Guidelines for Testing Geotextiles

for Navigable Waterways

January 1994
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Bibliography

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   Control (quality control) of construction materials, construction components and construction design

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1. Table of tests to be performed for basic, suitability, manufacturer’s factory production control (FPC), third party inspection and check tests for geotextiles

2. Sample test report for a basic test

3. Sample test report for a check test
1 General

These Guidelines deal with the testing of the material and filtration properties of geotextiles used as filters or as separation layers to protect the banks and bottoms of waterways or other structures on waterways. Reference is made in the Guidelines to the Technical Supply Conditions for Geotextile Filters /1/.

Products from other member states of the European Community or originating in the member states of the European Economic Area that do not comply with these technical specifications will be deemed equivalent if they permanently provide the same degree of protection that is required in respect of safety, health and serviceability. The same applies to tests and inspections conducted in the country of manufacture.

2 Tests

2.1 General

The various types of test are listed below:

- basic tests
- suitability tests
- factory production control tests by the manufacturer
- third-party inspection tests
- check tests (by the client)

2.2 Basic tests

2.2.1 General

Basic tests are conducted to verify the suitability of geotextiles for their intended purpose /1/. They are performed for manufacturers and suppliers upon request.

2.2.2 Information to be supplied by the applicant

Name and address of the manufacturer of the geotextile
Name of product
Product group
Name and address of the manufacturer or supplier of the fibres
Raw material(s) and their proportions
Raw material quality (new or recycled materials)
Raw material properties – absolute density, melting point, tensile strength, strain at failure
Additives (stabilizing agents, adhesives, etc.)
Type of fibre or yarn
Fineness of fibres or yarn
Nominal length of fibres
Strength of fibres or yarn
Colour of fibres or yarn
Proof of quality control during manufacture of the fibres
Type of bonding/assembly
Length of production unit (roll)
Roll width as manufactured
For factory-made seams, the data specified under 3.5.2.3.
Tests values for the properties of the materials, i.e. mass per unit area, thickness and tensile strength, expressed as mean values, including the standard deviation
Additionally, the number of samples and whether the test values were obtained using samples taken from a prototype or from a production run.

2.2.3 Requirements for laboratory samples

The applicant shall provide a sample for laboratory testing ("laboratory sample"). The sample shall be at least 5 m long, span the entire width of the roll and have an area of not less than 15 m². It shall be obtained from the middle section of the production unit.

The manufacturer’s name, product name, date of manufacture, number of the roll and the position at which the sample was taken in relation to the machine and cross-machine directions shall be marked indelibly on the upper surface of the sample. The upper surface is the surface of the geotextile designed to be installed facing upwards (i.e. towards the water or air).

A sample as specified in 3.5.2 shall be submitted for a basic test if the product includes factory-made seams.

For non-wovens and composites, samples each comprising 100 g of each type of fibre used in the geotextile shall be provided. For woven materials, 100 g of each yarn used in the weft and the warp shall be supplied.

2.2.4 Number and type of tests

The basic test comprises the tests described in Annex 1. The number and type of tests required for the mechanical and filtration properties are determined by the applicant and will depend on the intended use of the product.

2.2.5 Test report

The test data obtained in tests on qualitative characteristics as specified in the Technical Supply Conditions for Geotextile Filters /1/ are stated on a data sheet.

The characteristic values obtained in the tests are expressed in the test report as mean values, including the standard deviation and coefficient of variation.

The test data required to demonstrate compliance with the standard requirements set out in the Technical Supply Conditions for Geotextile Filters /1/ are stated on a data sheet.

The test results obtained using test methods to determine quantitative characteristics, i.e.

- mass per unit area
- thickness
- hydraulic conductivity
- tensile strength
- opening size
- mechanical filtration stability
- hydraulic filtration stability

are stated as follows:

- for minimum permitted values: the mean value minus the standard deviation
- for maximum permitted values: the mean value plus the standard deviation.

The qualitative characteristics determined in the test methods for
- resistance to dynamic perforation loads
- abrasion resistance
- resistance to temperatures up to 200°C
are deemed to have been confirmed if compliance with the requirements is demonstrated for all samples.

Test reports are issued in duplicate.

2.2.6 Reference sample
A reference sample with an area of 1 m² is taken from the laboratory sample submitted for the basic test and stored in a dark place at an ambient temperature of between 15°C and 35°C as specified in DIN 50014 for the period of validity of the test report.

2.2.7 Period of validity of the test report
The test report for the basic test is usually issued for a period of five years. The validity period may be extended once only for a further five years upon request provided that neither the product, the raw materials, the characteristic values of the fibres or yarns nor the method of production have changed and a statistical evaluation performed in accordance with /9/ and /10/ shows that the results of factory production control by the manufacturer and third-party inspection are at least equivalent to the test data obtained in the basic test. The third-party inspection reports shall be appended to the application.

2.3 Suitability test
Suitability tests /1/ are performed by the contractor. They may be needed to demonstrate compliance with requirements that arise owing to conditions specific to a particular construction project and are consequently not covered by the test report for the basic test.

The number of tests and the test methods used depend on which properties require verification. The test specifications set out in the Guidelines for Testing Geotextiles for Navigable Waterways, the relevant standards or other recognized test methods are normally used. In all other respects, the procedure is the same as that for the basic tests.

2.4 Quality control
2.4.1 Factory production control during production
See clause 4.4.1 of the Technical Supply Conditions for Geotextile Filters /1/.

2.4.2 Third-party inspection during production
See clause 4.4.2 of the Technical Supply Conditions for Geotextile Filters /1/.

2.4.3 On-site checks by the company installing the geotextile
See clauses 4.4.1 and 4.4.4 of the Supplementary Technical Contract Conditions – Hydraulic Engineering (ZTV-W), service area 210.

2.5 Check tests
2.5.1 General
Check tests are performed by the client to demonstrate that the geotextiles comply with the agreed properties.

2.5.2 Testing
Sampling, data on samples and the type, frequency and number of tests shall be as specified in clause 4.5 of the Technical Supply Conditions for Geotextile Filters /1/.

2.5.3 Test report
The results of the check test, together with the specified limit values and the values obtained in the basic test, are stated in the test report. It must be checked that the requirements specified in the invitation to tender have been met. The effect of any deviations must be properly assessed. Additional tests shall be performed prior to the final assessment if the deviation is classified as a defect (a defect usually being defined as failure to meet a requirement).

a) The filtration stability is tested if the mass per unit area and/or the hydraulic conductivity are found to be outside the tolerances specified for the basic test but all other requirements have been met. The resistance to dynamic perforation loads (if relevant) is also tested if the mass per unit area is lower than specified.

b) The number of random samples is doubled if the requirements for tensile strength, thickness or the size of openings are not satisfied. All the samples, including those taken previously, are evaluated.

Subject to confirmation, the product will usually be deemed to have passed the check test if the relevant requirements are met when the additional test is performed or after the number of samples has been doubled. If this is not the case, the procedure specified in clause 5 of the Technical Supply Conditions for Geotextile Filters /1/ shall be followed. The test report is issued in duplicate.

2.5.4 Scope
The test report issued upon completion of the check tests is only valid for that part of the construction project covered by the test.

2.5.5 Reference sample
No samples are taken from the laboratory sample or stored for reference purposes. Any remnants are stored for a maximum of three months.

3 Test methods
3.1 General principles
The following provisions apply to test methods and test reports in accordance with this test specification unless stated otherwise in the description of the test method:
- If a test method is closely based on a standard, that standard shall be stated, together with any deviations or additional provisions.
- Samples shall be taken from the laboratory sample as specified in DIN 53803, Part 2.
- It is recommended that 10 individual samples be tested in both the basic test and the suitability test. A minimum of five samples should be tested if the tests are complex. Five samples are usually sufficient for quality control tests.
- The tests are performed at a temperature of between 15°C and 35°C (test atmosphere as specified in DIN 50014).
- Drinking water is used for all tests described in this test specification.
- The geotextiles are either air- or oven-dried at a temperature not exceeding 40°C. Mineral materials used as substrates or filtrates are dried at 105°C, except for soil type 4 (see clause 3.8.2.2) which is dried at 70°C.
- The upper surface of a geotextile is the surface installed facing upwards.
- Any deviations from the test specification (e.g. for the suitability test) must be stated in the test report.
- Any sections of the test report in which test values obtained by third parties (e.g. values stated in works' certificates) are used must be marked as such and the source of the test values stated.
- Statistical evaluations shall be based on DIN 55303 Part 5 /10/, DIN 55350 /11/ and the "Basic Principles" issued by the Federal Institute of Construction Technology /9/.

3.2 Determination of types and proportions of raw materials
3.2.1 Test methods
The types and proportions of raw materials used are determined by the methods specified in the First Regulations for Analyses (Erste Analysenverordnung) of 20 December 1973 and the Second Regulations for Analyses (Zweite Analysenverordnung) of 29 July 1974 in accordance with the Textiles Marking Act /6/.

The types of raw material are only determined if a works' certificate has not been provided by the manufacturer of the fibres.

3.2.2 Test report
State the following information in the test report:
- the test method used,
- any special preconditioning
- the types of material and their proportions, expressed as mean values with standard deviations and coefficients of variation, to one decimal place.

