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Geotechnical investigation and testing — Laboratory testing of soil —

Part 11: Determination of permeability by constant and falling head

Reconnaissance et essais géotechniques — Essais de sol au laboratoire —

Partie 11: Détermination de la perméabilité au perméamètre à charge constante ou variable

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ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
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ISO/TS 17892-11 was prepared by the European Committee for Standardization (CEN) in collaboration with Technical Committee ISO/TC 182, *Geotechnics*, Subcommittee SC 1, *Geotechnical investigation and testing*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

Throughout the text of this document, read "...this European pre-Standard..." to mean "...this Technical Specification...".

ISO 17892 consists of the following parts, under the general title *Geotechnical investigation and testing — Laboratory testing of soil*:

— *Part 1: Determination of water content*

— *Part 2: Determination of density of fine-grained soil*

— *Part 3: Determination of particle density — Pycnometer method*

— *Part 4: Determination of particle size distribution*

— *Part 5: Incremental loading oedometer test*

— *Part 6: Fall cone test*

— *Part 7: Unconfined compression test on fine-grained soil*

— *Part 8: Unconsolidated undrained triaxial test*

— *Part 9: Consolidated triaxial compression tests on water-saturated soil*

— *Part 10: Direct shear tests*

— *Part 11: Determination of permeability by constant and falling head*

— *Part 12: Determination of the Atterberg limits*

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Foreword

This document (CEN ISO/TS 17892-11:2004) has been prepared by Technical Committee CEN/TC 341 "Geotechnical investigation and testing", the secretariat of which is held by DIN, in collaboration with Technical Committee ISO/TC 182 "Geotechnics".

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to announce this Technical Specification: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

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Introduction

This document covers areas in the international field of geotechnical engineering never previously standardised. It is intended that this document presents broad good practice throughout the world and significant differences with national documents is not anticipated. It is based on international practice (see [1]).

1 Scope

This document is intended for use in earthworks and foundation engineering. It specifies laboratory test methods to establish the coefficient of permeability of water through water-saturated soils. In the proposed laboratory tests soil specimens are subjected to a flow of water passing through the specimen. The water pressure conditions and volume of water passing through the specimens are measured for evaluation of the permeability.

The results obtained serve to calculate groundwater flow and to assess the permeability of man-made impervious layers and filter layers.

2 Normative references

The following referenced document is indispensable for the application 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.

prEN 1997-2, *Eurocode 7 - Geotechnical design — Part 2: Ground investigation and testing.*

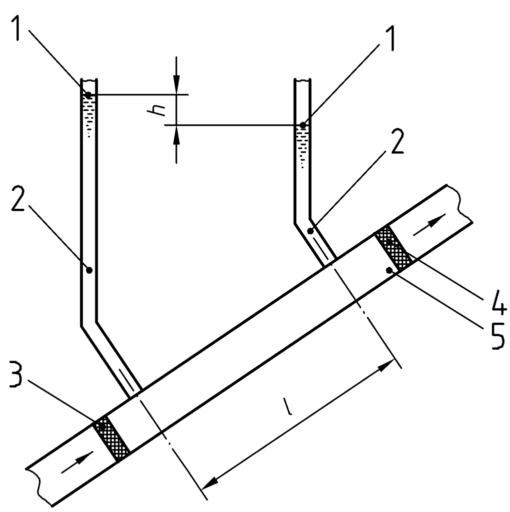
3 Terms and definitions

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

3.1
flow rate
Q
quantity of water passing through a specimen per unit time, *t*

3.2
discharge velocity
v
rate of flow of water per unit area of soil (including particles and voids) normal to the direction of flow

3.3
hydraulic gradient
i
ratio of the difference in total head of water (head loss), *h*, between two gland points, to the length of the flow path, *l* (distance between the gland points measured in the direction of flow, see Figure 1)



Key
1 Standpipe head
2 Standpipe
3 Filter block
4 Filter block
5 Specimen

Figure 1 — Water flow in a soil specimen

3.4
undisturbed sample
normally a sample of quality class 1 or at least 2 according to prEN 1997-2

3.5
coefficient of permeability
k
in accordance with Darcy's law for laminar flow, the coefficient of permeability of a water-saturated soil, k, is the ratio of the discharge velocity, v, to the hydraulic gradient, i

NOTE For partly saturated soil, the coefficient of permeability is always smaller than for fully water-saturated soil due to turbulence caused by air voids and non-function of .capillary action.

4 Test procedure

4.1 General requirements

4.1.1 Grading, particle structure and volume

Grading and particle structure shall not alter while measuring the permeability. Consolidation and swelling should substantially be completed before the measurements are done.

In clay swelling and consolidation cannot completely be avoided unless provisions are made to prevent it. Therefore, the height of the specimen should be locked or the load regulated to prevent changes in height. The height of the specimen should be recorded and any significant change in height should be accounted for, both in terms of expelled water and in change of seepage path.

