
Standard Method of Test for Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate

AASHTO Designation: T 104-22

Technically Revised: 2022

Technical Subcommittee: 1c, Aggregates



**American Association of State Highway and Transportation Officials
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1. SCOPE

- 1.1. This method covers the procedure to be followed in testing aggregates to determine their resistance to disintegration by saturated solutions of sodium sulfate or magnesium sulfate. This is accomplished by repeated immersion in saturated solutions of sodium or magnesium sulfate followed by oven drying to partially or completely dehydrate the salt precipitated in permeable pore spaces. The internal expansive force, derived from the rehydration of the salt upon re-immersion, simulates the expansion of water on freezing. This test method furnishes information helpful in judging the soundness of aggregates subject to weathering action, particularly when adequate information is not available from service records of the material exposed to actual weathering conditions. Attention is called to the fact that test results by the use of the two salts differ considerably and care must be exercised in fixing proper limits in any specifications that may include requirements for these tests.
- 1.2. The values stated in SI units are to be regarded as the standard.
- 1.3. *This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety concerns associated with its use. It is the responsibility of the user of this procedure to consult and establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to its use.* Regulatory information for the chemicals used in this standard can be found in 29 CFR 1910.1200.
- 1.4. *The quality of the results produced by this standard are 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.*
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2. REFERENCED DOCUMENTS

- 2.1. *AASHTO Standards:*
- M 231, Weighing Devices Used in the Testing of Materials
 - M 339M/M 399, Thermometers Used in the Testing of Construction Materials
 - R 18, Establishing and Implementing a Quality Management System for Construction Materials Testing Laboratories
 - T 27, Sieve Analysis of Fine and Coarse Aggregates

- 2.2. *ASTM Standards:*
- C670, Standard Practice for Preparing Precision and Bias Statements for Test Methods for Construction Materials
 - E1, Standard Specification for ASTM Liquid-in-Glass Thermometers
 - E11, Standard Specification for Woven Wire Test Sieve Cloth and Test Sieves
 - E100, Standard Specification for ASTM Hydrometers
 - E230/E230M, Standard Specification for Temperature-Electromotive Force (emf) Tables for Standardized Thermocouples
 - E879, Standard Specification for Thermistor Sensors for General Purpose and Laboratory Temperature Measurements
 - E2877, Standard Guide for Digital Contact Thermometers
- 2.3. *Federal Standard:*
- Fed. Std. No. 29, CFR 1910.1200 OSHA Hazard Communication Standard; see also Permissible Exposure Limits—Annotated Tables. Available from <https://www.osha.gov/dsg/annotated-pels/>
- 2.4. *International Electrotechnical Commission Standard:*
- IEC 60584-1:2013, Thermocouples - Part 1: EMF Specifications and Tolerances

3. APPARATUS

- 3.1. *Sieves*—With square openings of the following sizes conforming to ASTM E11, for sieving the samples in accordance with Sections 5, 6, and 8:

4.75 mm	(No. 4)	63 mm	(2½ in.)
4.00 mm	(No. 5)	50 mm	(2 in.)
2.36 mm	(No. 8)	37.5 mm	(1½ in.)
1.18 mm	(No. 16)	31.5 mm	(1¼ in.)
600 µm	(No. 30)	25.0 mm	(1 in.)
300 µm	(No. 50)	19.0 mm	(¾ in.)
150 µm	(No. 100)	16.0 mm	(⅝ in.)
		12.5 mm	(½ in.)
		9.5 mm	(⅜ in.)
		8.0 mm	(⅝ in.)

- 3.2. *Containers for Samples*—Sieves 203.2 mm (8 in.) in diameter for each separate size fractions of aggregate during test. Used, out-of-tolerance sieves according to ASTM E11, in acceptable condition, may be used as containers (Note 1).

- 3.2.1. *Coarse Aggregate*—2.36-mm (No. 8) Size.

- 3.2.2. *Fine Aggregate*—250-µm (No. 60) Size.

Note 1—Sieves 203.2 mm (8 in.) in diameter may be substituted with containers that permit free access of solution to the sample and drainage of the solution from the sample without loss of aggregate. Substitution with such containers may affect results. Referee testing, comparison testing, or testing of aggregate to be used in critical applications must be performed using sieves 203.2 mm (8 in.) in diameter.