3.3 Fineness of fibres and yarns
3.3.1 Test methods
Terms and the principles of measurement are explained in DIN 53810 "Fineness of staple fibres". Depending on the type and shape of the fibres, the tests specified in DIN 53811 "Determination of the diameter of fibres", DIN 58812, Part 1 "Determination of the fineness of staple fibres - Gravimetric method" and in DIN 58812, Part 2 "Vibroscope method" are used.

The fineness (linear density) of yarns is tested as specified in DIN 53830 Part 3. The fineness is only determined if a works' certificate has not been provided by the manufacturer of the fibres.

3.3.2 Test report
State the following information in the test report:
- the test method used,
- the mean value, standard deviation and coefficient of variation of the fineness of the fibres, in dtex or in per cent to one decimal place.

3.4 Mass per unit area
3.4.1 Single-layered geotextiles (non-wovens and wovens)
3.4.1.1 Test method
The mass per unit area of single-layered geotextiles is determined as specified in DIN 53854 "Determination of the weight of fabrics with the exception of knitted fabrics" using 10 circular samples, each with an area of 100 cm² (diameter: 112.8 mm). The samples are obtained by punching. The punching tool must be capable of cutting samples to an accuracy of 0.05 mm. For on-site checks, the mass per unit area can also be determined using a sample with an area of not less than 1 m² or, alternatively, using 10 rectangular samples, each with an area of 100 cm². After the samples have been cut out, measure them to the nearest 1 mm. Then calculate the area of each sample and express it in cm², rounded to one decimal place.

3.4.1.2 Test report
State the following information in the test report:
- the mean value and standard deviation, in g/cm², to the nearest whole number,
- and coefficient of variation in per cent, to one decimal place.

3.4.2 Multilayered geotextiles (geocomposites)
3.4.2.1 Test methods
For geocomposites, the total mass per unit area of the material and the mass per unit area of the individual layers are determined. The total mass per unit area is determined by testing 10 circular samples, each with an area of 100 cm², as described in 3.3.1.1. The samples are subsequently divided into their constituent layers and the mass per unit area of each layer determined separately as described in 3.3.1.1.

3.4.2.2 Test report
The total mass per unit area and the mass per unit area of each layer are stated as specified in 3.3.1.2.
3.5 Thickness and density

3.5.1 Single-layered geotextiles (non-wovens and wovens)

3.5.1.1 Test methods
The thickness and density of single-layered geotextiles is determined as specified in DIN 53855 Part 1 “Determination of the thickness of fabrics”.

By way of departure from DIN 53855 Part 1, the test is performed on 10 circular samples, each with an area of 25 cm² (diameter: 56.4 mm) and obtained by punching. The thickness of each sample is determined under a circular loading pad with a test surface measuring 25 cm² at a test pressure of 2 kN/m². The density is calculated in accordance with 3.4 from the mean thickness determined as specified in 3.3.

3.5.1.2 Test report
State the following information in the test report:
a) the mean thickness, in mm, to one decimal place.
b) the mean density, in g/cm², to two decimal places.

The standard deviations and coefficients of variation are also stated.

3.5.2 Multilayered geotextiles (geocomposites)

3.5.2.1 Test methods
The thickness of geocomposites is determined by testing a stack of five individual samples in two stages. The overall thickness is determined first, followed by the thickness of the individual layers. The overall thickness is measured as specified in 3.4.1.

3.5.2.2 Sampling, number of samples and conditioning
Rectangular samples, each 10 x 30 cm in size, are punched out, five in the machine direction and five in the cross-machine direction. The samples obtained in one of the directions are placed on top of each other, with their lower surfaces facing upwards, to form a stack. The samples are separated horizontally by four flat metal plates placed between the samples. The shape and dimensions of the metal plates enable them to act as templates for stacking the samples and aligning them correctly in the measuring section of the apparatus. The stack is positioned on the left-hand side of the measuring section of the test apparatus and low enough for the metal plates to be in contact with the guide rods. The longitudinal cut edges of the samples will be measured and they must be flush with the edges of the metal plates. The vertically infinitely adjustable cover plate is lowered until the distance between it and the base, which is parallel to it, is five times the thickness of the geocomposite and four times the thickness of the metal plates. A pressure of 2 kN/m² is applied, resulting in deformation of the individual samples in the stack.

3.5.2.3 Apparatus
The apparatus is an optoelectronic test set-up (Figs. 1 and 2). In addition to a specimen holder with three reference marks for aligning and fixing the stack of samples and to enable them to be displaced laterally at the same level, the apparatus comprises a vertically adjustable measuring microscope connected to a digital displacement measuring device and a computer for logging, analysing and documenting the readings.

3.5.2.4 Procedure
Focus the horizontal cross-wire in the sights of the optical measuring device on each of the boundaries between the individual layers in turn at the three measuring planes located in the centre of the specimen and 10 cm to the right and left of its centre, work perpendicular to the longitudinal axis of the stack, starting at the bottom and moving upwards. Set the best possible correspondence between the cross-wire and the boundaries between the layers over a width of 12 mm on the microscope. Record each reading on the computer.

Fifteen readings are recorded for each layer of the geocomposite. Manual measurements are taken directly on the stack in a similar manner.

The mean value, standard deviation and coefficient of variation for each individual layer are obtained in the analysis. The test is performed at a pressure of 2 kN/m² as specified in 3.4.1.

3.5.2.5 Test report
The total thickness of the geocomposite, the thickness of each layer, together with the densities, are stated as specified in 3.4.1.2.

3.6 Tensile strengths and strains

3.6.1 Wovens, non-wovens and composites

3.6.1.1 Test methods
The tensile strength and strain of geotextiles are tested in the machine direction and the cross-machine direction as specified in DIN 53857 “Simple strip method for fabrics”, Part 1 of which deals with wovens and Part 2 with non-wovens and composites.

Samples containing polyamides or with any additional chemical treatment (coatings) are tested using the wet tensile test. All other woven geotextiles are tested in a dry condition. Ten samples, each measuring 100 mm in width and with a clear length of 200 mm when installed, are tested at a deformation rate of 200 mm/min in each test direction. Samples of wovens are clamped over their entire width. Non-wovens and geocomposites are folded into 5 cm wide strips as specified in the standard. Samples of geocomposites comprising thick layers are clamped over their entire width if they cannot be folded easily into strips along their length.

3.6.1.2 Test report
State the following information in the test report:
a) the mean value, standard deviation and coefficient of variation of the
- the tensile strength, expressed as the maximum tensile force at failure, in kN/m or in per cent to two or one decimal place(s);
- the elongation at the maximum tensile force at failure, expressed in per cent to one decimal place;
b) graph showing the change in elongation plotted against the tensile force

c) for wovens, the number of threads held by the clamp.

3.6.2 Seams

3.6.2.1 Sampling, number of samples and conditioning

A straight seam joining two geotextile sheets and measuring 1.5 m in length is required as a laboratory sample. Five specimens, each with a length of 30 cm and a width of 20 cm, are cut in such a way that the seam is in the centre of each strip and is perpendicular to the direction of the tensile force. Starting at the cut edges, the seam is unpicked over a length of approx. 5 cm at each end, leaving a length of 10 cm intact. The threads of the unpicked seam are tied together tightly several times. The specimens are then cut to a width of 10 cm, taking care not to damage the knots in the thread.

3.6.2.2 Procedure

Test the unfolded sample as specified in 3.5.1.1. The characteristic values of the thread used for the seams are not usually tested.

3.6.2.3 Test report

State the following information in the test report:

a) the mean value, standard deviation and coefficient of variation of the maximum tensile force at failure in kN per metre seam length or in per cent, to two or one decimal place(s)

b) description of the seam (single or double seam, prayer or flat seam; distance from the edges; no. of stitches per 10 cm seam length; any other information)

c) raw material, fineness and tensile force of the thread, either as stated by the applicant or test results.

3.7 Hydraulic conductivity normal to the plane of geotextiles

3.7.1 Test method

The test method is used to determine the hydraulic conductivity of a geotextile normal to its plane, the test being performed on an unloaded sample. The test conducted is a falling head test in which the velocity v of the flow through the geotextile sample is determined as a function of the hydraulic head h. The way in which changes in temperature affect the viscosity of water is taken into account. The k/h relationship or k/i relationship can be calculated from the relationship between the flow velocity and the hydraulic head (v/h) for a known layer thickness.

3.7.2 Test apparatus (example of BAW test apparatus)

The test apparatus (Figs. 3 and 4) comprises two vertical Perspex test cylinders, 1035 mm and 1300 mm in length and with inside diameters of 142 mm, an unplasticized PVC sample container for the geotextile sample, a PVC tube with an inside diameter of 60 mm providing a hydraulic connection between the two cylinders, an electrically controlled DN 50 pneumatic valve and air-free drinking water supplied through a ½” pipe connection. The decrease in mass during the test is recorded by the weighing cell of a strain gauge with a 50 kg nominal load at the suspension of the larger test cylinder. The readings are recorded on a PC with specialized application software by means of a measuring amplifier and an analogue-digital converter. The test is recorded on-line in the form of a chart. Specialized application software is used to evaluate the test results.

If a different test set-up is used, it must be ensured that the values of the following are the same as for the BAW test apparatus:

- the hydraulic head
- the area of the sample
- the weighing cell
- the minimum diameter of the connecting pipe.

