Designation: D 427 – 04

Standard Test Method for Shrinkage Factors of Soils by the Mercury Method [1]

This standard is issued under the fixed designation D 427; 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.

1. Scope*

1.1 This test method covers a procedure for obtaining the data which are used to calculate the shrinkage limit and the shrinkage ratio.

1.2 This test method uses mercury which is a hazardous substance. Test Method D 4943 does not use mercury and is an acceptable alternate to this procedure.

1.3 The liquid limit, plastic limit, and shrinkage limit are often collectively referred to as the Atterberg Limits in recognition of their formation by Swedish soil scientist, A. Atterberg. These water contents distinguish the boundaries of the several consistency states of cohesive soils.

1.4 This test method is performed only on that portion of a soil which passes the 425-μm (No. 40) sieve. The relative contribution of this portion of the soil must be considered when using this test method to evaluate the properties of the soil as a whole.

1.5 The values stated in SI units are to be regarded as the standard. The values stated in inch-pound units are approximate and given for guidance only. Reporting of test results in units other than SI shall not be regarded as nonconformance with this standard.

1.6 All observed and calculated values shall conform to the guidelines for significant digits and rounding practices established in Practice D 6026.

1.6.1 The method used to specify how data are collected, calculated, or recorded in this standard is not directly related to the accuracy to which the data can be applied in design or other uses, or both. How one applies the results obtained using this standard is beyond its scope.

1.7 *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.* This test method involves the use of the hazardous material mercury (**Warning—**mercury is a definite health hazard in use and disposal), see Section 7.

2. Referenced Documents

2.1 *ASTM Standards:* [2]

C 670 Practice for Preparing Precision and Bias Statements for Test Methods for Construction Materials

D 421 Practice for Dry Preparation of Soil Samples for Particle-Size Analysis and Analysis and Determination of Soil Constants

D 653 Terminology Relating to Soil, Rock, and Contained Fluids

D 2216 Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass

D 2488 Practice for Description and Identification of Soils (Visual-Manual Procedure)

D 3740 Practice for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction

D 4318 Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

D 4753 Specification for Evaluating, Selecting, and Specifying Balances and Scales for Use in Testing Soil, Rock, and Related Construction Materials

D 4943 Test Method for Shrinkage Factors of Soils by the Wax Method

D 6026 Practice for Using Significant Digits in Geotechnical Data

3. Terminology

3.1 *Definitions:*

3.1.1 The definitions used in this test method shall be in accordance with Terminology D 653.

3.1.2 *dry strength*—a descriptive measure of the effort required to crush an air-dried 12-mm (½-in.) diameter ball of soil in accordance with Practice D 2488.

[1] This test method is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.03 on Texture, Plasticity, and Density Characteristics of Soils.

Current edition approved Feb. 1, 2004. Published February 2004. Originally approved in 1935. Last previous edition approved in 1998 as D 427 – 98.

[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.**

4. Summary of Test Method

4.1 A sample of fine-grained soil is thoroughly remolded with water to approximate the liquid limit consistency. The saturated paste is placed into a container of known volume and slowly dried. The final mass and volume of the solid soil pat are determined. These measurements are used to compute the soil constants.

5. Significance and Use

5.1 The shrinkage factors covered in this test method can only be determined on basically fine-grained (cohesive) soils which exhibit a dry strength when air dried.

5.2 The term shrinkage limit, expressed as a water content in percent, is typically assumed to represent the amount of water required to fill the voids of a given cohesive soil at its minimum void ratio obtained by drying (usually oven). Thus, the concept shrinkage limit can be used to evaluate the shrinkage potential or possibility of development, or both, of cracks in earthworks involving cohesive soils.

5.3 Data obtained from this test method may be used to compute the volumetric shrinkage and linear shrinkage.

NOTE 1—Notwithstanding the statements on precision and bias contained in this test method, the precision of this test method is dependent on the competence of the personnel performing it and the suitability of the equipment and facilities used. Agencies which meet the criteria of Practice D 3740 are generally considered capable of competent and objective testing. Users of this test method are cautioned that compliance with Practice D 3740 does not in itself ensure reliable testing. Reliable testing depends on several factors; Practice D 3740 provides a means of evaluating some of those factors.

