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An American National Standard

Standard Test Method for Capillary-Moisture Relationships for Fine-Textured Soils by Pressure-Membrane Apparatus[1]

This standard is issued under the fixed designation D 3152; 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 capillary-moisture properties of fine-textured soils as indicated by the moisture content - moisture tension relationships determined by pressure-membrane apparatus using tensions between 1 and 15 atm (101 and 1520 kPa). Moisture tension (matrix suction) is defined as the equivalent negative gage pressure, or suction, in soil moisture. The test result is a moisture content which is a measure of the water retained in the soil subjected to a given soil - water tension (or at an approximately equivalent height above the water table).

NOTE 1—For determination of capillary-moisture relationships of coarse- and medium-textured soils, refer to Test Method D 2325.

1.2 *This standard does not purport to address all of the safety problems, 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:*

D 421 Practice for Dry Preparation of Soil Samples for Particle-Size Analysis and Determination of Soil Constants[2]

D 698 Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft–lbf/ft^3(600 kN–m/m^3))[2]

D 2325 Test Method for Capillary-Moisture Relationships for Coarse- and Medium-Textured Soils by Porous-Plate Apparatus[2]

3. Summary of Test Method

3.1 Saturated soil samples are placed in contact with a saturated porous membrane resting on a screen disk installed within a high-pressure chamber. The bottom of the membrane-screen assembly is maintained at atmospheric pressure by means of a small drain tube or opening through the bottom of the pressure chamber. A desired air pressure admitted to the pressure chamber, and consequently to the top of the membrane, creates a pressure drop across the membrane. The saturated soil samples on the membrane establish equilibrium with the water in the membrane. The water, held at a tension less than the pressure drop across the membrane, will then move out of the soil, through the membrane, and out through the drain hose. When water has ceased to flow from the sample and the membrane, indicating equilibrium for that particular tension, the moisture content of each sample is determined. A series of these tests at various tensions is required to prepare a complete curve of the capillary-moisture properties for any particular soil.[3]

4. Apparatus (see Fig. 1)

4.1 *Pressure-Membrane Chamber*—A pressure chamber consisting of a space ring about 305 mm (12 in.) in diameter and about 13 mm (½ in.), 51 mm (2 in.), or 102 mm (4 in.) high, with heavy top and bottom steel plates 482 MPa (70 000 psi) tensile strength; the top and bottom plates shall be held tightly against O-ring gaskets on the spacer ring by heavy-duty ⅝-in. bolts. A rubber diaphragm 1.6 mm (1⁄16 in.) thick shall be cemented to the top plate.

NOTE 2—This equipment is available from several commercial firms.

NOTE 3—Chamber should have safe pressure strength of 2.07 MPa (300 psi). The test should be made in a constant-temperature room or cabinet, maintained at a temperature of 20°C (68°F), with a relative humidity of at least 50 %.

4.2 *Pressure Source*—Compressed air or nitrogen in cylinders, or a high-pressure compressor. Nitrogen should be used if solutions extracted are to be analyzed chemically.

4.3 *Pressure Manifold*—A U-tube containing 266 g of mercury, used to maintain a pressure differential of about 28 ± 7 kPa (4 ± 1 psi). (See flow diagram and photograph in Fig. 1.).

4.4 *Cellulose Membrane*—Cellulose sausage case, usually seamless tubing about 6 m (20 ft) long and about 152 mm (6 in.) wide.

4.5 *Sample Retainer Rings*—Rigid plastic rings 10.2 mm (0.4 in.) in height and of 50.8 mm (2 in.) inside diameter, with a wall thickness of approximately 3.0 mm (0.12 in.), capable of holding approximately 25 g of disturbed sample. Similar rings

[1] This test method is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.04 on Hydrologic Properties of Soil and Rock.

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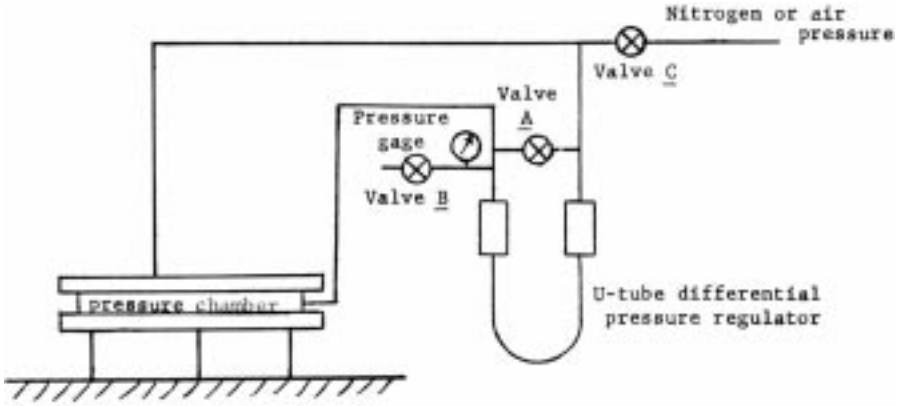
[2] *Annual Book of ASTM Standards*, Vol 04.08.

[3] This test method is modified from Richards, L. A., 1947, Pressure-Membrane Apparatus—Construction and Use: *Agricultural Engineering*, Vol 28, pp. 451–454.



Flow diagram

FIG. 1 Suggested Pressure-Membrane Apparatus

of other materials also may be used or undisturbed samples may be retained in sections of their sampler liners. The rings are numbered in pairs; for example, A1, A′1, A2, A′2, etc.

4.6 *Test Specimen Cutter*—A cylindrical ring with a sharp cutting edge beveled on the outer edge of one end. The inside diameter shall be 51 mm (2 in.) and the height shall be 25 mm (about 1 in.). A metal blank 51 mm (2 in.) in diameterand 13 mm (about ½ in.) thick, with a detachable handle, shall be available.

4.7 *Spatula*, short, wide blade (or small pancake turner), for removing samples from pressure plates.

4.8 *Test Specimen Packer Disk*—A flat steel disk 49.0 mm (1.93 in.) in diameter and 3.2 mm (⅛ in.) thick that can be loaded to 9000 g.

NOTE 4—A pocket-type penetrometer has been found convenient for loading the disk.

4.9 *Surcharge Weights*—Brass disks, 49.0 mm (1.93 in.) in diameter and 17.7 mm (0.7 in.) in diameter.

4.10 *Torque Wrench*, capable of exerting a torque of at least 6.8 N·m (5 lbf·ft) on apparatus bolts.

4.11 *Moisture Sample Containers*, of 60 to 90-mL (2 to 3-oz) capacity, made of material resistant to corrosion, and not subject to change in weight or disintegration on repeated