3.7.3 Sampling, number of samples and conditioning

Ten samples (each with a diameter of 165 mm) are taken from the laboratory sample using either a sample cutter or a punch. The samples are weighed and their mass per unit area and thickness at the centre are measured.

The samples are stored in water for at least 12 h before the test. Swellable fibrous raw materials (PA, PAC) are stored for a minimum of 24 h.

Remove the air from the samples by squeezing them out by hand under water several times until no more air bubbles appear.

3.7.4 Procedure

Re-fill the section between the reducer on the smaller test cylinder and the sample container with fresh air-free water before the first test on each day of testing. The suspended sample container is placed on the base and fixed so that the sample can be installed. Remove the Perspex tube and install the water-conditioned sample under water in the sample container with its lower surface facing upwards (covered with 2 to 3 cm of water). Replace the Perspex tube and close the pneumatic valve. Fill the apparatus with air-free water up to a height of 1 m above the upper edge of the sample container. Lift the larger test cylinder using the lifting device until the upper edges of the sample container and the reducer on the smaller cylinder are level with each other. Then adjust the water level in the smaller cylinder so that it is flush with the upper edge of the reducer by adding or discharging water. Start the test by pressing the start button on the PC when a hydraulic head of 1 m has been reached. The actual test starts when the pneumatic valve is opened as soon as the coordinate axes (ordinate = hydraulic head in cm, abscissa = time in seconds) with the initial hydraulic head appear on the screen. The decrease in weight of the larger test cylinder is measured at the predetermined rate and passed to the PC. The acquisition programme produces an on-line representation of the decrease in the hydraulic head over time on the computer screen and saves the data for separate evaluation. The temperature of the water is measured to the nearest 0.1°C at the beginning, in the middle and at the end of the test, after which the acquisition programme calculates the mean value and records the readings. The test ends when the water level is the same in both cylinders (v = 0 m/s).

3.7.5 Evaluation

The flow velocity normal to the geotextile sample is calculated by evaluating the change in the weight of the larger
test cylinder step by step. The mass $G$ of the water discharged during a specified time interval $t$ is calculated from the weight measurements (Fig. 5). At the same time, the mean hydraulic head $h$ is determined from the weight measured in the relevant time interval. Reducing the time interval $t$ enables the flow velocity at any time $t_x$ to be measured more accurately.

The water level at which the weight change rate, e.g. the flow velocity $v$ through the geotextile sample, is zero is selected as the reference level for $h$ (Fig. 5). The values of $v$ and $h$ are calculated step by step as follows:

\[ v_T = \frac{G}{A \cdot \gamma_w \cdot t} \]  
(Eq. 1a)

\[ h = \frac{2(G^* - G_{\text{min}})}{A \cdot \gamma_w} \]  
(Eq. 1b)

where

- $v_T$ is the flow velocity [m/s] perpendicular to the plane of the geotextile at the measured water temperature $T$ [°C]
- $h$ is the hydraulic head [m]
- $G$ is the difference in weight [kN] at time interval $t$
- $t$ is the selected time interval [s]
- $G^*$ is the mean weight [kN] of the larger test cylinder in the selected time interval
- $G_{\text{min}}$ is the lowest measured weight of the larger test cylinder (reference level)
- $A$ is the area of the geotextile sample through which water flows [m²]
- $\gamma_w$ is the unit weight of the water [kN/m³]
- $R_T$ is the correction factor for the reference water temperature $T = 20°C$
- $R_{T10}$ is the correction factor in accordance with Fig. 6 for converting the flow velocity at the reference temperature of 20°C to that at 10°C

The flow velocity $v$ determined in the test is converted to the value at the reference temperature of 20°C.

\[ v_{20} = \frac{v_T}{R_T} \]  
(Eq. 2)

The correction factor $R_T$ is given in Figure 6. Intermediate values can be obtained by linear interpolation.

A regression analysis is used to smooth the individual results over their entire spread. The readings taken as the valve is being opened must not taken into account.

\[ h = a \cdot v_{20} + b \cdot v_{20}^2 \]  
(Eq. 3)

$v_{20}$ is plotted against the hydraulic head $h$, being the abscissa in the linear network.

The coefficient of permeability $k$ at 10°C can be calculated from $v_{20}$ and $h$ using the following equations.

\[ v_{10} = \frac{v_{20}}{R_{T10}} \]  
(Eq. 4)

\[ k_{10} = \frac{v_{10} \cdot d}{h} \]  
(Eq. 5)

where $d$ is the nominal thickness of the filtration layer [m] obtained in accordance with 3.6.3.

3.7.6 Test report

State the following information in the test report:

- a graph showing the flow velocity $v_{20}$ plotted against the hydraulic head $h$ and the smoothed results for the individual samples
- the mean value, standard deviation and coefficient of variation of
  - the flow velocities $v_{20}$ at $h = 5$ and 25 cm in m/s or in per cent, to two or one decimal place(s)
  - the $k_{10}$ values at $h = 5$ and 25 cm in m/s or in per cent, to one decimal place in exponential representation.

3.8 Opening size of geotextiles

3.8.1 Test methods

The characteristic opening size of geotextiles is determined by wet screening using a defined test soil. During the test, the geotextile functions in the same way as a screen. The characteristic opening size is obtained from the soil passing through the geotextile and the coarser material retained on it.

The characteristic opening width ($D_w$ or $O_{90}$) is characterized by the diameter of the coarsest single fraction of the test soil, with 90% of the fraction being retained on the geotextile.

3.8.2 Sampling, number of samples and conditioning

Five samples, each with a diameter of 192 mm, are taken from the laboratory sample and stored under water for a minimum of 24 hours prior to the test.

3.8.3 Test apparatus

The test apparatus comprises a vertically oscillating laboratory screen and an electromagnetic drive; it can accommodate test screens with a diameter of 200 mm, has an oscillation frequency of 50 Hz and produces vertical oscillations with an amplitude of 1.5 mm when under load (Fig. 7). After conditioning as described in 3.7.2, the sample is placed in a 200 mm diameter test screen. The test set-up is assembled as follows, starting at the bottom and working upwards.

- screen
- pan with tube for discharging the soil passing through the screen
- 200 mm diameter test screen with a mesh size between 5-10 mm in which the sample is placed
3.8.4 Procedure
The test is conducted using either a no. 1 or no. 2 silica sand mix, dried at 105°C, depending on the expected opening size (Fig. 8). Care must be taken to ensure that \( D_W (O_{90}) \) is between \( d_{10} \) and \( d_{90} \).

Place the conditioned sample flat on the screen and fasten down its edge with a clamping ring. A mesh with approx. 5 mm apertures can be fixed at the side around 5 mm above the geotextile sample to break up any lumps of sand during sieving. Spread 300 g of the test soil, corresponding to 1.4 g/cm², evenly over the sample.

Before sieving begins, saturate the test soil with water using the screen head. During the subsequent wet screening process regular visual checks must be carried out to ensure that the soil particles do not begin to float, adjusting the water supply if necessary. Check the actual amplitude of the screen shown on the gauge at the beginning of the test and adjust it if necessary.

Collect the soil passing through the geotextile during screening on a paper filter with an aperture size \( \leq 4.5 \mu m \). After a screening period of 15 minutes, first switch off the screen, then the water supply.

Recover the soil collected on the geotextile by rinsing and beating the sample after it has been dried at 105°C, then add it to the soil retained on the geotextile.

Determine the particle size distribution of the soil passing through the screen and that retained on the geotextile as specified in DIN 18123 after the soils have been dried at 105°C. The determination is performed using a set of screens with mesh sizes 2.0, 1.18, 1.0, 0.71, 0.5, 0.40, 0.20, 0.10, 0.063 and 0.045 mm in accordance with ISO 565, R 20, or DIN 4188.

Test each of the five specimens and evaluate each one separately.

3.8.5 Evaluation
\[ G_D \] mass of each fraction of the material passing through the filter [g]
\[ G_R \] mass of the each fraction of the material retained on the filter [g]
\[ G_T \] total mass of material passing through the filter and material retained on the filter \((G_D + G_R)\) [g]

The ratio of the mass of the soil passing to that of the total mass, expressed in per cent \((G_T/G_T \times 100)\), for each of the mesh sizes used is taken from the wet screening test record (Table 2) and plotted on the probability network. Join the dots on the graph using straight lines (Fig. 9).

The apparent opening size \( D_W (O_{90}) \) of the geotextile corresponds to the particle diameter at \( G_D/G_T \times 100 = 10\% \) (Fig. 9).

3.8.6 Test report
State the following information in the test report:
a) mean value, standard deviation and coefficient of variation of the apparent opening size in mm or in per cent, to two or one decimal place(s).
b) the test soil used.

3.9 Filtration stability

3.9.1 Mechanical filtration stability for sandy and slightly silty soils (flow-through method)

3.9.1.1 Test method
The method is used to test the mechanical filtration stability of geotextiles for use with sandy or slightly silty soils \((d_{90} \geq 0.06 \text{ mm})\) on exposure to alternating flows through the material. The mechanical filtration stability of geotextiles for use with the test soil, or with similar soils with a specified particle range, is determined by measuring the soil passing through the geotextile at each stage of the test /2/. The test results will also show whether the rate at which soil passes through the geotextile has stabilized as required.

