INTERNATIONAL STANDARD

ISO 22282-5

First edition
2012-06-01

Geotechnical investigation and testing — Geohydraulic testing —

Part 5: Infiltrometer tests

Reconnaissance et essais géotechniques — Essais géohydrauliques — Partie 5: Essais d'infiltromètres

Reference number
ISO 22282-5:2012(E)

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 22282-5 was prepared by the European Committee for Standardization (CEN) Technical Committee CEN/TC 341, *Geotechnical investigation and testing*, 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).

ISO 22282 consists of the following parts, under the general title *Geotechnical investigation and testing — Geohydraulic testing*:

— *Part 1: General rules*

— *Part 2: Water permeability tests in a borehole using open systems*

— *Part 3: Water pressure tests in rock*

— *Part 4: Pumping tests*

— *Part 5: Infiltrometer tests*

— *Part 6: Water permeability tests in a borehole using closed systems*

Copyrighted material licensed to Dublin Institute of Technology by SAI Global (www.saiglobal.com), downloaded on 12 Jul 12 by Ann McSweeney.
No further reproduction or distribution is permitted. Uncontrolled when printed.

Copyrighted material licensed to Dublin Institute of Technology by SAI Global (www.saiglobal.com), downloaded on 12 Jul 12 by Ann McSweeney.
No further reproduction or distribution is permitted. Uncontrolled when printed.

Geotechnical investigation and testing — Geohydraulic testing —

Part 5: Infiltrometer tests

1 Scope

This part of ISO 22282 establishes requirements for ground investigations by means of infiltrometer tests as part of geotechnical investigation services in accordance with EN 1997-1 and EN 1997-2.

It applies to the *in situ* determination of the water permeability of an existing geological formation or of treated or compacted materials.

The infiltrometer test is used to determine the infiltration capacity of the ground at the surface or shallow depth. It is a simple test for determining the permeability coefficient. The method can be applied using either steady-state or transient conditions, in saturated or unsaturated soils.

The principle of the test is based on the measurement of a surface vertical flow rate of water which infiltrates the soil under the influence of a positive hydraulic head.

Surface infiltration devices include single and double-ring infiltrometer designs of the open or closed type.

The measurement devices and measurement procedures are adapted to different ranges of permeability. Open systems are adapted to permeability ranges from 10^{-5} to 10^{-8} m/s and closed systems for permeability lower than 10^{-8}.

Depending on the environmental conditions and the water permeability of the soil, a duration of a few minutes to a few days is needed to run the test.

This part of ISO 22282 defines the terminology and the measured parameters. It specifies the required characteristics of the equipment, defines the procedures of the tests relating to the different measurement techniques and specifies the tests results.

It is applicable to:

— civil engineering projects;

— hydrogeology studies; and

— waste storage.

2 Normative references

The following referenced documents are 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.

ISO 22282-1, *Geotechnical investigation and testing — Geohydraulic testing — Part 1: General rules*

ISO 22475-1, *Geotechnical investigation and testing — Sampling methods and groundwater measurements — Part 1: Technical principles for execution*

3 Terms, definitions and symbols

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 22282-1 apply.

3.2 Symbols

For the purposes of this document, the symbols given in Table 1 apply.

Table 1 — Symbols

Symbol	Designation	Unit
D_1	diameter of the inner infiltrometer ring	m
D_2	diameter of the outer infiltrometer ring	m
h	hydraulic head	m
$h(t)$	hydraulic head at time t	m
k	permeability coefficient	$m \cdot s^{-1}$
t	time	s
Z_w	thickness of saturated zone	m
Z_p	penetration depth of the cell	m
v	flow rate velocity	$m \cdot s^{-1}$
V	volume	—
η_T	dynamic viscosity at temperature T	mPa·s
θ	volumetric water content	—
w	(gravimetric) water content	—
ρ_d	density of dry soil	$kg \cdot m^{-3}$
ρ_s	density of solid particles	$kg \cdot m^{-3}$
ψ_f	suction at the infiltration front	m

4 Equipment

4.1 General

The test equipment comprises:

a) a test cell for infiltrating the water into the soil;

b) a device for measuring pressure, water level and/or infiltrated volumes as a function of time. In some cases (e.g. with constant head procedure) equipment and piping connecting the pressure and volume controller to the test cell is also needed;

c) equipment for installation of the rings (pushing, anchoring, bonding and/or sealing);

d) water supply and pump (optional);

e) a time measuring and/or recording device, reading in seconds;

f) additional equipment, e.g. heat insulation device, equipment for sampling and preparing the test area.

All the equipment and measuring devices shall be periodically calibrated according ISO 22282-1.

4.2 Test cell

4.2.1 General

The test can be performed with an open system or a closed system.

4.2.2 Open system

The test cell comprises a single cylindrical ring or two coaxial cylindrical rings (see Figure 1).

In the case of the double ring, the outer diameter D_2 shall be at least twice the diameter of the inner ring D_1, with $D_1 \geq 200$ mm.

In the case of the single ring, its diameter D_1 shall be at least 200 mm.

The test device shall be designed to be pushed into the ground to a penetration depth Z_p of at least 50 mm.

The rings shall be rigid and dimensionally stable. Their lower part shall be sharpened to facilitate penetration.

