
Standard Specification for Accelerated Determination of Potentially Deleterious Expansion of Concrete Cylinder due to Alkali- Silica Reaction (Accelerated Concrete Cylinder Test, ACCT)

AASHTO Designation: TP 142M/TP 142-24¹

Revised: 2024

Technical Subcommittee: 3c, Hardened Concrete



American Association of State Highway and Transportation Officials
555 12th St NW, Suite 1000
Washington, DC 20004

Accelerated Determination of Potentially Deleterious Expansion of Concrete Cylinder due to Alkali-Silica Reaction (Accelerated Concrete Cylinder Test, ACCT)

AASHTO Designation: TP 142M/TP 142-24¹



Revised: 2024

Technical Subcommittee: 3c, Hardened Concrete

1. SCOPE

- 1.1. This test method covers the determination of the susceptibility of an aggregate or combination of an aggregate with supplementary cementitious materials (SCMs) for participation in expansive alkali-silica reaction (ASR) by measurement of length change of concrete cylinders.
- 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. A specific precautionary statement is given in the section on reagents.
- 1.3. The values stated in either SI units or inch-pound units are to be regarded separately as standard. The inch-pound units are shown in parentheses. 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.
- 1.4. *The quality of the results produced by this standard is dependent on the competence of the personnel performing the procedure and the capability, calibration, and maintenance of the equipment used. Agencies that meet the criteria of R 18 are generally considered capable of competent and objective testing/sampling/inspection/etc. Users of this standard are cautioned that compliance with R 18 alone does not completely assure reliable results. Reliable results depend on many factors; following the suggestions of R 18 or some similar acceptable guideline provides a means of evaluating and controlling some of those factors.*

2. REFERENCED STANDARDS

- 2.1. *AASHTO Standards:*
 - M 85, Portland Cement
 - M 201, Mixing Rooms, Moist Cabinets, Moist Rooms, and Water Storage Tanks Used in the Testing of Hydraulic Cements and Concretes
 - M 205M/M 205, Molds for Forming Concrete Test Cylinders Vertically
 - M 231, Weighing Devices Used in the Testing of Materials

- R 18, Establishing and Implementing a Quality Management System for Construction Materials Testing Laboratories
- R 39M/R 39, Making and Curing Concrete Test Specimens in the Laboratory
- R 76, Reducing Samples of Aggregates to Testing Size
- R 90, Sampling Aggregate Products
- T 19M/T 19, Bulk Density (“Unit Weight”) and Voids in Aggregate
- T 22M/T 22, Compressive Strength of Cylindrical Concrete Specimens
- T 27, Sieve Analysis of Fine and Coarse Aggregates
- T 160, Length Change of Hardened Hydraulic Cement Mortar and Concrete
- T 336, Coefficient of Thermal Expansion of Hydraulic Cement Concrete
- T 380, Potential Alkali Reactivity of Aggregates and Effectiveness of ASR Mitigation Measures (Miniature Concrete Prism Test, MCPT)

2.2. *ASTM Standards:*

- A182/A182M, Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service
- C295/C295M, Guide for Petrographic Examination of Aggregates for Concrete
- C311/C311M, Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use in Portland-Cement Concrete
- C470, Standard Specification for Molds for Forming Concrete Test Cylinders Vertically
- C778, Standard Specification for Standard Sand
- C1293, Standard Test Method for Determination of Length Change of Concrete due to Alkali-Silica Reaction
- D1193, Standard Specification for Reagent Water

2.3. *National Institute of Standards and Technology:*

- NIST. Estimation of Pore Solution Conductivity. National Institute of Standards and Technology, Gaithersburg, MD. Available from <https://www.nist.gov/el/estimation-pore-solution-conductivity>

2.4. *Other Document:*

- Barneyback, R. S. and S. Diamond. Expression and Analysis of Pore Fluids from Hardened Cement Pastes and Mortars. Cement and Concrete Research, Vol. 11, No. 2, 1981, pp. 279–28.

