



Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)¹

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1. Scope*

1.1 This test method permits detection, within 16 days, of the potential for deleterious alkali-silica reaction of aggregate in mortar bars.

1.2 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard. When this test method refers to combined-unit standards, the selection of the measurement systems is at the user's discretion.

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 and health practices and determine the applicability of regulatory limitations prior to use.* A specific precautionary statement is given in the section on Reagents.

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](#)
- [C127 Test Method for Density, Relative Density \(Specific Gravity\), and Absorption of Coarse Aggregate](#)
- [C128 Test Method for Density, Relative Density \(Specific Gravity\), and Absorption of Fine Aggregate](#)
- [C150/C150M Specification for Portland Cement](#)
- [C151/C151M Test Method for Autoclave Expansion of Hydraulic Cement](#)
- [C295/C295M Guide for Petrographic Examination of Aggregates for Concrete](#)

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.

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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.

- [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](#)
- [C670 Practice for Preparing Precision and Bias Statements for Test Methods for Construction Materials](#)
- [C856 Practice for Petrographic Examination of Hardened Concrete](#)
- [D1193 Specification for Reagent Water](#)
- [E11 Specification for Woven Wire Test Sieve Cloth and Test Sieves](#)

3. Terminology

3.1 *Definitions*—For definitions of other terms relating to concrete or aggregates, see Terminology [C125](#).

3.1.1 *relative density (OD), n*—as defined in Test Methods [C127](#) or [C128](#), for coarse and fine aggregates, respectively.

4. Significance and Use

4.1 This test method provides a means of detecting the potential of an aggregate intended for use in concrete for undergoing alkali-silica reaction resulting in potentially deleterious internal expansion. It is based on the NBRI Accelerated Test Method ([1-4](#)).³ It is especially useful for aggregates that react slowly or produce expansion late in the reaction. However, it does not evaluate combinations of aggregates with cementitious materials nor are the test conditions representative of those encountered by concrete in service.

4.2 Because the specimens are exposed to a NaOH solution, the alkali content of the cement is not a significant factor in affecting expansions.

4.3 When excessive expansions (see [Appendix X1](#)) are observed, it is recommended that supplementary information be developed to confirm that the expansion is actually due to

³ The boldface numbers in parentheses refer to a list of references at the end of the text.

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

alkali-silica reaction. Sources of such supplementary information include: (1) petrographic examination of the aggregate (Guide C295/C295M) to determine if known reactive constituents are present; (2) examination of the specimens after tests (Practice C856) to identify the products of alkali reaction; and (3) where available, field service records can be used in the assessment of performance.

4.4 When it has been concluded from the results of tests performed using this test method and supplementary information that a given aggregate should be considered potentially deleteriously reactive, the use of mitigative measures such as low-alkali portland cement, mineral admixtures, or ground granulated blast-furnace slag should be evaluated (see last sentence of 4.1).

5. Apparatus

5.1 The apparatus shall conform to Specification 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 5.1 ± 0.3 mm.

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

5.5 *Containers*—The containers shall be of such a nature that the bars can be totally immersed in either the water or 1N NaOH solution. The containers shall be made of material that can withstand prolonged exposure to 80°C and must be resistant to a 1N NaOH solution (see Note 1). The containers must be so constructed that when used for storing specimens, the loss or gain of moisture is prevented by tight-fitting covers, by sealing, or both (see Note 2). The bars in the solution must be placed and supported so that the solution has access to the entire surface of the bar; therefore, it should be ensured that the specimens do not touch the sides of the container or each other. The specimens, if stood upright in the solution, shall not be supported by the metal gauge stud.

NOTE 1—The NaOH solution will corrode glass or metal containers.

NOTE 2—Some microwave-proof food storage containers made of polypropylene or high-density polyethylene have been found to be acceptable.

5.6 *Oven, or Water Bath*—A convection oven or water bath with temperature control maintaining $80.0 \pm 2.0^\circ\text{C}$.

6. Reagents

6.1 *Sodium Hydroxide (NaOH)*—USP or technical grade may be used, provided the Na^+ and OH^- concentrations are shown by chemical analysis to lie between 0.99N and 1.01N.

6.2 *Purity of Water*—Unless otherwise indicated, references to water shall be understood to mean reagent water conforming to Type IV of Specification D1193.

6.3 *Sodium Hydroxide Solution*—Each litre of solution shall contain 40.0 g of NaOH dissolved in 900 mL of water, and shall be diluted with additional distilled or deionized water to

obtain 1.0 L of solution. The volume proportion of sodium hydroxide solution to mortar bars in a storage container shall be 4 ± 0.5 volumes of solution to 1 volume of mortar bars. The volume of a mortar bar may be taken as 184 mL. Include sufficient test solution to ensure complete immersion of the mortar bars.

