This document is not an ASTM standard and is intended only to provide the user of an ASTM standard an indication of what changes have been made to the previous version. Because it may not be technically possible to adequately depict all changes accurately, ASTM recommends that users consult prior editions as appropriate. In all cases only the current version of the standard as published by ASTM is to be considered the official document.

Designation: ~~D425 – 88 (Reapproved 2008)~~ 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~~ 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 ~~disturbed~~ specimens of coarse-grained ~~soils having~~ sandy soils having a maximum particle size of less than 2.00 mm and with fines of low ~~plasticity~~ plasticity. Soils having a unified soil classification, based upon procedures outlined in Practice D2488 such as SP, SW, SC-SM, or SM ~~soils. The test is limited to soils passing the 2.00-mm sieve or that fraction of a soil passing a 2.00-mm sieve.~~ are considered acceptable for the test method.

~~NOTE 1—Test Method D3152 or Test Method D2325 should be used to evaluate the capillary-moisture relations of fine-grained soils and coarse-grained soils having fines of medium to high plasticity, undisturbed soils, and soils at specific desired units weights.~~

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 ~~The~~This test method is ~~temperature-dependent, and consistent comparable results can be obtained only if the tests are performed under a constant-temperature condition.~~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.~~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

~~D2325~~D2487 ~~Test Method for Capillary-Moisture Relationships for Coarse- and Medium-Textured Soils by Porous-Plate Apparatus~~Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System) ~~(Withdrawn 2007)~~

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

~~D3152~~D3740 ~~Test Method for Capillary-Moisture Relationships for Fine-Textured Soils by Pressure-Membrane Apparatus~~Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering

[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.

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[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**

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Design and Construction (Withdrawn 2007)
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 All definitions are in accordance with Terminology D653. Terms of particular significance are as follows:*Definitions:*

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

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

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.

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.

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

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4. Summary of Test Method

4.1 The centrifuge moisture equivalent of soils is determined by initially air-drying the soil, selecting two 5-g test specimens, thoroughly soaking each test specimen, and then determining the water content of each specimen after it has been 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 controlledconstant 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.

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5. Significance and Use

5.1 Not all All water contained in a saturated soil eancannot be removed by gravity drainage. drainage alone. The amount of water retained after gravity drainage is usually expressed as the water holding capacity or specific retention. It varies with time, and with retention of the soil. These values may be influenced by elapsed time, the particle-size distribution and the plasticity of the soil (in general, increasing in value with increasing plasticity index). 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 In general, the centrifuge moisture equivalent is based on the theory of applying a centrifugal force great enough to reduce the capillary fringe zone enough that it can be ignored without introducing much error, even in small specimens, and yet not so great as to withdraw a large proportion of the water that is held securely above the capillary fringe. For example, 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. 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 ~~such a size and so driven that a~~ generating a force equal to 1000 times the force of gravity ~~may be exerted~~ 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. ~~The revolutions per minute,~~ In place of ~~N, required to provide a centrifugal force of 1000 times gravity is determined from the equation:~~a temperature controlled chamber, the entire centrifuge may be operated in a

$$N = \sqrt{\frac{RCF}{0.0000111\ rm}} \tag{1}$$

controlled environment capable of meeting the temperature requirement of 20 ± 1°C.

~~where:~~

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

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

$$N = \sqrt{\frac{RCF}{0.00000111\ rm}} \tag{1}$$

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.
~~For normal equipment installation, *N* will equal approximately 2300 rpm.~~

6.2 *Gooch Crucible*—~~A~~Two procelain Gooch ~~crucible~~crucibles having a ~~perforated bottom, a~~ capacity of approximately 25 mL, and a diameter at the bottom of the crucible of about 20 mm (Fig. 1). ~~Crucibles should be numbered and paired in such a way that~~

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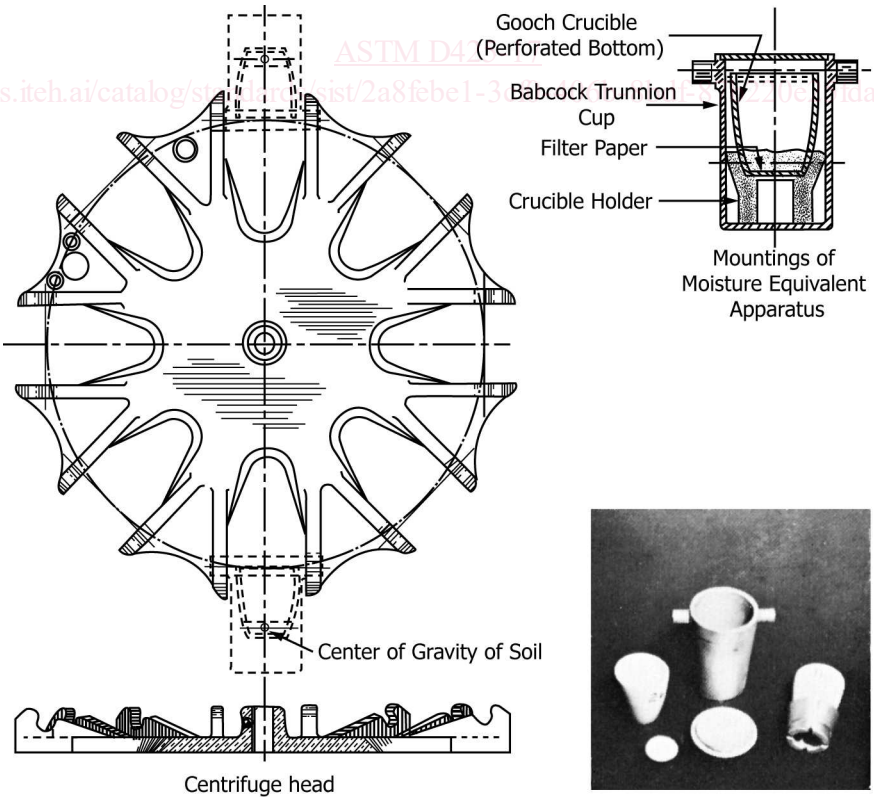

FIG. 1 Crucible, Trunnion Cup, and Cup Holder