3. SIGNIFICANCE AND USE

- 3.1. Alkali–silica reaction (ASR) in concrete is a chemical reaction between alkali hydroxides in pore solution and the reactive form of silica in aggregates that produces an ASR gel. The concentration of hydroxyl ions within the concrete is predominantly controlled by the concentration of sodium and potassium ions derived from portland cement, even though other alkali sources can potentially elevate hydroxyl and alkali ion concentration in the pore solution.
- 3.2. This test method is intended to detect the alkali silica reactivity of an aggregate or assess the effectiveness of mitigation measures of SCMs in terms of measuring length change of a cylindrical concrete specimen immersed in a soak solution with a chemistry equal to the pore solution of the tested concrete specimen at 60°C (140°F). SCMs from a specific source can be tested individually or in combination with SCMs from other sources.

- 3.3. When selecting a sample or deciding on the number of samples for testing, it is important to recognize the variability in lithology of material from a given source, whether a deposit of sand, gravel, or a rock formation of any origin. For specific advice, see ASTM C295/C295M.
- 3.4. This test (ACCT) is intended to provide results similar to the concrete prism test (CPT, ASTM C1293) or modified concrete prism test (MCPT, T 380). This test is performed differently than the CPT or MCPT method; the differences are briefly described below:
- 3.4.1. Aggregates directly from stockpiles are used to make concrete for the ACCT method. As the ACCT method uses concrete specimens of 76.2 x 152.4 mm (3 x 6 in.) dimension, coarse aggregate with maximum aggregate size up to 25.4 mm (1 in.) can be directly used to make concrete without involving any additional aggregate sample preparation (e.g., aggregate crushing).
- Note 1**—In the CPT method, the size of the particles of the tested coarse aggregate need to be between the 19 mm (0.75 in.) and 4.75 mm (0.2 in.) sieve. Similarly, the aggregate particles need to be between the 12.5 mm (0.5 in.) and 4.75 mm (0.2 inch) sieve in the MCPT method (T 380). Therefore, some amount of crushing of aggregate particles (e.g., particles with size >19 mm (0.75 in.) in the CPT method and particles with size >12.5 mm (0.5 in.) in the MCPT method) is involved for both methods. Both CPT and MCPT do not use aggregate particles below 4.75 mm (0.2 in.).
- 3.4.2. The ACCT is conducted with a lower level of alkali loading (i.e., 2.67 kg/m³ (4.5 lb/yd³)). Alkali leaching is addressed in the ACCT method by immersing the sample in a soak solution of chemistry equal to the pore solution alkalinity (PSA) of the tested concrete. The penetration of alkali ions from the soak solution to the concrete specimen was found to be negligible in the ACCT method because of this condition.
- 3.4.3. ACCT is conducted inside an oven at 60°C (140°F) with the use of an automatic data collection system (i.e., a combination of linear variable differential transducer (LVDT) and data acquisition system) to ensure continuous automatic length change measurement of concrete cylinder due to ASR over time. This allows elimination of errors (if any) associated with length change measurement by the standard comparator method at temperature (e.g., room temperature) different from the testing temperature and increases the quality of the data and reliability of the test.
- 3.4.4. ACCT is able to test concrete specimens at varying alkali loadings, (i.e., at higher as well as lower than the assigned testing alkali loading of 2.67 kg/m³ (4.5 lb/yd³)). As ACCT does not suffer from alkali leaching and ensures negligible alkali penetration from soak solution into the concrete specimen, the effect of cement alkalis as well as soluble alkali contributions from SCMs on ASR expansion can be detected by the ACCT method.
- 3.5. The total alkali content of the cement used in this test method should have Na₂O_{eq} content of 0.80 ± 0.05 percent. Cements with Na₂O_{eq} of 0.75 to 0.85 percent are commercially available.
- 3.6. This test method is intended for evaluating the behavior of aggregates in portland cement concrete with a total alkali loading of 2.67 kg/m³ (4.5 lb/yd³) or in concrete containing SCMs with an alkali loading proportionally reduced from 2.67 kg/m³ (4.5 lb/yd³) by the amount of SCMs replacing portland cement in terms of assessing the potential for deleterious expansion of concrete caused by alkali–silica reaction, of either coarse or fine aggregates.
- 3.7. This test method with relatively low alkali loading can be used to pass/fail an aggregate in a relatively short time (i.e., ≤ 45 days) with an expansion limit of 0.04 percent. Based on the work referenced in Section 12, it may be inferred that an aggregate might reasonably be classified as potentially deleteriously reactive if the average expansion of three concrete specimens is equal to or greater than 0.04 percent at 45 days. The criteria to characterize the aggregate reactivity in the ACCT method are presented in Table 1.