6.3.1 **Warning**—Before using NaOH, review: (1) the safety precautions for using NaOH; (2) first aid for burns; and (3) the emergency response to spills, as described in the manufacturer's Material Safety Data Sheet or other reliable safety literature. NaOH can cause very severe burns and injury to unprotected skin and eyes. Suitable personal protective equipment should always be used. These should include full-face shields, rubber aprons, and gloves impervious to NaOH. Gloves should be checked periodically for pin holes.

7. Conditioning

7.1 Maintain the temperature of the molding room and dry materials at not less than 20°C and not more than 27.5°C . The temperature of the mixing water, and of the moist closet or moist room, shall not vary from 23°C by more than 2.0°C .

7.2 Maintain the relative humidity of the molding room at not less than 50 %. The moist closet or room shall conform to Specification C511.

7.3 Maintain the storage oven or water bath in which the specimens are stored in the containers at a temperature of $80.0 \pm 2.0^\circ\text{C}$.

8. Sampling and Preparation of Test Specimens

8.1 *Selection of Aggregate*—Process materials proposed for use as fine aggregate in concrete as described in the section on Preparation of Aggregate with a minimum of crushing. Process materials proposed for use as coarse aggregate in concrete by crushing to produce as nearly as practical a graded product from which a sample can be obtained. Grade the sample as prescribed in Table 1. The sample shall represent the composition of the coarse aggregate as proposed for use.

8.1.1 When a given quarried material is proposed for use both as coarse and as fine aggregate, test it only by selection of an appropriate sample crushed to the fine aggregates sizes, unless there is reason to expect that the coarser size fractions have a different composition than the finer sizes and that these differences might significantly affect expansion due to reaction with the alkalis in cement or from the environment of service. In this case test the coarser size fractions in a manner similar to that employed in testing the fine aggregate sizes.

8.2 *Preparation of Aggregate*—Grade all aggregates to which this test method is applied in accordance with the

TABLE 1 Grading Requirements

| Sieve Size | | Mass, % |
|----------------------------|-----------------------------|---------|
| Passing | Retained on | |
| 4.75 mm (No. 4) | 2.36 mm (No. 8) | 10 |
| 2.36 mm (No. 8) | 1.18 mm (No. 16) | 25 |
| 1.18 mm (No. 16) | 600 μm (No. 30) | 25 |
| 600 μm (No. 30) | 300 μm (No. 50) | 25 |
| 300 μm (No. 50) | 150 μm (No. 100) | 15 |

requirements given in Table 1. Crush aggregates in which sufficient quantities of the sizes specified in Table 1 do not exist 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, make a special note thereof in the test report. After the aggregate has been separated into the various sieve sizes, wash each size with a water spray over the sieve to remove adhering dust and fine particles from the aggregate. Dry the portions retained on the various sieves and, unless used immediately, store each such portion individually in a clean container provided with a tight-fitting cover.

8.3 Selection and Preparation of Cement:

8.3.1 *Reference Cement*—Use a portland cement meeting the requirements of Specification C150/C150M (Note 3). In addition, the autoclave expansion in Test Method C151/C151M shall be less than 0.20 %.

NOTE 3—The alkali content of the cement has been found to have negligible (3) or minor (5) effects on expansion in this test.

8.3.2 *Preparation of Cement*—Pass cement for use in this test through an 850- μ m (No. 20) sieve to remove lumps before use.

8.4 Preparation of Test Specimens:

8.4.1 *Number of Specimens*—Make at least three test specimens for each cement-aggregate combination.

8.4.2 *Preparation of Molds*—Prepare the specimen molds in accordance with the requirements of Practice C490/C490M except, the interior surfaces of the mold shall be covered with a release agent (see Note 4). A release agent will be acceptable if it serves as a parting agent without affecting the time of setting of the cement and without leaving any residue that will inhibit the penetration of water into the specimen.

NOTE 4—TFE-fluorocarbon tape complies with the requirements for a mold release agent.

8.4.3 *Proportioning of Mortar*—Proportion the dry materials for the test mortar using 1 part of cement to 2.25 parts of graded aggregate by mass for aggregates with a relative density (OD) at or above 2.45. For aggregates with a relative density (OD) below 2.45, determine the aggregate proportion as follows:

$$\text{Aggregate proportion} = 2.25 \times D/2.65$$

where:

D = relative density (OD) of test aggregate.

8.4.3.1 For aggregates with a relative density (OD) equal to or greater than 2.45, the quantities of dry materials to be mixed at one time in the batch of mortar for making three specimens shall be 440 g of cement and 990 g of aggregate made up by recombining the portions retained on the various sieves in the grading prescribed in Table 1 (8.2). Use a water-cement ratio equal to 0.47 by mass (see Note 5).

