Designation: ~~D6572 – 12~~ D6572 – 13

Standard Test Methods for Determining Dispersive Characteristics of Clayey Soils by the Crumb Test[1]

This standard is issued under the fixed designation D6572; 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 Two test methods are provided to give a qualitative indication of the natural dispersive characteristics of clayey ~~soils. Test~~ soils:. Method A ~~is for natural soil clumps and Test Method B for remolded soil.~~and Method B.

1.1.1 *Method A*—Procedure for Natural Soil Crumbs described in 10.2.

1.1.2 *Method B*—Procedure for Remolded Soil Crumbs described in 10.3.

1.2 ~~These test methods are not applicable for soils with less than 12 % finer than 0.005 mm and with a plasticity index less than or equal~~The crumb test, while a good, quick indication of dispersive soil, should usually be run in conjunction with a pinhole test and a double hydrometer test, Test Methods A6 ~~to~~and A5~~8.~~, respectively.

1.3 The crumb test ~~method~~ has some limitations in its usefulness as an indicator of dispersive ~~clay.~~soil. A dispersive soil may sometimes give a non-dispersive reaction in the crumb test. Soils containing kaolinite with known field dispersion problems, have shown non-dispersive reactions in the crumb test (**1**).[2] However, if the crumb test indicates dispersion, the soil is probably dispersive.

1.4 ~~Oven-dried soil should not be used to prepare crumb test specimens, as irreversible changes could occur to the soil pore-water physicochemical properties responsible for dispersion~~These test methods are not applicable for soils with 12 % or less of the particles passing 0.005 mm and having a ~~(~~plasticity~~2).~~ index less than or equal to 8, as determined by Test Method A9.

1.5 ~~The crumb test method, while a good quick indication of dispersive clay, should usually be run in conjunction~~Oven-dried soil should not be used to prepare crumb test specimens, as irreversible changes could occur to the soil pore-water physicochemical properties responsible for dispersion ~~**with** (**2a**).pinhole test and a double hydrometer test, Test Methods D4647 and D4221, respectively.~~

NOTE 1—In some cases, the results of the pinhole, crumb, and double-hydrometer test methods may disagree. ~~Crumb test methods are~~ The crumb test is a better indicator of dispersive ~~clays~~soils than of ~~nondispersive clays~~non-dispersive soils (**3**).

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

1.6.1 The ~~method~~procedures used to specify how data are ~~collected, calculated,~~ collected/recorded or ~~recorded~~calculated 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.~~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 the 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 be commensurate with these considerations. It is beyond the scope of this standard to consider significant digits used in analytical methods for engineering design.

1.7 The values stated in SI units are to be regarded as ~~the standard. The values given in parentheses are for information only.~~standard. No other units of measurement are included in this standard.

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.*

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[1] These test methods are under the jurisdiction of ASTM Committee D18 on Soil and Rock and are 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 at the end of this standard.

***A Summary of Changes section appears at the end of this standard**

2. Referenced Documents

2.1 *ASTM Standards:*[3]

D653 Terminology Relating to Soil, Rock, and Contained Fluids
D1193 Specification for Reagent Water
D2216 Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
D3740 Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
D4221 Test Method for Dispersive Characteristics of Clay Soil by Double Hydrometer
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
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
E2251 Specification for Liquid-in-Glass ASTM Thermometers with Low-Hazard Precision Liquids

3. Terminology

3.1 *Definitions:*

3.1.1 For definitions of ~~other~~ common technical terms ~~used in these test methods,~~ in this standard, refer to Terminology D653.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *dispersive clays*—~~soils that disperse (deflocculate) easily and rapidly~~a type of soil that disaggregates easily and rapidly, without significant mechanical assistance, in water of low-salt concentration.

[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.

3.2.1.1 *Discussion*—

Such soils usually have a high proportion of their adsorptive capacity saturated with sodium cations although adsorbed lithium and magnesium may also play a role (**4**). Such soils also generally have a high shrink-swell potential, have low resistance to erosion, and have low permeability in an intact state.

4. Summary of Test Method

4.1 A cube of remolded soil with approximately 15 ± 5 mm ~~(~⅝ ± ¼ in.)~~ on each side (about the size of a single die in a pair of dice) or a natural soil crumb of approximately similar volume is placed on the bottom of a 300-mL container containing ~~300~~250 mL of ~~distilled~~ Type IV water.