4.1.2 Properties of water

The water used for testing shall not wash out constituents of the specimen, deposit any dissolved or suspended matter in it or alterthe colloidal state of the soil.

As far as possible, water similar in type to the pore water shall be used, de-aired tap water generally being adequate. Where necessary (e.g. where marine sediments are to be tested), the water shall be treated or obtained from a given source so that the natural conditions can be reliably reproduced.

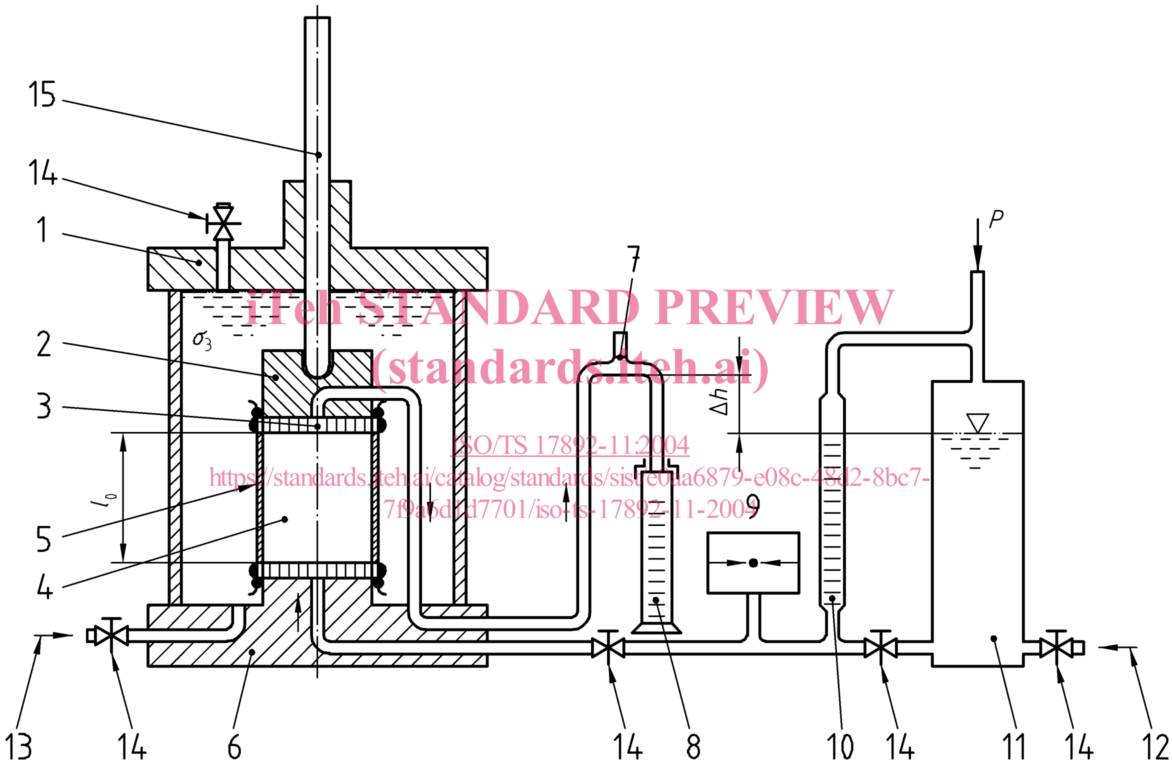
4.1.3 Degree of saturation

4.1.3.1 The specimen shall remain saturated during the measurement of the permeability.

4.1.3.2 Saturation of the specimen can be achieved by applying a back pressure u_0 (as specified in Table 1), which is produced by subjecting the pore water in the specimen to a hydrostatic pressure which shall be maintained throughout the test. This may be accomplished using the test arrangement shown in Figure 2.

Table 1 — Back pressure as function of initial saturation

Initial saturation S_r %	Back pressure u_0 kN/m^2
100	0
95	300
90	600
85	900



Key

1 Top plate

2 Cell top with spiral groove

3 Filter block with k greater than or equal to ten times that of the specimen

4 Specimen

5 Rubber membrane with O-rings

6 Pedestal

7 Glass tube with vent opening less than 1 mm in diameter

8 Graduated glass cylinder or volume change sensor

9 Pressure gauge

10 Burette to determine the quantity of inflowing water

11 Vessel containing pressurized de-aired water

12 Supply of de-aired water

13 Inlet for cell water and cell pressure, σ_3

14 Valve

15 Piston for applying anisotropic load to the specimen

l_0 Specimen height (= length of seepage path)

p Pressure to produce hydraulic gradient

In tests with back pressure, the pressure in the vent opening (7) should be raised to correspond to the back-pressure u_0 and the pressure p raised to $p + u_0$.

Figure 2 — Example for test arrangement for triaxial cell test