4.2.3 Closed system

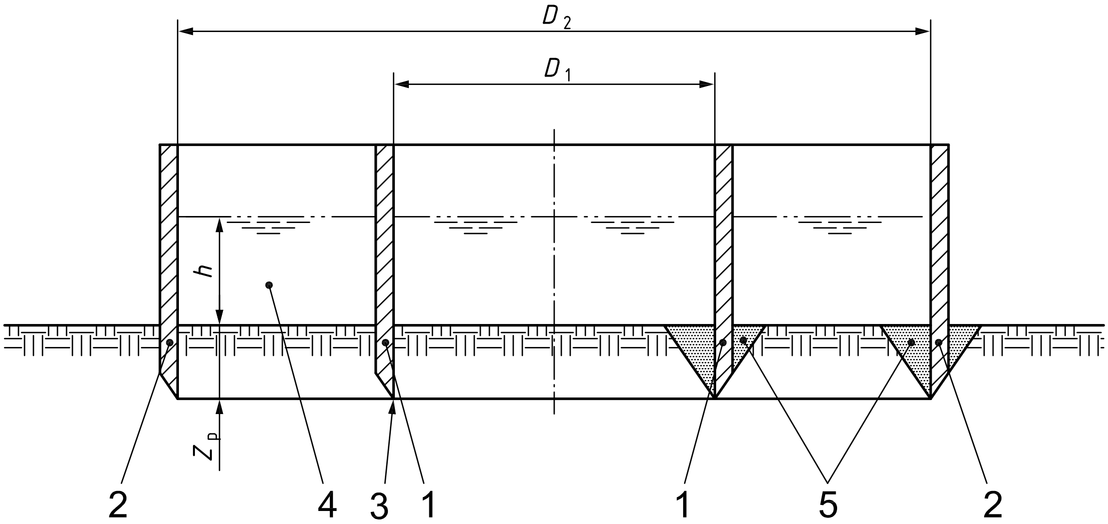
The test cell comprises a single cylindrical ring sealed by a tight rigid lid (see Figures 2 and 3). The diameter of the ring D_1 shall not be less than 200 mm.

The lid shall be equipped with drain valves and test fluid supply valves. A rigid, filtering, porous device resting on the ground and in contact with the lid (see Figure 2) should be included to confine the test area (to avoid swelling and soil alteration).

The test device shall be designed to be pushed into the ground to a penetration depth Z_p of at least 50 mm.

To prevent the displacement of the test cell due to the forces generated by the applied pressure, a dead weight system or anchoring device shall be used. The possible displacement of the test cell shall be monitored with a resolution of at least 0,01 mm.

Copyrighted material licensed to Dublin Institute of Technology by SAI Global (www.saiglobal.com), downloaded on 12 Jul 12 by Ann McSweeney.
No further reproduction or distribution is permitted. Uncontrolled when printed.



Key

1 inner ring

2 outer ring

3 sharpened edge

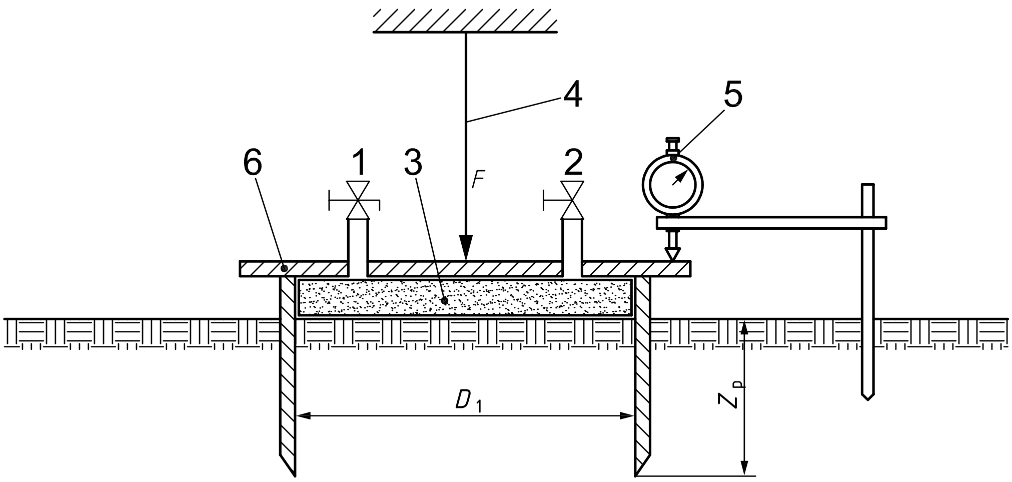
4 water volume

5 sealing material

Z_p penetration depth

See also Annex A.

Figure 1 — Cross-section of an open double ring — Example



Key

1 drain valves

2 water supply valves

3 confining device (optional)

4 confining force

5 displacement gauge

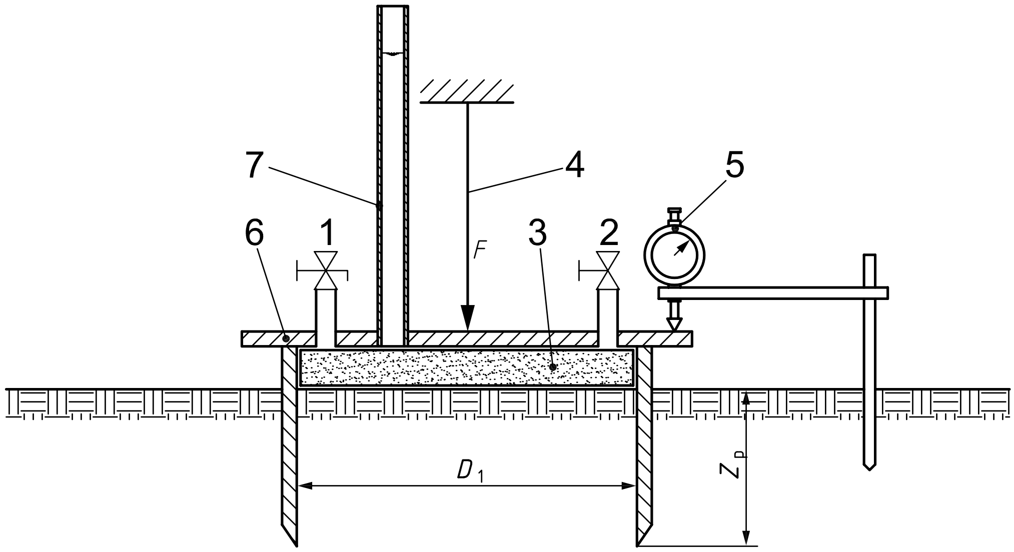
6 infiltrometer cell

F force

Z_p penetration depth

See also Annex A.

