Designation: D559 – 03

Standard Test Methods for Wetting and Drying Compacted Soil-Cement Mixtures [1]

This standard is issued under the fixed designation D559; 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 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 wetting and drying 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:

	Sections
Test Method A, using soil material passing a No. 4 (4.75-mm) sieve. This method shall be used when 100 % of the soil sample passes the No. 4 (4.75-mm) sieve	7
Test Method B, using soil material passing a ¾-in. (19.0-mm) sieve. This method shall be used when part of the soil sample is retained on the No. 4 (4.75-mm) sieve. This test method may be used only on materials with 30 % or less retained on the ¾-in. (19.0-mm) sieve.	8

1.3 All observed and calculated values shall conform to the guidelines for significant digits and rounding established in Practice D6026.

1.4 The values stated in inch-pound units are to be regarded as standard, except as noted below. The values given in parentheses are mathematical conversions to SI units, and are provided for information only and are not considered standard.

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.

1.4.2 The slug unit of mass is almost never used in commercial practice (density, scales, balances, etc.). Therefore, the standard unit for mass in this standard is either kilogram (kg) or gram (g) or both. Also, the equivalent inch-pound unit (slug) is not given.

1.4.3 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 units; 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 in 1.4.2, 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/ft^3 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:*

C150 Specification for Portland Cement[2]
C595 Specification for Blended Hydraulic Cements[3]
D558 Test Methods for Moisture-Density (Unit Weight) Relations of Soil-Cement Mixtures[3]
D560 Test Methods for Freezing and Thawing Compacted Soil-Cement Mixtures[3]
D653 Terminology Relating to Soil, Rock, and Contained Fluids[3]
D2168 Practices for Calibration of Laboratory Mechanical-Rammer Soil Compactors[3]
D2216 Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass[3]
D3740 Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction[3]
D4753 Guide for Evaluating, Selecting, and Specifying Balances and Standard Masses for Use in Soil, Rock, and Construction Materials Testing[4]

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

Current edition approved Feb. 10, 2003. Published April 2003. Originally approved in 1939. Last previous edition approved in 1996 as D559 – 96. DOI: 10.1520/D0559-03.

[2] *Annual Book of ASTM Standards*, Vol 04.01.
[3] *Annual Book of ASTM Standards*, Vol 04.08.
[4] *Annual Book of ASTM Standards*, Vol 04.09.

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

D6026 Practice for Using Significant Digits in Geotechnical Data[5]
E11 Specification for Woven Wire Test Sieve Cloth and Test Sieves[6]
E145 Specification for Gravity-Convection and Forced-Ventilation Ovens

3. Terminology

3.1 For common definitions of 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 wetting and drying. These test methods were developed to be used in conjunction with Test Methods D560 and criteria given in the *Soil-Cement Laboratory Handbook*[7] 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 assure reliable results. Reliable results depend on many factors; Practice D3740 provides a means of evaluating some of those factors.

5. Apparatus

5.1 *Mold*—A cylindrical metal mold having a volume of 1/30 ± 0.00040 ft^3 (944 ± 11 cm^3) with an internal diameter of 4.0 ± 0.016 in. (101.60 ± 0.41 mm) and conforming to Fig. 1 to permit preparing compacted specimens of soil-cement mixtures of this size. The mold shall be provided with a detachable collar assembly approximately 2½-in. (63.5 mm) in height. The mold may be of the split type consisting of two half-round sections or a section of pipe with one side split perpendicular to the pipe circumference and that can be securely locked in place to form a closed cylinder having the dimensions described above. The mold and collar assembly shall be so constructed that it can be fastened firmly to a detachable base.

5.2 *Rammer:*

5.2.1 *Manual Rammer*—A manually operated metal rammer having a 2.000 ± 0.005-in. (50.80 ± 0.13-mm) diameter circular face and a mass of 2.49 ± 0.01 kg. The rammer shall be equipped with a suitable guidesleeve to control the height of drop to a free fall of 12.0 ± 1/16 in. (304.8 ± 1.6 mm) above the elevation of the soil-cement. The guidesleeve shall have at least four vent holes not smaller than ⅜ in. (9.5 mm) spaced 90° apart and located with centers ¾ ± 1/16 in. (19.0 ± 1.6 mm) from each end and shall provide sufficient clearance that freefalls of the rammer shaft and head will not be restricted.

5.2.2 *Mechanical Rammer*—A mechanically operated metal rammer having a 2.000 ± 0.005-in. (50.80 ± 0.13-mm) diameter face and a manufactured mass of 2.49 ± 0.01 kg. The operating mass of the rammer shall be determined from a calibration in accordance with Methods D2168. The rammer shall be equipped with a suitable arrangement to control the height of drop to a free-fall of 12.0 ± 1/16 in. (304.8 ± 1.6 mm) above the elevation of the soil-cement.

5.2.3 *Rammer Face*—Strength and resistance to wetting-and-drying of specimens compacted with the sector face rammer may differ from that of specimens compacted with the circular face rammer. Therefore, the sector face rammer shall not be used unless previous tests on like soil-cement mixtures show that similar resistance to wetting and drying is obtained with the two types of rammers.

5.3 *Sample Extruder*—A jack, lever frame, or other device adapted for the purpose of extruding compacted specimens from the mold. Not required when a split-type mold is used.

