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Geotextiles and geotextile-related products — Determination of water flow capacity in their plane —

Part 1:
Index test

Géotextiles et produits apparentés — Détermination de la capacité de débit dans leur plan —

Partie 1: Essai index

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 221, *Geosynthetics*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 189, *Geosynthetics*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This first edition of ISO 12958-1, together with ISO 12958-2, cancels and replaces ISO 12958:2010, which has been technically revised.

The main changes to ISO 12958:2010 are as follows:

— introduction of the concept of index versus performance test;

— permission given to test using rigid/rigid, soft/soft or soft/rigid boundaries;

— addition of guidance for testing cuspated sheets on a single side and for testing multilinear drainage geocomposites;

— withdrawal of apparatus types b) and c);

— several cosmetic improvements, in particular terms and definitions, procedure, calculation and reporting.

A list of all parts in the ISO 12958 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Geotextiles and geotextile-related products — Determination of water flow capacity in their plane —

Part 1:
Index test

1   Scope

This document specifies a method for determining the constant-head water flow capacity within the plane of a geotextile or geotextile-related product. This document describes the in-plane water flow index test, only applicable to factory-assembled products. For the in-plane water flow performance test, see ISO 12958-2.

2   Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 9863-1, *Geosynthetics — Determination of thickness at specified pressures — Part 1: Single layers*

ISO 10320, *Geosynthetics — Identification on site*

3   Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
normal compressive stress
σ
compressive stress normal to the plane of the geotextile or geotextile-related product, expressed in kilopascals [kPa]

3.2
in-plane flow
Q
fluid flow within the geotextile or geotextile-related product and parallel to its plane, expressed in litres per second [l/s]

3.3
in-plane water flow capacity
$q_{p\ index(\sigma/i)}$
volumetric flow rate of water per unit width of specimen at a defined normal compressive stress (σ), hydraulic gradient (i), measured in the present index test and expressed in litres per second per meter [(l/s)/m]

Note 1 to entry: The term 'transmissivity' is related to laminar flow conditions only and equals the water flow capacity at a hydraulic gradient equal to unity. As non-laminar flow may occur, the term 'water flow capacity' is preferred.

3.4
hydraulic gradient
i
ratio of the head loss in the geotextile or geotextile-related product specimen to the distance between two measuring points within the geotextile or geotextile-related product

Note 1 to entry: ISO/TR 18228-4[1) provides information on the significance of the hydraulic gradient.

3.5
contact surface
surface contacting the specimen

Note 1 to entry: Contact surfaces may be either closed-cell foam rubber on both sides (F/F), smooth rigid membrane on one side and closed-cell foam rubber on the other side (R/F) or smooth rigid membrane on both sides (R/R).

3.6
in-plane water flow index test
test that yields an indication of the in-plane water flow

3.7
in-plane water flow performance test
test to confirm full compliance of the in-plane water flow with the requirements under specified conditions

4   Principle

The flow of water within the plane of a geotextile or geotextile-related product is measured under varying normal compressive stresses, with typical hydraulic gradients and with defined contact surfaces.

5   Apparatus and materials

5.1   Constant-head in-plane water flow apparatus, as follows:

a)   The apparatus shall be capable of maintaining a constant head loss at different water levels, at least those corresponding to hydraulic gradients of 0,1 and 1,0, while maintaining a water head at the point of discharge not greater than 100 mm.

b)   If the average water head above the specimen exceeds 100 mm, and the applied normal load is equal to or less than 20 kPa, the normal stress shall be corrected for the excess considering the average water head.

c)   The apparatus shall be capable of maintaining the proposed normal compressive stress on the specimen without any deformation which would influence the test results.

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1)   Under preparation. Stage at the time of publication: ISO/CD TR 18228-4:2020.

d) The apparatus shall include a loading mechanism capable of exerting a constant normal compressive stress on the geotextile or geotextile-related product specimen to a maximum permissible error of ± 5 % of applied normal compressive stress.

e) The surfaces contacting the specimen should be either:

— foam rubber (F) whose properties should satisfy the compression deflection envelope, illustrated in Figure 1, when tested in accordance with ISO 9863-1; or

— smooth rigid (R) high-density polyethylene liner 2 mm thick without any surface damage.

