BRITISH STANDARD

BS EN ISO 11058:1999

Geotextiles and geotextile-related products — Determination of water permeability characteristics normal to the plane, without load

The European Standard EN ISO 11058:1999 has the status of a British Standard

ICS 59.080.70

National foreword

This British Standard is the English language version of EN ISO 11058:1999. It is identical with ISO 11058:1999.

The UK participation in its preparation was entrusted to Technical Committee B/553, Geomembranes and geotextiles, which has the responsibility to:

— aid enquirers to understand the text;

— present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;

— monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this committee can be obtained on request to its secretary.

Cross-references

Attention is drawn to the fact that CEN and CENELEC Standards normally include an annex which lists normative references to international publications with their corresponding European publications. The British Standards which implement these international or European publications may be found in the BSI Standards Catalogue under the section entitled "International Standards Correspondence Index", or by using the "Find" facility of the BSI Standards Electronic Catalogue.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, the EN ISO title page, pages 2 to 14 and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

This British Standard, having been prepared under the direction of the Sector Committee for Building and Civil Engineering, was published under the authority of the Standards Committee and comes into effect on 15 May 1999

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English version

Geotextiles and geotextile-related products — Determination of water permeability characteristics normal to the plane, without load

(ISO 11058:1999)

Géotextiles et produits apparentés — Détermination des caractéristiques de perméabilité à l'eau normalement au plan, sans contrainte mécanique
(ISO 11058:1999)

Geotextilien und geotextilverwandte Produkte — Bestimmung der Wasserdurchlässigkeit normal zur Ebene, ohne Auflast
(ISO 11058:1999)

This European Standard was approved by CEN on 29 November 1998.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

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CEN

European Committee for Standardization
Comité Européen de Normalisation
Europäisches Komitee für Normung

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Ref. No. EN ISO 11058:1999 E

Foreword

The text of EN ISO 11058:1999 has been prepared by Technical Committee CEN/TC 189 "Geotextiles and geotextile-related products", the secretariat of which is held by IBN, in collaboration with Technical Committee ISO/TC 38 "Textiles".

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by August 1999, and conflicting national standards shall be withdrawn at the latest by August 1999.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

Contents

1 Scope

This European Standard specifies two test methods for determining the water permeability characteristics of a single layer of geotextile or geotextile-related product normal to the plane: the constant head method and the falling head method.

NOTE If the full permeability characteristics of the geotextile or geotextile-related product have previously been established, then for control purposes it can be sufficient to determine the velocity index at a head loss of 50 mm only.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to, or revisions of, any of these publications apply to this European standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

EN 963, *Geotextiles and geotextile-related products — Sampling and preparation of test specimens.*

EN 30320, *Geotextiles — Identification on site.* (ISO 10320:1991)

ISO 2854, *Statistical interpretation of data — Techniques of estimation and tests relating to means and variances.*

EN ISO 5813, *Water quality — Determination of dissolved oxygen — Iodometric method.* (ISO 5813:1983)

3 Definitions

For the purposes of this standard, the following definition applies:

3.1
velocity index (VI_{H50})

the velocity corresponding to a head loss of 50 mm across a specimen, expressed to the nearest 1 mm s^{-1}

4 Test specimens

4.1 Handling

The sample shall not be folded and shall be handled as infrequently as possible to avoid disturbance to its structure. The sample shall be kept in a flat position without any load.

4.2 Selection

Take specimens from the sample according to EN 963.

4.3 Number and dimensions

Cut five test specimens from the sample, each of suitable dimensions for the water permeability apparatus to be used.

NOTE Where it is necessary to determine the results to within a given confidence interval of the mean, the number of test specimens should be determined in accordance with ISO 2854.

4.4 Condition of specimens

The specimens shall be clean, free from surface deposits and without visible damage or folding marks.

5 Constant head method

5.1 Principle

A single, unloaded layer of geotextile, or geotextile-related product is subjected to a unidirectional flow of water normal to the plane under a range of constant heads.

5.2 Apparatus

5.2.1 A transparent water-permeability apparatus with a diameter of minimum 50 mm shall comply with the following requirements:

a) The apparatus shall be capable of installing a maximum head loss of at least 70 mm and maintaining a constant head for the duration of each test with water on both sides of the specimen. It shall be capable of achieving a constant water head of up to 250 mm;

NOTE Some examples of apparatus are shown in Figure 1.

b) The mean internal diameter of the apparatus shall be known to an accuracy of at least 0,1 mm. The exposed diameter of the specimen shall be the same as the internal diameter of the apparatus. The diameter of the apparatus shall remain identical on both sides of the specimen over a length of at least twice its internal diameter [see Figure 1 a) and Figure 1 b)]. Abrupt changes in diameter shall be avoided.

