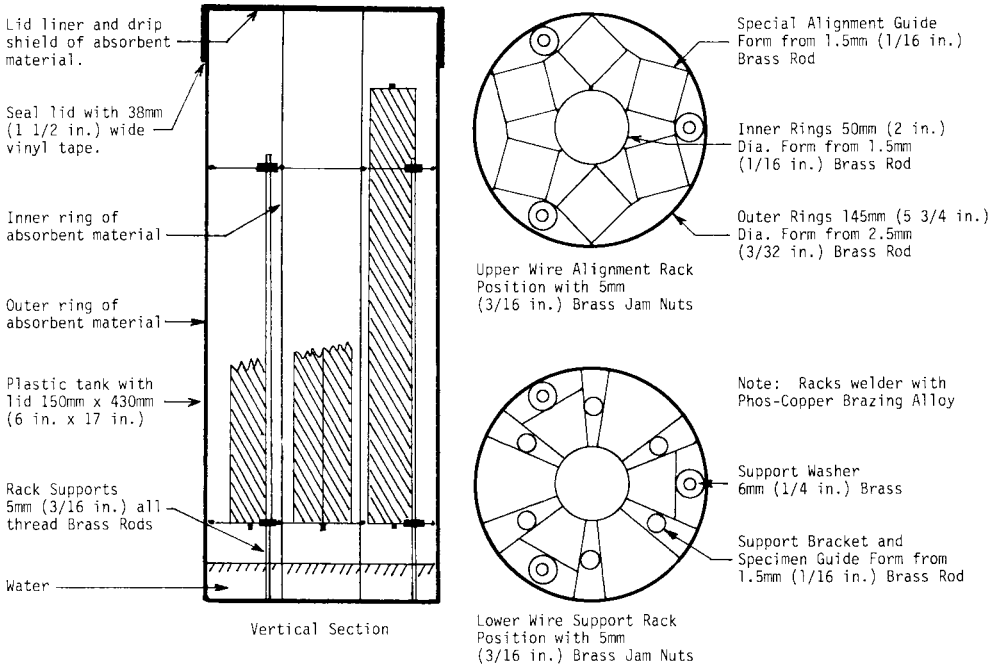

FIG. 1 Diagram of an Acceptable Assembled Container