8.4.3.2 For aggregates with a relative density (OD) less than 2.45, the quantities of dry materials to be mixed at one time in

the batch of mortar for making three specimens shall be 440 g of cement and mass of aggregate shall be 440 g multiplied by the aggregate proportion determined in 8.4.3. This aggregate mass shall be made up by recombining the portions retained on the various sieves in the grading prescribed in Table 1 (8.2). Use a water-cement ratio equal to 0.47 by mass (see Note 5).

NOTE 5—Ruggedness tests indicated that mortar bar expansions were less variable at a fixed water to cement ratio than when gaged to a constant flow (3).

8.4.4 *Mixing of Mortar*—Mix the mortar in accordance with the requirements of Practice C305.

8.4.5 *Molding of Test Specimens*—Mold test specimens within a total elapsed time of not more than 2 min and 15 s after completion of the original mixing of the mortar batch. Fill the molds with two approximately equal layers, each layer being compacted with the tamper. Work the mortar into the corners, around the gauge studs, and along the surfaces of the mold with the tamper until a homogeneous specimen is obtained. After the top layer has been compacted, cut off the mortar flush with the top of the mold and smooth the surface with a few strokes of the trowel.

9. Procedure

9.1 *Initial Storage and Reading*—Place each mold in the moist cabinet or room immediately after molds have been filled. The specimens shall remain in the molds for 24 ± 2 h. Remove the specimens from the molds and, while they are being protected from loss of moisture, properly identify and make an initial comparatory reading. Make and record the initial and all subsequent readings following the length change measurement procedures of Specification C490/C490M. Place the specimens made with each aggregate sample in a storage container with sufficient tap water to totally immerse them. The temperature of the water used to immerse the specimens shall be $23.0 \pm 2.0^\circ\text{C}$. Seal and place the containers in an oven or water bath at $80.0 \pm 2.0^\circ\text{C}$ for a period of 24 h.

9.2 *Zero Readings*—Remove the containers from the oven or water bath one at a time. Remove other containers only after the bars in the first container have been measured and returned to the oven or water bath. The time elapsed between removal and return of the specimens to the oven or water bath shall not exceed 10.0 min. Remove the bars one at a time from the water and dry their surface with a towel paying particular attention to the two metal gauge studs. Take the zero reading (see Note 6) of each bar immediately after drying, and read as soon as the bar is in position. Complete the process of drying and reading within 15 ± 5 s of removing the specimen from the water. After readings, leave the specimen on a towel until comparatory readings have been taken on the remainder of the bars. Place all specimens made with each aggregate sample in a container with sufficient 1N NaOH, at $80.0 \pm 2.0^\circ\text{C}$ for the samples to be totally immersed. Seal the container and return it to the oven or water bath.

NOTE 6—The reference bar should be read prior to each set of specimens since the heat from the mortar bars may cause the length of the comparator to change.

9.3 *Subsequent Storage and Measurement*—Make subsequent comparator readings of the specimens periodically, with

at least three intermediate readings, for 14 days after the zero reading, at approximately the same time each day. If readings are continued beyond the 14-day period, take at least one reading per week. The procedure is identical to that described in the section on Zero Readings except that the specimens are returned to their own container after measurement.

10. Calculation

10.1 Calculate the difference between the zero comparative reading of the specimen and the reading at each period to the nearest 0.001 % of the effective gauge length and record as the expansion of the specimen for that period. Report the average expansion of the three specimens of a given cement-aggregate combination to the nearest 0.01 % as the expansion for the combination for a given period.

11. Report

11.1 Report the following information:

11.1.1 Type and source of aggregate,

11.1.2 Type and source of portland cement,

11.1.3 Autoclave expansion and alkali content of cement as percent potassium oxide (K_2O), sodium oxide (Na_2O), and calculated sodium oxide (Na_2O) equivalent ($Na_2O_{eq} = \%Na_2O + 0.658 \times \%K_2O$),

11.1.4 Average length change in percent at each reading of the specimens,

11.1.5 Any relevant information concerning the preparation of aggregates, including the grading of the aggregate when it differs from that given in 8.2,

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

11.1.7 Amount of mixing water expressed as mass percent of cement, and

11.1.8 A graph of the length change data from the time of the zero reading to the end of the 16 day period.

12. Precision and Bias

12.1 *Within-Laboratory Precision*—It has been found that the average within-laboratory coefficient of variation for materials with an average expansion greater than 0.1 % at 14 days is 2.94 % (6) (Note 7). Therefore, the results of two properly conducted tests within the same laboratory on specimens of a sample of aggregate should not differ by more than 8.3 % (Note 7) of the mean expansion.

