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Geotextiles and geotextile-related products — Determination of water permeability characteristics normal to the plane, under load

Géotextiles et produits apparentés — Détermination des caractéristiques de perméabilité à l'eau, perpendiculairement au plan et sous contrainte

Reference number
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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.

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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.

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ISO 10776 was prepared by Technical Committee ISO/TC 221, *Geosynthetics*.

Geotextiles and geotextile-related products — Determination of water permeability characteristics normal to the plane, under load

1 Scope

This International Standard describes a method for determining the water permeability characteristics of geotextiles or geotextile-related products normal to the plane when subjected to specific normal compressive loads.

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

ISO 5813, *Water quality — Determination of dissolved oxygen — Iodometric method*

ISO 9862, Geosynthetics — Sampling and preparation of test specimens

ISO 10318, Geosynthetics — Terms and definitions.

ISO 10320, *Geotextiles and geotextile-related products — Identification on site*

3 Terms and definitions

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

3.1
flow velocity
$v_{N50/\sigma}$
flow velocity normal to the plane at a 50 mm water head under a compressive stress σ (2, 20 and 200 kPa)

NOTE The flow velocity is expressed in metres per second.

4 Principle

The flow of water normal to the plane of a geotextile or geotextile-related product is measured under a range of constant heads under a compressive stress of 2, 20 and 200 kPa.

5 Specimens

5.1 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.

5.2 Selection

Take specimens from the sample according to ISO 9862.

5.3 Number and dimensions

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

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

5.4 Specimen conditions

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

6 Apparatus, water supply and measuring devices

6.1 Apparatus

The apparatus shall be capable of allowing free water flow through the specimen in a direction normal to its plane while confining it between two planes. An example of the apparatus is shown in Figure 1.

The test apparatus shall consist of a cylindrical cell as follows,

a) The apparatus shall be capable of installing a 50 mm head loss on the specimen and maintaining a constant head, for example, by adjusting the flow rate for the duration of each test with water on both sides of the specimen.

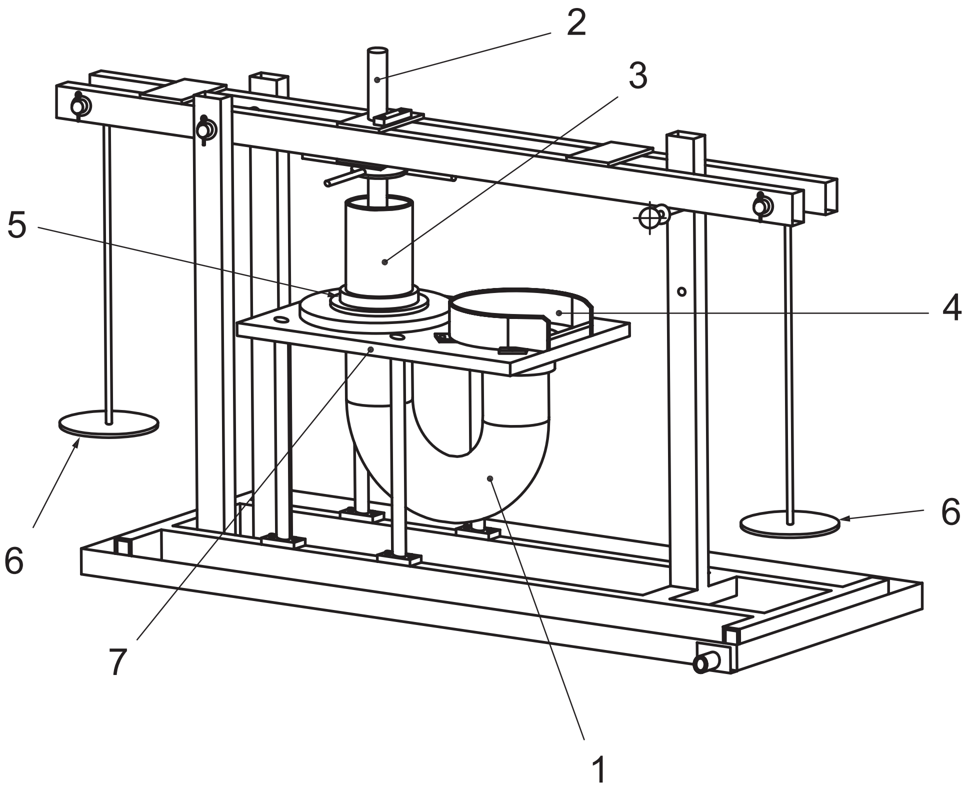
b) The apparatus shall have an internal diameter of 95 mm ± 2 mm. The internal diameter shall have a tolerance of ± 0,1 mm. The diameter of the apparatus shall remain identical on both sides of the specimen. Abrupt changes in diameter shall be avoided (see Figure 2).

