Designation: C441/C441M – 17

Standard Test Method for Effectiveness of Pozzolans or Ground Blast-Furnace Slag in Preventing Excessive Expansion of Concrete Due to the Alkali-Silica Reaction[1]

This standard is issued under the fixed designation C441/C441M; 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 effectiveness of pozzolans or slag in preventing the excessive expansion caused by reaction between aggregates and alkalies in portland cement mixtures. The evaluation is based on the expansion developed in mortar bars by a combination of portland cement and a pozzolan or slag, made with reactive aggregates (borosilicate glass), during storage under prescribed conditions of test.

1.2 *Units*—The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in nonconformance with the standard. Some values have only SI units because the inch-pound equivalents are not used in practice.

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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C109/C109M Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens)
C125 Terminology Relating to Concrete and Concrete Aggregates
C150/C150M Specification for Portland 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
C618 Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
C989/C989M Specification for Slag Cement for Use in Concrete and Mortars
C1240 Specification for Silica Fume Used in Cementitious Mixtures
C1437 Test Method for Flow of Hydraulic Cement Mortar
E11 Specification for Woven Wire Test Sieve Cloth and Test Sieves

3. Terminology

3.1 *Definitions:* For definitions of terms used in this test method, refer to Terminology C125.

4. Significance and Use

4.1 This test method may be used as a preliminary or screening test to evaluate the relative effectiveness of a number of different materials being considered for use to prevent excessive expansion due to alkali-silica reaction.

4.2 This test method may also be used to evaluate materials proposed for use on a particular job to prevent excessive expansion due to alkali-silica reaction, by testing in the quantity and in combination with the cement or cements to be used on the job.

4.3 This test method does not assess the suitability of pozzolans or slag for use in concrete. These materials should

[1] This test method is under the jurisdiction of ASTM Committee C09 on Concrete and Concrete Aggregates and is the direct responsibility of Subcommittee C09.50 on Aggregate Reactions in Concrete.

Current edition approved Dec. 15, 2017. Published January 2018. Originally approved in 1959. Last previous edition approved in 2011 as C441/C441M–11. DOI: 10.1520/C0441_C0441M–17.

[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.

*A Summary of Changes section appears at the end of this standard

comply with Specification C618, Specification C989/C989M or Specification C1240.

5. Apparatus

5.1 The apparatus shall conform to Practice C490/C490M, except as follows:

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

5.3 *Mixer, Paddle, and Mixing Bowl*—Mixer, paddle, and mixing bowl shall conform to the requirements of Practice 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.].

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

5.5 *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.] (Note 1). The cover shall be constructed in a manner to maintain a tight seal between the cover and top of the container wall (Note 2). The container shall be arranged to provide every surface of each specimen with an equal exposure to an absorbent wicking material, as shown in the upper wire rack position feature in Fig. 1. 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. The inner walls and the center cores of the containers are to be lined with an absorbent material, such as blotting or filter paper (Note 3). The wicking liners shall extend into the top of the water in the bottom of the containers and above the tops of the specimens. Make provisions to support the bars in a vertical position with the lower end of the bars 25 ± 5 mm [1 ± 0.2 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 water vapors within the container. Provisions shall be made to prevent water from splashing and dripping onto the specimens (Notes 4 and 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—The purpose of this limit is to reduce the insulating effect and provide a rapid heat transfer for the initial 14-day test period.

NOTE 2—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 3—The purpose of this material is 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 4—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 5—The container described in 5.5 and in Fig. 1 has been shown to produce large and reproducible expansions with cement-aggregate combinations such as borosilicate glass and high-alkali cement combination called for by this method. However, studies suggest that the same factors that are responsible for the success of this method (high, constant, uniform internal relative humidity) will, under certain permitted conditions, promote leaching of alkali from the specimens and result in little or no expansion from some combinations of high-alkali cement and aggregate known to be deleteriously alkali reactive. Each laboratory should evaluate its containers with a known deleteriously alkali-reactive aggregate (not borosilicate glass which releases alkali) and a high-alkali

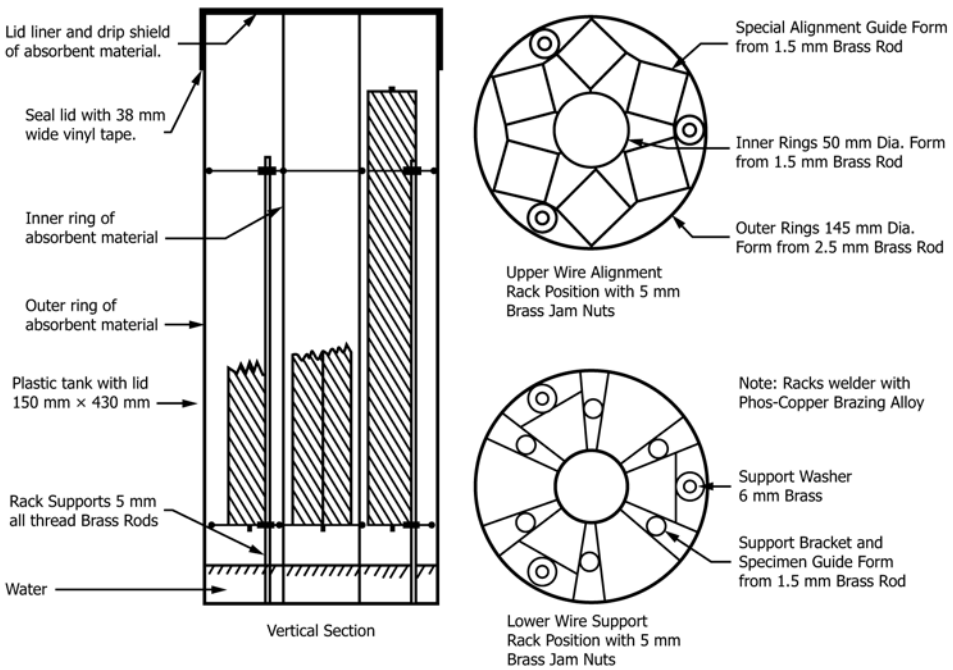

FIG. 1 Diagram of an Acceptable Assembled Container