Performances of a geotextile-related product with any other boundary condition can be measured in accordance with the performance test of ISO 12958-2.

f) For specimens with a thickness up to 10 mm, foam rubber with a nominal thickness of 10 mm shall be used on each face.

g) For specimens with a thickness between 10 mm and 25 mm, foam rubber with a nominal thickness of 1 to 1,25 times the specimen thickness shall be used on each face.

h) For specimens with a thickness over 25 mm, the foam rubber on each face shall have a nominal thickness of 25 mm.

i) Two layers of foam rubber may be combined to achieve the desired thickness only when the foam thickness is greater than 10 mm.

j) The width of the foam shall be the same as that of the loading platen. The length of the foam should normally be the same as the loading platen. However, to avoid obstruction at both the inlet and outlet due to compression of the foam, it is recommended that the length of the foam be reduced, where necessary, by 0,4 times its nominal thickness.

k) The test report shall include the specific boundary used.

l) The multiple use of foam rubber should be carefully monitored. The foam rubber shall be discarded if there is more than 10 % deformation in thickness tested in accordance with ISO 9863-1 at 2 kPa.

m) The apparatus shall have a minimum width of 0,2 m and a minimum net hydraulic length of 0,3 m. It shall be capable of testing specimens up to a thickness of 50 mm. It shall also be capable of accepting foam rubber with a thickness of 25 mm in contact with both faces of the material to be tested.

n) The apparatus shall be essentially leak tight when the specimen is inside. To measure the leakage in the apparatus, a test can be conducted with a specimen of similar thickness, wrapped in a thin impervious plastic sheet, to avoid any flow into the specimen. The flow measured in this condition is the leakage of the apparatus. This leakage shall not exceed 5 % of the flow values recorded during an actual test, when measured under the same test conditions.

Key
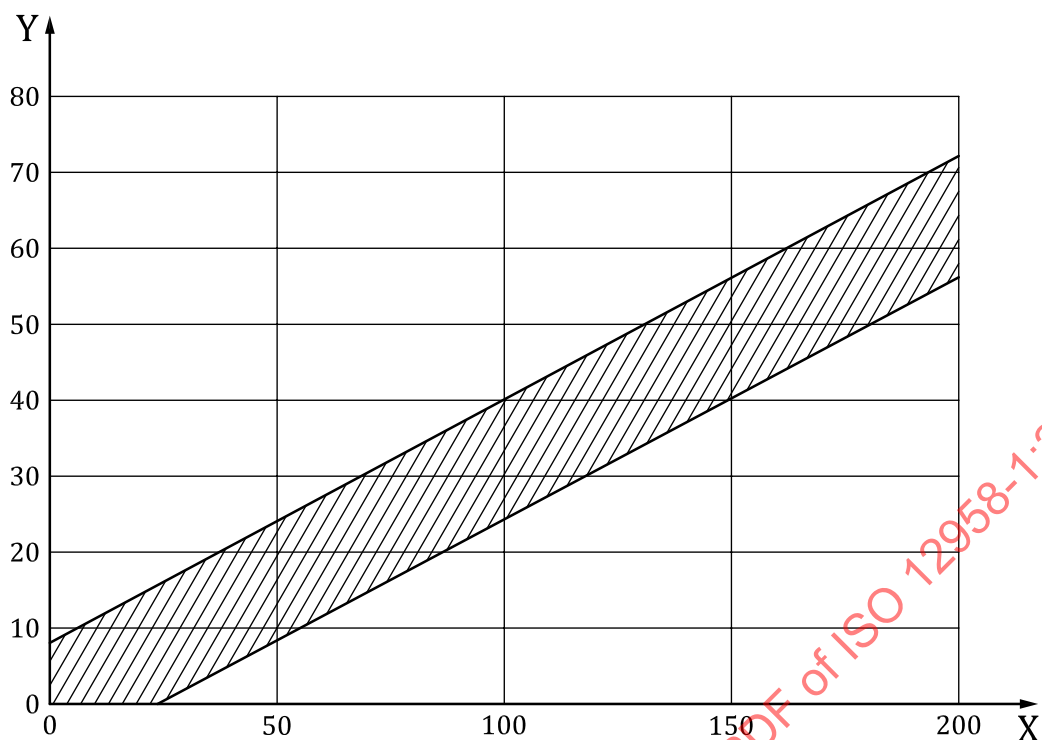
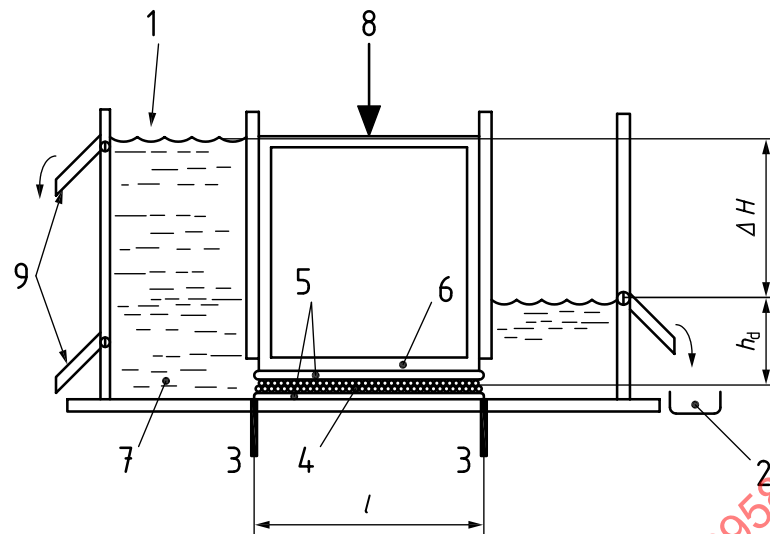X normal compressive stress, in kilopascals