4.2 ~~Temperature~~ The temperature of the water is recorded and visual determinations of the dispersion grade are made and recorded at 2 min ± 15 s, 1 h ± 8 min, and 6 h ± 45 min. Determination of grade is based on the formation, extent, and turbidity of a dense "cloud" or halo of colloidal-sized particles extending from the soil crumb.

4.3 Determinations consist of: Grade 1 (Non-dispersive), Grade 2 (Intermediate), Grade 3 (Dispersive), and Grade 4 (Highly Dispersive).

5. Significance and Use

5.1 The crumb test ~~method~~ provides a simple, quick method for field or laboratory identification of a dispersive ~~clay~~clayey soil. The internal erosion failures of a number of homogeneous earth dams, erosion along channel or canal banks, and rainfall erosion of earthen structures have been attributed to colloidal erosion along cracks or other flow channels formed in masses of dispersive clay (**5**).

5.2 The crumb ~~test method,~~ test, as originally developed by Emerson (**6**), was called the aggregate coherence test and had seven different categories of soil-water reactions. Sherard (**5**) later simplified the test by combining some soil-water reactions so that only four categories, or grades, of soil dispersion are observed during the test. The crumb test is a relatively accurate positive indicator of the presence of dispersive properties in a soil. The crumb test, however, is not a completely reliable negative indicator that soils are not dispersive. The crumb test can seldom be relied upon as a sole test method for determining the presence of dispersive clays. The double-hydrometer test (Test Method D4221) and pinhole test (Test Method D4647) are test methods that provide valuable additional insight into the probable dispersive behavior of clay soils.

NOTE 2—The quality of the result produced by these test methods 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 these test methods 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. Interference

6.1 Oven-dried soil shall not be used in performing the crumb test as irreversible changes could occur to the soil pore-water physicochemical properties responsible for dispersion (**2**).

6.2 ~~Using~~ The use of water other than Type IV ~~water~~ in accordance with Specification D1193, can interfere with dispersion of the colloidal clay particles.

6.3 ~~Carefully place the~~ The cube or crumb shall be carefully placed directly on the bottom of the dish when submerging the crumb. Dropping the crumb from the water surface can cause excessive slaking and may result in erroneous interpretation of the dispersion grade.

6.4 Jarring or moving the soil specimen or container once the test method has begun can cause excessive turbidity and may result in erroneous interpretation of the dispersion grade.

6.5 The use of a single, natural, irregular-shaped soil ~~crumbs~~crumb may result in a specimen that is not representative of the total sample. Therefore, several crumb test specimens should be selected to ~~ensure~~ make sure that representative test results are obtained. The total number of test specimens should be determined during the test program and will depend on the degree of agreement of individual test results.

6.6 These test methods are not applicable to soils with ~~less than 12 % finer than~~12 % or less of the particles passing 0.005 mm and ~~with~~having a plasticity index less than or equal to 8, ~~refer to~~ as determined by Test Method D4318.

7. Apparatus

7.1 *Specimen Container*—~~An evaporating~~ A white or clear, non-porous, glass or equivalent inert container with a minimum capacity of ~~300-mL.~~300 mL and having a flat bottom of at least 85-mm across. The container shall be large enough to allow for the specimen to be fully immersed when placed in the container.

~~NOTE 3—Plastic bowls or cups can also be used but they should be white or clear to help in distinguishing the colloidal cloud. The container should be at least 85 mm (3 in.) across the bottom if flat-bottomed.~~

7.2 *Thermometer*—0 to 50°C range, 0.1°C divisions, conforming to the requirements of Specification E1. Temperature measuring devices such as RTDs, thermistors, or liquid-in-glass thermometers (for example, Specification E2251) conforming to Specification E1, and the temperature range and accuracy may be used.

7.3 *Sieve(s),* 4.75-mm (No. 4) and 2-mm (No. 10) sieve, in accordance with Specification E11.

7.4 *Timing Device*—A clock, stopwatch, digital timer, or alike readable to 1 second or better.

8. Reagents and Materials

8.1 *Purity of Water*—Type IV ~~of~~ water in accordance with Specification D1193 or distilled water with a pH between 5.5 and 7.0 should be used for conducting the test ~~method~~methods and preparing remolded specimens. Distilled water is preferred.

