



Designation: D4221 – 11

Standard Test Method for Dispersive Characteristics of Clay Soil by Double Hydrometer¹

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 (ϵ) 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 [D422](#) on a duplicate soil sample, provides an indication of the natural dispersive characteristics of clay soils (1).²

1.2 This test method is applicable only to soils with a plasticity index greater than 4 as determined in accordance with Test Method [D4318](#) and more than 12 % of the soil fraction finer than 5- μ m as determined in accordance with Test Method [D422](#) (2).

1.3 This test method is similar to Test Method [D422](#), except that this method covers the determination of percent of soil particles smaller than 5- μ 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- μ m determined by this method compared with the total amount of particles smaller than 5- μ m determined by Test Method [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 [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 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 appro-*

¹ This test method is under the jurisdiction of ASTM Committee [D18](#) on Soil and Rock and is the direct responsibility of Subcommittee [D18.06](#) on Physical-Chemical Interactions of Soil and Rock.

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

priate safety and health practices and determine the applicability of regulatory limitations prior to use.

2. Referenced Documents

2.1 ASTM Standards:³

[D422](#) Test Method for Particle-Size Analysis of Soils

[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

[D2251](#) Test Method for Metal Corrosion by Halogenated Organic Solvents and Their Admixtures

[D3740](#) Practice for Minimum Requirements for Agencies Engaged in 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](#) 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 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

³ 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

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 **D653**.

4. Summary of Test Method

4.1 The percent passing the 5- μm size is determined first using test procedures in Test Method **D422**.

4.2 Then the percent passing the 5- μm size is determined using the test procedures in this test method. This test method differs from Test Method **D422** 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- μm size using this test method by the percent passing the 5- μm size obtained using Test Method **D422** 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 **D4647**, 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 **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 ensure reliable testing. Reliable testing depends on several factors; Practice **D3740** 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 **E11**. 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 **D4753**. 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 **E100**. Zero point should be checked every 12 months.

6.8 *Thermometer*, accurate to 0.5°C and conforming to Specification **E1**. 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.

NOTE 2—Trace minerals may be present in some Type IV water. However, since this is a qualitative test, such minerals should not affect the test results.

6.11 *Drying Oven*, conforming to the requirements of Specification **E145**. The oven should be thermostatically controlled, preferably of the forced-draft type, and capable of maintaining a uniform temperature of 110 \pm 5°C throughout the drying chamber. The temperature should be verified every four months.

7. Sample Preparation

7.1 Sieve approximately 200 g of soil through a 2.00-mm (No. 10) sieve. If materials are quite moist, this may require hand rubbing or use of a rubber-tipped pestle to force material through the sieve. It is recommended that this test be performed at natural water content. When samples are very moist, they should be dried to about the plastic limit before proceeding with the test.

7.2 Collect a representative sample of about 100 g of material passing the No. 10 sieve for water content determination and retain the remainder of the minus No. 10 material in an airtight container.

7.3 Determine the water content of the minus No. 10 material in accordance with Test Method **D2216**.

8. Procedure

8.1 Obtain 50 g of oven-dried soil in accordance with 7.3. Determine the percent passing 5 μm in accordance with Test Method **D422**.

8.2 Place approximately 125 mL of distilled water in the filtering flask.

8.3 Obtain from the container of minus No. 10 moist soil, a representative sample equivalent to 25.0 g of oven-dry soil, by splitting or other appropriate means, and place into the filtering flask with the distilled water.