Y thickness reduction, in per cent

Figure 1 — Compression-deflection envelope of an elastomeric closed-cell foam rubber

A typical example of apparatus is shown in Figure 2.

For determination of the hydraulic head loss, it is recommended that the apparatus in Figure 2 be provided with two manometers.

Key

1	water supply	7	water reservoir
2	water collection	8	normal compressive load
3	upstream water head manometers/piezometers	9	overflow weirs at hydraulic gradients 0,1 and 1,0
4	specimen	l	effective flow length (≥300 mm)
5	closed-cell foam rubber (F) or smooth rigid membrane (R)	ΔH	head loss
6	loading platen	h_d	downstream water head (≤100 mm)

Figure 2 — Typical example of apparatus

5.2 Water

For water flow rates up to 0,3 (l/s)/m, the water used shall be de-aerated or fed from a stilling tank. The water should be at a temperature between 18 °C and 22 °C and the water temperature should preferably be at or above the ambient temperature of the test laboratory. The oxygen content shall not exceed 10 mg/kg when measured in accordance with ISO 5813 at the point where the water enters the apparatus, to avoid air-clogging of the specimen due to the duration of the test.

For water flow rates greater than 0,3 (l/s)/m water may be recirculated but care shall be given to avoid changes of temperature across the duration of the test. Water from the mains supply may be used only if its normal temperature is between 18 °C and 22 °C. Mixing hot and cold water to achieve a temperature between 18 °C and 22 °C is not acceptable as it will release the oxygen dissolved in the colder water because of the change of temperature.

As temperature correction 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.

The water shall be filtered to avoid presence of suspended solids.

To avoid biological activity, the water in the stilling tank shall be periodically replaced and shall not be used for a long duration.

5.3 Dissolved-oxygen meter, or apparatus in accordance with ISO 5813.

5.4 Stopwatch, with a maximum permissible measurement error of 0,1 s.

5.5 Thermometer, with a maximum permissible measurement error of 0,5 °C.

5.6 Equipment for determining the water flow rate, with a maximum permissible measurement error of 2 %.

5.7 Measuring device for determining the applied head, with a maximum permissible measurement error of 1 mm.

5.8 Measuring device for determining the applied normal stress, with a maximum permissible measurement error of 5 %.

6 Specimens

6.1 Handling

In order to prevent disturbing its structure, the sample shall be handled as infrequently as possible and shall not be folded. Keep the sample in a flat position without any load.