9. Sampling ~~and Test Specimens~~

9.1 *Sampling*—Obtain a ~~representative~~ representative, homogenous soil sample passing the 4.75-mm (No. 4) sieve. Depending on the percentage of coarse sand in the material, approximately 25 to 75 g of material is needed to perform a crumb ~~test method and approximately 400 to 500 g of material is needed to perform the crumb, pinhole, and double-hydrometer tests.~~test. If using Method A, more material may be needed in order to make sure representative test results are obtained. Material for the crumb test should be selected as soon as possible after obtaining the representative sample as discussed in 10.1.

9.1.1 ~~Water~~ Determine the water content of the sample prior to ~~specimen preparation should be determined using either~~specimen(s) preparation according to Test Method D2216 ~~in situ, air-dried, or water content as specified in Test Method~~and record to the nearest 0.1 %. Record the qualitative state ~~D2216.~~used in the determination such as, in situ, as-received or air-dried.

~~9.2 *Test Specimens:*~~

~~9.2.1 Test specimens may be from natural, irregularly shaped soil crumbs (Test Method A) or may be remolded from material passing a 2-mm (No. 10) sieve (Test Method B). Material for the crumb test method should be selected as soon as possible after obtaining the soil sample.~~

~~9.2.2 *Test Method A—Natural Soil Crumbs:*~~

~~9.2.2.1 A natural, irregularly shaped soil crumb is selected from a homogeneous soil sample with an abundance of aggregated soil lumps suitable for crumb test specimens that has been preserved at in situ or as-received water content or only allowed to air-dry. This soil crumb should be approximately the same volume as a cube 15 ± 5 mm (~⅝ ± ¼ in.) on each side (about the size of a single die of a pair of dice). If no one crumb is equivalent to a cube approximately 15 ± 5 mm (~⅝ ± ¼ in.) on each side, a series of smaller cubes can be used. Crumb volume should not be less than equivalent to a cube 7 ± 3 mm (~¼ ± ⅛ in.) on each side.~~

~~9.2.2.2 Use of natural soil crumbs may result in a specimen that is not representative of the total sample. Therefore, it is recommended that several crumb specimens be tested to ensure the total sample is represented. The number chosen is dependent on the homogeneity of the total sample.~~

~~9.2.3 *Test Method B—Remolded Specimens:*~~

~~9.2.3.1 A cube, approximately 15 ± 5 mm (~⅝ ± ¼ in.) on each side, is prepared from moist soil which has passed a 2-mm (No. 10) sieve.~~

~~9.2.3.2 If the crumb test method is being done in conjunction with the pinhole test method (Test Method D4647), the cube can be prepared from material cured to the moisture content desired for compacting the pinhole specimen. Alternatively, air-dried soil or soil at natural moisture can be passed through a 2-mm (No. 10) sieve and formed into the cube. If additional moisture is needed to form the cube, Type IV water in accordance with Specification D1193 can be added until the cube can be formed.~~

~~9.2.3.3 Results of the crumb test methods can be altered by mixing portions of a sample that have dispersive properties with a portion of the sample with non-dispersive properties. If remolded crumbs are used for testing, minimize the mixing of visually nonhomogeneous soil to obtain the material for the remolded crumb to avoid mixing dispersive and non-dispersive segments of the sample.~~

10. ~~Conditioning~~Test Specimen(s)

10.1 Preserve ~~crumb~~the test ~~specimens~~specimen(s) at the in situ or as-received water content, if possible, or ~~allow specimens~~ allowed to air-dry. Do not ~~oven-dry crumb test specimens.~~oven dry the test specimen(s).

10.2 *Method A—Natural Soil Crumbs:*

10.2.1 Select one or more natural, irregularly shaped, soil crumbs from the sample obtained in Section 9 with an abundance of aggregated soil lumps suitable for crumb test specimens. This soil crumb should be approximately the same volume as a cube with 15 ± 5 mm on each side (about the size of a single die of a pair of dice). If no one crumb is equivalent to this size cube, a series of smaller cubes can be used. The crumb volume should not be less than equivalent to a cube with 7 ± 3 mm on each side. Record the test specimen identification information and begin the test as soon as practicable after obtaining the test specimen(s).

