INTERNATIONAL STANDARD

ISO 17892-11

First edition
2019-01

Geotechnical investigation and testing — Laboratory testing of soil —

Part 11:
Permeability tests

Reconnaissance et essais géotechniques — Essais de laboratoire sur les sols —

Partie 11: Essais de perméabilité

Reference number
ISO 17892-11:2019(E)

Contents

Page

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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by the European Committee for Standardization (CEN) Technical Committee CEN/TC 341, *Geotechnical Investigation and Testing*, in collaboration with ISO Technical Committee ISO/TC 182, *Geotechnics*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This first edition cancels and replaces ISO/TS 17892-11:2004, which has been technically revised. It also incorporates the Technical Corrigendum ISO/TS 17892-11:2004/Cor 1:2006.

The main changes compared to the previous edition are as follows:

— the document has been restructured with general revision of text and figures and addition of specimen preparation procedures;

— types of apparatus have been included for rigid wall permeameters, both cylindrical and oedometer ring equipment, and flexible wall permeameters;

— permeability measurement by constant head, falling head and constant flow conditions has been included;

— normative Annex A on calibration, maintenance and checks has been added.

A list of all the parts in the ISO 17892 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

This document provides laboratory test methods for the determination of the coefficient of permeability of soils within the international field of geotechnical engineering.

The tests have not previously been standardized internationally. It is intended that this document presents broad good practice and significant differences with national documents is not anticipated. It is based on international practice (see Reference [1]).

The permeability test is carried out on a cylindrical test specimen that is either confined laterally by a rigid container or by a flexible membrane. The specimen is subjected to differential hydraulic head and the water flow is measured under either a constant or falling head. The results are used to determine the coefficient of permeability of the soil specimen. Tests can be carried out on undisturbed, remoulded, compacted or reconstituted specimens.

The calculation of the coefficient of permeability assumes the application of Darcy's law for laminar flow of water under saturated conditions.

It is possible that the size of the specimen does not adequately represent the fabric features present in field conditions.

Geotechnical investigation and testing — Laboratory testing of soil —

Part 11: Permeability tests

1 Scope

This document specifies methods for the laboratory determination of the water flow characteristics in soil.

This document is applicable to the laboratory determination of the coefficient of permeability of soil within the scope of geotechnical investigations.

NOTE This document fulfils the requirements of the determination of the coefficient of permeability of soils in the laboratory for geotechnical investigation and testing in accordance with EN 1997-1 and EN 1997-2.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 386, *Liquid-in-glass laboratory thermometers — Principles of design, construction and use*

ISO 14688-1, *Geotechnical investigation and testing — Identification and classification of soil — Part 1: Identification and description*

ISO 17892-1, *Geotechnical investigation and testing — Laboratory testing of soil — Part 1: Determination of water content*

ISO 17892-2, *Geotechnical investigation and testing — Laboratory testing of soil — Part 2: Determination of bulk density*

ISO 17892-3, *Geotechnical investigation and testing — Laboratory testing of soil — Part 3: Determination of particle density*

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

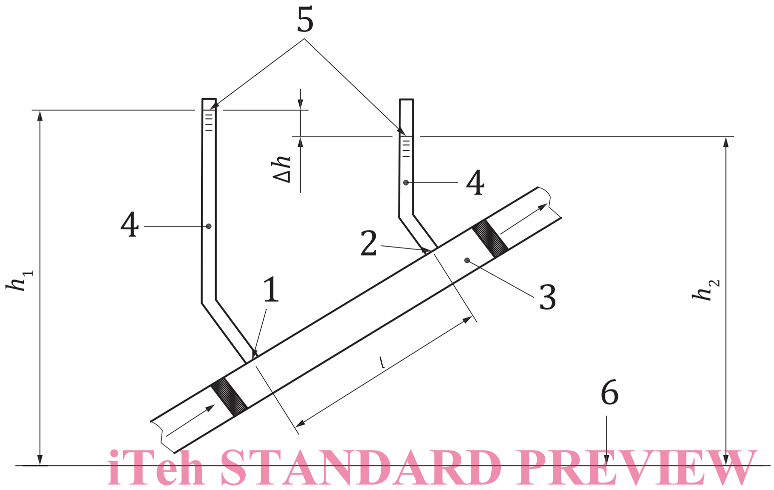
3.1
permeameter
apparatus (cell) containing the test specimen in a permeability test

3.2
flow rate
volume of water passing through a specimen per unit time

3.3
discharge velocity
rate of flow of water per unit cross-sectional area of specimen in the direction of flow

3.4
hydraulic gradient
ratio of the difference in elevation head of water (head loss) between two points, to the length of the flow path (distance between the points measured in the direction of flow)

Note 1 to entry: In Figure 1 the hydraulic gradient is $i = \Delta h/l$.



