



Designation: ~~D 4221-99~~ Designation: D4221 - 11

## Standard Test Method for Dispersive Characteristics of Clay Soil by Double Hydrometer<sup>1</sup>

This standard is issued under the fixed designation D4221; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

### 1. Scope

~~1.1 This test method, when used in conjunction with a test performed by Test Method D 422D 422-\*~~

1.1 This test method, when used in conjunction with a test performed by Test Method D422 on a duplicate soil sample, provides an indication of the natural dispersive characteristics of clay soils (1).<sup>2</sup>

1.2 This test method is applicable only to soils with a plasticity index greater than 4 as determined in accordance with Test Method ~~D 4318~~D4318 and more than 12 % of the soil fraction finer than 5- $\mu$ m as determined in accordance with Test Method ~~D 422~~D422 (2).

1.3 This test method is similar to Test Method ~~D 422~~D422, except that this method covers the determination of percent of soil particles smaller than 5- $\mu$ m in diameter in a soil-water suspension without mechanical agitation and to which no dispersing agent has been added.

1.4 The amount of particles smaller than 5- $\mu$ m determined by this method compared with the total amount of particles smaller than 5- $\mu$ m determined by Test Method ~~D 422~~D422 is a measure of the dispersive characteristics of the soil.

1.5 This test method may not identify all dispersive clay soils. Pinholes (Test Method ~~D 4647~~D4647 and crumb tests, or both, (3-5) or the analysis of pore water extract (4-7) may be performed to help verify dispersion.

~~1.6~~

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

1.7 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.8 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:*<sup>3</sup>

D422 Test Method for Particle-Size Analysis of Soils

D653 ~~Terminology Relating to Soil, Rock, and Contained Fluids~~<sup>3</sup>

~~D1193 Specification for Reagent Water~~ Terminology Relating to Soil, Rock, and Contained Fluids

D2216 ~~Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock~~<sup>3</sup> Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass

D2251 Test Method for Metal Corrosion by Halogenated Organic Solvents and Their Admixtures

D3740 Practice for Minimum Requirements for Agencies Engaged in ~~the~~ Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction

D4318 Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

D4647 Test Method for Identification and Classification of Dispersive Clay Soils by the Pinhole Test

D4753 ~~Specification for Evaluating, Selecting, and Specifying Balances and Scales for Use in Testing Soil, Rock, and Related~~

<sup>1</sup> This test method is under the jurisdiction of ASTM Committee ~~D 18~~D18 on Soil and Rock and is the direct responsibility of Subcommittee ~~D18.06 on Physico-Chemical Properties of Soils and Rocks~~

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<sup>2</sup> The boldface numbers in parentheses refer to the list of references appended to this standard.

<sup>3</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* Vol 04.08, 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.

Construction Materials<sup>3</sup> 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

E1 Specification for ASTM Liquid-in-Glass Thermometers

E11 Specification for Wire-Cloth Sieves for Testing Purposes—Specification for Woven Wire Test Sieve Cloth and Test Sieves

E100 Specification for ASTM Hydrometers

E145 Specification for Gravity-Convection and Forced-Ventilation Ovens

### 3. Terminology

#### 3.1 Definitions:

3.1.1 *dispersive clays*—soils that disperse (deflocculate) easily and rapidly without significant mechanical assistance in water of low-salt concentration.

3.1.1.1 Such soils usually have a high proportion of their adsorptive capacity saturated with sodium cation although adsorbed lithium and magnesium may also play a role (6). Such soils also generally have a high shrink-swell potential, have low resistance to erosion, and have low permeability in an intact state.

3.2 For other definitions relating to this standard, refer to Terminology D-653D653.

### 4. Summary of Test Method

4.1 The percent passing the 5- $\mu$ m size is determined first using test procedures in Test Method D-422D422.

4.2 Then the percent passing the 5- $\mu$ m size is determined using the test procedures in this test method. This test method differs from Test Method D-422D422 primarily in that no mechanical agitation nor chemical dispersants are used.

4.3 The percent dispersion is calculated by dividing the percent passing the 5- $\mu$ m size using this test method by the percent passing the 5- $\mu$ m size obtained using Test Method D-422D422 and by multiplying the result by 100.

### 5. Significance and Use

5.1 Dispersive clays are those which normally deflocculate when exposed to water of low-salt concentration, the opposite of aggregated clays that would remain flocculated in the same soil-water system (3, 4, 7). Generally, dispersive clays are highly erosive, possibly subject to high shrink-swell potential, may have lower shear strength, and have lower permeability rates than aggregated clays.

5.2 Available data (1) indicates that the test method has about 85 % reliance in predicting dispersive performance (85 % of dispersive clays show more than 35 % dispersion).

5.3 Since this test method may not identify all dispersive clays, design decisions based solely on this test method may not be conservative. It is often run in conjunction with the crumb test (4, 7), the pinhole test given in Test Method D-4647D4647, or the analysis of the pore water extract (4, 7), or combination thereof, to identify possible dispersive clay behavior.

NOTE 1—Notwithstanding the statement on precision and bias contained in this test method, the precision of this test method is dependent on the competence of the personal performing it, and the suitability of the equipment and facilities used. Agencies that meet the criteria of Practice D-3740D3740 are generally considered capable of competent and objective testing. Users of this test method are cautioned that compliance with Practice D-3740D3740 does not in itself ensure reliable testing. Reliable testing depends on several factors; Practice D-3740D3740 provides a means of evaluating some of those factors.

### 6. Apparatus

6.1 *Sieve*—A 2.00-mm (No. 10) sieve conforming to the requirements of Specification E-HE11. The physical condition of sieves should be checked at least every 12 months.

6.2 *Containers*—Airtight, for storing moist sample.

6.3 *Balance*, meeting the requirements of Class GP2 in Specification D-4753D4753. Measurements should be verified every 12 months.

6.4 *Filtering Flask*—A 500-mL filtering flask with a rubber stopper and a side tube capable of withstanding a vacuum.

6.5 *Vacuum Pump*, for evacuating entrapped air from the samples, and capable of pulling at least 20 to 25 in. Hg. Check pressure every 12 months.

6.6 *Sedimentation Cylinder*—A glass cylinder approximately 460 mm (18 in.) in height and 63.5 mm (2.5 in.) in diameter and marked  $360 \pm 20$  mm from the bottom of the inside for a volume of 1000 mL.

6.7 *Hydrometer*—An ASTM hydrometer conforming to the requirements for Hydrometers 151H or 152H of Specification E-100E100. Zero point should be checked every 12 months.

6.8 *Thermometer*, accurate to 0.5°C and conforming to Specification E-1E-1. Zero point should be checked every 12 months. In addition, thermometric devices such as Resistance Temperature Detectors (RTDs), thermistors, thermocouples, and liquid-in-glass thermometers conforming to Test Method D2251, may be used. Zero point should be checked every 12 months.

6.9 *Timing Device*—A watch or clock capable of being read to the nearest second.

6.10 *Distilled Water*, with a pH 5.5–7.