Designation: D 4511 – 92 (Reapproved 1996)

Standard Test Method for Hydraulic Conductivity of Essentially Saturated Peat (Constant Head)[1]

This standard is issued under the fixed designation D 4511; 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 the hydraulic conductivity (permeability) of essentially saturated, intact cylindrical specimens of peat when the hydraulic conductivity is greater than 1×10^{-5} cm/s. During the test, the specimens are contained in the core holder, or in right, regular cylindrical sections cut from the sampling tube in which they were originally obtained in the field.

1.2 Hydraulic conductivity is calculated on the basis of the measured constant flow rate through the specimen under constant head.[2] For verification, flow rate determinations may be made at two or more values of constant head with corresponding calculations of hydraulic conductivity.

1.3 The values stated in SI units are to be regarded as the standard.

1.4 *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:*

D 653 Terminology Relating to Soil, Rock, and Contained Fluids[3]
D 1587 Practice for Thin-Walled Tube Sampling of Soils[3]
D 2434 Test Method for Permeability of Granular Soils (Constant Head)[3]
D 2974 Test Methods for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils[3]
D 4220 Practices for Preserving and Transporting Soil Samples[3]

2.2 *NRC Document:*

Peat Testing Manual[4]

3. Terminology

3.1 *Definitions*—The definitions used in this test method shall be in accordance with Terminology D 653.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *deaerated (de-aired) water*—water in which the amount of dissolved gas (air) has been reduced.

3.2.2 *flow rate*—the quantity of water flowing through the test specimen in a given period of time, when subjected to a certain constant head differential.

3.2.3 *soaking*—placement of a specimen in water for the purpose of removing gas contained in the pore space, through bouyancy, and replacement with water to cause saturation of the specimen. This method of saturation does not effectively remove all the gas contained in the specimen and does not prevent the continuous slow formation of gas from decomposition under anaerobic conditions.

4. Significance and Use

4.1 Values of hydraulic conductivity determined by this test method may be useful in making rough preliminary estimates of the initial rates of drainage and compression of peat deposits when the only effective stress increase on the deposit is that resulting from a moderate, gradual lowering of the water table.

4.2 Even under light, sustained loads, peat will undergo dramatic volume changes which will influence (decrease) the hydraulic conductivity of the deposit by several orders of magnitude. This test method does not offer provisions for the determination of the relationship between hydraulic conductivity and the void ratios corresponding to increasing stress levels. Therefore, this test method is not suitable for applications involving grade increases, such as embankment construction or placement of access berms alongside drainage ditches.

5. Interferences

5.1 Due to the generally fibrous texture and extremely high compressibility of peat, present sampling technologies may not be able to obtain samples truly representative of the in situ conditions. It should therefore be recognized that disturbance caused during sampling and subsequent specimen preparation, together with natural variations in material composition, may result in differences in the measured hydraulic conductivity of the specimens by several orders of magnitude.

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[1] This test method is under the jurisdiction of ASTM Committee D-18 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] For further information, see "Methods for Measurement of Saturated Hydraulic Conductivity," *Peat Testing Manual*, Technical Memorandum No. 125, NRC Canada, pp. 80–84.

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

[4] Available from National Research Council of Canada, Publications Section, Building R-88, Ottawa, Ontario, Canada K1A 0R6.

5.2 There are no provisions in this test method for verification of compliance with the fundamental test conditions listed in 6.1.1 and 6.1.2. The assumption is made that these conditions are satisfied if the flow rate, with time, is a linear relationship.

5.3 The result of the test may be influenced by flow through open passages between the specimen and the rigid wall of the specimen container. If such a condition is suspected or visually verified, notice thereof should be made in the test report.

6. Fundamental Test Conditions

6.1 The following ideal test conditions are prerequisite for laminar flow of water through porous media under constant-head conditions:

6.1.1 Continuity of flow with no volume change during a test,

6.1.2 Flow with the void space saturated with water and no air bubbles in the voids,

6.1.3 Flow in the steady state with no changes in hydraulic gradient, and

6.1.4 Direct proportionality of flow velocity with hydraulic gradients below certain values, after which flow becomes turbulent.