This test method only delivers results that can be reliably reproduced for sandy to slightly silty soils with k-values \( \geq 1\times10^{-5} \text{ m/s} \). The reversing turbulent flow method is used for finer-grained or less permeable soils.

3.9.1.2 Test soils
Three different types of soil are used for the standard test. The grading bands are shown in Fig. 10 (see also /1/ and /2/; see the reversing turbulent flow method for soil type 4). The test can also be performed with other permeable soils \((k \geq 1\times10^{-5} \text{ m/s})\) if required.

3.9.1.3 Sampling, number of samples and conditioning
Five samples, each with a diameter of 168 mm, are punched out of the laboratory sample. The samples are first placed in the unplasticized PVC ring with the upper surface of the geotextile facing downwards, then on the stainless steel screen, each of the edges being pushed under the groove at the circumference of the screen. The PVC pipe is placed in the unplasticized PVC ring and pressed firmly against the sample. 1500 g of test soil (dried at 105°C) are placed loosely in the test space formed by the geotextile and the PVC pipe, to form a even layer. The sample container is clamped together using the PVC coupling, the Perspex pipe, the upper brass ring and the threaded brass rods. The sample container is lowered very slowly into the water tank up to the lower edge of the PVC coupling for conditioning and testing. As soon as the water levels in the sample container and the water tank are the same, fill the sample container carefully with water from above while at the same time holding it under water to prevent a hydraulic head from forming. The sample container is fastened at a depth of 415 mm below the surface of the water until the beginning of the test.

3.9.1.4 Test apparatus
The test apparatus comprises a test frame with an electric motor, an electronic control system, a continuous shaft with rope pulleys, 10 sample containers and 10 water...
The electronic control system regulates the speed required for the drive, the direction of rotation, the length of the stationary phases at the highest and lowest points and the lifting and lowering times.

The lifting and lowering heights depend on the diameter of the water tanks as the constant displacement of water by the sample container causes the water level in the water tanks to fall or rise in relation to the diameter of the tanks (BAW = 7 cm).

If a different test set-up is used, care must be taken to ensure that:
- the area of the samples
- the sample containers
- the lifting, lowering and stationary phases and
- the hydraulic heads

are the same as for the BAW test apparatus as regards number, dimensions and shape.

3.9.1.5 Procedure

Measure the temperature of the water in the tank at the beginning and the end of the test. The sample containers, which are stored 415 mm below the water surface until the test, are alternately immersed in water and then removed from the water during the test. Each lifting and lowering phase lasts 7 seconds; the stationary phases at the highest and lowest points each last 30 sec. The initial hydraulic head of 400 mm occurring when the sample containers have been lifted out of the water decreases during the 30 sec stationary phase at the highest point by the quantity of water discharged. The head loss depends on the permeability of the test soil and the hydraulic conductivity of the geotextile. During immersion and the stationary phase under water the head loss corresponds to the maximum hydraulic head. The water flowing through the sample from below causes the soil to fracture, producing intense turbulence. The loading caused by alternating the flow directions lasts a total of 34 hours (1826 lifting and lowering operations). The water tanks in which the samples are immersed are exchanged for sediment-free water containing the sample and the sample container causes the water level in the water tanks to fall or rise in relation to the diameter of the tanks (BAW = 7 cm).

The quantity of soil washed through the filter sample during each test phase is determined by filtering, drying (at 105°C) and weighing.

3.9.1.6 Evaluation

The mean quantities of soil passing through the filter during each test phase are determined for each of the five samples and plotted against the four loading phases to produce a cumulative curve (Fig. 13).

The hydraulic gradient at the highest point (I = h/d) is plotted in a graph below the abscissa of the diagram.
placed in a sample container with the upper surface of the geotextile facing downwards. 1500 g of soil type 4 are placed loosely on the geotextile and spread evenly over the sample using an adjustable gauge. The test soil is dried to constant mass at 70°C directly before installation and then compacted using a load that exerts a surface pressure of 2 kN/m² on the geotextile. The load is produced by the 1500 g of soil type 4 and a 151 mm diameter brass disc weighing 2130 g. Two pieces of non-woven geotextile material (mass per unit area: 600 g/m², thickness: 6 mm) with diameters of 152 mm are placed between the upper surface of the test soil and the brass disc to prevent any loss of soil at the annular gap between the sample mould and the disc. The test specimen is fastened securely on a vertically oscillating electromagnetic screen (e.g. as described in 3.7.3) for compaction. A 5 mm thick PVC disc placed beneath the geotextile prevents the material sagging while the soil is being compacted. The soil is compacted at a frequency of 50 Hz and an amplitude of 1.5 mm for 240 seconds. The lid of the test specimen is then closed and the specimen stored in drinking water up to a depth of 20.5 cm. Remove the specimen at an angle to prevent any air bubbles being trapped under the surface of the geotextile.

3.9.2.4 Test apparatus
The test apparatus is designed to test three samples simultaneously (Fig. 14). It comprises a load-bearing steel frame with a flange-mounted electric motor (the drive), an electric control system, a v-belt drive, drive shafts fitted with turbulence-producing fans, sample containers and testing and collecting vessels. The materials, dimensions and structure of the sample containers are shown in Fig. 15. The containers are fastened firmly to the test frame by means of the brass pipe bolted in the centre of the Perspex lid. The pipe is also used to evacuate air from the sample containers and equalize the pressure in them during the test. The water level in the water tank at rest is set using the millimetre scale on the Perspex window at the front of the tank. The rotor speed depends on the fixed v-belt pulley ratios. A reliable means of measuring the speed will be required if a variable-speed motor is used.

The 4-bladed turbulence-producing agitator rotating at 260 rpm produces a turbulent flow that hits the filter sample at speeds between 70 and 90 cm/s. The passage of the blades beneath the geotextile sample produces pressure pulsations with a frequency of 17.3 Hz.

If a different test set-up is used the dimensions and shape of the test vessel, the turbulence-producing fan and the sample container as well as their lay-out and the distances between them must be the same as for the BAW test apparatus. The same applies to the fan speed and the water level in the tank.

3.9.2.5 Procedure
Measure the water temperature in the test vessels at the beginning and end of the test. Fill the test vessels with drinking water up to a depth of 20.5 cm. Remove the sample container from the water in which it has been stored and place it in the test vessel immediately, immersing it at an angle to prevent any air bubbles forming beneath the test surface. Adjust the height of the sample container by placing a spacer with a height of 3 cm between the lower edge of the sample container and the upper surface of the fan and fasten it to the test frame. The spacer is removed for the test. Subject the filter sample to a turbulent flow for five loading phases each lasting 30 min (a total of 150 min). Each phase is started manually at the control unit and terminated by a timer after 30 minutes. The number of test phases is shown on a phase counter.

Discharge the water in the water tank into a vessel after each loading phase and carefully rinse the tank. Continue the test after refilling the tank with fresh water. The quantity of soil passing through the filter is determined from the water collected in the vessel by filtering, drying (at 105°C) and weighing.

3.9.2.6 Evaluation
The mean values for the soil passing through the filter obtained for the five samples are plotted against the loading phases to produce a cumulative curve (Fig. 16).

The slope of the graph shows whether the filtration rate has stabilized, the relevant values being the quantity of soil washed through the filter in the final test phase (120 to 150 min after the beginning of the test). Geotextiles are deemed to act as stable filters for soil type 4 if the quantity of soil passing through the filter during the final test phase and the quantity passing during the test as a whole (mean value + standard deviation) does not exceed the maximum permitted quantities specified in /1/ and /2/.

3.9.2.7 Test report
State the following information in the test report:

a) the type of soil used in the test. If a soil other than soil type 4 is used, state the soil parameters plasticity, cohesion, uniformity and grading
b) mean value, standard deviation and coefficient of variation of the quantity of soil passing through the filter during the final test phase and the quantity passing during the test as a whole in g and in g/m² or in per cent, to one decimal place
c) the cumulative curve of the mean values of the soil passing through the filter

3.9.3 Hydraulic filtration stability
3.9.3.1 Test method
The method is used to determine the hydraulic conductivity of unloaded soil-covered geotextile samples normal to their plane (hydraulic filtration stability). The test procedure and apparatus are very similar to those described in clause 3.6. Any variations are given below.

3.9.3.2 Sampling, number of samples and conditioning
Following the test to determine the mechanical filtration stability, the filter samples in which test soil has collected (clauses 3.8.1 and 3.8.2) are taken out and the overlying soil removed down to the surface of the geotextile. A filter sample is then placed in the larger test cylinder with its lower surface facing upwards. The water level is now below the sample, in contrast to clause 3.6. Fill the test cylinder with water very slowly and carefully from below, the water passing through the sample until the water level is around 3 cm above the upper surface of the sample. Continue to fill the cylinder, this time from above, until a water column of 50 cm has been reached. Store the
samples in water until the test unless testing takes place immediately after the mechanical filtration stability test.

3.9.3.3 Procedure
The hydraulic conductivity of the five samples is determined as specified in clause 3.6 by performing one measurement per sample. By contrast to clause 3.6, the test is conducted with a hydraulic head of 50 cm. The total thickness of the soil-covered geotextile is measured in the centre of the sample as described in clause 3.4 prior to the test.