Figure 2 — Cross-section of a closed single ring (example) — Constant-head type



Key

1 drain valves

2 water supply valves

3 confining device (optional)

4 confining force

5 displacement gauge

6 infiltrometer cell

7 measuring tube

F force

Z_p penetration depth

See also Annex A.

Figure 3 — Cross-section of a closed single ring (example) — Variable-head type

4.3 Measuring system for hydrostatic pressure or infiltrated volume

4.3.1 Open system

The system for measuring the changes with time of the hydraulic head and therefore the infiltrated water volume depends on the permeability of the soil and shall have a resolution better than 1 % of the measured change.

When the double ring is used, the hydraulic head shall be the same in both rings.

4.3.2 Closed system

For the constant head procedure, a pressure-volume controller shall be used to impose and to maintain constant the hydrostatic pressure in the measurement ring. The infiltrated volume variations shall be measured with the pressure-volume controller with a resolution of at least 0,1 ml. For the variable head procedure, a pressure gauge or transducer shall be used for the measurement within the measuring tube of the hydraulic head variations with an uncertainty of 1 mm or better.

4.4 Temperature measuring device

If viscosity corrections are required, a temperature measuring device shall be used to record water temperature with a resolution of at least 0,5 °C.

4.5 Material requirements

Only clean water, free of suspended solids, shall be used.

If sealing material is required for installation of the ring, its composition shall be determined according to site conditions.

5 Test procedure

5.1 Preparation of the test surface

The test area shall be sufficiently larger than the infiltrometer to allow any leakage to be observed. This surface shall be horizontal, smooth, clean and undisturbed.

5.2 Installation of the ring or rings

The rings shall be installed such that no undesired lateral leakage occurs and the area of infiltration is clearly defined.

One of the following methods should be used:

— placing the ring in an excavated slot, which is then backfilled with sealant (see Figure 1);

— pushing the ring at least 5 cm into the ground by hammering or applying downward pressure (see Figure 2).

5.3 Conducting the test

5.3.1 General

During the test, observations shall be made to detect any lateral leakage. If lateral leakages occur, the test shall be terminated, the sealing shall be improved and a new test shall be performed.

The duration of the test depends on the permeability and the water content and degree of saturation of the soil, as well as on the applied hydraulic head.

5.3.2 Constant head procedure

The following successive operations shall be carried out:

a) installation:

   — of the temperature sensor placed in the water of the inner ring (optional);

   — of the heat insulation device above the appliance (optional);

   — of the system for application and measurement of the hydraulic head and of the infiltrated volume;

b) filling the test cell with clean water. The test cell and the connecting pipes shall be fully saturated;

c) application of the hydraulic head h of generally less than 1 m. The pressure measurement reference is the soil level;

d) measurement of the infiltrated volume.

The first step of the test is intended to ensure that the soil is saturated. The minimum duration of this saturation phase should be estimated.

The infiltrated volumes in each ring or at least in the central ring shall be measured after the saturation phase until the infiltration velocity is nearly constant.

NOTE Recommended durations of saturation phase and measuring phase are given in Annex C, as a function of permeability coefficient range.

The infiltrated volume and temperature measurements shall be carried out:

— either manually;

— or by recording by means of a data logging unit.

Each reading shall include the time elapsed since the start of the test, the value of the infiltrated volume, the temperature and the value of the applied head. These measurements should be presented graphically.

5.3.3 Variable head procedure

The following successive operations shall be carried out:

a) installation:

   — of the temperature sensor placed in the water of the inner ring (optional);

   — of the heat insulation device above the appliance (optional);

   — of the system for application and measurement of the hydraulic head and of the infiltrated volume;

b) filling the test cell with clean water. The test cell and the connecting pipes shall be fully saturated;

c) application of the hydraulic head h to a value which takes into account the water supply and the permeability of the soil. The head measurement reference is the soil level;

d) measurement of the hydraulic head and infiltrated volume.

The measurements shall start immediately after the filling of the infiltrometer.

NOTE Because hydraulic head variations are more important during the initial stages of the test, measurements are more frequent at the beginning of testing. Test duration depends on soil permeability.

5.4 Decommissioning of the infiltrometer

When the test is finished, the following operations shall be carried out immediately:

— careful extraction of the infiltrometer in such a manner as to avoid damaging the tested soil;

— sampling of soil for characterization of the physical state of the tested material;

— visual observations or photographs.

For interpretation of test results, the depth of the infiltration front, the extension of the saturated zone created during the test, as well as the porosity and the initial and final degree of saturation in the vertical section of soil affected by the test shall be determined by sampling.

6 Test results

The test results are:

a) for the constant head procedure: the infiltrated volumes as a function of time;

b) for the variable head procedure: the hydraulic head as a function of time.

Moreover, the recorded volumes shall be plotted on a graph (see also Annex A).

The test results can be used for evaluating:

a) for the constant head procedure:

   — the surface flow rate (or infiltration velocity) for the specified hydraulic head;

— the permeability coefficient k from the relationship between surface flow rate and hydraulic gradient;

b) for the variable head procedure:

— the permeability coefficient k should be determined from the variation of the water level observed during the test.

NOTE Methods to determine these parameters are given in Annex C.

7 Reports

7.1 Field report

7.1.1 General

At the project site, a field report shall be completed. This field report shall consist of the following, if applicable:

a) summary log according to ISO 22475-1;

b) record of measured values and other visual observations according to 7.1.2.