Alternatively [see Figure 1 c)], the outflow may discharge into a reservoir with a diameter of at least four times the exposed diameter of the specimen. In this case the distance from the geotextile to the base of the reservoir shall be at least 1,5 times the exposed diameter of the specimen.

If the product shows an obvious pattern, this pattern shall be included at least 3 times along any diameter of the specimen.

c) Where necessary, to avoid any visible deformation, a grid of 1 mm diameter wire and a mesh size of (10 ± 1) mm shall be placed downstream of the specimen to support it during the test.

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d) The head loss measured at any velocity when a test is performed without the test specimen but including any specimen-supporting grid, shall be less than 1 mm.

5.2.2 Water supply, quality and condition

a) The water shall be at a temperature of between 18 °C and 22 °C.

NOTE As the temperature correction (see Annex A) relates only to laminar flow, it is advisable to work at temperatures as close as possible to 20 °C to minimize inaccuracies associated with inappropriate correction factors, should the flow be non-laminar.

b) Water may not be fed into the apparatus directly from a mains supply due to problems caused by the release of air bubbles which can be entrapped in the structure of the specimen. The water should preferably be de-aired or fed from a stilling tank. The water should not be continuously recycled.

c) The oxygen content shall not exceed 10 mg/kg. The oxygen content shall be measured at the point at which the water enters the apparatus.

d) The water shall be filtered if suspended solids are visible to the naked eye or if solids accumulate on or in the specimen thus reducing the flow with time.

5.2.3 A dissolved-oxygen meter or apparatus complying with ISO 5813.

5.2.4 A stopwatch with an accuracy of 0,1 s.

5.2.5 A thermometer with an accuracy of 0,2 °C.

5.2.6 A measuring vessel for determining volume of water to an accuracy of 10 cm^3. Alternatively where direct measurements of flow velocity are made, the gauge shall be calibrated to an accuracy of 5 % of the reading.

5.2.7 A measuring device to determine the applied head to an accuracy of 0,2 mm.

5.3 Procedure

5.3.1 Place the specimens under water containing a wetting agent at laboratory temperature, gently stir to remove air bubbles and leave to saturate for at least 12 h. The wetting agent is aryl alkyl sodium sulfonate at 0,1 % V/V content.

5.3.2 Place a specimen in the apparatus and ensure that all joints are watertight.

5.3.3 Charge the apparatus with water until there is a 50 mm water head difference across the specimen. Shut off the water supply and if the water heads do not equalize on each side of the specimen within 5 min, investigate the likelihood of any trapped air within the apparatus and repeat the procedure. If the water heads cannot be equalized within 5 min, this shall be noted in the test report.

5.3.4 Adjust the flow to attain a head loss of (70 ± 5) mm and record this value to the nearest 1 mm. When the head has been steady for a minimum of 30 s, collect the water passing through the system in the measuring vessel over a fixed period of time and record the volume of water collected to the nearest 10 cm^3 and the time to the nearest s. The volume of water collected should be a minimum of 1 000 cm^3 and the collection time should be a minimum of 30 s.

If a flow velocity gauge is used, then a maximum velocity giving a head loss of about 70 mm should be set. The real velocity shall be taken as the average of three consecutive readings with a minimum time interval between readings of 15 s.

5.3.5 Repeat **5.3.4** for four lower head losses of approximately 0,8; 0,6; 0,4 and 0,2 times the maximum head loss starting with the highest velocity and ending with the lowest.

NOTE If the full permeability characteristics of the geotextile or geotextile-related product have previously been established, then for control purposes it can be sufficient to determine the velocity index at a head loss of 50 mm only.

The same principle applies to the velocity when using a flow velocity gauge.

5.3.6 Record the water temperature to the nearest 0,2 °C.

5.3.7 Repeat **5.3.2** to **5.3.6** with each of the remaining specimens.

5.4 Calculation and expression of results

5.4.1 Calculate the flow velocity v_{20} (m s^{-1}) at 20 °C using the following equation:

$$v_{20} = \frac{V R_T}{At} \qquad (1.1)$$

where:

- V is the water volume measured (m^3)
- R_T is the correction factor to a water temperature of 20 °C (see Annex A)
- T is the water temperature (°C)
- A is the exposed specimen area (m^2)
- t is the time measured to achieve the volume V (s).

Where the flow velocity v_T has been measured directly, a temperature correction is necessary according to: $v_{20} = v_T R_T$ (1.2)

NOTE The flow velocity V_{20} expressed in mm s^{-1} equals the discharge q expressed in l $(m^2\ s)^{-1}$.