- 3.3. *Apparatus for Immersing Samples in Solution (optional)*—When necessary, apparatus for holding the sieves containing the sample for immersing into the solution shall be constructed in such a manner as to permit free access of the solution to the sample and drainage of the solution from the sample.
- 3.4. *Temperature Regulation*—Suitable means for regulating the temperature of the samples during immersion in the sodium sulfate or magnesium sulfate solution shall be provided.
- 3.5. *Thermometer*—A thermometer for measuring the temperature of water and materials in solution shall meet the requirements of M 339M/M 339 with a temperature range of at least 0 to 60°C (32 to 140°F), with an accuracy of $\pm 0.5^\circ\text{C}$ ($\pm 0.9^\circ\text{F}$) (see Note 2).
Note 2—Thermometer types suitable for use include ASTM E1 mercury thermometers; ASTM E230/E230M thermocouple thermometer, Type T, Special Class; IEC 60584 thermocouple thermometer, Type T, Class 1; or ASTM E879 thermistor thermometer.
- 3.6. *Temperature Recorder*—A temperature device for monitoring and recording temperature, meeting the requirements of M 339M/M 339, shall have a temperature range of at least 0 to 60°C (32 to 140°F) matched to a sensor type and tolerance class, capable of recording temperatures to within $\pm 0.5^\circ\text{C}$ ($\pm 0.9^\circ\text{F}$) every 10 minutes or less (see Note 3).
Note 3—Thermometer types suitable for use include ASTM E1 mercury thermometers; ASTM E230/E230M thermocouple thermometer, Type T, Special Class; IEC 60584 thermocouple thermometer, Type T, Class 1; or ASTM E879 thermistor thermometer.
- 3.7. *Balance*—The balance shall have sufficient capacity, be readable to 0.1 percent of the sample mass or better, and conform to the requirements of M 231.
- 3.8. *Drying Oven*—The oven shall be capable of being heated continuously at $110 \pm 5^\circ\text{C}$ ($230 \pm 9^\circ\text{F}$) and the rate of evaporation, at this range of temperature, shall be at least 25 g/h for 4 h, during which period the doors of the oven shall be kept closed. This rate shall be determined by the loss of water from 1-L Griffin low-form beakers, each initially containing 500 g of water at a temperature of $21 \pm 2^\circ\text{C}$ ($70 \pm 3^\circ\text{F}$), placed at each corner and the center of each shelf of the oven. The evaporation requirement is to apply to all test locations when the oven is empty except for the beakers of water. Oven(s) for heating and drying shall be capable of operation at the temperatures required, between 100 to 120°C (212 to 248°F), within $\pm 5^\circ\text{C}$ ($\pm 9^\circ\text{F}$), as corrected, if necessary, by standardization. More than one oven may be used, provided each is used within its proper operating temperature range. The thermometer for measuring the temperature, regardless of drying apparatus used, shall meet the requirements of M 339M/M 339 with a temperature range of at least 90 to 130°C (194 to 266°F), and an accuracy of $\pm 1.25^\circ\text{C}$ ($\pm 2.25^\circ\text{F}$) (see Note 4).
Note 4—Thermometer types suitable for use include ASTM E1 mercury thermometers; ASTM E2877 digital metal stem thermometer; ASTM E230/E230M thermocouple thermometer, Type J or K, Special Class, Type T any Class; IEC 60584 thermocouple thermometer, Type J or K, Class 1, Type T any Class; or dial gauge metal stem (bi-metal) thermometer.
- 3.9. *Specific Gravity Measurement*—Hydrometers conforming to the requirements of ASTM E100, or a suitable combination of graduated glassware and balance, capable of measuring the solution specific gravity within ± 0.001 .

4. SPECIAL SOLUTIONS REQUIRED

- 4.1. Prepare the solution for immersion of test samples from either sodium or magnesium sulfate in accordance with Section 4.1.1 or 4.1.2 (Note 5). The volume of the solution shall be at least five times the solid volume of all samples immersed at any one time.