c) The upper and lower porous circular plates bounding the sample shall consist of metallic plates of diameter that is lower than or equal to 0,5 mm less than the nominal internal diameter of the apparatus. The thickness of each plate shall be greater than or equal to 15 mm. The porous central area of the plate shall be perforated by a series of 2,5 mm ± 0,2 mm holes that are perpendicular to the face of the plate. The pattern of holes shall be uniformly distributed about the horizontal and vertical diameter of the plate in accordance with Figure 3. The plates shall have markings that facilitate alignment of the holes The diameter of the specimen that is exposed to flow shall be greater than or equal to 85 % of the internal diameter of the apparatus.

d) d) A loading mechanism shall be capable of sustaining a constant normal compressive stress on the specimen of 2, 20 and 200 kPa with a tolerance of ± 5 %. For the purpose of calculating the compressive stress, the area to be used shall be the gross area of the upper plate.The normal compressive stress shall be applied to the upper and lower porous plates by a circular stainless steel ring of outer diameter 1 mm less than the internal diameter of the apparatus and a thickness lower than or equal to 2,5 mm. The height of the ring shall be greater than 25 mm. The transference of load from the loading mechanism to the loading ring above the porous plates shall not reduce the flow area of the apparatus by more than 1 000 mm^2.

e) The apparatus shall be capable of maintaining the proposed normal compressive stress on the specimen without deformations that could influence the test results.

f) The apparatus shall be capable of preventing flow at the edge of the specimen.



Key

1 Glass tube

2 Loading device

3 Hydraulic head application device

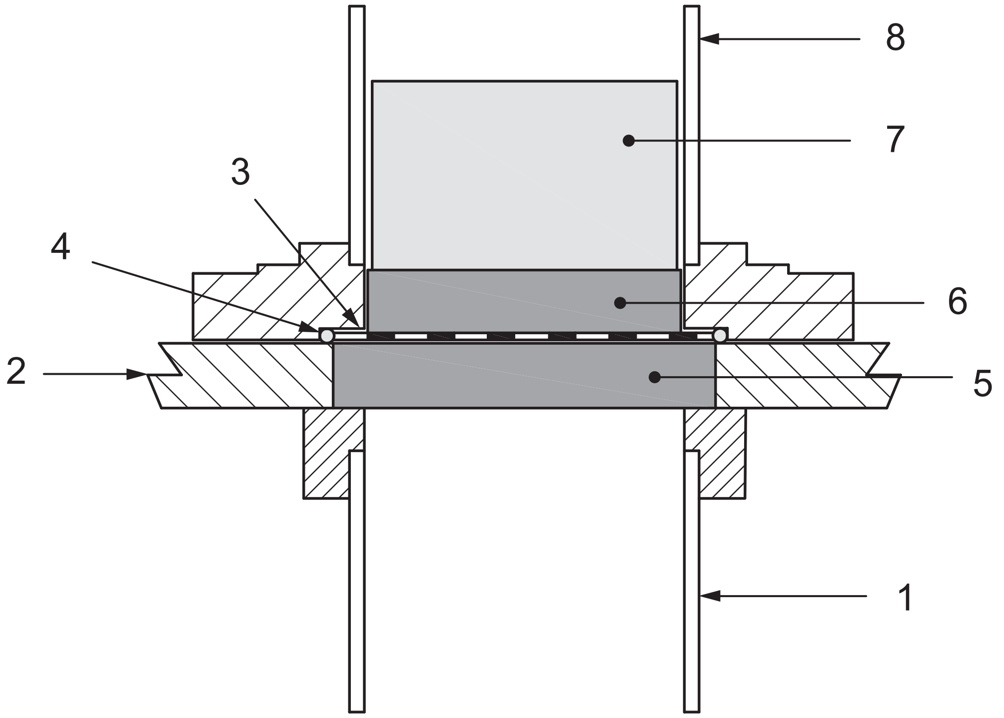
4 Overflow

5 Specimen location (see detail on Figure 1b)

6 Carrying plate for accommodation of dead weights

7 Central plate

Figure 1 — Example of apparatus; schematic principle for the determination of the permeability characteristics under load