3.9.3.4 Evaluation
The test results are evaluated as described in clause 3.6, taking the total thickness of the soil-covered geotextile as the thickness.

3.9.3.5 Test report
Include the following in the test report:
- the drop energy: 600 Nm (size class II) /4/
- the type of any damage and the drop energy used
- the number of samples damaged
- the flange of the cart to enable the sample to be fixed more firmly in place.

3.10 Resistance to dynamic perforation loads

3.10.1 Test method
The method is used to test the resistance of geotextiles to dynamic perforation loads (impacts). The type and severity of the load should simulate the load that could occur on the construction site, e.g. during the installation of armourstone.

To test the resistance to dynamic perforation loads a rammer with a defined drop energy is dropped onto a geotextile sample placed on the test soil and fastened down around its edge. The test will provide either a pass or fail result.

3.10.2 Sampling, number of samples and conditioning
Five 100 x 100 cm samples are cut out of the laboratory sample for the test. The sand bed is compacted by tamping it in the cart outside the test rig and its surface is struck off level with the supports. The particle range of the sand bed corresponds to that of soil type 3 as described in clause 3.8.1.2. The sand bed measures 80 x 80 cm and is 31 cm deep. The geotextile sample can be a non-woven, composite or woven material. Its lower surface is placed on the sand bed such that the direction of the sample with the lower tensile force in accordance with clause 3.5 is at right angles to the longitudinal axis of the cutting edge of the rammer. For woven materials, 3 mm thick rubber sheeting with a textile insert is placed around the flange of the cart to enable the sample to be fixed more firmly in place.

3.10.3 Test apparatus
The test apparatus (Fig. 17) comprises a test rig with four columns and a central rammer guide comprising two columns, a 76 kg rammer with a specially designed cutting edge, a rammer lifting-device driven by an electric motor, an electromagnetic rammer coupling and release mechanism, and a hydraulic lifting device for installing and removing the samples, a hydraulic press for loading the samples during the test and a cart containing a sand bed.

If a different test set-up is used, the drop energy of the rammer, the design of the cutting edge, the support conditions and the way in which the geotextile is fastened down must be the same as for the BAW test apparatus.

3.10.4 Procedure
The standard test is performed under the following conditions:
- hydraulic pressure of 100 bar
- edge fastening: 12.2 N/cm²
- drop energy: 1200 Nm (size class III) /4/
- edge fastening: 12.2 N/cm²
- substrate: 31 cm soil type 3, dry, medium density
- drop energy: 600 Nm or 1200 Nm mark, depending on the require-
ments
- edge fastening: 12.2 N/cm²

Place the prepared sample on the cart in the test position beneath the test rig and clamp it down at the edges with a hydraulic pressure of 100 bar. Lift the rammer to either the 600 Nm or 1200 Nm mark, depending on the requirements, and release it to perform the test. Remove the sample after securing the rammer in its rest position and examine it for damage.

Perforations (holes) and any visible changes indicating a reduction in filtration stability and strength (e.g. damage to the weft and warp threads, displacement of threads) are regarded as damage.

This test can also be performed as a suitability test using a different drop energy and/or another soil type.

3.10.5 Test report
State the following information in the test report:
- the drop energy used
- the type and extent of any damage and the number of samples damaged

Geotextiles shown to have sufficient resistance to dynamic perforation loads at 1200 Nm will also have sufficient resistance at 600 Nm, provided the same test soil is used.

3.11 Abrasion resistance

3.11.1 Test method
The test method simulates abrasion loads on geotextiles such as that caused by the movement of rocks in a revetment. A mixture of stone chippings and water passes over geotextile samples installed in a rotating drum for 40,000 revolutions in an anti-clockwise direction and 40,000 revolutions in a clockwise direction. If the samples are not
destroyed in the test their tensile force, thickness and mass per unit area are subsequently determined. The changes in the test values during the test are used to assess the abrasion resistance.

3.11.2 Sampling, number of samples and conditioning

Ten samples, each measuring 200 x 300 mm, are cut out of the laboratory sample in the direction of the lower tensile force (see clause 3.5). The samples are stored under water with a temperature of 20 ± 5°C for a minimum of 24 hours prior to the test. The samples are fastened onto steel plates for the test and installed in the abrasion sections of the test apparatus. The upper surface of the geotextile must be exposed to the abrasion loads.

3.11.3 Test apparatus

The test apparatus (Fig. 18) comprises an octagonal steel drum with eight test sections driven by a horizontal shaft, an adjustable drive motor, an electronic control system and a test frame. The direction of rotation can be changed and the number of revolutions per minute and the total number of revolutions can be set as required.

The composition of the abrasive material is as follows:
- 2 kg of 8/11 mm angular-grained high-quality basalt chippings
- 1 kg of 5/8 mm angular-grained high-quality basalt chippings
- 1 kg of 2/5 mm angular-grained high-quality basalt chippings
- 8 l of water

If a different test set-up is used, the dimensions, geometry and rotational speed of the test drum and the type and quantities of abrasive material used must be the same as those used for the BAW test apparatus.

Other particle sizes can be used for suitability tests, depending on the loads expected to occur on site.

3.11.4 Procedure

The standard test comprises two abrasion phases of 40,000 revolutions each. Set the drum speed at 16 rpm and reverse the direction of rotation every 5,000 revolutions. Examine the samples visually after the first 40,000 revolutions. If the samples have not been destroyed renew the abrasion mixture and carry out the second phase.

If the samples have not been destroyed after 80,000 revolutions take five samples from the centres of the abraded surfaces and test their tensile strength (as specified in clause 3.6). Before conducting the tensile force test, prepare the samples by washing them thoroughly and air-drying them. The mass per unit area (clause 3.3) and the thickness (clause 3.4) of the dried samples are determined prior to the test.

3.11.5 Test report

State the following information in the test report:
a) mean value, standard deviation and coefficient of variation of the density in g/cm³, thickness in mm, mass per unit area in g/m² and tensile strength in kN/m to the number of decimal places stated in the relevant clauses.

3.12 Resistance to high temperatures (200°C)

3.12.1 Test method

The method is used to assess the resistance of geotextiles to brief exposure to high temperatures (e.g. asphalt mastic, temperature approx. 170°C). The changes in the tensile strength at the maximum tensile force that are caused by exposure to heat are taken as the criterion for assessing the resistance to high temperatures. Geotextiles made of the fibrous raw materials PA PAC and PES do not need to be tested as their resistance to high temperatures is already known. Geotextiles containing PE or PP or based on a new raw material must be tested.

3.12.2 Sampling, number of samples and conditioning

Five 300 x 100 mm samples are taken from the laboratory sample in the direction of the lower tensile force (clause 3.5) for the tensile test and stored in a dry place in the laboratory until thermal exposure. After exposure, the preparation of the samples continues as described in clause 3.5.

3.12.3 Test apparatus

Perforated calcium silicate bricks as specified in DIN 106 with the dimensions 24 x 11.5 x 11.3 cm, an oven with a temperature range up to 220°C and the test equipment described in clause 3.5 are required for the test.

3.12.4 Procedure

Heat the bricks to 200°C in the oven for one hour, then place them on the samples such that surfaces to be tested in the tensile test are exposed to heat. Place the bricks on the samples with their unperforated sides facing downwards and leave them there until they have cooled to room temperature. The tensile test can be performed immediately afterwards.

3.12.5 Test report

State the following information in the test report:
- mean value, standard deviation and coefficient of variation of the tensile strength in kN/m or in per cent, rounded to the nearest whole number.

3.13 Static puncture test

The static puncture test is used as an index test to assess the resistance of geotextiles to puncture. The resistance to puncture may be important in the construction of revetments if the latter are subjected to unavoidable traffic by construction vehicles.

The static puncture test can be used to assess the suitability of geotextiles for use as separation layers in service roads, site roads or under a high layer of cover material. The static puncture test is performed as specified in DIN 54307.
3.14 Verification of compliance with the General Requirements stated in the Technical Supply Conditions for Geotextile Filters

3.14.1 Environmental compatibility
PAC-, PA-, PES-, PE- and PP-based geotextiles manufactured solely by mechanical means (wovens, non-wovens) will cause no harm to the environment during normal use on navigable waterways. Based on the data obtained for the basic test, the test house will decide whether verification is required and, if so, how it should be performed.

3.14.2 Resistance to decay, oil, sea water and frost
Many years of experience have shown that geotextiles complying with the criteria stated in 3.13.1 are resistant to decay, oil, sea water and frost, i.e. they will fulfil their required function if they are installed and maintained correctly. In the case of novel raw materials and manufacturing methods, the test house will decide to what extent verification is required and, if so, which methods are to be used (e.g. DIN 53739, DIN 53521, DIN 53857).

3.14.3 Limited resistance to UV radiation
The light-resistance of geotextiles is limited to the installation period in normal applications. However, the light-resistance of PA, PE and PP without stabilizing agents and additives is also limited during installation. The test house will assess the light-resistance based on the data obtained in the basic test. In cases of doubt, the applicant will be required to submit a works’ report or works’ certificate issued by the manufacturer of the fibres.