Key
1 measurement point 1
2 measurement point 2
3 specimen
4 standpipe
5 standpipe head
6 datum

Figure 1 — Water flow in a soil specimen

3.5
coefficient of permeability
ratio of the *discharge velocity* (3.3) to the *hydraulic gradient* (3.4)

Note 1 to entry: The coefficient of permeability is in accordance with Darcy's law for laminar flow.

3.6
degree of saturation
ratio of the volume of water to the volume of voids

4 Symbols

A	cross-sectional area of specimen in the direction of flow
a	cross-sectional area of standpipe
a_{in}	cross-sectional area of inlet pipe
a_{out}	cross-sectional area of outlet pipe
B	pore pressure coefficient
D	diameter of the specimen

h_1	total head of water above datum at measurement point 1
h_2	total head of water above datum at measurement point 2
Δh	difference in head of water between measurement point 1 and 2
Δh_{t1}	head of water above outlet elevation at time t_1
Δh_{t2}	head of water above outlet elevation at time t_2
l	distance between measuring points 1 and 2 in the direction of flow
k	coefficient of permeability
k_T	coefficient of permeability corrected to temperature
Q	flow rate
v	discharge velocity
i	hydraulic gradient
S	degree of saturation
$\Delta\sigma_c$	increment of cell pressure
Δt	increment of time between two readings
Δu	change in pore pressure due increment of cell pressure
α	correction factor for temperature
T	temperature

5 Apparatus

5.1 General

The equipment shall undergo regular calibration, maintenance and checks as specified in Annex A.

The permeability test arrangement requires a container for the specimen (the permeameter) which may have either rigid or flexible walls and a system for applying and measuring water pressures to either or both ends of the specimen. Schematics of some typical arrangements are shown in Figures 2 to 4.

5.2 Permeameters

5.2.1 General

The minimum internal dimension (height and diameter) of the permeameter shall be at least six times the maximum particle size of the specimen.

5.2.2 Rigid wall permeameters

5.2.2.1 General

Rigid wall permeameters shall be made of corrosion-resistant materials of sufficient rigidity to resist deformation during the test. The inlet and outlet arrangements shall be of sufficient flow capacity to not influence the test results. Hydrophobic coating can be used on the inside of the permeameter, mould or ring to prevent channels and cavities that can cause bypass seepage along the surface. This coating can consist of silicon grease, petroleum jelly coated with bentonite powder or other suitable lubricant.

