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Soil quality — Determination of hydraulic conductivity of saturated porous materials using a rigid-wall permeameter

Qualité du sol — Détermination de la conductivité hydraulique de matériaux poreux saturés à l'aide d'un perméamètre à paroi rigide

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 17312 was prepared by Technical Committee ISO/TC 190, *Soil quality*, Subcommittee SC 5, *Physical methods*.

Introduction

The rate of water flow through the soil is of considerable importance in many aspects of agricultural and urban life. The entry of water into soil, the movement of water to plant roots, the flow of water to drains and wells, and the evaporation of water from the soil surface are but a few of the obvious situations in which the rate of water flow plays an important role. Also, in cases of soil pollution and polluted groundwater, prediction of the rate of movement of soil water is of great importance to obtain knowledge about the spreading of pollutants.

The soil properties that determine the behaviour of soil water flow systems are the hydraulic conductivity and water-retention characteristics. The hydraulic conductivity of soil is a measure of its ability to transmit water. The water-retention characteristics are an expression of its ability to store water. These properties determine the response of a soil/water system to imposed boundary conditions.

Soil quality — Determination of hydraulic conductivity of saturated porous materials using a rigid-wall permeameter

WARNING — This International 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 International Standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

1 Scope

This International Standard specifies the determination of the hydraulic conductivity of granular soils (e.g. sand and gravel) using a constant-head method involving a rigid-wall permeameter to measure the laminar flow of water. The procedure establishes representative values of the hydraulic conductivity of granular soils that can occur in natural deposits as placed in embankments, or when used as base courses under pavements.

In order to limit consolidation influences during testing, this procedure is applicable only to disturbed granular soils containing not more than 10 % soil passing a 75-µm sieve.

This procedure is applicable to the measurement of hydraulic conductivity of compacted samples of sands and gravels containing little or no silt, where flow along the rigid wall of the permeameter has no practical implications on the test results. This International Standard is not applicable to silt and clay, where seepage/flow at the boundaries is not acceptable.

2 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

2.1
compaction
densification of a soil by means of mechanical manipulation

2.2
dry bulk density
ρ_d
mass per volume of dry soil

NOTE It is expressed in kilograms per cubic metre (kg/m^3).

2.3
hydraulic conductivity
k
rate of discharge of water under laminar flow conditions through a unit cross-sectional area of a porous medium under a unit hydraulic gradient and standard temperature conditions (20 °C)

2.4
hydraulic gradient
change in total hydraulic head of water per unit distance of flow

2.5
pore volume of flow
cumulative quantity (volume) of flow into a test specimen divided by the volume of voids in the specimen

2.6
vacuum
negative pressure
degree of rarefaction below atmospheric pressure

3 Fundamental test conditions

The following ideal test conditions are prerequisites for the laminar flow of water through granular soils under constant-head conditions:

— continuity of flow with no soil volume change during a test;

— flow with the soil voids saturated with water and no air bubbles in the soil voids;

— flow in steady state with no changes in hydraulic gradient; and

— direct proportionality of flow velocity to hydraulic gradients below certain values (see Figure 3), at which turbulent flow starts.

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

4 Apparatus

4.1 Permeameters (see Figure 1)**,** having specimen cylinders with minimum diameters approximately 8 or 12 times the maximum particle size in accordance with Table 1.

The permeameter should be fitted with:

a) a porous disk or suitable reinforced screen at the bottom with a hydraulic conductivity greater than that of the soil specimen, but with openings sufficiently small (not larger than 10 % finer size) to prevent loss of particles;

b) manometer tube outlets for measuring the loss of head, h (= $h_1 - h_2$), over a length, l (see Figure 1), which shall be equivalent to at least the diameter of the cylinder;

c) a porous disk or suitable reinforced screen with a spring attached to the top, or any other device, for applying a light spring pressure of 22 N to 45 N total load when the top plate is attached in place. This will maintain the placement density and volume of soil without significant change during saturation of the specimen and hydraulic conductivity testing to satisfy the requirement specified in Clause 3.

4.2 Constant-head filter tank, to supply water and remove most of the air from tap water.

The tank shall be fitted with suitable control valves to maintain conditions described in Clause 3.

De-aerated water may be used if preferred.

