



Standard Test Methods for Freezing and Thawing Compacted Soil-Cement Mixtures ¹

This standard is issued under the fixed designation D560/D560M; 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 U.S. Department of Defense.

1. Scope*

1.1 These test methods cover procedures for determining the soil-cement losses, water content changes, and volume changes (swell and shrinkage) produced by repeated freezing and thawing of hardened soil-cement specimens. The specimens are compacted in a mold, before cement hydration, to maximum density at optimum water content using the compaction procedure described in Test Methods **D558**.

1.2 Two test methods, depending on soil gradation, are covered for preparation of material for molding specimens and for molding specimens as follows:

<i>Test Method A</i> , using soil material passing a 4.75-mm [No. 4] sieve.	Sections
This method shall be used when 100 % of the soil sample passes the 4.75-mm [No. 4] sieve.	7
<i>Test Method B</i> , using soil material passing a [0.75-in.] 19.0-mm sieve.	
This method shall be used when part of the soil sample is retained on the 4.75-mm [No. 4] sieve. This test method may be used only on those materials that have 30 % or less retained on the 19.0 mm [0.75-in.] sieve	8

1.3 All observed and calculated values shall conform to the guidelines for significant digits and rounding established in Practice **D6026**, unless superseded by this test method.

1.3.1 The procedures used to specify how data are collected /recorded and calculated in the standard are regarded as the industry standard. In addition, they are representative of the significant digits that generally should be retained. The procedures used do not consider material variation, purpose for obtaining the data, special purpose studies, or any considerations for the user’s objectives; and it is common practice to increase or reduce significant digits of reported data to be commensurate with these considerations. It is beyond the scope of these test methods to consider significant digits used in analysis methods for engineering data.

1.4 *Units*—The values stated in either SI units or inch-pound units [presented in brackets] are to be regarded separately as standard. The values stated in each system shall be

¹ These test methods are under the jurisdiction of ASTM Committee **D18** on Soil and Rock and are the direct responsibility of Subcommittee **D18.15** on Stabilization With Admixtures.

Current edition approved Nov. 1, 2016. Published November 2016. Originally approved in 1939. Last previous edition approved in 2015 as D560/D560M–15. DOI: 10.1520/D0560_D0560M-16.

used independently of the other. Combining values from the two systems may result in non-conformance with the standard. Sieve size is identified by its standard designation in Specification **E11**. The alternative designation given in parentheses is for information only and does not represent a different standard sieve size.

1.4.1 The gravitational system of inch-pound units is used when dealing with inch-pound units. In this system, the pound (lbf) represents a unit of force (weight), while the unit for mass is slugs. The rationalized slug unit is not given, unless dynamic ($F = ma$) calculations are involved.

1.4.2 It is common practice in the engineering/construction profession to use pounds to represent both a unit of mass (lbm) and of force (lbf). This implicitly combines two separate systems of unit; that is, the absolute system and the gravitational system. It is scientifically undesirable to combine the use of two separate sets of inch-pound units within a single standard. As stated, this standard includes the gravitational system of inch-pound units and does not use/present the slug unit for mass. However, the use of balances or scales recording pounds of mass (lbm) or recording density in lbm/ft³ shall not be regarded as nonconformance with this standard.

1.5 *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*:²
 - C150/C150M** Specification for Portland Cement
 - C595/C595M** Specification for Blended Hydraulic Cements
 - D558** Test Methods for Moisture-Density (Unit Weight) Relations of Soil-Cement Mixtures
 - D559/D559M** Test Methods for Wetting and Drying Compacted Soil-Cement Mixtures
 - D653** Terminology Relating to Soil, Rock, and Contained Fluids

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



- D698** Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³))
- D2168** Practices for Calibration of Laboratory Mechanical-Rammer Soil Compactors
- D2216** Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
- D3282** Practice for Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes
- D3740** Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
- D4753** Guide for Evaluating, Selecting, and Specifying Balances and Standard Masses for Use in Soil, Rock, and Construction Materials Testing
- D6026** Practice for Using Significant Digits in Geotechnical Data
- E11** Specification for Woven Wire Test Sieve Cloth and Test Sieves
- E145** Specification for Gravity-Convection and Forced-Ventilation Ovens
- 2.2 *AASHTO Standards*:³
- M 145** Classifications of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes

3. Terminology

3.1 For common definitions of technical terms used in this standard, refer to Terminology **D653**.

4. Significance and Use

4.1 These test methods are used to determine the resistance of compacted soil-cement specimens to repeated freezing and thawing. These test methods were developed to be used in conjunction with Test Methods **D559/D559M** and criteria given in the *Soil-Cement Laboratory Handbook*⁴ to determine the minimum amount of cement required in soil-cement to achieve a degree of hardness adequate to resist field weathering.