All field investigations shall be reported such that a third person is able to check and understand the results.

7.1.2 Record of measured values and other visual observations

The record of measured values and other visual observations shall be attached to the summary log and include the following essential information, if applicable (see Annex A):

a) name of the enterprise performing the test;

b) name of the client;

c) test date(s) and time;

d) name and number of project;

e) number of test;

f) a reference to this International Standard, i.e. ISO 22282-5;

g) records concerning the surface conditions and preparation of the test area:

— location of the test zone, description of the surface condition;

— preparation of the surface;

— weather conditions;

h) description of the apparatus:

— indication of the type of infiltrometer used: commercial reference, if appropriate, type of measurement, type of pressure-volume controller;

— geometrical characteristics of the device;

i) reference and data relating to the test procedure:

— the method of installation of the ring or rings into the ground;

— the saturation procedure prior to the actual test (duration, infiltrated volumes);

— the nature of the water used;

- the execution of the test (possible incidents, etc.);
- the sampling record;
- the post-test visual observations of the ground conditions;
- photographs of test site and test area (optional);

j) records of measurements:

- all of the raw measurements relative to infiltration (hydraulic head, volumes);
- additional visual determinations;
- observations made during the test that might have an influence on the test results;

k) name and signature of the test operator.

7.2 Test report

The test report shall include the following essential information:

a) the field report (in original and/or computerized form);

b) a graphical presentation of the test results;

c) the corrections made (e.g. temperature correction);

d) the permeability coefficient value;

e) name and signature of the responsible expert.

Copyrighted material licensed to Dublin Institute of Technology by SAI Global (www.saiglobal.com), downloaded on 12 Jul 12 by Ann McSweeney.
No further reproduction or distribution is permitted. Uncontrolled when printed.

Annex A
(informative)

Record of measured values and test results of the infiltrometer test

Enterprise:	RECORD	Test conducted according to ISO 22282-5
	OPEN DOUBLE RING INFILTROMETER (constant head test)	

Client:

Site:

Date:

Operator:

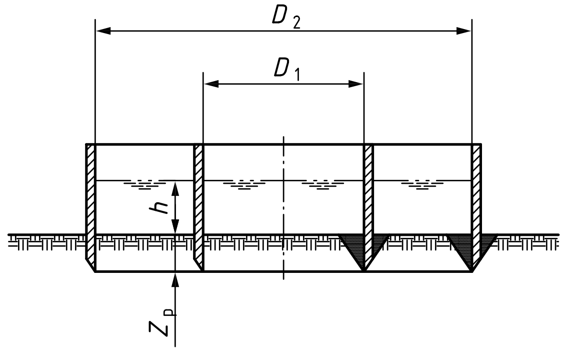
Nature of soil:

Ref. apparatus:

Type of pressure volume controller:

Ring installation

☐ **Sealing** ☐ **Pushing** ☐ **Hammering**



Raw measurements

Time	Volume readings	T°	0V	Flow rate

D_1 **(cm)** =	D_2 **(cm)** =
h **(cm)** =	
Z_p **(cm)** =	
Total infiltrated volume (cm^3) =	

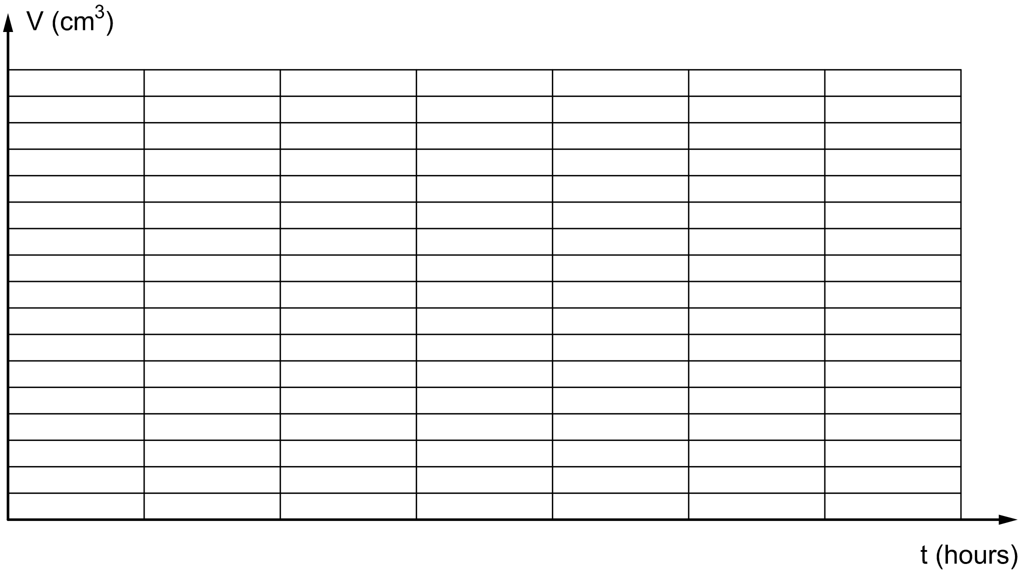
Additional measurements

☐ **Moisture profile** ☐ **Sampling**

Z_w **(mm)** =

Final flow rate (m/s) =

Permeability coefficient k **(m/s)** =



Enterprise:	RECORD	Test conducted according to ISO 22282-5

SEALED SINGLE RING INFILTROMETER (constant head test)

Client:

Site:

Test ref:

Date:

Operator:

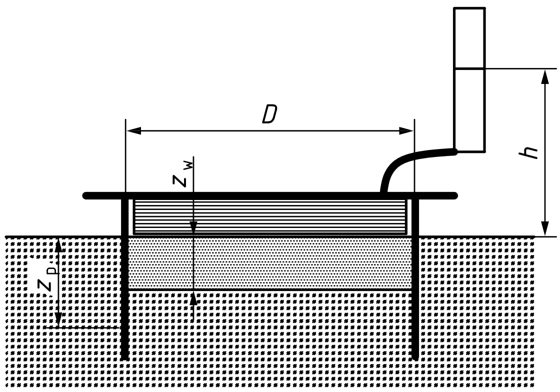
Nature of soil:

Ref. apparatus:

Type of pressure volume controller:

Ring installation

☐ **Sealing** ☐ **Pushing** ☐ **Hammering**



Raw measurements

Time	Volume readings	T°	0V	Flow rate

D **(cm)** =	h_0 **(cm)** =

Z_p **(cm)** =

Total infiltrated volume (cm^3) =

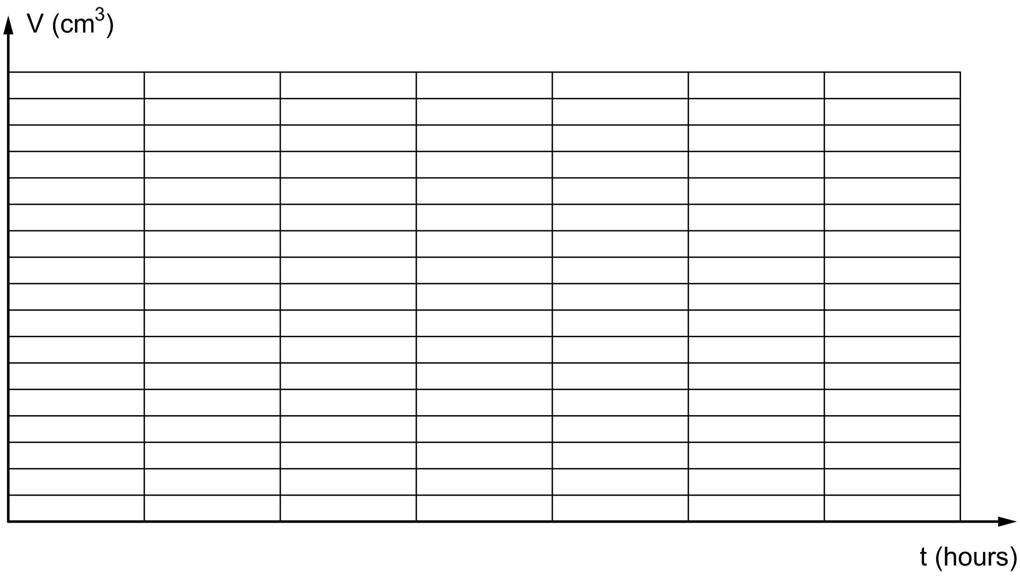
Additional measurements

☐ **Moisture profile** ☐ **Sampling**

Z_w **(mm)** =

Final flow rate (m/s) =

Permeability coefficient k **(m/s)** =



Copyrighted material licensed to Dublin Institute of Technology by SAI Global (www.saiglobal.com), downloaded on 12 Jul 12 by Ann McSweeney.
No further reproduction or distribution is permitted. Uncontrolled when printed.

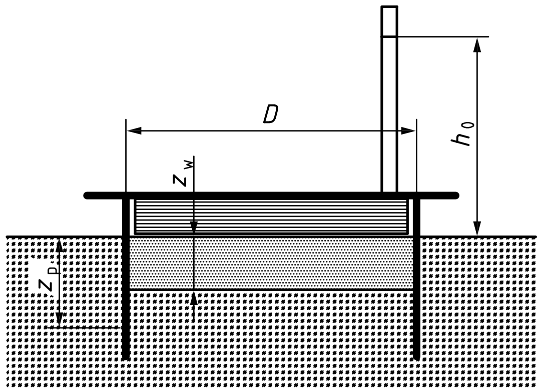
Enterprise:	**RECORD**	**Test conducted according to ISO 22282-5**
SEALED SINGLE RING INFILTROMETER (variable head test)		

Client:
Site:
Test ref:
Date:
Operator:
Nature of soil:

Ref. apparatus:
Type of pressure volume controller:

Ring installation

☐ **Sealing** ☐ **Pushing** ☐ **Hammering**



Measures brutes

Time	Head readings	T°	$h_0 - h(t)$

D **(cm)** =	h **(cm)** =

Z_p **(cm)** =

Total infiltrated volume (cm^3) =

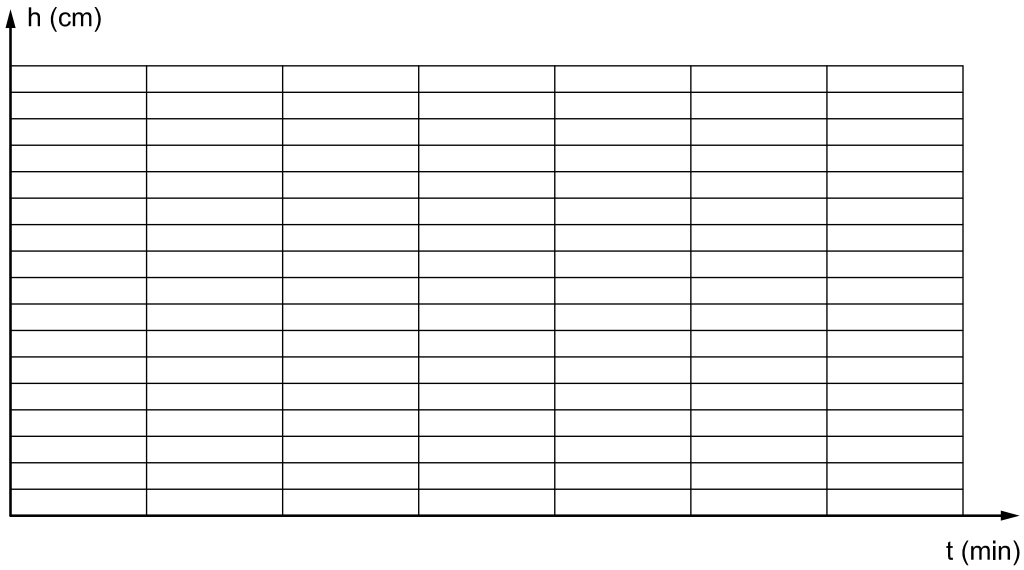
Additional measurements

☐ **Moisture profile** ☐ **Sampling**

Z_w **(mm)** =

Final flow rate (m/s) =

Permeability coefficient k **(m/s)** =



Annex B
(informative)