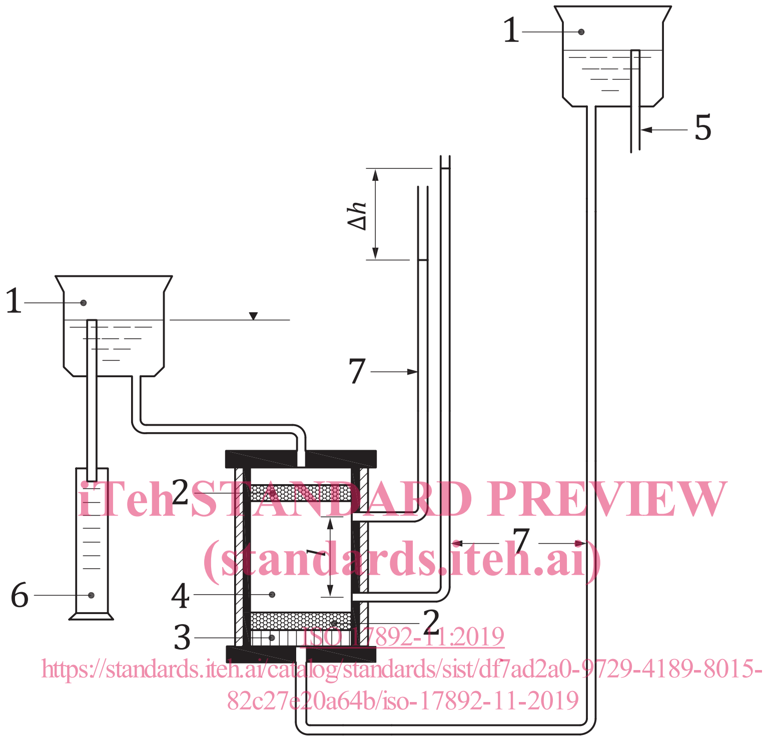
5.2.2.2 Cylindrical permeameter

A cylindrical permeameter comprises a cylindrical mould fitted with porous discs on a top-plate and baseplate. The plates are mounted with watertight seals and equipped with valves where water inlet and outlet can be connected.

Two or more fitted glands can be provided for connecting manometer tubes/standpipes along the length of the cylinder.

If required a piston that goes through the top plate and can be locked with a watertight seal at the vertical position where it is in contact with the top porous disc, should be provided to maintain the specimen height during the test.

A typical arrangement for a permeability test in a cylindrical rigid wall permeameter is shown in Figure 2.



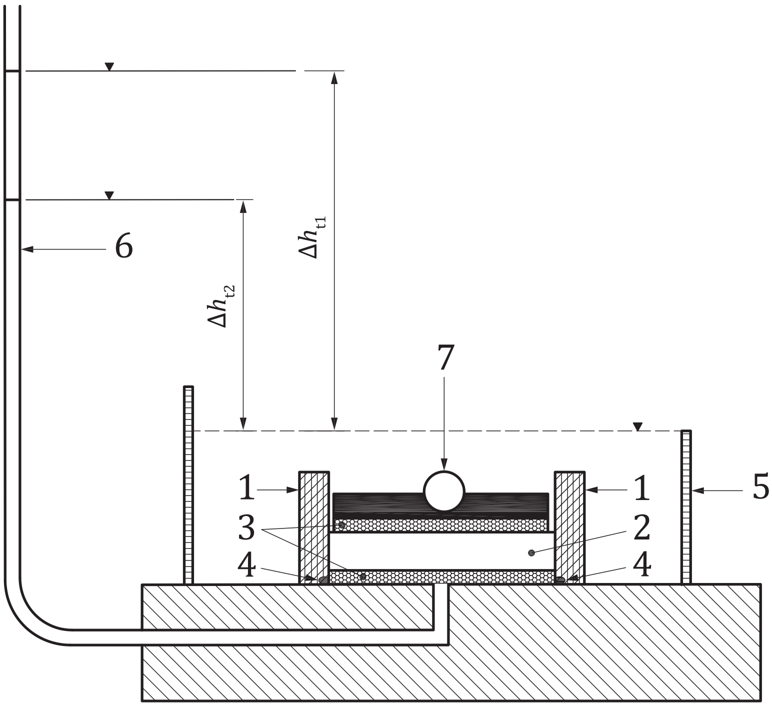
Key

1 reservoir
2 porous disc
3 perforated base plate
4 specimen
5 overflow
6 measuring cylinder
7 standpipe

Figure 2 — Example arrangement for a constant head test in a cylindrical rigid wall permeameter

5.2.2.3 Oedometer ring permeameter

An oedometer ring permeameter comprises an oedometer ring that holds the specimen in an oedometer used for compression tests. A typical arrangement for a permeability test in an oedometer ring permeameter is shown in Figure 3.



Key

1 oedometer ring
2 specimen
3 porous disc
4 water seal
5 reservoir
6 standpipe
7 vertical load and displacement measurement device

Figure 3 — Example arrangement for a falling head test in an oedometer cell permeameter

5.2.3 Flexible wall permeameter

5.2.3.1 General

A flexible wall permeameter can be used where the soil specimen is to be tested under specific effective stress conditions and/or where back pressure will be used to fully saturate the specimen. The test can be performed in a standard triaxial apparatus. It needs to have a cell that can be pressurised, a base pedestal and top cap with porous discs and connectors to the water flow measurement system and a membrane that seals the surface of the specimen.

A typical arrangement for a permeability test in a flexible wall permeameter is shown in Figure 4.