5.4.2 For each of the five specimens, calculate the flow velocity v_{20} for each head loss H.

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Plot the head loss H against velocity v_{20} and select the best-fit curve through the origin for each specimen (see Figure 2) in accordance with Annex B, either by mathematical or graphical means. Present the five specimen curves on one graph.

As indicated in the note in clause **1**, it can be sufficient, for control purposes, to determine the flow velocity value at a head loss of 50 mm only.

5.4.3 Produce a flow velocity value at the head loss of 50 mm either by calculation or by graphical interpretation.

6 Falling head method

6.1 Principle

A single unloaded layer of geotextile or geotextile-related product is subjected to a unidirectional flow of water normal to the plane under a falling head.

6.2 Apparatus

6.2.1 A transparent water-permeability apparatus consisting of two interconnected vertical cylinders of the same diameter of minimum 50 mm, complying with the following requirements:

a) The apparatus shall be capable of achieving water heads of at least 250 mm for appropriate calculations.

NOTE 1 To achieve a water head of at least 250 mm it is recommended to start with a higher water level because the water head values recorded during the opening time of the valve cannot be used for calculation.

b) The mean internal diameter of the apparatus shall be known to an accuracy of at least 0,1 mm. The exposed diameter of the specimen shall be the same as the internal diameter of the apparatus. The diameter of the apparatus on both sides of the specimen shall remain identical over a length of at least twice its internal diameter. Within the range of changing water levels the diameter shall be constant. Abrupt changes in diameter should be avoided.

If the product shows an obvious pattern, this pattern shall be included at least 3 times, along any diameter of the specimen.

c) Where necessary, to avoid any visible deformation, a grid of 1 mm diameter wire and a mesh size of (10 ± 1) mm shall be placed downstream of the specimen to support it during the test.

d) The head loss measured at any velocity when a test is performed without the test specimen but including any specimen-supporting grid, shall be less than 1 mm.

NOTE 2 Some examples of apparatus are shown in Figure 3.

e) The connecting tube between the two cylinders shall have a minimum diameter of 40 % of the diameter of the cylinders. It shall be flexible if the weighing cell method is used.

6.2.2 Water supply, quality and condition:

a) The water shall be at a temperature between 18 °C and 22 °C.

NOTE As the temperature correction (see Annex A) relates only to laminar flow it is advisable to work at temperatures as close as possible to 20 °C to minimize inaccuracies associated with inappropriate correction factors, should the flow be non-laminar.

b) Water may not be fed into the apparatus directly from a main supply due to problems caused by the release of air bubbles which can lodge in the test specimen. The water should be preferably de-aired or fed from a stilling tank. The water in the apparatus should be replaced daily.

c) The oxygen content shall not exceed 10 mg/kg. The oxygen content shall be measured at the point at which the water enters the apparatus.

d) The water shall be filtered if suspended solids are visible to the naked eye or if solids accumulate on or in the specimen thus reducing the flow with time.

6.2.3 A dissolved-oxygen meter or apparatus complying with ISO 5813.

6.2.4 Means for measuring the changing water head to an accuracy of 0,2 mm.

NOTE 1 Possible means are:
a) measuring the change in column weight (to ± 1 g);
b) measuring the change in water pressure (to ± 1 Pa);
c) measuring the change in water level by an optical method (reading of water level using digitalized video equipment) or by an ultrasonic method.

NOTE 2 Continuous recording of the data by an analogue writer or computer from the beginning to the end of the test is recommended (see Figure 4).

6.2.5 A thermometer with an accuracy of 0,2 °C.

6.3 Procedure

6.3.1 Place the specimens under water at laboratory temperature, gently stir to remove air bubbles and leave to saturate for at least 12 h. Aryl alkyl sodium sulfonate at 0,1 % *V/V* is added as a wetting agent.

6.3.2 Place a specimen in the apparatus and ensure that all joints are watertight.

6.3.3 Charge the apparatus with water until there is a 50 mm water head difference across the specimen. Shut off the water supply and if the water heads do not equalize on each side of the specimen within 5 min, investigate the likelihood of any trapped air within the apparatus and repeat the procedure. If the water heads cannot be equalized within 5 min, this shall be noted in the test report.

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6.3.4 Close the valve. Charge the specimen cylinder of the apparatus to a height such that a useful head difference of at least 250 mm after complete opening of the valve is achieved (see NOTE 1 of **6.2.1**).

6.3.5 Record the water temperature to the nearest 0,2 °C.

6.3.6 Switch on all instruments required for the method used (see notes in **6.2.4**) and open the valve.

6.3.7 The test ends when head loss and flow velocity reach zero.

NOTE For highly permeable specimens, the water levels at $v = 0$ ms⁻¹ may not be equalized due to inertia effects (see Figure 4). In this case the water level corresponding to $V = 0$ m s⁻¹ for the first time is taken as the reference level for calculating head losses.