10.2.2 Use of natural soil crumbs may result in a specimen that is not representative of the total sample; therefore, it is recommended that several crumb specimens be tested to make sure the total sample is represented. The number chosen is dependent on the homogeneity of the total sample.

10.3 *Test Method B—Remolded Soil Crumbs:*

10.3.1 Process the sample over a 2-mm (No. 10) sieve and retain the material passing the 2-mm (No. 10) sieve.

10.3.2 Prepare a test specimen from the material passing the 2-mm (No. 10) sieve by lightly compressing a moist soil sample into a cube approximately 15 ± 5 mm on each side. Use the thumbs and index finger to gently form the cube. Record the test specimen identification information and begin the test as soon as practicable after obtaining the test specimen(s).

10.4 If the crumb test is performed in conjunction with the pinhole test (Test Method D4647), the cube can be prepared from material cured to the moisture content desired for compacting the pinhole specimen. Alternatively, air-dried soil or soil at the natural moisture can be passed through a 2-mm (No. 10) sieve and formed into the cube. If additional moisture is needed to form the cube, Type IV or distilled water can be added until the cube can be formed.

11. Procedure

~~11.1 Record data on a "Crumb Test" form. An example of an acceptable form is shown in Fig. 1.~~

11.1 ~~Place a suitable 300 ml non-porous container that can fully~~For either Method, place the specimen container described in 7.1 ~~immerse the sample~~ on a horizontal working surface, which will be relatively free of vibration for the next 6 ~~h.~~h ± 45 min.

~~NOTE 4—Placing the dish on the top edge of the crumb test form facilitates easy identification of a number of specimens and reduces the potential for misidentification.~~

11.2 Pour approximately ~~250 mL~~ 250-mL of Type IV ~~water in accordance with Specification~~ or distilled water ~~D1193~~into the container and allow the water temperature to ~~stabilize~~equalize to 21 ± ~~6 degrees and~~ 6°C. This temperature shall be maintained throughout the test.

11.3 ~~Record the applicable test specimen information on the crumb test form as shown in~~Verify the water temperature has equalized prior to placing the specimen in the water. ~~Fig. 1. Information should be in accordance with Practice~~ Record the temperature to the nearest 0.1°C.~~D6026.~~

11.4 ~~Prepare a crumb test specimen using one of two test methods.~~Record the specimen container identification along with the test specimen that is placed in that container.

~~11.5.1 *Test Method A: Natural Soil Crumbs:*~~

~~11.5.1.1 A natural soil crumb equivalent in volume to a cube approximately 15 ± 5 mm (~⅝ ± ¼ in.) on each side is selected.~~

~~NOTE 5—When using natural crumb specimens, it is better to use a series of crumbs to ensure results representative of the entire sample.~~

NOTE 3—Placing the container(s) on the top edge of the test form facilitates easy identification of a number of specimens and reduces the potential for misidentification.

~~11.5.2 *Test Method B: Remolded Soil Crumbs:*~~

~~11.5.2.1 Prepare a crumb test specimen by lightly compressing a moist soil sample into a cube approximately 15 ± 5 mm (~⅝ ± ¼ in.) on each side. Use the thumbs and index finger to gently form the cube.~~

11.5 Carefully place the specimen in the water and gently release it only after placing it directly on the bottom of the ~~dish.~~ container . Do not move or vibrate the ~~dish~~container or stir the water from specimen placement until the end of this ~~test method.~~test.

11.6 ~~Note and record~~ Record the time of specimen placement ~~on the crumb test form~~ and start the ~~stopwatch.~~timing device.

11.7 As the soil crumb begins to absorb water, observe the tendency for colloidal-sized particles to deflocculate and go into suspension.

NOTE 4—The colloidal-sized particles are visible in the form of a dense "cloud" or halo that extends from the soil crumb. The extent and turbidity of the suspended clay particle "cloud" is visually interpreted. The ~~colloidal" cloud"~~colloidal "cloud" is influenced by soil ~~color,~~color; that is, dark soils produce a darker, more distinctly visible "cloud."

11.8 Determine and record the dispersion grade, in accordance with the following criteria (Fig. 1), and temperature at 2 min ± 15 s, 1 hour ± 8 min, and 6 hours ± 45 min. Be careful to submerge the thermometer bulb without touching or disturbing the test specimen.