6.2 All other types of flow involving partial saturation of void space, turbulent flow, and unsteady state of flow are transient in character and yield variable and time-dependent values of hydraulic conductivity; therefore, they require special test conditions and procedures.

7. Apparatus

7.1 *Flow Device*—The flow device shall be as shown in Fig. 1, fitted with the following components:

7.1.1 *Constant-Head Filter Tank*, as shown in Fig. 1 of Test Method D 2434, to supply water and to remove most of the air from the water. The tank shall be fitted with a suitable siphon.

NOTE 1—Alternatively, deaerated water may be used, supplied from a self-siphoning burette with attached inverted flask (minimum 750-mL capacity), filled with deaerated water, and closed with a rubber stopper holding a tube, 15 cm (6 in.) long with the end cut diagonally.

7.1.2 *Upper Reservoir*, of the same diameter as the sampling cylinder and approximately 15 cm (6 in.) high.

7.1.3 *Wire-Screen Support*, fabricated from a ring clamp, with an inside diameter greater than the specimen cylinder and covered with 425-µm (No. 40) wire mesh screening.

7.1.4 *Circular Disk*, cut from 425-µm (No. 40) wire mesh screening, with a diameter 0.1 cm smaller than that of the specimen.

7.1.5 *Funnel*, with a head diameter at least 10 % larger than that of the specimen cylinder.

7.1.6 *Two 400-mL Beakers*.

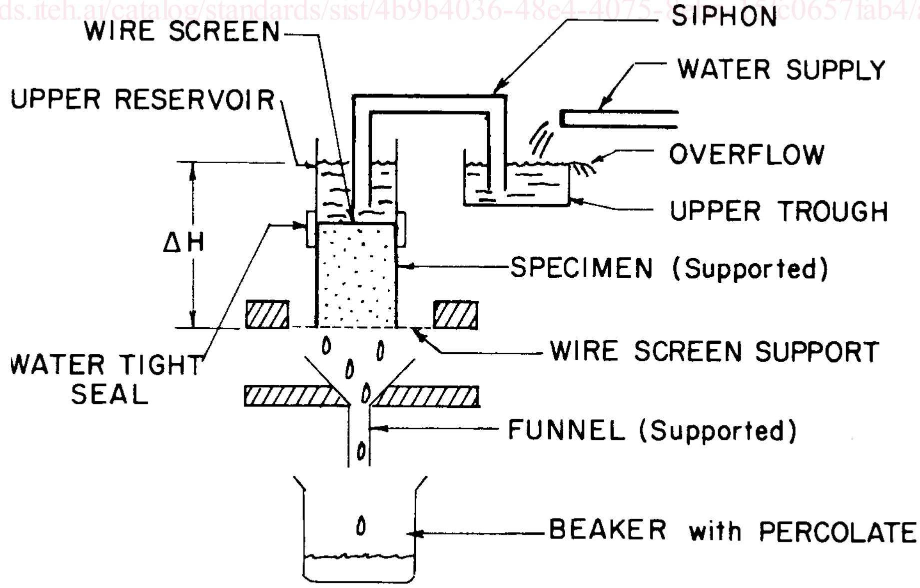
7.2 *Balances*, having a precision (repeatability) of ±0.01 g for weighing involving a mass of 200 g or less, ±0.1 g for weighings of a mass between 200 and 1000 g, or ±1 g for a mass greater than 1000 g.

7.3 *Miscellaneous Apparatus and Materials*, such as thermometers, clock with sweep second hand, soaking pan, pipe cutters, trimming knife, cheese cloth, rubber bands, vinyl electrical tape, and micro-crystalline wax.

8. Specimen Preparation

8.1 Specimens shall have a minimum diameter of 7.3 cm (2.87 in.). The height-to-diameter ratio shall be between 1 and 2.

8.2 Prepare specimens from tube samples secured in accordance with Practice D 1587, or other acceptable undisturbed sampling procedure, yielding cylindrical samples obtained in tight-fitting, rigid-metal core holders (Note 2). Preserve and



ΔH = TOTAL HYDRAULIC HEAD DIFFERENCE ACROSS SPECIMEN.

FIG. 1 Diagram for the Constant-Head System for Conductivity Measurement