6.2 Selection

Take specimens from the sample in accordance with ISO 9862.

6.3 Number and dimensions

Cut three test specimens from the sample with the length parallel to the machine direction and three specimens with the length parallel to the cross-machine direction so that the specimens measure at least 0,3 m in the length, or flow, direction, and at least 0,2 m in the cross-machine direction. When the width of the product is less than 0,2 m, the full width of the product shall be tested by modifying the apparatus.

The specimen shall be cut in a location where the structural integrity of the structure will not be affected. If this leads to the use of a specimen that is less than the width of the apparatus, the edges shall be sealed, for example with a block of closed-cell foam. The calculation of in-plane flow capacity shall be made using the actual width of the specimen. The normal load and hydraulic gradient applied shall be corrected taking into account dimensions of the specimen as well as foam properties. For an apparatus with rigid platen loading (see Figure 2), the length of the specimen shall be equal to the length of the loading platen, taking into account 5.1 j).

For products without integrated flow to both sides of the core which are to be used for single-sided drainage, six specimens shall be taken to enable testing of each of the two sides after one of them has been sealed.

It is important that the specimen width is not undersized, i.e. that it shows a good push-tight fit.

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.

When the geocomposite includes a central impermeable core (e.g. a double cuspated sheet) and the flow to drain penetrates only from one face of the geosynthetic, the flow capacity test should be performed on a specimen purposely prepared in order to prevent the input flow along one of the two faces of the impermeable core (for example by placing a rubber or mastic strip at the inlet of the specimen). If the flow collected by the geosynthetic is transported on both sides of the impermeable core to the outlet, the flow capacity test should be performed on a specimen with soft–soft boundaries. When the geocomposite with an impermeable core is not planarly continuous, but it is used in the form of discrete narrow strips, the input flow in the geocomposite strips can also occur laterally and be transported on both sides of the impermeable core. In this case, the flow capacity test should be performed on a specimen with soft–soft boundaries.

6.4 Specimen condition

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

7 Test procedure

7.1 Measure the thickness of the test specimens at a pressure of 20 kPa in general accordance with ISO 9863-1.

7.2 Place the specimens under water containing 0,1 % volume non-ionic surfactant at laboratory temperature, gently stir to remove air bubbles and leave to saturate for at least 12 h.

7.3 Define the thickness of the foam contact surface in relation to the nominal thickness of the test specimen.

7.4 Place the lower foam or lower polyethylene liner contact surface material on the base of the apparatus and then place a test specimen on top. Place the upper foam or upper polyethylene liner contact surface material over the specimen in a similar manner. Lower the loading platen or pressure membrane on to the test specimen.

7.5 Apply a seating stress between 2 kPa and 10 kPa (including the loading platen) to the test specimen and fill the inlet reservoir with water to allow the water to flow through the test specimen in order to remove air. Take all necessary precautions to avoid preferential flow paths along the boundaries of the specimen. If such flows are observed, reseat or discard the specimen as necessary.

7.6 Adjust the normal stress to 20 kPa and hold this pressure for 360 s.

7.7 Fill the inlet reservoir to the level corresponding to the hydraulic gradient 1.

NOTE   It is good practice to flush out air bubbles potentially trapped in the specimen by applying a much higher hydraulic gradient, such as 1,0 or more, before proceeding with the measurement under the selected gradient.

7.8 Allow water to flow through the specimen under these conditions for 120 s ± 5 s.

For some materials, especially those exhibiting compression creep, the stress sometimes tends to decay during the test if, for example, a hydraulic jack is employed to apply the stress. In this case, continual readjustment of the stress is necessary to maintain a constant value during the test period.

7.9 Collect the water passing through the system over a fixed period of time in the measuring vessel. The volume of water collected shall be at least 0,05 l and the collection time shall be at least 5 s. Record the volume of water collected.

For products with a very low water flow capacity, for the volume of water collected, the collection time may be limited to 600 s. Record the water temperature. Repeat this procedure two more times, i.e. take three flow readings in all, and take the average of the volumes of water collected.

