SIST

SLOVENSKI STANDARD
SIST-TS CEN ISO/TS 17892-11:2004

01-december-2004

Geotehniļ no preiskovanje in preskuģanje ï Laboratorijsko preskuģanje zemljin ï 11. del: Ugotavljanje prepustnosti s konstantnim in spremenljivim hidravliļ nim padcem (ISO/TS 17892-11:2004)

Geotechnical investigation and testing - Laboratory testing of soil - Part 11: Determination of permeability by constant and falling head (ISO/TS 17892-11:2004)

Geotechnische Erkundung und Untersuchung - Laborversuche an Bodenproben - Teil 11: Bestimmung der Durchlässigkeit mit konstanter und fallender Druckhöhe (ISO/TS 17892-11:2004)

Reconnaissance et essais géotechniques - Essais de laboratoire sur les sols - Partie 11: Détermination de perméabilité a charge constante et a charge variable décroissante (ISO/TS 17892-11:2004)

Ta slovenski standard je istoveten z: CEN ISO/TS 17892-11:2004

ICS:

13.080.20	Fizikalne lastnosti tal	Physical properties of soils
93.020	Zemeljska dela. Izkopavanja. Gradnja temeljev. Dela pod zemljo	Earthworks. Excavations. Foundation construction. Underground works

SIST-TS CEN ISO/TS 17892-11:2004 en

TECHNICAL SPECIFICATION

SPÉCIFICATION TECHNIQUE

TECHNISCHE SPEZIFIKATION

CEN ISO/TS 17892-11

October 2004

ICS 13.080.20; 93.020

English version

Geotechnical investigation and testing - Laboratory testing of soil - Part 11: Determination of permeability by constant and falling head (ISO/TS 17892-11:2004)

Reconnaissance et essais géotechniques - Essais de sol au laboratoire - Partie 11: Détermination de la perméabilité au perméamètre à charge constante ou variable (ISO/TS 17892-11:2004)

Geotechnische Erkundung und Untersuchung - Laborversuche an Bodenproben - Teil 11: Bestimmung der Durchlässigkeit mit konstanter und fallender Druckhöhe (ISO/TS 17892-11:2004)

This Technical Specification (CEN/TS) was approved by CEN on 2 December 2003 for provisional application.

The period of validity of this CEN/TS is limited initially to three years. After two years the members of CEN will be requested to submit their comments, particularly on the question whether the CEN/TS can be converted into a European Standard.

CEN members are required to announce the existence of this CEN/TS in the same way as for an EN and to make the CEN/TS available promptly at national level in an appropriate form. It is permissible to keep conflicting national standards in force (in parallel to the CEN/TS) until the final decision about the possible conversion of the CEN/TS into an EN is reached.

CEN members are the national standards bodies of 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.

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Management Centre: rue de Stassart, 36 B-1050 Brussels

Ref. No. CEN ISO/TS 17892-11:2004: E

Contents

Page

Figures

Tables

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.

CEN ISO/TS 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 grain soils

— Part 8: Unconsolidated undrained triaxial test

— Part 9: Consolidated triaxial compression tests on water saturated soils

— Part 10: Direct shear tests

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

— Part 12: Determination of the Atterberg limits

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.*

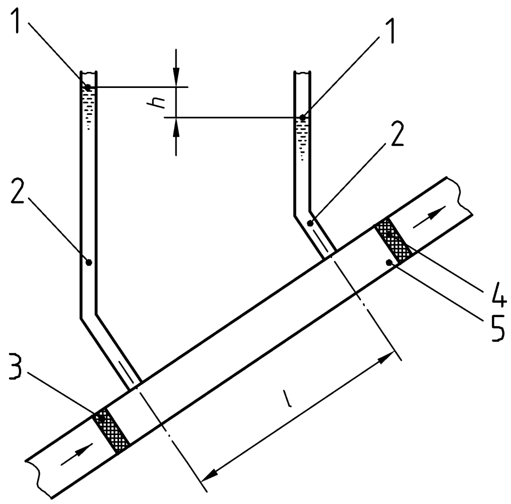
3 Terms and definitions

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.