6.3.8 Repeat **6.3.2** to **6.3.7** with each of the remaining specimens.

6.4 Calculation and expression of results

6.4.1 From a chosen water-level interval on the graph of the analogue writer (see Figure 4) or the computerized data, calculate the flow velocity v_{20} (m s^{-1}) at 20 °C using the following equation:

$$v_{20} = \frac{\Delta h}{t} R_T \qquad (2)$$

where:

Δh is the difference between the upper water level h_u and the lower water level h_l(m) at the time interval (t)

t is the time interval between h_u and h_l(s)

R_T is the correction factor to a water temperature of 20 °C (see Annex A)

and the head loss H (m) which is given by:

$$H = h_u + h_l - 2\ h_0 \qquad (3)$$

where:

h_0 is the height of the water level at $v = 0$ m s^{-1} (see note in **6.3.7**).

h_u and h_l is the upper and lower level of the head range on which the calculation is based.

NOTE The flow velocity v expressed in mm s^{-1} equals the discharge q expressed in l (m^2 s)$^{-1}$.

6.4.2 For each of the five specimens, calculate the flow velocity v for each water head loss H at a minimum of five points along each curve.

NOTE In calculating the falling head curve, it is recommended that time intervals should be 1/5 to 1/10 of the total time to carry out the experiment.

Plot the head loss H against velocity v and select the best-fit curve through the origin for each specimen, in accordance with Annex B, by either mathematical or graphical means. Present the five specimen curves on one graph (see Figure 2).

6.4.3 The test shall be used to produce a flow velocity value at the head loss of 50 mm either by calculation or by graphical interpretation.

7 Test report

The test report shall include the following information:

a) the number and year of publication of this standard;

b) the test laboratory and, if required, the test operator;

c) a description of the product tested in accordance with EN 30320;

d) the exposed specimen area;

e) only where the full permeability characteristics are being measured a collective plot of the velocity v and head loss H for each specimen;

f) velocity index for a head loss of 50 mm (VI_{H50}) and, if required, specimen values, sample mean, specimen maximum and minimum (see Annex C);

g) water temperature range;

h) water type (stilled, de-aerated, de-ionized, filtered) and dissolved oxygen values;

i) type of flow gauge if used;

j) any deviation from the standard;

k) any anomaly in the hydraulic behaviour of the product;

In addition, if required:

l) details of apparatus used, including a diagram;

m) the experimental data and calculations for each specimen can be tabulated. An example of such a table is given in Table D.1 (constant head method) or Table D.2 (falling head method).

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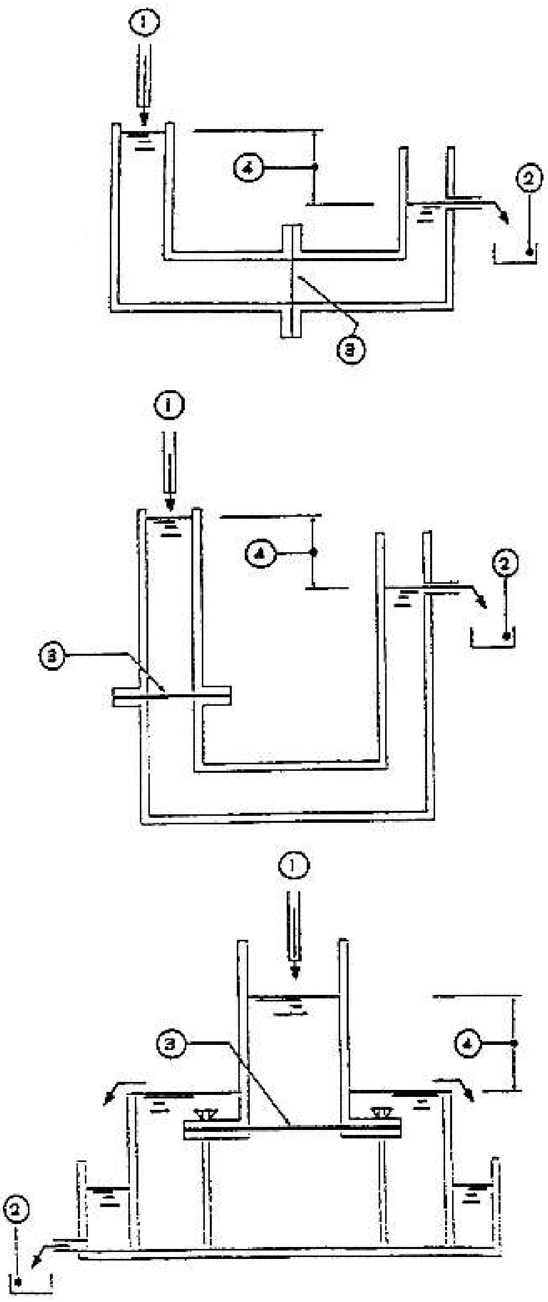
a) Horizontal