Correction of the influence of temperature variations

The surface flow rate of infiltration of the water into the soil is directly linked to the viscosity of the water. The higher the viscosity, the lower the flow rate. The calculated values of v (or of k) should therefore be corrected to a reference temperature when the measurements are carried out at different temperatures.

The reference temperature is generally taken as 20 °C, for which the dynamic viscosity of the water is 1,00 mPa·s.

The general relation between the dynamic viscosity, the permeability and the temperature is given by the equation:

$$k_{20} = k_{\mathrm{T}} \frac{\eta_{\mathrm{T}}}{\eta_{20}} \qquad \text{(B.1)}$$

where

k_{20} is the permeability at 20 °C;

k_{T} is the permeability at the temperature T (°C);

η_{20} is the dynamic viscosity at 20 °C.

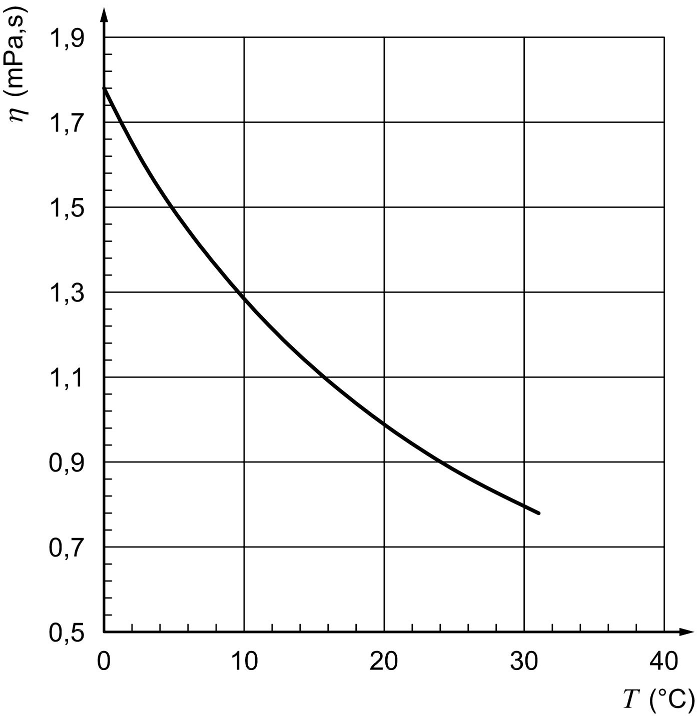
η_{T} is the dynamic viscosity at temperature T.

The η_{T} values are given in the table of Figure B.1 (values at atmospheric pressure).

An approximate expression of the law of variation ηT can be used in the following form:

$$\frac{\eta_{\mathrm{T}}}{\eta_{20}} = \exp[2{,}44\ 10^{-2}(20-T) + 1{,}8\ 10^{-4}(20-T)^2 + 2{,}5\ 10^{-6}(20-T)^3] \qquad \text{(B.2)}$$

Where T is the temperature of the water, in degrees Celsius, in the infiltration zone.



T °C	η (mPa·s)	T °C	η (mPa·s)
0	1,787	16	1,109
1	1,728	17	1,081
2	1,671	18	1,053
3	1,618	19	1,027
4	1,567	20	1,002
5	1,519	21	0,978
6	1,472	22	0,955
7	1,428	23	0,932
8	1,386	24	0,911
9	1,346	25	0,890
10	1,307	26	0,870
11	1,271	27	0,851
12	1,235	28	0,833
13	1,202	29	0,815
14	1,169	30	0,797
15	1,139	31	0,781

Figure B.1 — Variation in the dynamic viscosity η of the water at atmospheric pressure

Annex C
(informative)

Determination of permeability

C.1 Constant head procedure

The test includes two phases:

— a preliminary saturation phase of minimal duration t_{min},

— a measuring phase allowing the calculation of the stabilized flow rate v.

The minimum duration of the saturation phase and the measuring phase are estimated by making reference to Tables C.1 and C.2.

Table C.1 — Minimum indicative duration for the saturation phase for open devices

	Estimated permeability coefficient k m/s			
	1·· 10^{-5}	1·· 10^{-6}	1·· 10^{-7}	1·· 10^{-8}
t_{min} (hours)	0,2	0,6	2	6
Minimum duration of measuring phase (hours)	0,1	0,3	0,6	2
Recommended uncertainty for volume measurement device	±2,0 cm^3	±2,0 cm^3	±1,0 cm^3	±0,5 cm^3