If a discharge gauge is used then the discharge rate shall be the average of three consecutive readings with a minimum time interval between readings of 15 s.

In any case, the maximum permissible measurement error of 2 % should be respected (according to 5.6).

7.10 Reduce the hydraulic gradient to 0,1 while maintaining the stress value. Repeat the procedure given in 7.9.

7.11 Increase the hydraulic gradient to 1,0, increase the normal compressive stress to 100 kPa and hold for 120 s prior to flow. Repeat the procedure given in 7.9 and 7.10.

7.12 Continue in this way until the specimen has been tested at each hydraulic gradient and at least for stresses equal to 20 kPa, 100 kPa and 200 kPa.

7.13 Repeat the entire sequence of operations given in 7.4 to 7.12 for the remaining test specimens.

NOTE   If agreed between the parties, it is possible to determine the water flow capacity at some specific loads and gradients selected from the ones mentioned in this clause.

8 Calculations and expression of results

8.1 Products with a continuous structure (i.e. with no discrete draining elements)

Calculate the in-plane water flow capacity $q_{\mathrm{p\,index}(\sigma/i)}$ at 20 °C for each given hydraulic gradient and normal stress, for homogeneous products, using Formula (1):

$$q_{\mathrm{p\,index}(\sigma/i)} = \frac{V \times R_{\mathrm{T}}}{W \times t} \tag{1}$$

where

$q_{\mathrm{p\,index}(\sigma/i)}$ is the in-plane water flow capacity per unit width at a defined stress and gradient, in litres per metre second [(l/s)/m];

V is the average volume measured, in litres;

R_{T} is the correction factor for converting to a water temperature of 20 °C (see Annex A);

W is the width of the specimen, in metres;

t is the time, in seconds.

Where the discharge rate Q has been measured directly, a temperature correction is necessary, and the in-plane water flow capacity $q_{\mathrm{p\,index}(\sigma/i)}$ is then given by Formula (2):

$$q_{\mathrm{p\,index}(\sigma/i)} = \frac{Q \times R_{\mathrm{T}}}{W} \tag{2}$$

where Q is the discharge rate, in cubic metres per second.

Express the in-plane water flow capacity $q_{\mathrm{p\,index}(\sigma/i)}$ to two significant figures.

When the product is heterogeneous, the unit of replication should preferably be defined and subsequently converted to a value per metre width.

8.2 Products with discrete draining elements

For products with discrete draining elements, the contribution of the main layer (i.e. geotextile) and the spacing of the discrete draining elements (i.e. pipe) shall be considered in the determination of an equivalent in-plane water flow capacity per unit width of the geocomposite. To do so, six specimens shall be taken on the laboratory sample to enable testing of all parts of the product contributing to the water flow:

— three specimens including one single draining element;

— three specimens located between draining elements, identified "carrier".

Both series of tests shall be performed on the same test width.

Calculate the in-plane water flow capacity of the specimen cut in the cross-machine direction without draining elements as described in 8.1.

The average of three measurements is identified as $Q_{\sigma,i\,(C+L)}$ for the discharge rate of the carrier with one draining element and $Q_{\sigma,i\,(C)}$ for the discharge rate of the carrier alone.

The discharge rate in l/s passing through a single draining element under these test conditions, $Q_{\sigma,i\,(L)}$, is then determined by Formula (3):

$$Q_{\sigma,i\,(L)} = Q_{\sigma,i\,(C+L)} - Q_{\sigma,i\,(C)} \tag{3}$$

The index in-plane water flow of the product can then be determined by adding up the contributions of the draining elements and the carrier, considering the distance between two draining elements D, as shown in Formula (4):