12.2 *Multi-Laboratory Precision*—It has been found that the average multilaboratory coefficient of variation for materials with an average expansion greater than 0.1 % at 14 days is 15.2 % (6) (Note 7). Therefore, the results of two properly conducted tests in different laboratories on specimens of a sample of aggregate should not differ by more than 43 % (Note 7) of the mean expansion.

NOTE 7—These numbers represent, respectively, the (1s %) and (d2s %) limits as described in Practice C670.

12.3 *Bias*—Since there is no accepted reference material for determining the bias of this test method, no statement on bias is being developed.

13. Keywords

13.1 aggregate; alkali-silica reactivity; length change; mortar; sodium hydroxide

APPENDIX

(Nonmandatory Information)

X1. INTERPRETATION OF TEST RESULTS

X1.1 There is good agreement in the published literature (1, 2, 7-10) for the following expansion limits:

X1.1.1 Expansions of less than 0.10 % at 16 days after casting are indicative of innocuous behavior in most cases (see Note X1.1).

X1.1.2 Expansions of more than 0.20 % at 16 days after casting are indicative of potentially deleterious expansion (see 4.3).

X1.1.3 Expansions between 0.10 and 0.20 % at 16 days after casting include both aggregates that are known to be

innocuous and deleterious in field performance. For these aggregates, it is particularly important to develop supplemental information as described in 4.3. In such a situation, it may also be useful to take comparator readings until 28 days (8, 10).

NOTE X1.1—Some granitic gneisses and metabasalts have been found to be deleteriously expansive in field performance even though their expansion in this test was less than 0.10 % at 16 days after casting (10). With such aggregate, it is recommended that prior field performance be investigated. In the absence of field performance data, mitigative measures should be taken as discussed in 4.4.

REFERENCES

- (1) Oberholster, R. E., and Davies, G., “An Accelerated Method for Testing the Potential Alkali Reactivity of Siliceous Aggregates.” *Cement and Concrete Research*, Vol 16, 1986, pp. 181–189.
- (2) Davies, G., and Oberholster, R. E., “Use of the NBRI Accelerated Test to Evaluate the Effectiveness of Mineral Admixtures in Preventing the Alkali-Silica Reaction,” *Cement and Concrete Research*, Vol 17, 1987, pp. 97–107.
- (3) Davies, G., and Oberholster, R. E., “An Interlaboratory Test Programme on the NBRI Accelerated Test to Determine the Alkali-Reactivity of Aggregates,” National Building Research Institute, CSIRO, Special Report BOU 92-1987, Pretoria, RSA, 1987, 16 pp.
- (4) Oberholster, R. E., “Alkali Reactivity of Siliceous Rock Aggregates: Diagnosis of the Reaction, Testing of Cement and Aggregate and Prescription of Preventative Measures,” *Alkali in Concrete, Research and Practice*, Copenhagen, 1983, Danish Concrete Association, pp. 419–433.
- (5) Hooton, R. D., “Interlaboratory Study of the NBRI Rapid Test Method and CSA Standardization Status,” *Report EM-92*, Ontario Ministry of Transport, March 1990, pp. 225–240.
- (6) Rogers, C.A., “Multi-laboratory Study of the Accelerated Mortar Bar Test (ASTM Test Method C1260) for Alkali-Silica Reaction,” *Cement, Concrete, and Aggregates*, Vol 21, 1999, pp. 185–194.
- (7) Hooton, R. D., and Rogers, C. A., “Evaluation of Rapid Test Methods for Detecting Alkali-Reactive Aggregates,” *Proceedings*, Eighth International Conference on Alkali-Aggregate Reaction, Kyoto, 1989, pp. 439–444.
- (8) Hooton, R. D., “New Aggregate Alkali-Reactivity Test Methods,” *Report MAT-91-14*, Ontario Ministry of Transportation, November 1991.
- (9) Fournier, B., and Berube, M. A., “Application of the NBRI Accelerated Mortar Bar Test to Siliceous Carbonate Aggregates Produced in the St. Lawrence Lowlands, Part 2: Proposed Limits, Rates of Expansion, and Microstructure of Reaction Products,” *Cement and Concrete Research*, Vol 21, 1991, pp. 1069–1082.
- (10) Hooton, R. D., and Rogers, C. A., “Development of the NBRI Rapid Mortar Bar Test Leading to its Use in North America,” *Proceedings*, Ninth International Conference on AAR in Concrete, London, 1992, pp. 461–467.

SUMMARY OF CHANGES

Committee C09 has identified the location of selected changes to this standard since the last issue (C1260 – 07) that may impact the use of this standard. (Approved Aug. 1, 2014.)

(1) Revised 1.2, 2.1, 5.1, and 9.1.

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