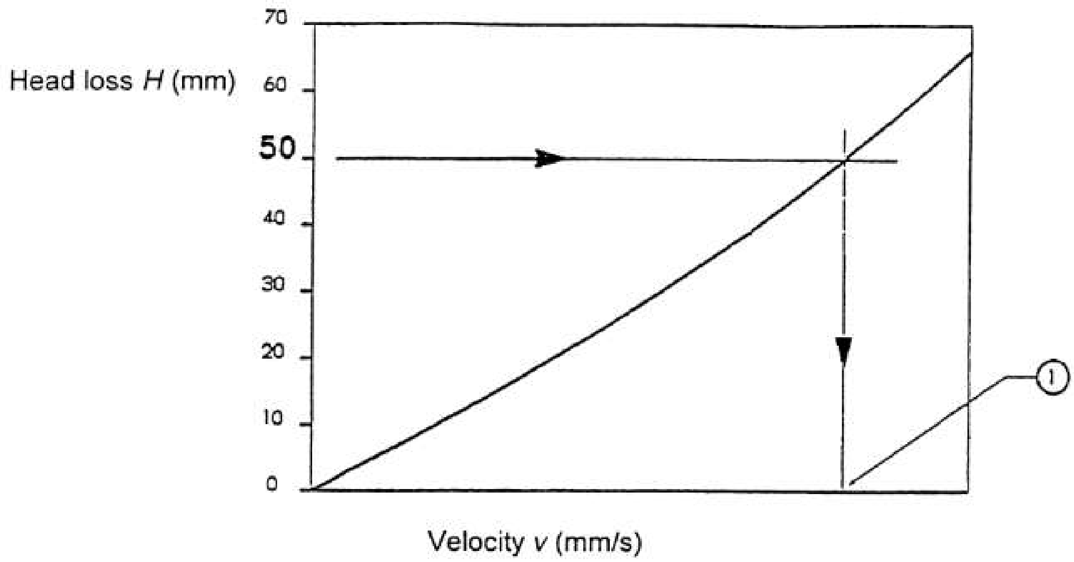
b) Vertical

c) Open



1 inflow
2 collected outflow
3 specimen
4 head loss (H)

Figure 1 — Examples of apparatus for the constant head method



1 **velocity index (VI_{H50})**

Figure 2 — Fitted quadratic regression curve (*v*, *H*)