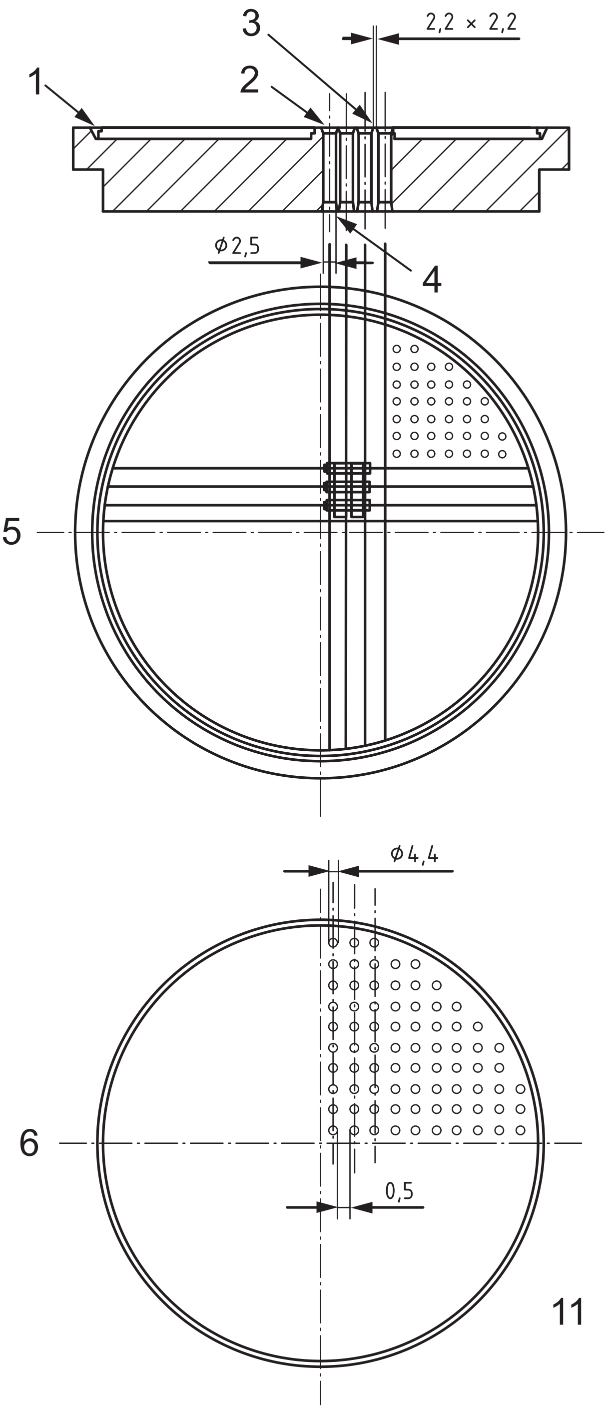


Key

1 Glass tube
2 Central plate
3 Specimen
4 O-ring
5 Lower perforated plate
6 Upper perforated plate
7 Loading device
8 Hydraulic head application device

Figure 2 — Schematic drawing (not to scale) of central part of the cell with specimen

Dimensions in millimetres



Key

1 Ring notch

2 Hole perforation

3 Bearing

4 Hole perforation

5 Lower face of the top plate

6 Upper face of the top plate

Figure 3 — Perforation pattern and upper and lower plate arrangement

6.2 Water supply, quality and condition

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

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 shall be de-aired or fed from a stilling tank. The water shall not be continuously recycled unless special measures are taken to avoid the accumulation of sediment or particles and that the water is continuously monitored to ensure the acceptability of the water quality.

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.

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.

6.3 Measuring devices

6.3.1 A dissolved-oxygen meter or apparatus conforming to ISO 5813.

6.3.2 A stopwatch with an accuracy of 0.1 s.

6.3.3 A thermometer with an accuracy of 0.2°C.

6.3.4 A measuring vessel for determining the volume of water which has a maximum permissible error lower than or equal to 20 ml. Alternatively, the volume may be determined by weighing with a balance having a maximum permissible error lower than or equal to 2 % of the measured value.

Where direct measurements of flow velocity are made, the gauge shall be calibrated to a maximum permissible error of 5 %.

6.3.5 A measurement device to determine the 50 mm head loss with an accuracy of 3 %.

7 Procedure

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

7.2 Assemble the apparatus and ensure that all joints are watertight. The plates must be installed so that the holes in both plates are aligned.

7.3 Place a seating stress of 2 kPa on the loading plates (without specimen) and fill the apparatus inlet reservoir with water to allow water to flow through the plates in order to remove air. Take all necessary precautions to avoid preferential flow paths along the boundaries of the specimen(s). If such flows are observed, re-seal and re-seat the plates.

7.4 Charge the apparatus with water until there is a 50 mm head loss across the plates. Shut off the water supply and, if the water heads do not equalize in the reservoirs on each side of the specimen(s) 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.