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

5.5 *Drying Ovens*—Thermostatically controlled, preferably 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 chamber for the water content specimens, and a temperature of 71 ± 3 °C (160 ± 5 °F) throughout the drying chamber for drying compacted soil-cement specimens.

5.6 *Moist Room*—A moist room or suitable covered container capable of maintaining a temperature of 70 ± 3°F (21 ± 1.7°C) and a relative humidity of 100 % for 7-day storage of compacted specimens.

5.7 *Water Bath*—Suitable tank for submerging compacted specimens in water at room temperature.

5.8 *Wire Scratch Brush*—A wire scratch brush made of 2 by 1/16-in. (50.800 by 1.588-mm) flat No. 26 gage (0.46-mm) wire bristles assembled in 50 groups of 10 bristles each and mounted to form 5 longitudinal rows and 10 transverse rows of bristles on a 7-½ by 2-½-in. (190.0 by 63.5-mm) hardwood block.

5.9 *Straightedge*—A stiff metal straightedge of any convenient length but not less than 10-in. (250-mm). The total length of the straightedge shall be machined straight to a tolerance of ± 0.005-in (±0.1-mm). The scraping edge shall be beveled, if it is thicker than ⅛ -in (3-mm).

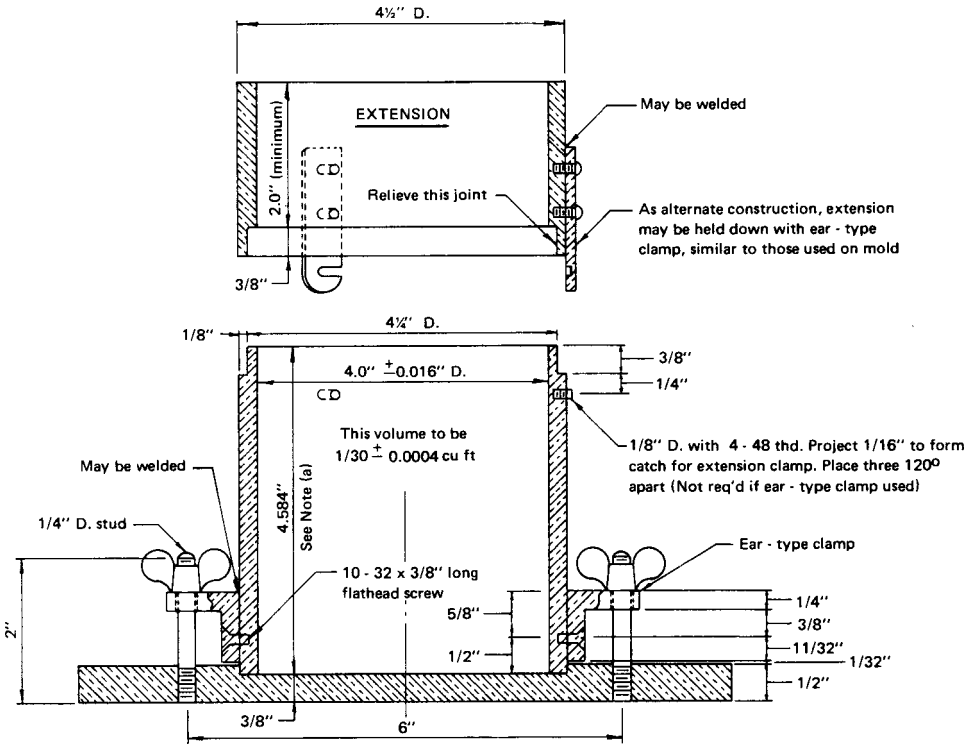
5.10 *Sieves*—3-in. (75-mm), ¾-in. (19.0-mm), and No. 4 (4.75-mm) sieves conforming to the requirements of Specification E11.

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

5.12 *Butcher Knife*—A butcher knife approximately 10 in. (250 mm) in length for trimming the top of the specimens.

5.13 *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] *Annual Book of ASTM Standards*, Vol 14.02.
[6] *Annual Book of ASTM Standards*, Vol 14.04.
[7] *Soil-Cement Laboratory Handbook*, Portland Cement Assn., 1971.



Metric Equivalents	
in.	mm
0.016	0.41
0.026	0.66
1/32	0.80
1/16	1.6
1/8	3.2
1/4	6.4
11/32	8.7
3/8	9.5
1/2	12.7
5/8	15.9
2	50.8
2½	63.5
4	101.6
4¼	108.0
4½	114.3
4.584	116.43
6	152.4
6½	165.1
8	203.2
ft^3	cm
1/30	944
0.004	11
1/13 333	2124
0.0009	25

NOTE 1—The tolerance on the height is governed by the allowable volume and diameter tolerances.

NOTE 2—The methods shown for attaching the extension collar to the mold and the mold to the base plate are recommended. However, others methods are acceptable, providing the attachments are equally as rigid as those shown.

FIG. 1 Cylindrical Mold

5.14 *Container*—A flat, round pan for moisture absorption by soil-cement mixtures, about 12 in. (305 mm) in diameter and 2 in. (50 mm) deep.

5.15 *Measuring Device*—A measuring device suitable for accurately measuring the heights and diameters of test specimens to the nearest 0.01 in. (0.20 mm).