11.9 ~~At 2 min, 1 h, and 6 h, determine and record the soil dispersion grade in accordance with the following criteria (refer to~~Carefully place the specimen in the water and gently release it only after placing it directly on the bottom of the dish. Do not move ~~Fig. 2~~):or vibrate the dish or stir the water from specimen placement until the end of this test method.

11.9.1 *Grade ~~1,~~1 (Non-dispersive)*—No reaction; the soil may crumble, slake, diffuse, and spread out, but there is no turbid water created by colloids suspended in the water. All particles settle during the first hour.

11.9.2 *Grade ~~2,~~2 (Intermediate)*—Slight reaction; ~~this~~ Grade 2 is the transition grade. A faint, barely visible colloidal suspension causes turbid water near portions of the soil crumb surface. If the cloud is easily visible, assign Grade 3. If the cloud is faintly seen in only one small area, assign Grade 1.

11.9.3 *Grade ~~3,~~3 (Dispersive)*—Moderate reaction; an easily visible cloud of suspended clay colloids is seen around the outside of the soil crumb surface. The cloud may extend up to 10 mm ~~(⅜ in.)~~ away from the soil crumb mass along the bottom of the dish.

11.9.4 *Grade ~~4,~~4 (Highly Dispersive)*—Strong reaction; a dense, profuse cloud of suspended clay colloids is seen around the entire bottom of the dish. Occasionally, the soil crumb dispersion is so extensive that it is difficult to determine the interface of the original soil crumb and the colloidal suspension. Often, the colloidal suspension is easily visible on the sides of the dish.

~~11.10 After determining the dispersion grade, determine and record the water temperature at 2-min, 1 h, and 6 h after beginning the test. Be careful to submerge the thermometer bulb without touching or disturbing the test specimen. The water temperature should be 21 ± 6°C (70 ± 10°F).~~

11.10 If a permanent record is desired, photograph the ~~crumb~~ test specimen after the ~~6-h~~ 6 hours ± 45 min reading.

12. Interpretation of Results

12.1 Use the following criteria to classify crumb test results:

12.1.1 *Grade 1*—Nondispersive.

12.1.2 *Grade 2*—Intermediate.

12.1.3 *Grade 3*—Dispersive.

12.1.4 *Grade 4*—Highly Dispersive.

12.2 If the dispersive grade changed during the test, the ~~1-h~~ 1 hour ± 8 min reading is normally used for the overall test evaluation. However, if the grade changes from 2 to 3 or from 3 to 4 between the 1 ~~and 6-h~~ hour ± 8 min and 6 hours ± 45 min readings, use the ~~6-h~~ 6 hours ± 45 min reading.

13. Report: Test Data Sheet(s)/Form(s)

13.1 The methodology used to specify how data are recorded on the test data sheet(s)/form(s) as given below, is covered in 1.6 and Practice D6026.

13.2 Record as a minimum the following general information (data):

13.2.1 Project name and, if known, the location of project.

13.2.2 Boring number, sample number, depth, color, and visual estimated classification of the material type.

13.2.3 Name or initials of the person performing the test and date of testing.

13.3 ~~Report the following information for the crumb test for dispersive clayey soils:~~Record as a minimum the following test specimen data:

13.3.1 ~~Name and location of project.~~Method used, A or B.

13.3.2 ~~Drill hole number, depth, color, and purpose of sample tested, such as, Test Hole No. 1, depth 0.9 to 1.8 m, (3 to 6 ft), red clay, embankment borrow area.~~Water content of the sample in % and the qualitative state (in situ, as-received, or air-dried).