$$q_{\text{p index}(D)(\sigma,i)} = \left[\frac{Q_{\sigma,i(C)}}{W} + \frac{Q_{\sigma,i(L)}}{D} \right] \times R_T \tag{4}$$
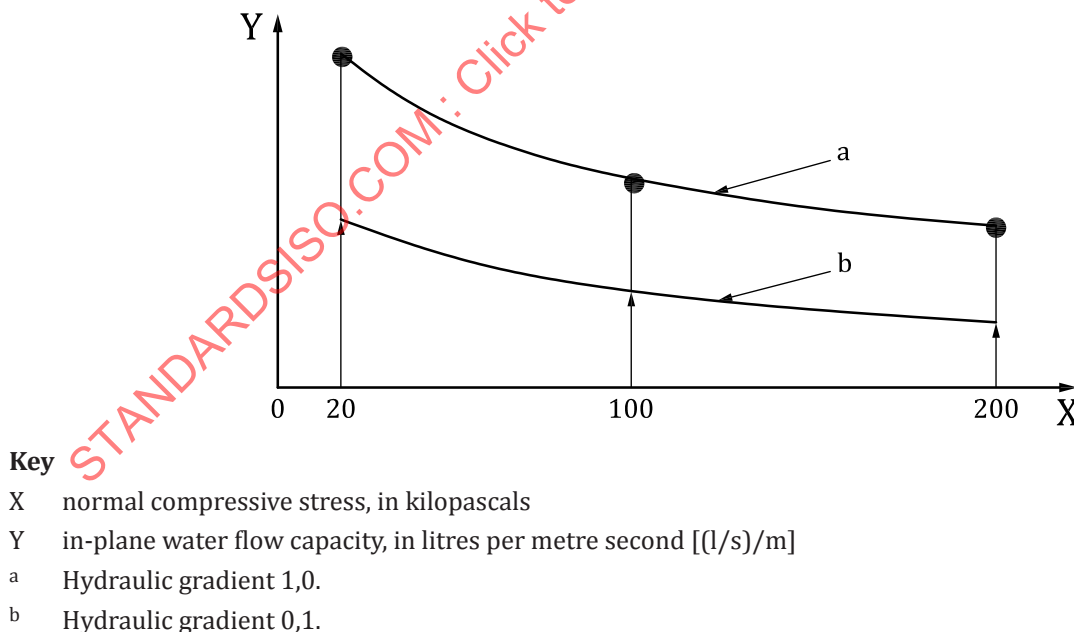
where

W is the test width;

D is the distance between two draining elements, in metres.

8.3 Graphical representation

Results can be expressed as a plot of in-plane water flow capacity versus normal compressive stress for the two hydraulic gradients used (see Figure 3).

Key

X normal compressive stress, in kilopascals

Y in-plane water flow capacity, in litres per metre second [(l/s)/m]

a Hydraulic gradient 1,0.

b Hydraulic gradient 0,1.

Figure 3 — Typical examples of in-plane water flow capacity curves

9 Test report

The test report shall include the following information:

a) reference to this document, i.e. ISO 12958-1:2020;

b) test laboratory and test operator;

c) description of the geotextile or geotextile-related product, in accordance with ISO 10320;

d) details of the apparatus used, including a diagram;

e) width and length of the specimen;

f) description of the tested plane for double-cuspated geospacer;

g) description of the boundary conditions (F/F, R/F, R/R);

h) if required, a table giving the experimental data and the calculations for each specimen (see Annex B):

— one table with the results on the specimens including at least one draining element (machine direction only),

— one table with the results on the specimens of the part located between draining elements (machine direction and cross direction);

i) combined plot of the normal compressive stress and the in-plane water flow capacity for both applied hydraulic gradients (see Figure 3), if the full in-plane water flow capacity characteristics are being measured;

j) mean in-plane water flow capacity values at the defined hydraulic gradients and normal stresses and, if required, the individual values (see Table 1);

k) water temperature range;

l) water type (de-aerated, stilled or mains supply);

m) any deviation from the procedure described in this document;

n) any anomaly in the hydraulic behaviour of the geotextile or geotextile-related product under test;

o) date of the test.