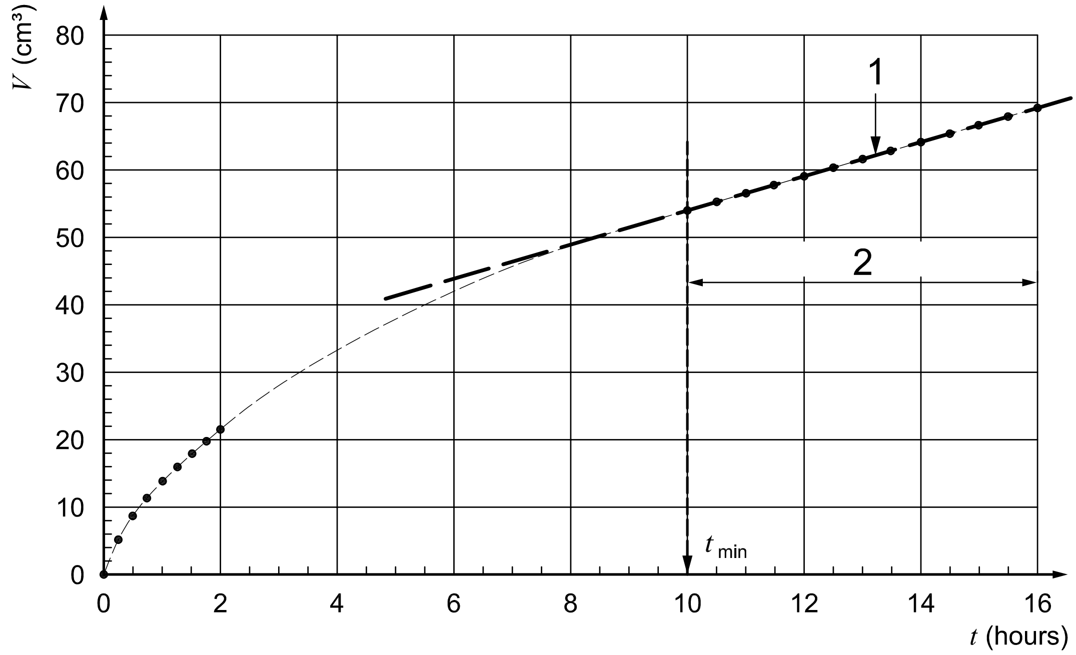
Table C.2 — Minimum indicative duration for the saturation phase for closed devices (maximum hydraulic head: 1 m)

	Estimated permeability coefficient k m/s		
	1·· 10^{-8}	1·· 10^{-9}	1·· 10^{-10}
t_{min} (hours)	3	10	20
Minimum duration of measuring phase (hours)	1	4	8
Recommended uncertainty for volume measurement device	±0,5 cm^3	±0,2 cm^3	±0,1 cm^3

Beyond the minimum duration t_{min}, the infiltration velocity is calculated at the end of the measuring phase over an interval Δt, as follows:

$$v = \frac{\Delta V}{A \cdot \Delta t} \tag{C.1}$$

ΔV and Δt correspond to the end of the test, when flow is close to steady-state condition (see Figure C.1). The values of V are corrected from temperature effects when relevant (see Annex A).



Key

1 steady state

2 measuring phase

Figure C.1 — Typical curve of infiltrated volume as a function of time

The relationship between infiltration velocity v and hydraulic gradient i is expressed by Darcy's law:

$$v = ki \tag{C.2}$$

with

$$i = (Z_W + h)/z_W \tag{C.3}$$

where

h is the constant hydraulic head;

Z_W is the saturated thickness through which flow occurs.

Z_W is experimentally determined at the end of the test by sampling (depth of the point of inflexion of the curve of the saturation profile, see Figure C.2). A theoretical determination can also be made using the following equation:

$$Z_W = V/(A\ \Delta\theta) \tag{C.4}$$

where

V is the total volume infiltrated over the entire duration of the test (saturation phase and measurement phase);

A is the surface area of infiltration;

$\Delta\theta$ is the difference between the saturated soil volumetric water content (θ_S) and the initial soil volumetric water content (θ_i).

Interpretation requires prior determination of $\Delta\theta$:

$$\Delta\theta = \theta_s - \theta_i \tag{C.5}$$

Initial soil volumetric water content (θ_i) is obtained from a measurement of the initial gravimetric water content (w_i) and of the soil dry mass density ρ_d:

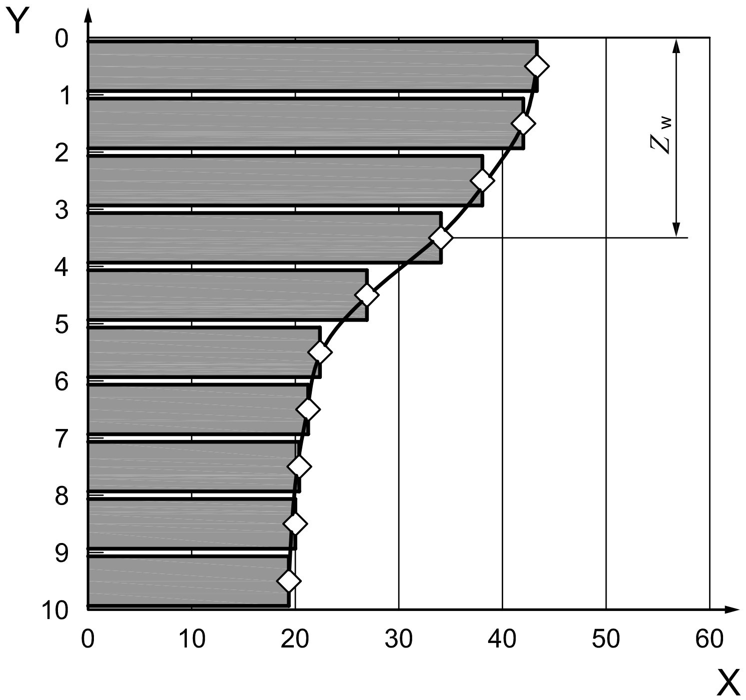
$$\theta_i = w_i \times \frac{\rho_d}{\rho_w} \tag{C.6}$$

θ_s can be obtained from

$$\theta_s = 1 - \frac{\rho_d}{\rho_s} \tag{C.7}$$

where ρ_s is the particle density (a value of 2,65 g/cm3 can be typically assumed).