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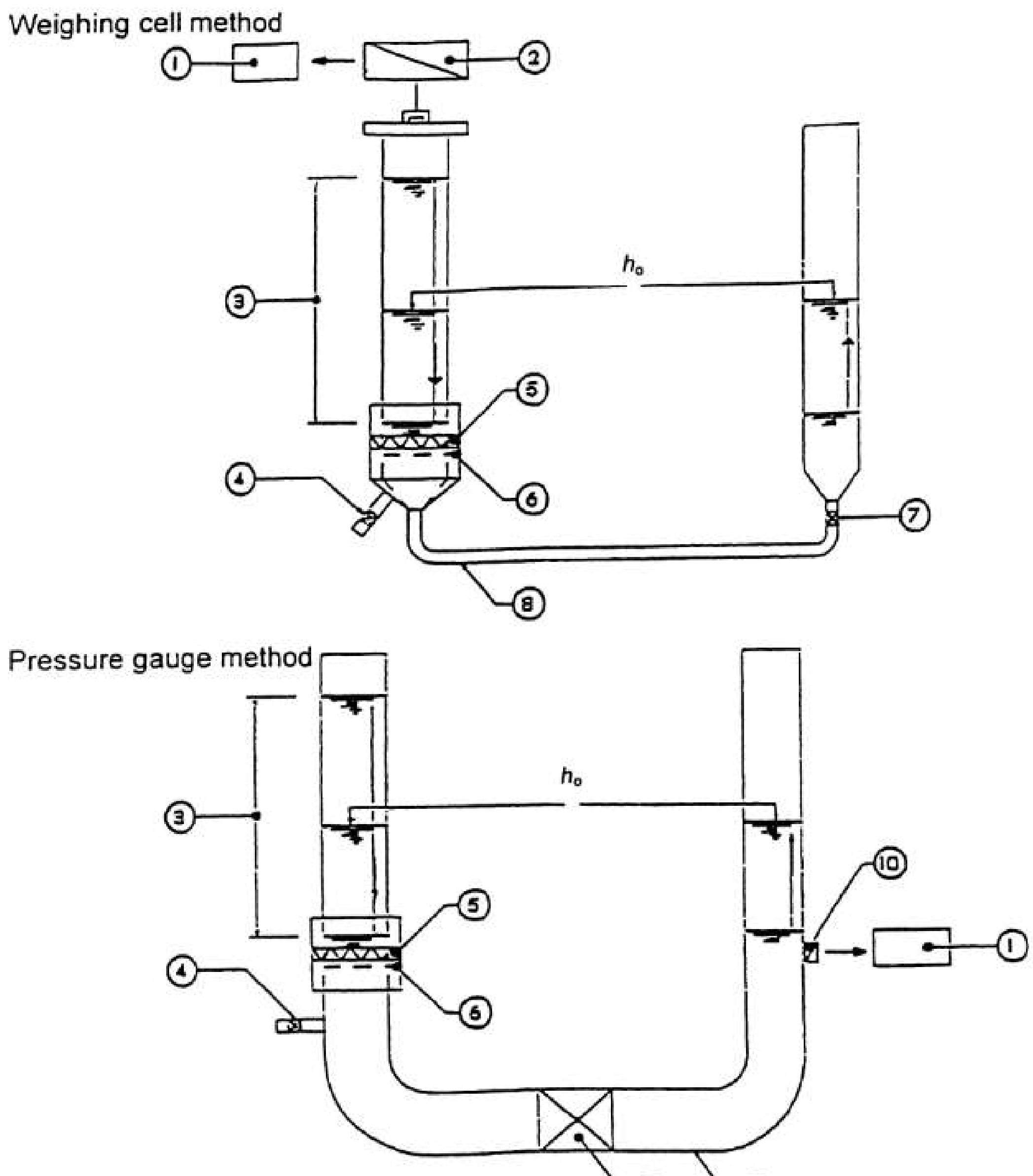
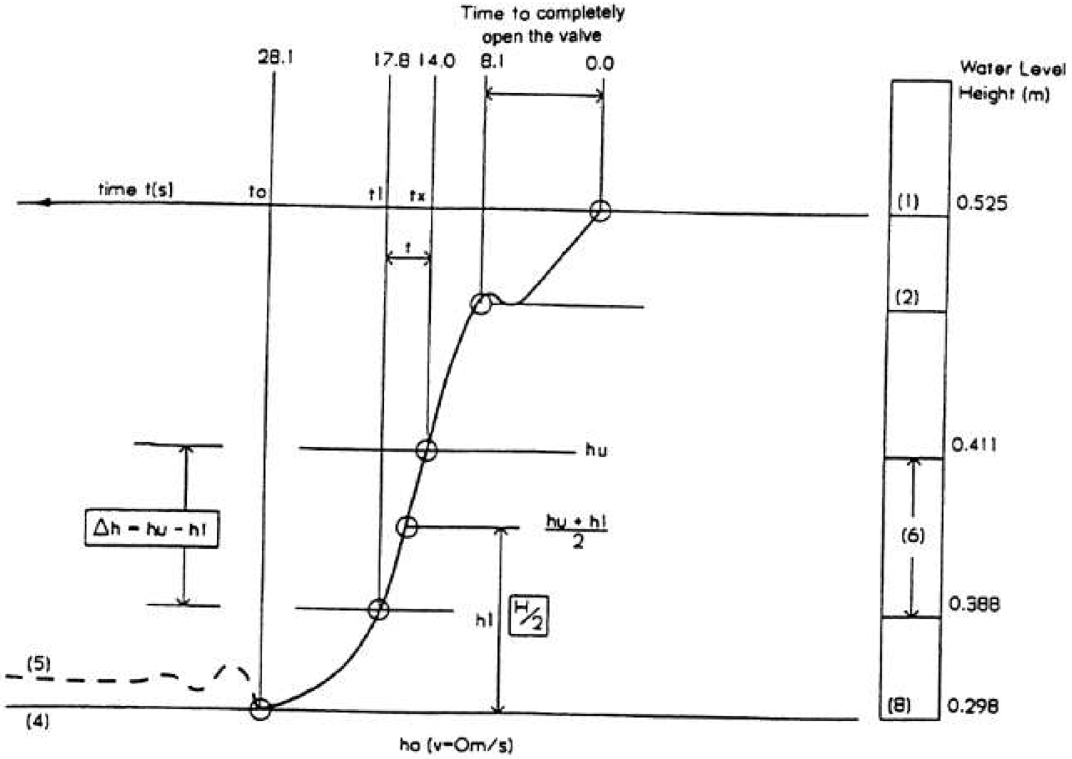