NOTE 1—The quality of the result produced by this standard is dependent on the competence of the personnel performing it and the suitability of the equipment and facilities used. Agencies that meet the criteria of Practice **D3740** are generally considered capable of competent and objective testing/sampling/inspection/etc. Users of this standard are cautioned that compliance with Practice **D3740** does not in itself ensure reliable results. Reliable results depend on many factors; Practice **D3740** provides a means of evaluating some of those factors.

5. Apparatus

5.1 *Mold, Rammer, and Sample Extruder*—Refer to Test Methods **D698** for detailed specifications.

5.2 *Balances*—A balance or scale conforming to the requirements of Class GP5 with a readability of 1 g in Specification **D4753**, except that a Class GP2 balance of 0.1 g readability is required for water content determination.

³ Available from American Association of State Highway and Transportation Officials (AASHTO), 444 N. Capitol St., NW, Suite 249, Washington, DC 20001, <http://www.transportation.org>.

⁴ *Soil-Cement Laboratory Handbook*, Portland Cement Assn., 1992.

5.3 *Drying Oven*—Thermostatically controlled, preferably of the forced-draft type, meeting the requirements of Specification **E145** and capable of maintaining a uniform temperature of 110 ± 5°C [230 ± 9°F] throughout the drying chamber.

5.4 *Freezing Cabinet*—A freezing cabinet capable of maintaining temperatures of –23°C [–10°F] or lower.

5.5 *Moist Room*—A moist room, or curing environment, capable of maintaining a temperature of 23 ± 2°C [73.5 ± 3.5°F] and a relative humidity of 100 % for seven-day storage of compacted specimens and for thawing frozen specimens.

5.6 *Wire Scratch Brush*—A wire scratch brush made of 50-mm [2-in.] long by 1.6-mm [0.06 in.] wide by 0.5-mm [No. 26 gage] thick flat wire bristles assembled in 50 groups of 10 bristles each and mounted to form five longitudinal rows and ten transverse rows of bristles on a 190 by 65-mm [7.5- by 2.5-in.] hardwood block.

5.7 *Straightedge*—A stiff metal straightedge of any convenient length but not less than 250 mm [10-in.]. The total length of the straightedge shall be machined straight to a tolerance of ± 0.1-mm [±0.004-in.]. The scraping edge shall be beveled if it is thicker than 3-mm [0.12-in.].

5.8 *Sieves*—75-mm [3-in.], 19.0-mm [0.75-in.], and 4.75-mm [No. 4] sieves conforming to the requirements of Specification **E11**.

5.9 *Mixing Tools*—Miscellaneous tools such as mixing pan, and trowel, or a suitable mechanical device for thoroughly mixing the soil with cement and water.

5.10 *Butcher Knife*—A butcher knife approximately 250 mm [10 in.] in length for trimming the top of the specimens.

5.11 *Scarifier*—A six-pronged ice pick or similar apparatus to remove the smooth compaction plane at the top of the first and second layers of the specimen.

5.12 *Container*—A flat, round pan, for initial preparation of heavy textured clayey material to facilitate moisture absorption by the soil-cement mixtures, about 300 mm [12 in.] in diameter and at least 50 mm [2 in.] deep.

5.13 *Measuring Device*—A measuring device suitable for accurately measuring the heights and diameters of test specimens to the nearest 0.25 mm [0.01 in.].

5.14 *Pans and Carriers*—Suitable pans for handling materials and carriers or trays for handling test specimens.

5.15 *Absorptive Pads*—6-mm [0.25-in.] thick felt pads, blotters, or similar absorptive material for placing between specimens and specimen carriers.

5.16 *Graduate*—A graduated cylinder of 250-mL [8.4 oz] capacity for measuring water.

5.17 *Water Content Containers*—Suitable containers made of material resistant to corrosion and change in mass upon repeated heating, cooling, exposure to materials of varying pH, and cleaning. Unless a desiccator is used, containers with close fitting lids shall be used for testing specimens having a mass of about 200 g [0.4 lbf]; while for specimens having a mass