The highest value of both experimental and theoretical values of Z_w is used for the calculation of the permeability coefficient.



Key

X moisture content (%)

Y depth (cm)

Figure C.2 — Example of volumetric water content profiles measured after testing

C.2 Variable head procedure

Equation C.8 relates time to measured hydraulic head and takes into account the variation of the hydraulic gradient over time:

$$t = \left(\frac{S_s}{S_l}\right)^2 \frac{h_o - h(t)}{k\ (\frac{S_s}{S_l} - \Delta\theta)} + \left(\frac{S_s}{S_l}\right)^2 \frac{\Delta\theta(\psi_f - h_o)}{k\ (\frac{S_s}{S_l} - \Delta\theta)^2} \ln\left[\frac{(\frac{S_s}{S_l} - \Delta\theta)[h_o - h(t)]}{\Delta\theta\ (h_o - \psi_f)} + 1\right] \tag{C.8}$$

where

- t is the time at which a ponded water level $h(t)$ is measured;
- S_s is the section of the tube in which the water level varies;
- S_l is the section of the base of the infiltrometer;
- h_o is the ponded water level at the start of the test;
- k is the saturated field permeability coefficient (hydraulic conductivity);
- ψ_f is the suction at the infiltration front;
- $\Delta\theta$ is the difference between saturated volumetric water content and initial volumetric water content of the tested soil.

When the suction at the infiltration front (ψ_f) is neglected, there will be a slight overestimation of k.

Interpretation requires prior determination of $\Delta\theta$, i.e. the difference between the saturated soil volumetric water content (θ_s) and the initial soil volumetric water content (θ_i):

$$\Delta\theta = \theta_s - \theta_i \tag{C.9}$$

Initial soil volumetric water content (θ_i) is obtained from a measurement of the initial gravimetric water content (w_i) and of the soil dry mass density ρ_d:

$$\theta_i = w_i \times \frac{\rho_d}{\rho_w} \tag{C.10}$$

The following two methods can be used to determine the saturated volumetric water content. Application of both methods for the purpose of applying Equation C.8 provides an indication of the uncertainty with respect to the determination of the permeability coefficient.

a) θ_s can be obtained from

$$\theta_s = 1 - \frac{\rho_d}{\rho_s} \tag{C.11}$$

where ρ_s is the particle density (a value of 2,65 g/cm3 can be typically assumed).

b) θ_s can be obtained from the depth of the infiltration front (Z_w) measured after testing, knowing the volume of water (V) infiltrated over the entire duration of the test:

$$\theta_s = \frac{V}{Z_w A} \tag{C.12}$$

Knowing $\Delta\theta$, the permeability coefficient k is varied in Equation C.8 until a satisfactory match is obtained between measured and calculated values of hydraulic head.

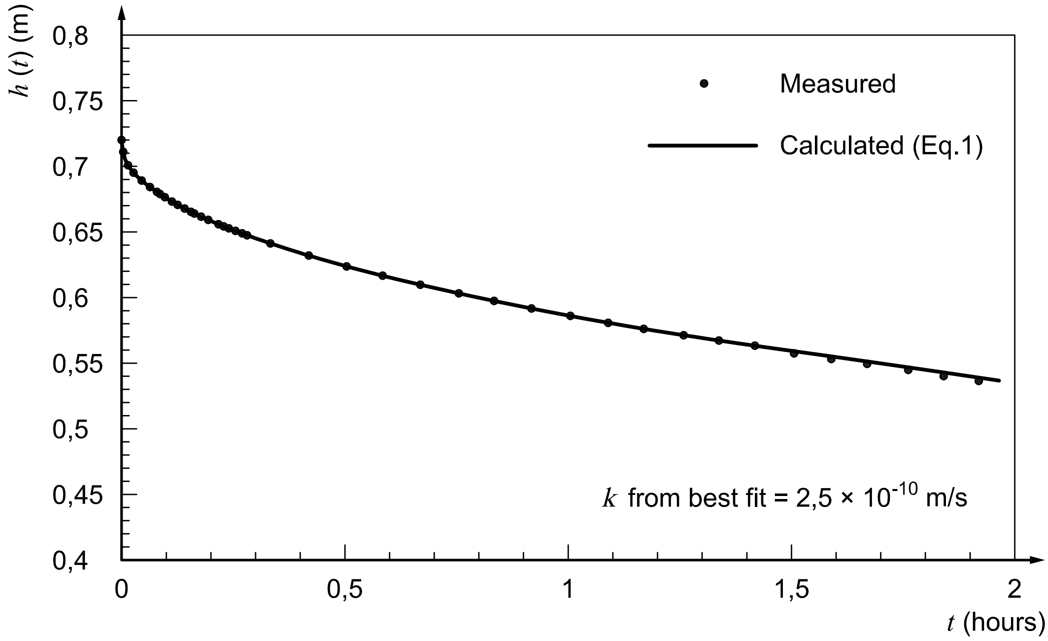


Figure C.3 — Example of match between measured data and values calculated using Equation (C.8) to determine the permeability coefficient k

Bibliography

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

[2] EN 1997-1, *Eurocode 7: Geotechnical design — Part 1: General rules*

[3] EN 1997-2, *Eurocode 7: Geotechnical design — Part 2: Ground investigation and testing*

Copyrighted material licensed to Dublin Institute of Technology by SAI Global (www.saiglobal.com), downloaded on 12 Jul 12 by Ann McSweeney.
No further reproduction or distribution is permitted. Uncontrolled when printed.

ICS 93.020

Price based on 21 pages

Copyrighted material licensed to Dublin Institute of Technology by SAI Global (www.saiglobal.com), downloaded on 12 Jul 12 by Ann McSweeney.
No further reproduction or distribution is permitted. Uncontrolled when printed.