3.14.4 Capacity to adapt to irregularities in the soil
The available test methods do not state any objective testing criteria for this requirement. The test house will assess this requirement on the basis of the elongation in the tensile test and the subjective comparison with geotextiles that have been tried and tested in practice.

3.14.5 Full bonding of multilayered geotextiles (geocomposites)
The layers of geocomposites are usually joined together mechanically. The geotextile can be bonded over its entire area by an adequate degree of needle-punching. Spot connections as permitted in the Technical Supply Conditions for Geotextile Filters are limited to connections between the filter layer and an additional layer. The geotextiles are examined visually after they have been separated into their individual layers. There is no limiting value for the tensile stresses that geotextile layers exert on each other.

3.14.6 Test report
The test report must state which requirements have been satisfied.
Fig. 1 Apparatus for measuring the thickness of single- and multilayered geotextiles

Example: BAW test apparatus
Fig. 2  Apparatus for measuring the thickness of single- and multilayered geotextiles
Example: BAW test apparatus

Section A-A

5 geotextile sample 300/100mm
4 separating plates 300/105/1,25mm

max. height of sample stack 140mm

Depth of sample stack

distance between front edges of samples and axis of measuring instrument

marking gauge for digital displacement measurements

centring microscope
**Fig. 3** Sample container (Detail A, Fig. 4)
Example: BAW test apparatus

[Diagram of sample container with details on loading pad, stainless steel screens, and wire mesh sizes]
Fig. 4 Test apparatus for the determination of the hydraulic conductivity normal to the plane of a geotextile

Example: BAW test apparatus

electric hoist

weighing cell

water level at start of test

cylinder for collecting the water that has flowed through the sample

water level at end of test

temperatur sensor

gotextile sample

electrically controlled pneumatic valve
Fig. 5: Example of head loss over time

Explanations | Remarks
--- | ---
(1) weight of measuring cylinder at start of test | (1) - (2) range unsuitable for evaluation purposes
(2) weight of measuring cylinder after valve has fully opened | 
(3) lowest weight of measuring cylinder | (2) - (3) range suitable for evaluation purposes
(4) example of calculation | see table 1
Table illustrating how to determine the flow velocity $V_{20}$ as a function of the hydraulic head $h$ using a weighing cell

<table>
<thead>
<tr>
<th>Nr.</th>
<th>A [m²]</th>
<th>$G_{max}$ (h=0.9) [kN]</th>
<th>Water-temperature T [°C]</th>
<th>Interval selected</th>
<th>Correction factor $R_{20}$</th>
<th>$G^*$ = $G$/[(5)+(8)]</th>
<th>$G$ = (5)-(8)</th>
<th>$V_{20}$ = $[(10)-(8)]/[(2)-(7)]$. $V_w$</th>
<th>$H$ = 2.($[(9)-(3)]/[(2)]$. $V_w$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>0.0177</td>
<td>0.0506</td>
<td>20.8</td>
<td>0.0745</td>
<td>0.0709</td>
<td>1.44</td>
<td>0.975</td>
<td>0.07276</td>
<td>0.00363</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1) Example to illustrate Fig. 5
**Fig. 6:** Correction factor $R_T$ to take account of the viscosity of the water, based on the reference water temperature of 20°C.
Fig. 7: Test apparatus for determining the apparent opening size

- Spray nozzle
- Test soil sample on a wide-meshed sieve
- Vertically oscillating screen
- Filter to collect test soil
Fig. 8: Particle size distributions for test soils 1 and 2
**Table 2: Sample wet-screening test record**

<table>
<thead>
<tr>
<th>mesh size (mm)</th>
<th>percent finer D</th>
<th>percent coarser R</th>
<th>test soil T = D + R</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>G₀, D, ΣD</td>
<td>G₀, R, ΣR</td>
<td>G₀ + G₀, T</td>
</tr>
<tr>
<td></td>
<td>g, %, %</td>
<td>g, %, %</td>
<td>g, %, %</td>
</tr>
<tr>
<td>2.50</td>
<td>0.00, 0.00, 13.46</td>
<td>0.00, 0.00, 100.00</td>
<td>0.00, 0.00, 0.00</td>
</tr>
<tr>
<td>1.18</td>
<td>0.00, 0.00, 13.46</td>
<td>7.20, 2.40, 2.40</td>
<td>100.00, 7.20, 2.40</td>
</tr>
<tr>
<td>0.71</td>
<td>0.00, 0.00, 13.46</td>
<td>25.80, 8.60, 11.00</td>
<td>100.00, 25.80, 8.60</td>
</tr>
<tr>
<td>0.50</td>
<td>0.00, 0.00, 13.46</td>
<td>28.80, 9.60, 20.60</td>
<td>100.00, 28.80, 9.60</td>
</tr>
<tr>
<td>0.40</td>
<td>0.01, 0.00, 13.46</td>
<td>26.39, 8.80, 29.40</td>
<td>98.96, 26.40, 8.80</td>
</tr>
<tr>
<td>0.20</td>
<td>1.23, 0.41, 13.45</td>
<td>90.57, 30.19, 59.59</td>
<td>98.66, 91.88, 30.60</td>
</tr>
<tr>
<td>0.10</td>
<td>8.97, 2.99, 13.04</td>
<td>60.03, 20.01, 79.60</td>
<td>87.00, 69.00, 23.00</td>
</tr>
<tr>
<td>0.063</td>
<td>7.99, 2.66, 10.05</td>
<td>14.21, 4.74, 84.33</td>
<td>64.01, 22.20, 7.40</td>
</tr>
<tr>
<td>0.045</td>
<td>7.66, 2.55, 7.39</td>
<td>5.54, 1.85, 86.18</td>
<td>41.97, 13.20, 4.40</td>
</tr>
<tr>
<td>&lt;0.045</td>
<td>14.51, 4.84, 83.01</td>
<td>1.09, 0.36, 86.54</td>
<td>6.99, 15.00, 5.20</td>
</tr>
<tr>
<td>Σ</td>
<td>40.37, 13.46, 258.63</td>
<td>86.54</td>
<td>300.00, 100.00</td>
</tr>
</tbody>
</table>
Fig. 9: Graph of the ratio of the mass of the soil passing to that of the total mass, expressed in per cent \( \frac{G_D}{G_T} \times 100 \).

\[ D_W = 0.11 \text{ mm at } \frac{G_D}{G_T} \times 100 = 10\% \]
Fig. 10: Grading bands for soil types 1 to 4 used as test soils

Mean coefficients of permeability $k$ for soil types BT1 to BT4

- Soil type 1 = gravelly sand
  \[ k = 4 \cdot 10^{-4} \text{ m/s} \]
- Soil type 2 = medium sand with fine sand
  \[ k = 3 \cdot 10^{-4} \text{ m/s} \]
- Soil type 3 = slightly silty fine to medium sand
  \[ k = 6 \cdot 10^{-5} \text{ m/s} \]
- Soil type 4 = medium to coarse silt
  \[ k = 1 \cdot 10^{-9} \text{ m/s} \]
**Fig. 11:** Test to determine the mechanical filtration stability using the flow-through method.
Example: BAW test apparatus

The head loss during the lifting phase and the 30s stationary phase depends on the permeability of the test soil and the hydraulic conductivity of the geotextile.
Fig. 12: Sample container.
Example: BAW test apparatus
Fig. 13: Cumulative curve of the soil passing through the filter and the corresponding hydraulic gradient \(i\) at the beginning of the stationary phase at the highest point

**MECHANICAL FILTRATION STABILITY FOR SOIL TYPES 1-3, FLOW-THROUGH METHOD**
Fig. 14: Test apparatus for determining the mechanical filtration stability using the reversing turbulent flow method. Example: BAW test apparatus.
Fig. 15: Example: BAW test apparatus

**Test container**

**Section A - A**

**Section B - B**

**Cross-section through sample container**

- Perspexrubber gasket
- PVC tube
- test soil 1500gr
- unplasticized PVC
- Geotextile sample 168 ø
- Stainless steel mesh
  - Mesh size 12mm, wire size 1mm
Fig. 16: Example of a cumulative curve for the soil passing through the filter (soil type 4)

MECHANICAL FILTRATION STABILITY FOR SOIL TYPE 4
Reserving turbulent flow method
Fig. 17a: Test apparatus for determining the resistance to dynamic perforation loads.
Example: BAW test apparatus
Fig. 17b: top view

Section A - A

rails for cart
Fig. 18: Abrasion tester.
Example: BAW test apparatus
Fig. 19: Installation of sample
Example: BAW test apparatus