7.5 Adjust the flow to attain a 50 mm head loss or a head loss as close as possible to 50 mm (so that the flow is such that there is no loss or gain in head) and record this value with a resolution of 1 mm . When the head loss has been steady for a minimum of 30 s, collect the water passing through the system in the measuring vessel over a fixed period and record the volume of water collected with a resolution of 2 % of the mass and the time with a resolution of 1 s.. The minimum volume of water collected shall be a minimum of 1 000 ml and the collection time shall be a minimum of 30 s.

If a flow velocity gauge is used, then the velocity giving a steady head condition 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.

7.6 A minimum of three consecutive readings shall be taken and the mean of these flow velocities shall be calculated.

7.7 Repeat the procedures in 7.5 and 7.6 until the plates have been tested at the other compressive stresses, (20 kPa and 200 kPa). Enter the mean flow velocity values in Table 1, column 2 ("Without specimen").

7.8 Check the assembly and position of the lower perforated plate.

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

7.10 Place a seating stress, by means of the upper perforated plate, of 2 kPa on the specimen (including the loading plate). If the mass of the upper perforated plate and loading mechanism exceed the 2 kPa seating stress then the actual seating stress shall be noted and used in subsequent calculations and plots. Fill the apparatus outlet reservoir with water to allow water to flow through the specimen in order to remove air. Take all necessary precautions to avoid preferential flow paths along the boundaries of the specimen(s). If such flows are observed, re-seat or discard the specimens as necessary.

7.11 Charge the inlet reservoir of the apparatus with water until there is a 50 mm head loss across the specimen. Shut off the water supply and, if the water heads do not equalize in the reservoirs on each side of the specimen(s) 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.

7.12 Adjust the flow to attain a 50 mm head loss across the specimen. When the head loss has been steady for a minimum of 30 s, collect the water passing through the system in the measuring vessel over a fixed period and record the volume of water collected with a resolution of 20 ml or ± 2 % by mass and the time to the nearest second (s). The volume of water collected shall be a minimum of 1l and the collection time shall be a minimum of 30 s.

If a flow velocity gauge is used, then a maximum velocity giving a 50 mm head loss across the specimen 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.

7.13 A minimum of three consecutive readings are necessary and the mean of these flow velocities is calculated.

7.14 Repeat the procedures in 7.10 to 7.13 until the specimen has been tested at the compressive stresses, 20 kPa and 200 kPa. Enter the mean flow velocity values in Table 1.

7.15 Repeat the entire sequence of operations given in 7.8 to 7.14 for the remaining test specimens.

NOTE If the full permeability characteristics of the geotextile or geotextile-related product under load have previously been established, then for control purposes it can be sufficient to determine the flow velocity under a compressive-stress at 20 kPa.

8 Calculation and expression of results

8.1 For all the specimens and at each specific stress, determine the mean value of three consecutive readings of the flow velocity, calculated using the following equation:

$$v_{N50/\sigma} = \frac{V}{A \cdot t} \quad (1)$$

where

V is the water volume measured (m^3);

A is the exposed specimen area (m^2) which shall be calculated based on the diameter of the specimen that is exposed to flow; refer to 6.1.c).

NOTE It is recognized that this method of calculating area may overestimate the actual area and result in the flow being underestimated.

t is the time measured to achieve the volume V (s)

8.2 Tabulate the mean value of three consecutive readings of the flow velocities as in Table 1.

Table 1 — Report of the obtained experimental values

Compressive stress σ kPa	**Flow velocity** (mean value of three readings) $v_{N50/\sigma}$ m/s						**Mean flow velocity of specimens 1 à 5** $\bar{v}_{N50/\sigma}$ m/s
	Without specimen	**With specimen number: 1**	**2**	**3**	**4**	**5**	
2							
20							
200							

8.3 Plot the mean flow velocity $\bar{v}_{N50/\sigma}$ as the ordinate against the compressive stress as the abscissa in logarithmic scale.

The water permeability characteristic normal to the plane shall be considered as an index test, but not to be representative of the in-service performance of the product.

The permittivity of the plates shall be at least the double of the permittivity of the specimens. If not, the measurements obtained must be disregarded (refer to ISO 10318 for the definition of permittivity).

9 Test report

The test report shall include the following information.

a) the number and year of publication of this International Standard;

b) a description of the product tested according to ISO 10320;

c) the exposed specimen area;

d) if required, a collective plot of the mean flow velocity $\bar{v}_{N50/\sigma}$ as a function of the compressive stress, σ, for each specimen;

e) water type (stilled, de-aired, de-ionized, filtered) and dissolved oxygen values;

f) water temperature range;

g) type of flow gauge, if used;

h) any deviation from this International Standard;

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

j) details of apparatus used, including a diagram;

k) the experimental data and calculations for each specimen;

NOTE The experimental data and calculations can be tabulated. An example is given in Table 1

l) the mean flow velocity under all loads;

m) date of test,

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