1	analog recorder or computer	6	support grid
2	weighing cell	7	main valve
3	water level difference at test start	8	flexible connecting tube
4	release valve	9	fixed connecting tube
5	specimen	10	pressure gauge

Figure 3 — Examples of apparatus for the falling head method



explanations		remarks
(1)	water level at test start	(1) – (2) range inappropriate for calculation
(2)	water level after complete opening of the valve	(2) – (8) range appropriate for calculation
(8)	lowest water level (reference level for calculation)	
(4)	course of water level alteration (low permeable geotextile)	
(5)	course of water level alteration (high permeable geotextile)	see note in **6.3.7**
(6)	example for calculation	see Table D.2

Figure 4 — Example of a falling water level as recorded by an analog writer

Annex A (informative)

Determination of the correction factor R_T to a water temperature of 20 °C

$$R_T = \frac{\eta_T}{\eta_{20}} = \frac{1{,}762}{1 + 0{,}0337T + 0{,}00022T^2} \quad \text{(dimensionless)}$$

with

$$\eta_T = \frac{1{,}78}{1 + 0{,}0337T + 0{,}00022T^2} \quad \text{(mPa.s)}$$

where

η_T is the dynamic viscosity at T °C (mPa.s)
T is the water temperature (°C)
η_{20} is the dynamic viscosity at 20 °C (mPa.s)
R_T is the correction factor to a water temperature of 20 °C.

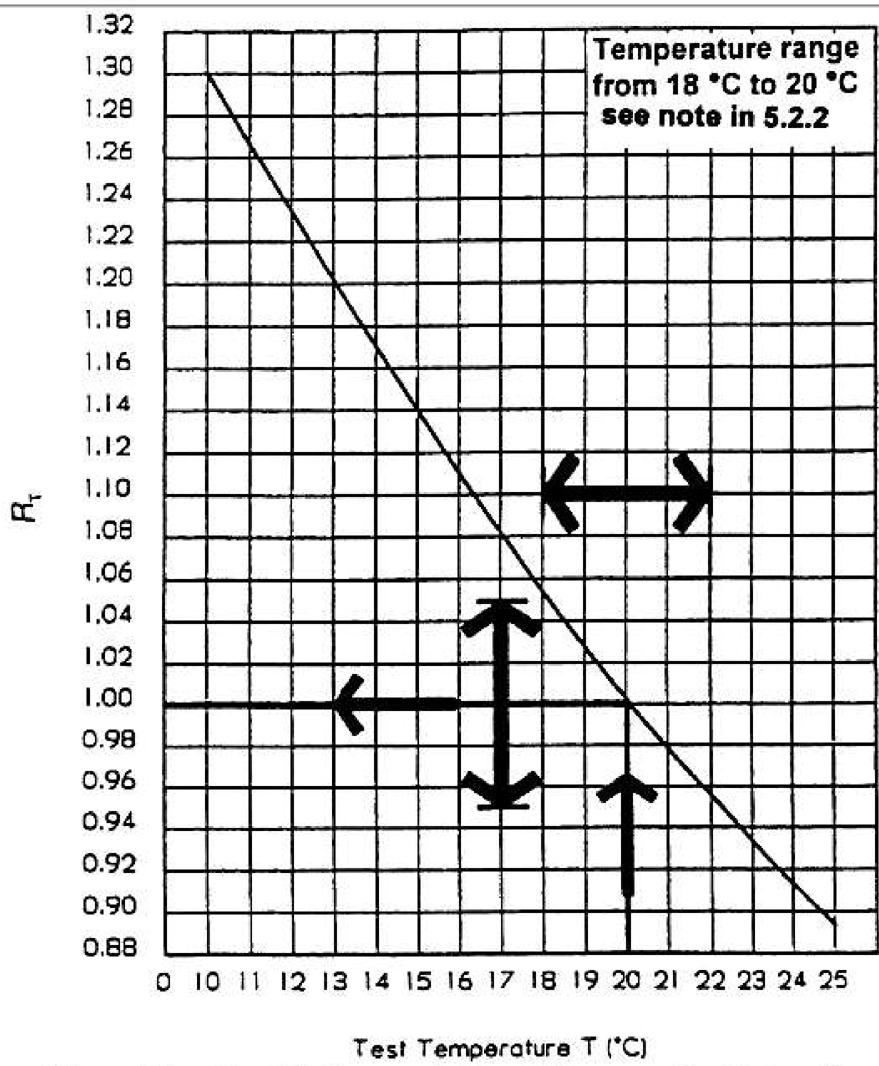


Figure A.1 — Graphical presentation of the correction factor R_T

Annex B (informative)
Relationship between head loss and flow velocity

The general relationship between head loss H and flow velocity v can be expressed by the quadratic function:

$$H = av + bv^2$$

Using the experimental data v and H of this annex, the best fit quadratic curve passing through the origin, can be determined through the paired terms v and H, as illustrated in Figure B.1.