Section A - B

- Steel plate
- Sponge rubber
- Steel plate
- Geotextile sample
- Abrasion plate V2A, 3mm
- PVC, 8mm
<table>
<thead>
<tr>
<th>Column 1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tests to be conducted</td>
<td>Basic test</td>
<td>Suitability test</td>
<td>Quality control test</td>
<td>Third-party inspection</td>
<td>Check test</td>
</tr>
<tr>
<td>1</td>
<td>Determination of types of raw materials</td>
<td>(x) Only if a certificate is not provided by the manufacturer of the fibres.</td>
<td>(x) Only if a certificate is not provided by the manufacturer of the fibres.</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>Fineness of fibres</td>
<td>(x) Same as for line 1</td>
<td>(x) Same as for line 1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>Mass per unit area</td>
<td>x</td>
<td>x</td>
<td>1st roll 1), then every 500 m²</td>
<td>x During the six-monthly standard test</td>
</tr>
<tr>
<td>4</td>
<td>Thickness Density</td>
<td>x</td>
<td>x</td>
<td>1st roll 1), then every 2,600 m²</td>
<td>x Same as for line 3</td>
</tr>
<tr>
<td>5</td>
<td>Tensile strength</td>
<td>x</td>
<td>x</td>
<td>1st roll 1), then every 2,500 m²</td>
<td>x Same as for line 3</td>
</tr>
<tr>
<td>6</td>
<td>Hydraulic conductivity</td>
<td>x</td>
<td>x</td>
<td>1st roll 1), then every 2,500 m²</td>
<td>x Same as for line 3</td>
</tr>
<tr>
<td>7</td>
<td>Opening size</td>
<td>x</td>
<td>-</td>
<td>1st roll 1), then every 2,500 m²</td>
<td>x Same as for line 3</td>
</tr>
<tr>
<td>8</td>
<td>Filtration stability as determined by the BAW's flow-through or reversing turbulent flow method</td>
<td>Soil type to be selected by the applicant</td>
<td>(x)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>9</td>
<td>Resistance to dynamic perforation loads</td>
<td>x</td>
<td>Drop energy (600 or 1200 Nm) to be selected by the applicant</td>
<td>(x)</td>
<td>-</td>
</tr>
<tr>
<td>10</td>
<td>Abrasion resistance</td>
<td>x</td>
<td>(x)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>11</td>
<td>Resistance to high temperatures</td>
<td>x</td>
<td>(x)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>12</td>
<td>Static puncture test</td>
<td>At the applicant’s request</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>13</td>
<td>General material properties in accordance with section 3.1 of the Technical Supply Conditions for Geotextile Filters</td>
<td>x</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Notes and additions:
1) The suitability test is performed to check compliance with specific requirements. The tests in lines 1 to 6 are required for identification purposes. The remaining tests (x) depend on the type of construction project.
2) The information given in the 4th column refers to the manufacturer’s factory production control.
3) The term “1st roll” applies to the commencement of production and the resumption of production at a later date.
Federal Waterway Engineering and Research Institute
(BUNDESANSTALT FÜR WASSERBAU)
(B A W)

TEST REPORT
for the
Basic Test on
Geotextiles for Navigable Waterways

Client:
Product name:
Date of commission:
No. of commission:
No. of test report:

Issued by: Department: Structural Engineering
Section: Construction Materials

This test report has pages and annexes.

Karlsruhe, (date)
The test report is valid until ............

- Only unabridged versions of this test report may be used. -
1 Preliminary remarks

The following tests were performed as specified in the Guidelines for Testing Geotextiles for Navigable Waterways published by the Federal Waterway Engineering and Research Institute (BAW),

2 General description

2.1 Dimensions of samples

The sample received by the BAW on ............... has the following dimensions:
Length: m
Width: m
Area: m²

2.2 Information supplied by the client

Manufacturer:
Product name:
Product group:
Raw materials (fibres):
Percentages of fibres:
Fineness(es) of fibres:
Type of bonding or assembly:
Additives:

2.3 Description after visual inspection

Sample

2.4 Remarks

Mean value
Standard deviation
Coefficient of variation

ρ
σ
v
3 Test results

3.1 Types and percentages of raw materials

As stated in the works' certificates (DIN 50049) issued by the manufacturer of the fibre and the manufacturer of the geotextile.
As determined in tests performed to section 3.1 of the Guidelines for Testing Geotextiles on Navigable Waterways.

<table>
<thead>
<tr>
<th></th>
<th>PA</th>
<th>PAC</th>
<th>PE</th>
<th>PES</th>
<th>PP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Types and percentages of raw materials</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3.2 Fineness of fibres and yarns

As stated in the works' certificate (DIN 50049) issued by the manufacturer of the fibre.
As determined in tests performed to section 3.2 of the Guidelines for Testing Geotextiles on Navigable Waterways.

<table>
<thead>
<tr>
<th>Type of fibre/yarn:</th>
<th>PA</th>
<th>PAC</th>
<th>PE</th>
<th>PES</th>
<th>PP</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>dtex</td>
<td>dtex</td>
<td>dtex</td>
<td>dtex</td>
<td></td>
</tr>
</tbody>
</table>

3.3 Mass per unit area

| Totalmass:               | ± g/m² | % |
| 1st filter layer:       | ± g/m² | % |
| 2nd filter layer:       | ± g/m² | % |
| Additional layer:       | ± g/m² | % |

3.4.1 Thicknesses at 2 kN/m² normal stress

| Total thickness:         | ± mm  | % |
| 1st filter layer:       | ± mm  | % |
| 2nd filter layer:       | ± mm  | % |
| Additional layer:       | ± mm  | % |

3.4.2 Density at 2 kN/m² normal stress

| Totalmass:               | ± g/m² | % |
| 1st filter layer:       | ± g/m² | % |
| 2nd filter layer:       | ± g/m² | % |
| Additional layer:       | ± g/m² | % |
3.5 Tensile strengths of __ cm wide strips
folded / unfolded

In machine direction

<table>
<thead>
<tr>
<th>×</th>
<th>s</th>
<th>v</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum tensile force:</td>
<td>± kN/m</td>
<td>%</td>
</tr>
<tr>
<td>Elongation at maximum: tensile force:</td>
<td>± %</td>
<td>%</td>
</tr>
</tbody>
</table>

In cross-machine direction

<table>
<thead>
<tr>
<th>×</th>
<th>s</th>
<th>v</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum tensile force:</td>
<td>± kN/m</td>
<td>%</td>
</tr>
<tr>
<td>Elongation at maximum: tensile force:</td>
<td>± %</td>
<td>%</td>
</tr>
</tbody>
</table>

3.6 Hydraulic conductivity normal to the plane of the geotextile

3.6.1 Expressed as flow velocity $V_{20}$ in m/s with a hydraulic head (reference temperature 20 °C)

| h = 5cm | ± m/s | % |
| h = 25cm | ± m/s | % |

General equation for any value of $h$:

$V_{20} =$ m/s

3.6.2 Expressed as the coefficient of permeability $k_{10}$ in m/s with a hydraulic head (reference temperature 10 °C)

| h = 5cm | ± m/s | % |
| h = 25cm | ± m/s | % |

General equation for any value of $h$:

$k_{10} =$ m/s

3.7 Characteristic opening size ($D_W$ or $O_{90}$)

Test soil:

Apparent opening size $D_W$ ($O_{90}$)

<table>
<thead>
<tr>
<th>×</th>
<th>s</th>
<th>v</th>
</tr>
</thead>
<tbody>
<tr>
<td>Filter</td>
<td>± mm</td>
<td>%</td>
</tr>
<tr>
<td>Additional layer</td>
<td>± mm</td>
<td>%</td>
</tr>
</tbody>
</table>
3.8 Mechanical filtration stability

Soil passing through the filter

3.8.1 Soil type (flow-through method)

<table>
<thead>
<tr>
<th>Soil type</th>
<th>s</th>
<th>v</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total after 34 h</td>
<td>± g</td>
<td>%</td>
</tr>
<tr>
<td>In final test phase (10 h)</td>
<td>± g</td>
<td>%</td>
</tr>
</tbody>
</table>

3.8.2 Soil type 4 (reversing turbulent flow method)

<table>
<thead>
<tr>
<th>Soil type</th>
<th>s</th>
<th>v</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total after 2.5 h</td>
<td>± g</td>
<td>%</td>
</tr>
<tr>
<td>In final test phase (0.5 h)</td>
<td>± g</td>
<td>%</td>
</tr>
</tbody>
</table>

3.8.3 Hydraulic filtration stability

3.8.3.1 Soil type

Expressed as flow velocity $V_{20}$ in m/s with a hydraulic head

<table>
<thead>
<tr>
<th>h</th>
<th>s</th>
<th>v</th>
</tr>
</thead>
<tbody>
<tr>
<td>5cm</td>
<td>± m/s</td>
<td>%</td>
</tr>
<tr>
<td>25cm</td>
<td>± m/s</td>
<td>%</td>
</tr>
</tbody>
</table>

General equation for any value of $h$:

$V_{20} = \ldots$ m/s

Expressed as coefficient of permeability $k_{10}$ in m/s with a hydraulic head (reference temperature 10 °C)

<table>
<thead>
<tr>
<th>h</th>
<th>s</th>
<th>v</th>
</tr>
</thead>
<tbody>
<tr>
<td>5cm</td>
<td>± m/s</td>
<td>%</td>
</tr>
<tr>
<td>25cm</td>
<td>± m/s</td>
<td>%</td>
</tr>
</tbody>
</table>

General equation for any value of $i$:

$k_{10} = \ldots$ m/s

Sample
3.8.3.2 Soil type

Expressed as flow velocity $V_{20}$ in m/s with a hydraulic head

$$ h = 5\text{cm} \quad \pm \quad m/s \quad \% $$

$$ h = 25\text{cm} \quad \pm \quad m/s \quad \% $$

General equation for any value of $h$:

$$ V_{20} = \ldots \quad \text{m/s} $$

Expressed as coefficient of permeability $k_{10}$ in m/s with a hydraulic head (reference temperature 10 °C)

$$ h = 5\text{cm} \quad \pm \quad m/s \quad \% $$

$$ h = 25\text{cm} \quad \pm \quad m/s \quad \% $$

General equation for any value of $i$:

$$ k_{10} = \ldots \quad \text{m/s} $$

3.9 Resistance to dynamic perforation loads

No. of samples perforated on a sand bed (soil type 3) when subjected to one of the following perforation loads

- 600 Nm  No.
- 1200 Nm  No.