Table 1—Criteria to Characterize the Aggregate Reactivity in the ACCT Method

Aggregate Reactivity	45-day Expansion in ACCT, percent
Nonreactive	<0.04
Slowly Reactive	0.04–0.12
Moderate Reactive	>0.12–0.24
Highly Reactive	>0.24

- 3.8. This test method is intended to determine optimum level of any kind of SCMs. Extending the testing period by an additional 30 and 45 days was found to be adequate to determine the optimum level of SCMs for moderate/highly reactive and slowly reactive aggregates respectively. The SCM content that makes expansion below 0.04 percent at 75 days (for moderate/highly reactive aggregates) and 90 days (for slowly reactive aggregates) was considered as optimum level of replacement. This test method also has the ability to test job concrete mix (e.g., a mix with typical ASR mitigation measures). It has been found that a total testing period of 120 days (4 months) is adequate to ensure the effectiveness of mitigation measures for job concrete mix. ACCT results with varying alkali loadings and fly ash contents supported by limited exposure block data ensure further validation and enhance the reliability of the ACCT method.

4. APPARATUS

- 4.1. *Scales*—The scales and weights used for weighing materials shall conform to the requirements prescribed in M 231.
- 4.2. *Crushing Equipment*—It is recommended to collect coarse aggregates from a stockpile with a 25 mm (1-in.) maximum size in order to avoid crushing. However, if any coarse aggregate source contains particles with a maximum size >25 mm (>1 in.), then break the oversize aggregate (larger than the 25 mm (1-in.) sieve) using suitable crushing equipment (e.g., a hand hammer) to pass the 25 mm (1-in.) sieve.
- 4.3. *Glassware*—All glass apparatus and vessels should be carefully selected to meet the particular requirements for each operation. Standard volumetric flasks, burets, and pipets should be of precision grade.
- 4.4. The device (see Figure 1) consists of a stainless steel container (Figures 2 and 3), a stainless steel lid (see Figures 2 and 4), and a linear variable differential transducer (LVDT). A detailed drawing of the assembled system is provided in Figure 2. The detailed drawings of the individual parts are provided in Figures 3 and 4 respectively. One O-ring is placed in the junction between the container and lid. The LVDT is placed in the center hole of the base plate on the lid. Three screws located through the side of the base plate are properly tightened to ensure a vertical alignment of the LVDT. The alignment screws shall be firmly attached to the LVDT to prevent loosening during a test. Tighten the screws until the first sign of resistance and then apply another one-sixteenth turn.
- Note 2**—If alkali-resistant O-rings are available, it is recommended to use that type of O-rings. If non-alkali-resistant O-rings are used, O-ring replacement after each test is highly recommended.
- 4.4.1. The device is made of stainless steel 316 (ASTM A182/A182). The tolerances for all dimensions in Figures 1 to 4 are 1.30 to 2.50 mm (0.05 in.–0.10 in.).
- 4.4.2. The LVDT shall be alkali resistant, have a nominal linear range of ± 2.54 mm (0.10 in.), and operating temperature range up to 100°C (212°F). The type of LVDT recommended to use in T 336 can meet these requirements.