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Standard Test Methods for Measurement of Hydraulic Conductivity of Unsaturated Soils[1]

This standard is issued under the fixed designation D7664; 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.

ε^1 NOTE—Reapproval with changes editorially added in October 2018.

1. Scope

1.1 These test methods cover the quantitative measurement of data points suitable for defining the hydraulic conductivity functions (HCF) of unsaturated soils. The HCF is defined as either the relationship between hydraulic conductivity and matric suction or that between hydraulic conductivity and volumetric water content, gravimetric water content, or the degree of saturation. Darcy's law provides the basis for measurement of points on the HCF, in which the hydraulic conductivity of a soil specimen is equal to the coefficient of proportionality between the flow rate of water through the specimen and the hydraulic gradient across the specimen. To define a point on the HCF, a hydraulic gradient is applied across a soil specimen, the corresponding transient or steady-state water flow rate is measured (or vice versa), and the hydraulic conductivity calculated using Darcy's law is paired with independent measurements of matric suction or volumetric water content in the soil specimen.

1.2 These test methods describe a family of test methods that can be used to define points on the HCF for different types of soils. Unfortunately, there is no single test that can be applied to all soils to measure the HCF due to testing times and the need for stress control. It is the responsibility of the requestor of a test to select the method that is most suitable for a given soil type. Guidance is provided in the significance and use section of these test methods.

1.3 Similar to the Soil Water Retention Curve (SWRC), defined as the relationship between volumetric water content and matric suction, the HCF may not be a unique function. Both the SWRC and HCF may follow different paths whether the unsaturated soil is being wetted or dried. A test method should be selected which replicates the flow process occurring in the field.

1.4 These test methods describe three categories of methods (Categories A through C) for direct measurement of the HCF. Category A (column tests) involves methods used to define the HCF using measured one-dimensional profiles of volumetric water content or suction with height in a column of soil compacted into a rigid wall permeameter during imposed transient and steady-state water flow processes. Different means of imposing water flow processes are described in separate methods within Category A. Category B (axis translation tests) involves methods used to define the HCF using outflow measurements from a soil specimen underlain by a saturated high-air entry porous disc in a permeameter during imposed transient water flow processes. The uses of rigid-wall or flexible-wall permeameters are described in separate methods within Category B. Category C (centrifuge permeameter test) includes a method to define the HCF using measured volumetric water content or suction profiles in a column of soil confined in a centrifuge permeameter during imposed steady-state water flow processes. The methods in this standard can be used to measure hydraulic conductivity values ranging from the saturated hydraulic conductivity of the soil to approximately 10^{-11} m/s.

1.5 The methods of data analysis described in these test methods involve measurement of the water flow rate and hydraulic gradient, and calculation of the hydraulic conductivity using Darcy's law (direct methods) (**1**).[2] Alternatively, inverse methods may also be used to define the HCF (**2**). These employ an iterative, regression-based approach to estimate the hydraulic conductivity that a soil specimen would need to have given a measured water flow response. However, as they require specialized engineering analyses, they are excluded from the scope of these test methods.

1.6 These test methods apply to soils that do not change significantly in volume during changes in volumetric water content or suction, or both (that is, expansive clays or collapsing soils). This implies that these methods should be used for sands, silts, and clays of low plasticity.

[1] These test methods are under the jurisdiction of ASTM Committee D18 on Soil and Rock and are the direct responsibility of Subcommittee D18.04 on Hydrologic Properties and Hydraulic Barriers.

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[2] The boldface numbers in parentheses refer to the list of references at the end of this standard.

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