Table 1 — Presentation of test results in the recommended operating range

Product designation:				Date:		
Flow direction:				Type of contact surfaces:		
Sample designation:						
Specimen	$q_{p\ index\ (20/1)}$ (l/s)/m	$q_{p\ index\ (100/1)}$ (l/s)/m	$q_{p\ index\ (200/1)}$ (l/s)/m	$q_{p\ index\ (20/0,1)}$ (l/s)/m	$q_{p\ index\ (100/0,1)}$ (l/s)/m	$q_{p\ index\ (200/0,1)}$ (l/s)/m
1						
2						
3						
Mean						

Annex A
(informative)

Determination of the correction factor R_T for conversion to a water temperature of 20 °C
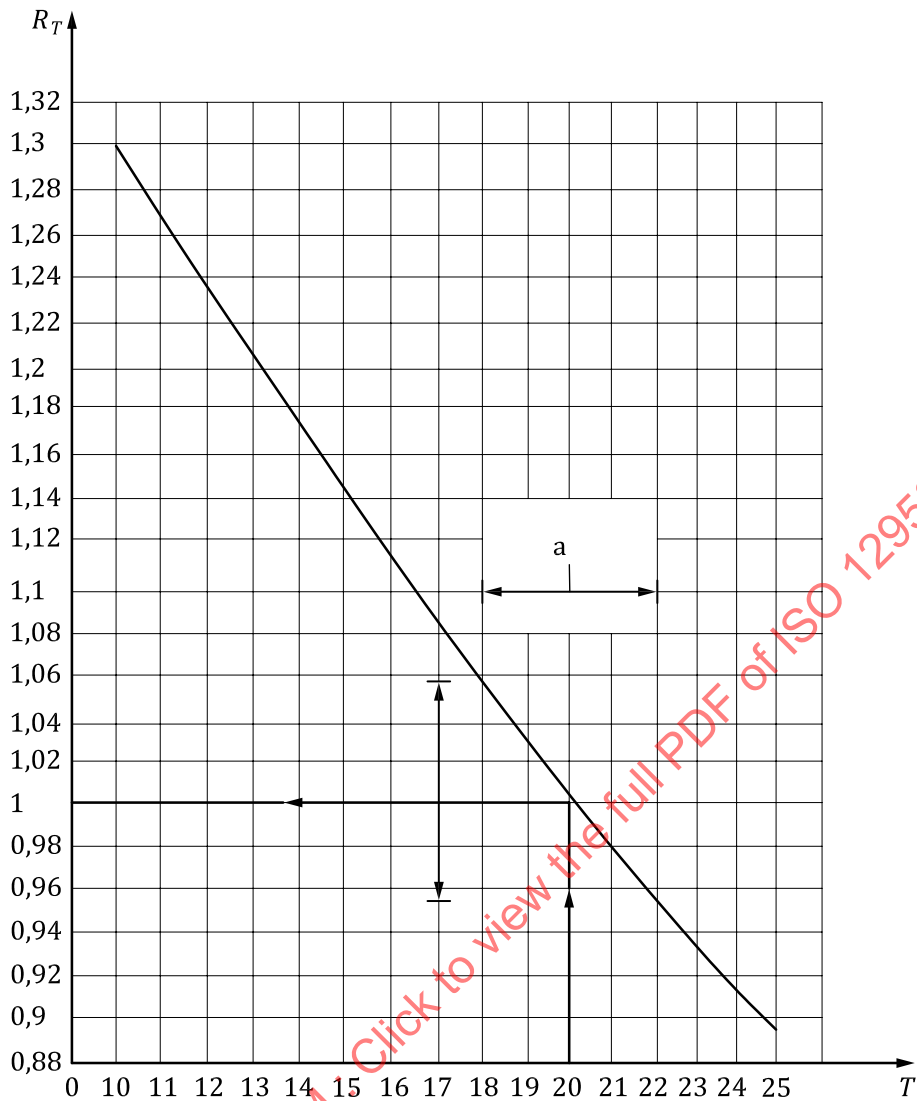
$$R_T = \frac{T}{20} = \frac{1{,}762}{1 + 0{,}033\,7T + 0{,}000\,22T^2} \text{ (dimensionless)}$$

where

R_T is the correction factor for converting to a water temperature of 20 °C;

T is the water temperature, in degrees Celsius.

A graphical representation of R_T versus T is given in Figure A.1.

Key

T test temperature, in degrees Celsius

R_T correction factor

a   Temperature range 18 °C to 22 °C (see 5.2).

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