Any other damage observed:

3.10 Abrasion resistance

Test data after abrasion loads for

- mass per unit area  \( \pm \)  g/m²  \%
- thickness  \( \pm \)  m/s  \%
- density  \( \pm \)  g/m³  \%
- maximum tensile force  \( \pm \)  kN/m  \%
### Resistance to temperatures up to 200 °C

Test data after exposure to high temperatures

<table>
<thead>
<tr>
<th>Maximum tensile force</th>
<th>± kN/m</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>in machine / cross-machine direction</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Static puncture test

<table>
<thead>
<tr>
<th>Maximum static puncture force</th>
<th>± N</th>
<th>%</th>
</tr>
</thead>
</table>

Force/deformation function

<table>
<thead>
<tr>
<th>Force [N]</th>
<th>100</th>
<th>250</th>
<th>500</th>
<th>750</th>
<th>1000</th>
<th>1250</th>
<th>1500</th>
<th>1750</th>
<th>2000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deformation [%]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### General requirements as specified in section 3.1 of the Technical Supply Conditions for Geotextile Filters

The General requirements specified in the Technical Supply Conditions for Geotextile Filters have been satisfied.

Of the following General requirements specified in the Technical Supply Conditions for Geotextile Filters:

1. Environmental compatibility
2. Resistance to decay, oil, sea water and frost
3. Limited resistance to UV radiation
4. Capacity to adapt to irregularities in the soil
5. Full bonding of multilayered geotextiles

No(s). has/have been satisfied
No(s). has/have not been satisfied

Karlsruhe, (date)

Federal Waterway Engineering and Research Institute

pp. Technical Officer
# Geotextiles for Navigable Waterways

## Basic test

<table>
<thead>
<tr>
<th>No.</th>
<th>Test</th>
<th>Unit</th>
<th>Test value as specified in the Technical Supply Conditions for Geotextile Filters</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Types of raw materials and their percentages</td>
<td>%</td>
<td>± s</td>
</tr>
<tr>
<td>2</td>
<td>Fineness of fibres and yarns</td>
<td>dtex</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Mass per unit area</td>
<td>g/m²</td>
<td>1&lt;sup&gt;st&lt;/sup&gt; filter layer: 2&lt;sup&gt;nd&lt;/sup&gt; filter layer: Additional layer: Total mass per unit area:</td>
</tr>
<tr>
<td>4</td>
<td>Thickness/density</td>
<td>mm g/cm³</td>
<td>1&lt;sup&gt;st&lt;/sup&gt; filter layer: 2&lt;sup&gt;nd&lt;/sup&gt; filter layer: Additional layer: Total thickness:</td>
</tr>
<tr>
<td>5</td>
<td>Tensile strength in machine direction in cross machine direction</td>
<td>kN/m</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Hydraulic conductivity [W₀]</td>
<td>m/s</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Opening size [O₉₀]</td>
<td>mm</td>
<td>Filter layer: Additional layer:</td>
</tr>
</tbody>
</table>

### Filtration stability

#### Flow-through

- Soil passing through filter in 34 h: g
- Soil passing through filter in 24 - 34 h: g

#### Reversing turbulent flow

- Soil passing through filter in 150 min.: g
- Soil passing through filter in 120 – 150 min.: g

### Hydraulic filtration stability

- Soil type 1: Soil type 3: Soil type 2: Soil type 4:

### Resistance to dynamic perforation loads

- Armourstone size class II, 600 Nm: Nm
- Armourstone size class III, 1200 Nm:

### Abrasion resistance

- Thickness: mm g/cm³ kN/m Density: Tensile strength:

### Resistance to high temperatures

- kN/m Tensile strength:

### Static puncture test

- N % Static puncture resistance: $\varepsilon$

### General properties as specified in the Technical Supply Conditions for Geotextile Filters

- -

---

Commission no.: 
Date: 
Annex 1

---

**Karlsruhe, (date)**

**Technical officer:**
3.5 Tensile strength and strain
In machine direction

Zwick PC - Software 27001
3.8.1 Mechanical filtration stability for soil types 1-3
Flow-through method

soil passing [g]

soil type 3

gradient at highest point

\[ i = \frac{h}{d} \]
3.6 Hydraulic conductivity

Hydraulic Conductivity

\[ k \text{ [m/s] at 20°C} \]

\[ k = 4.08 \times 10^{-2} \times \text{i} \]

\[ \text{hydr. gradient i [\text{-}] } \]
3.8.3 Hydraulic filtration stability

Hydraulic conductivity of soil-covered samples

\[ k = 1.38 \times 10^{-2} \times i \quad [\text{m/s}] \]

Graph showing hydraulic conductivity \( k \) vs. hydr. gradient \( i \).
Test Report No.

Check test for geotextile samples taken from the construction site, as specified in the Guidelines for Testing Geotextile Filters for Navigable Waterways (1993)

Office:
Commission: , file ref.
Any additional correspondence: , file ref.
Date on which BAW received the samples:

Waterway:
Construction project:
Samples taken at/geotextile installed at:
Delivery no./roll no.:
Sampling no.:
Date of sampling:

Geotextile:
-Product name:
-Supplier/manufacturer:
-Type:
-Raw materials (fibres), as stated by the manufacturer:
-Type of bonding:
-Certificate of suitability: BAW No.: Date:

Type of cover layer:

Type of soil to be protected, as specified in the Technical Supply Conditions for Geotextile Filters:

Soil type:

Test result: The sample taken at the construction site satisfies the requirements stated in the invitation to tender. (See annex for individual results).

Karlsruhe, (date) pp.

Technical officer responsible for testing materials

This test report is only valid for the section of the construction project covered by the test.
Summary of individual test results

Product name

A) Verification of compliance with contractually agreed minimum requirements as specified in the Technical Supply Conditions for Geotextile Filters

<table>
<thead>
<tr>
<th>Type of test</th>
<th>Test data stated in certificate of suitability</th>
<th>Contractually agreed minimum requirements</th>
<th>Results of check tests</th>
<th>Minimum requirement satisfied yes/no</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thickness mm:</td>
<td>±</td>
<td>≥</td>
<td>±</td>
<td></td>
</tr>
<tr>
<td>Filter layer</td>
<td>±</td>
<td>≥</td>
<td>±</td>
<td></td>
</tr>
<tr>
<td>Additional layer</td>
<td>±</td>
<td>≥</td>
<td>±</td>
<td></td>
</tr>
<tr>
<td>Apparent opening size Dw of additional layer (mm)</td>
<td>±</td>
<td>≥</td>
<td>±</td>
<td></td>
</tr>
<tr>
<td>Maximum tensile strengths (N/10 cm):</td>
<td>±</td>
<td>≥ 1 200</td>
<td>±</td>
<td></td>
</tr>
<tr>
<td>Machine direction</td>
<td>±</td>
<td>≥ 1 200</td>
<td>±</td>
<td></td>
</tr>
<tr>
<td>Cross-machine direction</td>
<td>±</td>
<td>≥ 1 200</td>
<td>±</td>
<td></td>
</tr>
<tr>
<td>Seam</td>
<td>±</td>
<td>≥ 1 200</td>
<td>±</td>
<td></td>
</tr>
<tr>
<td>Mechanical filtration stability for soil type:</td>
<td>±</td>
<td>≤</td>
<td>Only tested if defects as described in clause 5 of the Technical Supply Conditions for Geotextile Filters occur</td>
<td>yes</td>
</tr>
<tr>
<td>Total soil passing through filter (g)</td>
<td>±</td>
<td>≤</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soil passing through filter in final test phase (g)</td>
<td>±</td>
<td>≤</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hydraulic filtration stability for soil type (m/s)</td>
<td>x 10</td>
<td>&gt; x 10</td>
<td>only tested if defects as described in clause 5 of the Technical Supply Conditions for Geotextile Filters occur</td>
<td>yes</td>
</tr>
</tbody>
</table>

B) Additional values for checking compliance if filtration stability is not tested

<table>
<thead>
<tr>
<th>Type of test</th>
<th>Mean value stated in certificate of suitability</th>
<th>Mean value obtained in check tests</th>
<th>Deviation of column 2 from column 1</th>
<th>Permitted deviation of column 2 from column 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass per unit area (g/m²)</td>
<td>± 10 %</td>
<td>± 15 %</td>
<td>± 20 %</td>
<td>± 20 %</td>
</tr>
<tr>
<td>-non-wovens</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-geocomposites:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total mass</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1ˢᵗ filter layer</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2ⁿᵈ filter layer</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Additional layer</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>k-value without soil (m/s)</td>
<td>x 10</td>
<td>x 10</td>
<td>± 50 %</td>
<td></td>
</tr>
</tbody>
</table>

Assessment of cases in which the values are outside the specified tolerances: