Designation: D425 – 17

Standard Test Method for Centrifuge Moisture Equivalent of Soils[1]

This standard is issued under the fixed designation D425; 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 the determination of the moisture equivalent of soil in the laboratory by means of a centrifuge technique.

1.2 This test method is limited to specimens of coarse-grained sandy soils having a maximum particle size of less than 2.00 mm and with fines of low plasticity. Soils having a unified soil classification, based upon procedures outlined in Practice D2488 such as SP, SW, SC-SM, or SM are considered acceptable for the test method.

1.2.1 For soils that are predominantly fine-grained, coarse-grained soils with medium to high plasticity, intact specimens or soils being tested at a specific density or unit weight refer to Test Methods D6836.

1.3 This test method is intended to be performed in a constant temperature environment. Variations in temperature exceeding the range outlined in 8.7 may influence the test data.

1.4 *Units*—The values stated in SI units are to be regarded as the standard except for sieve designations, which also include the "alternative" system in accordance with E11.

1.5 All recorded and calculated values shall conform to the guide for significant digits and rounding established in Practice D6026.

1.6 The procedures used to specify how data are collected/recorded and calculated in this 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 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 commensurate with these considerations. It is beyond the scope of these test methods to consider significant digits used in analysis methods for engineering design.

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.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D653 Terminology Relating to Soil, Rock, and Contained Fluids

D2216 Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass

D2487 Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)

D2488 Practice for Description and Identification of Soils (Visual-Manual Procedure)

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

D6836 Test Methods for Determination of the Soil Water Characteristic Curve for Desorption Using Hanging Column, Pressure Extractor, Chilled Mirror Hygrometer, or Centrifuge

E11 Specification for Woven Wire Test Sieve Cloth and Test Sieves

3. Terminology

3.1 *Definitions:*

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

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *capillary fringe zone*—the zone above the free water elevation in which water is held by capillary action.

[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 Jan. 15, 2017. Published January 2017. Originally approved in 1935. Last previous edition approved in 2008 as D425 – 88 (2008). DOI: 10.1520/D0425-17.

[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

3.2.2 *centrifuge moisture equivalent*—the water content of a soil after it has been saturated with water and then subjected for one hour to a centrifugal force equal to 1000 times that of gravity.

3.2.3 *specific retention*—the ratio of the volume of water that cannot be drained from a saturated soil under the action of force of gravity to the total volume of voids.

3.2.4 *water-holding capacity*—the smallest value to which the water content of soil or rock can be reduced by gravity drainage.

4. Summary of Test Method

4.1 The centrifuge moisture equivalent of soils is determined by initially air-drying the soil sample. Two 5-g test specimens are selected from the sample and thoroughly soaked in distilled or deionized water. The specimens are centrifuged for 1 h at a force equal to 1000 times that of gravity at a constant temperature of 20 ± 1°C. The moisture content is determined after centrifuging in accordance with Test Methods D2216. The average of the two water contents is the moisture equivalent of the soil.

5. Significance and Use

5.1 All water contained in a saturated soil cannot be removed by gravity drainage alone. The amount of water retained after gravity drainage is usually expressed as the water holding capacity or specific retention of the soil. These values may be influenced by elapsed time, the particle-size distribution and the plasticity of the soil. In most cases, as the plasticity increases so does the moisture equivalent value.

5.2 The centrifuge moisture equivalent is determined by applying a centrifugal force great enough to reduce the capillary fringe zone sufficiently so that it can be ignored without introducing error. The centrifical force is maintained sufficiently low as not to withdraw a large proportion of the water that is held securely above the capillary fringe (see Note 1).

5.3 It has been determined that for at least medium-textured soils (sandy to silty particle-size distribution) the centrifuge moisture equivalent approximates the water holding capacity and when combined with the bulk density can be used to calculate an approximate specific retention and specific yield. These properties when combined with porosity can be used to estimate aquifer storage coefficient.

NOTE 1—If a soil will hold water 100 mm by capillarity acting against gravity, the soil will theoretically be able to hold the water only 0.1 mm against a centrifugal force that is 1000 times greater than the force of gravity.

NOTE 2—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 that meet the criteria of Practice D3740 are generally considered capable of competent and objective testing. Users of this test method are cautioned that compliance with Practice D3740 does not in itself assure reliable testing. Reliable testing depends on many factors; Practice D3740 provides a means of evaluating some of these factors.

6. Apparatus

6.1 *Centrifuge*—A centrifuge capable of generating a force equal to 1000 times the force of gravity on the center of gravity of the soil specimen for a period of 1 h. The centrifuge chamber shall be capable of maintaining a controlled temperature of 20 ± 1°C. In place of a temperature controlled chamber, the entire centrifuge may be operated in a controlled environment capable of meeting the temperature requirement of 20 ± 1°C.

6.1.1 The revolutions per minute, *N*, required to provide a centrifugal force of 1000 times gravity is determined from the equation:

$$N = \sqrt{\frac{RCF}{0.00000111\ rm}} \quad (1)$$

where:

N = revolutions per minute,
RCF = relative centrifugal force (1000),
r = radius of rotation to center of gravity of the test specimen, mm, and
m = mass of the body, taken as unity.

For most standard centrifuges, *N* will equal approximately 2300 rpm.

6.2 *Gooch Crucible*—Two procelain Gooch crucibles having a capacity of approximately 25 mL, and a diameter at the bottom of the crucible of about 20 mm (Fig. 1). The crucible shall have a perforated bottom and be compatible for use with the centrifuge being used.

6.3 *Babcock Trunnion Cups*—At least two centrifuge cups with caps and with a crucible holder for supporting the Gooch crucible above the bottom of the cup (Fig. 1). The holder shall have sufficient clearance to fit fully within the cup and support the cup in such a manner that the water removed during the centrifuging operation does not come in contact with the crucible and soil. Cups and crucible holders shall be balanced in pairs opposite each other in the centrifuge.

6.4 *Filter Paper*—A circular piece of filter paper of sufficient size to cover the inside bottom of the Gooch crucible (see Note 3).

NOTE 3—A medium speed, high wet strength (hardened) filter paper is recommended.

6.5 *Balance*—A balance having a readability of 0.01 g, and accurate to ±0.03 g, conforming to Specification D4753.

6.6 *Humidifier*—A cabinet or large jar with water in the lower half of the container. A shelf positioned above the level of the water should be covered with moisture resistant fabric on which to store the crucibles and soil specimens.

6.7 *Oven*—A thermostatically controlled drying oven, preferably of the forced-draft type, capable of maintaining a uniform temperature of 110 ± 5°C throughout.

6.8 *Water Content Containers*—Suitable containers made of material resistant to corrosion and change in mass upon repeated heating, cooling, and cleaning. Containers shall have close-fitting lids to prevent loss of moisture from the soil prior to the initial weighing and to prevent absorption of moisture from the atmosphere following oven drying and before final