This graph allows the determination of the velocity at a head loss of 50 mm.

Table B.1 — Experimental data of velocity v and head loss H after temperature correction

v_{20} (mm s^{-1})	H (mm)
19,7	20,0
28,3	30,1
35,3	40,0
41,9	50,0
46,8	60,0

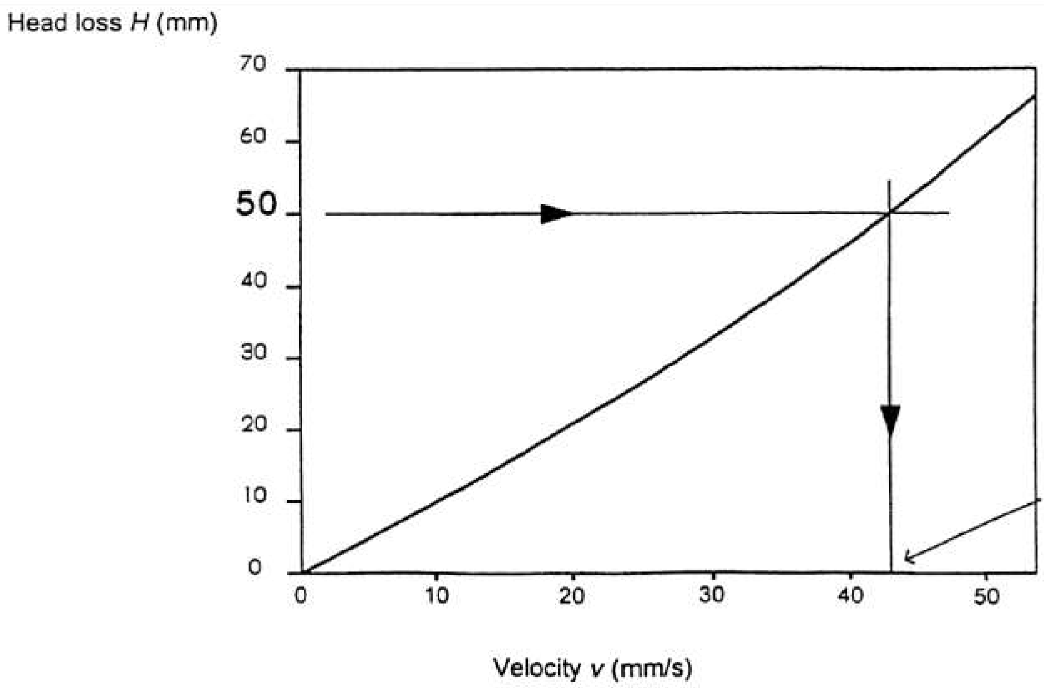


Figure B.1 — Fitted quadratic regression curve v_{20}, H

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Annex C (informative)

Table C.1 — Velocity index

Product designation ______________________

Date: __________________

Sample designation ______________________

Specimen	Velocity index (VI_{H50}) at a head loss of 50 mm (m s^{-1})
1	
2	
3	
4	
5	
Mean	
Maximum	
Minimum	

Annex D (informative)

Table D.1 — Experimental data and calculations for a geotextile or geotextile-related product specimen (constant head method)

Specimen __________________ Date: _____________

Exposed area of the tested specimen :_________m^2

Product designation :___________

Laboratory temperature :___________°C

Sample designation :___________

Head loss H (m)	Water volume V (m^3)	Time t (s)	Water temperature T (°C)	Correction factor R_T	Velocity v_{20} (m s^{-1})	Gauge v_T (m s^{-1})

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Table D.2 — Experimental data and calculations for a geotextile or geotextile-related product specimen (falling head method)

Specimen ____________________ Date:

____

Exposed area of the tested specimen :__________m^2

Product designation :_____________ °C

Laboratory temperature :_____________°C

Sample designation :_____________

Chosen water level interval					Water level at $v = 0$	Temperature	Correction factor	$\Delta h =$ (2)–(4)	$t =$ (5)–(3)	$v_{20} =$ (9)(8)/(10)	$H =$ (2)+(4)–2(6)
Nr	upper limit		lower limit		h_0 (m)	T (°C)	R_T (–)	(m)	(s)	(m.s^{-1})	(m)
	h_u (m)	t_u (s)	h_l (m)	t_l (s)							
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1											
2[a]	0,411	14,0	0,388	17,8	0,298	18,0	1,051	0,073	3,8	0,020	0,167
3											
4											
5											

[a] Example see Figure 4.

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