13.3.3 If any additional water was added to form the cube as described in Method B.

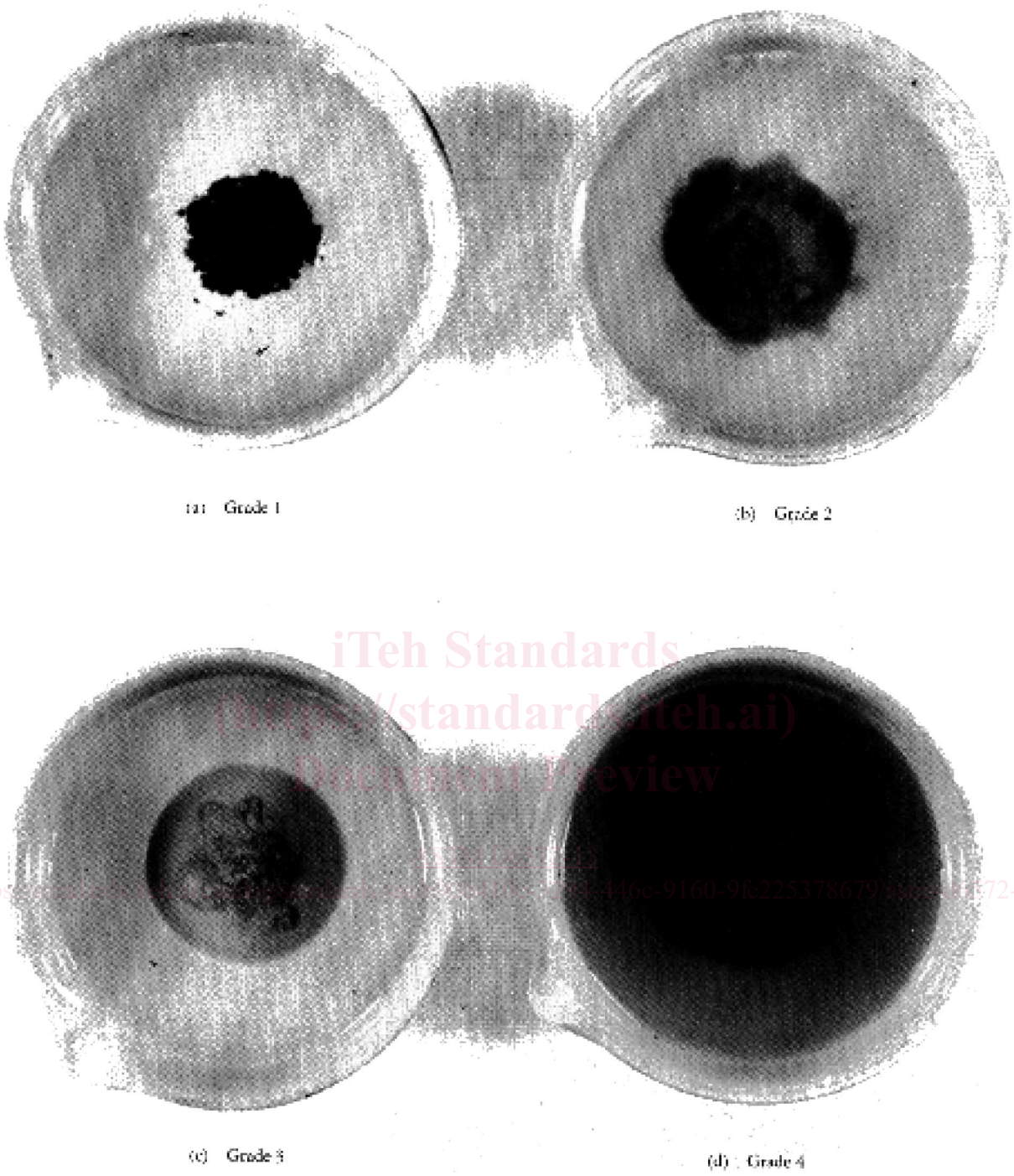

FIG. 1 Soil Crumb Specimens and Assigned Dispersion Grades (7)

13.3.4 Test Specimen identification.
13.3.5 Specimen container identification, if any.
13.3.6 Type of water used for testing: distilled or ~~distilled and demineralized.~~Type IV.
~~13.2.4 Type of crumb tested: natural or remolded.~~
13.3.7 ~~Water content of the sample prior to specimen preparation: natural, air-dried, or water content determined in accordance with Test Method~~ Initial temperature of the water.~~D2216.~~
13.3.8 ~~Curing time, if applicable.~~Start time of the test (hh:mm:ss).
13.3.9 ~~Name of operator performing the test method and date test started.~~Grade number, temperature, and time readings.
13.3.10 Dispersive classification of the test ~~method~~specimen(s) as: nondispersive, intermediate, dispersive, or highly dispersive.