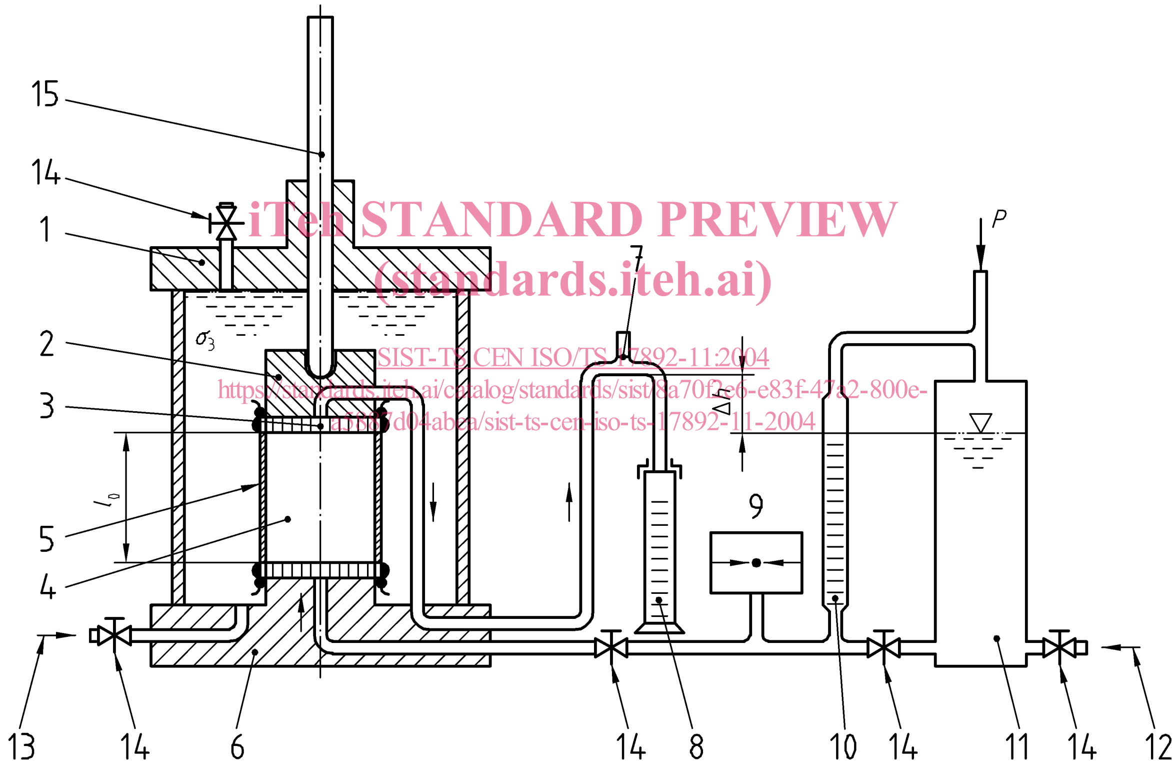
4.1.3 Degree of saturation

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

At full saturation, the quantities of water entering and leaving a specimen shall be equal, with constant pressure and constant hydraulic gradient being assumed.

Disturbed specimens are normally not fully saturated with water, the same applying to specimens in which the pore water pressure dropped as the specimen was taken, thus releasing dissolved gas. Air dissolved in the water passing through the specimen may be retained in the specimen and thus reduce the latter's permeability.

There are also other methods to saturate specimens. It can be done e.g. by flushing the specimen with water or by replacing the air in the dry specimen by CO_2 before filling the specimen with water. Bubbles of CO_2 can more easily be solved in water.

4.1.4 Hydraulic gradient

For testing purposes, the hydraulic gradient may be selected to satisfy practical considerations as long as the flow characteristics given by the gradient complies with Darcy's law. In case of doubt whether the test conditions comply with Darcy's law the hydraulic gradient has to be varied to check it. Where the flow is not linear, the hydraulic gradient in the laboratory shall approximate that in the field.

NOTE The flow behaviour of coarse-grained soil deviates from laminar flow as described by Darcy's law, if the hydraulic gradient exceeds a certain level, i.e. the discharge velocity increases non-linearly with increasing hydraulic gradient due to the influence of inertial forces. For fine-grained soil the discharge velocity decreases non-linearly with decreasing hydraulic gradient when passing a certain lower level.

4.1.5 Temperature

4.1.5.1 Testing shall be carried out at approximately constant ambient temperature (± 2 °C), with which the temperature of the specimen and water shall be in equilibrium. The temperature shall be measured and recorded.