4.3 Large funnels, fitted with special cylindrical spouts of 25 mm diameter for particles of maximum size 9,5 mm, and 13 mm diameter for particles of maximum size 2,00 mm.

The length of the funnel spout shall be greater than the full length of the hydraulic conductivity chamber, and at least 150 mm.

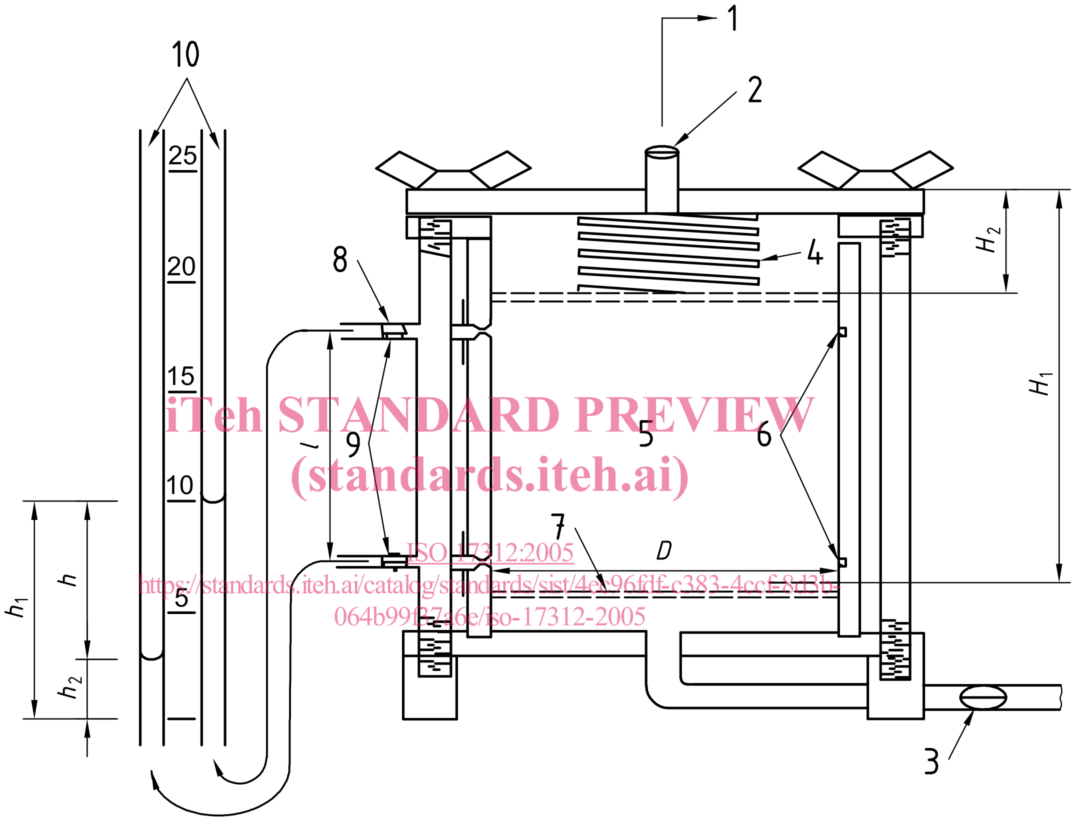
4.4 Specimen compaction equipment (optional):

a) a vibrating tamper fitted with a tamping foot 51 mm in diameter;

b) a sliding tamper with a tamping foot 51 mm in diameter,

c) a rod for sliding weights of 100 g (for sands) to 1 kg (for soils with large gravel content), having an adjustable drop height of 102 mm for sands and 203 mm for soils with large gravel content.

4.5 Vacuum pump or water-tap aspirator, for evacuating and for saturating soil specimens under full vacuum (see Figure 2).



Key

1 to constant head filter tank
2 inlet valve
3 outlet valve
4 spring
5 soil specimen
6 manometer grooves
7 porous disk
8 valve
9 manometer outlets
10 manometer tubes

h_1 Manometer reading, inlet
h_2 Manometer reading, outlet
H_1 Distance from upper surface of the top plate of the cylinder to the top of the upper porous plate temporarily placed on the lower porous plate
H_2 Distance from upper surface of the top plate of the cylinder to the top of the upper porous plate in place on top of the sample

Figure 1 — Constant-head permeameter