6. Apparatus

6.1 *Evaporating Dish*, porcelain, about 140 mm (5½ in.) in diameter.

6.2 *Spatula*, or pill knife having a blade about 76 mm (3 in.) in length and about 19.0 mm (¾ in.) in width.

6.3 *Shrinkage Dish*—A circular porcelain or monel metal milk dish having a flat bottom and being about 44 mm (1¾ in.) in diameter and about 12 mm (½ in.) in height.

6.4 *Straightedge*, steel, about 150 mm (6 in.) in length.

6.5 *Glass Cup*, about 57 mm (2¼) in.) in diameter and about 31 mm (1¼ in.) in height, the top rim of which is ground smooth and is in a plane essentially parallel with the bottom of the cup.

6.6 *Glass Plate*, with three metal prongs for immersing the soil pat in mercury, as shown in Fig. 1.

6.7 *Glass Plate*, a plane glass plate large enough to cover the glass cup.

6.8 *Graduate*, glass, having a capacity of 25 mL and graduated to 0.2 mL.

6.9 *Balance*, meeting the requirements of Specification D 4753 for a balance of 0.01 g readability..

6.10 *Mercury*, sufficient to fill the glass cup to overflowing.

6.11 *Shallow Pan*, about 20 by 20 by 5-cm (8 by 8 by 2-in.) deep nonmetallic (preferably glass) pan used to contain accidental mercury spills.

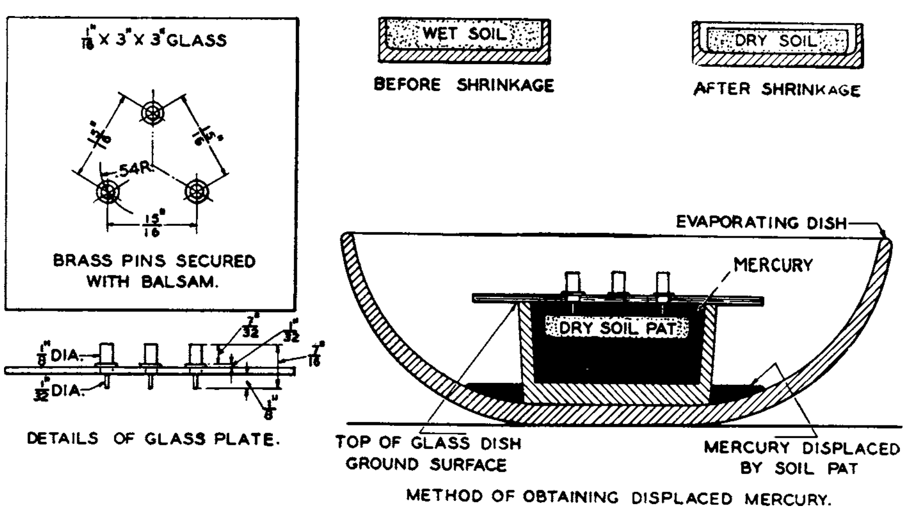
7. Hazards

7.1 **Warning**—Mercury is a hazardous substance that can cause illness and death. Inhalation of mercury vapor is a serious health hazard. Mercury can also be absorbed through the skin. The effects of mercury are cumulative.

7.2 **Precaution**—In addition to other precautions, store mercury in sealed shatter-proof containers to control evaporation, work in a well-ventilated area (preferably under a fume hood), and avoid contact with skin. Rubber gloves should be worn at all times.

7.3 Minimize uncontrolled spills by performing those parts of the procedure (9.3 and 9.6) in a large shallow pan which can act as a catchment.

7.4 Clean up spills immediately using a recommended procedure explicitly for mercury.



Metric Equivalents

in.	1⁄32	1⁄16	1⁄8	7⁄32	7⁄16	15⁄16	3
mm	0.8	1.6	3.2	5.6	11.1	23.8	76.2

FIG. 1 Apparatus for Determining the Volumetric Change of Subgrade Soils