4.1.5.2 To obtain reproducible results, the value of k as determined in the test shall be converted to a reference temperature of 10 °C using the following empirical equation (1) from Poiseuille:

$$k_{10} = \alpha \times k_{\mathrm{T}} \tag{1}$$

$$\alpha = \frac{1{,}359}{1 + 0{,}0337 \times T + 0{,}00022 \times T^2} \tag{2}$$

where

T is the water temperature (°C) throughout the test;

k_{T} is the coefficient of permeability at ambient temperature (m/s);

α is a correction factor, to be calculated or taken from Table 2. For intermediate values linear interpolation is allowed.

A reference temperature of 10 °C equals the average temperature of groundwater. A different temperature may be used where required.

Table 2 — Correction factor α to allow for the viscosity of water

Temperature T [°C]	5	10	15	20	25
Correction factor α [–]	1,158	1,000	0,874	0,771	0,686

4.1.6 Specimen dimensions

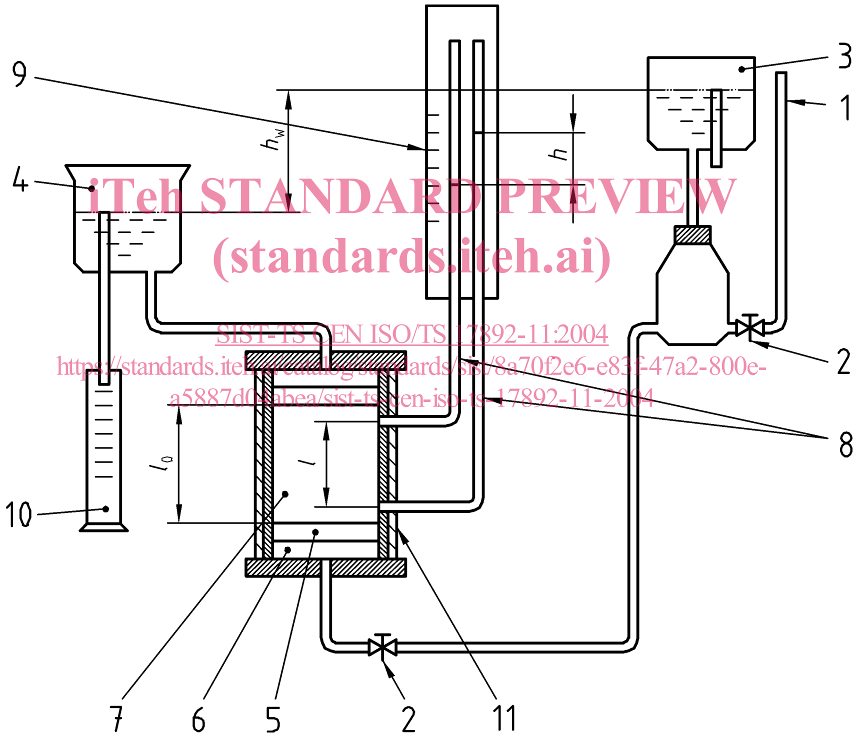
4.1.6.1 Specimen diameter and height shall be selected so as to prevent any inhomogeneities influencing the test results.

4.1.6.2 The ratio of maximum particle size to specimen diameter or length shall be not less than 1 : 5 for non-uniform and 1 : 10 for uniform soils.

4.1.6.3 For cohesive (fine-grained) soil, the cross-sectional area of the specimen A shall be not less than 1000 mm^2 and for coarse-grained soil, not less than 2000 mm^2, unless the test equipment requires the use of larger specimens (see 4.4.4).

4.1.7 Measurement of standpipe heads

4.1.7.1 For permeable to highly permeable soil specimens, the difference in head shall not be measured between the specimen ends but only across the length of that part of the specimen through which the water is flowing (see Figure 3), in order to prevent any loss of head and to prevent the result being affected by interference effects at the specimen ends.



Key

1 Inlet for de-aired water
2 Pinch cock or ball valve
3 Inlet reservoir
4 Outlet reservoir
5 Filter
6 Perforated plate with wire gauze
7 Specimen
8 Piezometric tubes
9 Graduated scale
10 Graduated cylinder
11 Cell
h Difference in piezometric heads
h_w Difference in head in inlet and outlet reservoirs
l Length of seepage path
l_0 Specimen height

Figure 3 — Example for a test arrangement for constant head permeameter test

4.1.7.2 Standpipes (piezometric tubes) shall have an internal diameter of 3 mm to 4 mm and be located at a minimum of 15 mm from the top and bottom ends of the specimen. The end of the tube entering the specimen shall be protected by a wire gauze against blockage. In the case of soil with low permeability, the loss of head between