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Geotextiles — Test method for the determination of the filtration behaviour of geotextiles under turbulent water flow conditions

Géotextiles — Méthode d'essai pour la détermination du comportement en filtration des géotextiles en régime d'écoulement turbulent

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ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 10772 was prepared by Technical Committee ISO/TC 221, *Geosynthetics*.

Geotextiles — Test method for the determination of the filtration behaviour of geotextiles under turbulent water flow conditions

1 Scope

This International Standard describes a test method for determining the soil passing through a geotextile filter when exposed to turbulent external water flow conditions.

The test provides a value for one specific type of soil as a performance test for the design of erosion protection layers with geotextile filters in hydraulic engineering applications.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 9862, *Geosynthetics — Sampling and preparation of test specimens*

ISO 12956, *Geotextiles and geotextile-related products — Determination of the characteristic opening size*

3 Terms and definitions

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

3.1
soil passing value
S_{pv}
cumulative average soil passing value for the three specimens after the final stage

3.2
cohesion
c_u
undrained cohesion of the test soil

3.3
plasticity index
I_P
plasticity of test soil

4 Principles

The test simulates the exposure of geotextiles to turbulent conditions such as those that occur during wave action, the passage of a ship, etc. The filtration stability of the geotextile is determined by measuring the amount and rate of soil passing through the geotextile during the test.

5 Test method

The mechanical filtration stability of the test soil and of similar soils is determined by measuring the soil passing through the filter during each stage of the test. The test results will also show whether the rate at which soil passes through the geotextile filter has been stabilized as necessary.

6 Test soils

The test soil is dried to constant mass at 105°C directly before use.

An example for the grading curve of a medium to coarse silt as test soil is shown in Annex A. The cohesion of the undrained test soil is less than or equal to 1,5 kN/m^2.

7 Sampling and sample installation

The sampling shall be carried out in accordance with ISO 9862. Three geotextile specimens, each with a diameter of 168 mm, are punched out of the laboratory sample. Each specimen shall be placed in a sample container with the upper surface of the geotextile facing downwards as shown in Figure 1. 1 500 g of the test soil type are placed loosely on the geotextile and spread evenly over the sample using an adjustable gauge. Compact the test soil by using a pressure that exerts a surface pressure of 2 kN/m^2 on the geotextile. The load is applied using 1 500 g of the test soil and a 151 mm diameter brass disc weighing 2 130 g. Two pieces of non-woven geotextile material (mass per unit area: 600 g/m^2, thickness: 6 mm) with diameters of 152 mm shall be placed between the upper surface of the test soil and the metal disc to prevent any loss of soil at the annular gap between the sample mould and the disc.

Fasten the specimen container securely on a vertically oscillating electromagnetic screen (e.g. sieving device according to ISO 12956) for compaction. Place a 5 mm thick plastic disc beneath the geotextile specimen to prevent the material from sagging while the soil is being compacted. The soil shall be compacted at a frequency of 50 Hz and an amplitude of 1,5 mm for 240 s. The lid of the test specimen is then closed and the specimen stored in tap water at a temperature of 20°C ± 5°C and left to saturate for at least 16 h. Cover the test specimen with water to a depth of 20 cm. Immerse the specimen at an angle such as to prevent any air bubbles being trapped under the surface of the geotextile.

8 Test apparatus

The test apparatus shall be designed to test with three sample containers simultaneously. 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 collecting vessels. The dimensions of the test apparatus are shown in Figures 2a), 2b) and 3. The materials, dimensions and structure of the single sample containers are shown in Figures 1a) and 1b). The sample containers are fastened firmly to the test frame by means of the brass pipe bolted in the centre of the transparent plastic lid. The pipe is also used to evacuate air from the sample containers and equalize the pressure inside them during the test. The water level in the water tank at rest is set using the millimetre scale on the transparent plastic 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 four-bladed turbulence-producing agitator rotating at 260 rpm produces a turbulent flow that hits the filter sample at speeds between 70 cm/s and 90 cm/s. The passage of the blades beneath the geotextile sample produces pressure pulsations with a frequency of 17,3 Hz.

The following are also necessary to carry out the determination of the filtration behaviour of geotextiles under turbulent water flow conditions:

8.1 **Drying oven,** capable of maintaining a temperature of 105°C ± 5°C.

8.2 **Electronic balance** (the resolution must be 0,01 g).

8.3 **Tap water.**

8.4 **Vertically oscillating device**, as described in ISO 12956.

8.5 **Vessels for the water collection,** with a volume greater than 60 l.

8.6 **Hydrophilic cellulose folded filter**, with a diameter of 500 mm and a retention range of 5 µm to 13 µm.

8.7 **Stainless steel mesh**, mesh size 11 mm, wire size 1 mm.

8.8 **Spacer**, with the dimensions 30 mm × 30 mm × 90 mm, made of plastic or wood.

9 Procedure

The test procedure includes five loading phases each lasting 30 min with a total duration of 150 min for each geotextile specimen. For each load phase, the following procedure should be used:

9.1 Measure the water temperature in the test container at the beginning and end of the test, which shall be in the range 20°C ± 5°C.

9.2 Fill the test container with water up to a height of 20,5 cm.

9.3 Remove the specimen container from the water in which it has been stored and place it in the test container immediately, immersing it at an angle to prevent any air bubbles forming beneath the test surface.

9.4 Adjust the height of the specimen container by placing a spacer with a height of 30 mm between the lower edge of the stainless steel mesh in the specimen container and the upper surface of the propeller, and fasten it to the test frame. Remove the spacer for the test.

9.5 Subject the filter sample to a turbulent flow. Each phase is started manually at the control unit and terminated by a timer after 30 min.

Place vessels for water collection beneath the test container. The outlet of the test container shall be opened to allow for water discharge without significant turbulence. The water with the passed granular material shall be collected to enable measurement and analysis of the soil.

9.6 Continue the test after refilling the test container with fresh water for each remaining phase.

9.7 The quantity of soil passing through the filter is determined from the water collected in the vessel by filtering, drying (at 105°C ± 5°C) and weighing. If required, the grading curve of the soil passing through the filter can be determined. A hydrophilic cellulose folded filter is used for the filtration.

10 Evaluation

The mean values for the soil passing through the geotextile filter obtained for the three specimens are plotted against the loading phases to produce a cumulative curve.

The gradient of the slope of the graph shows whether the filtration rate has been stabilized, the relevant values being the quantity of soil washed through the filter in the final test phase (120 min to 150 min after the beginning of the test).

The soil passing value for each test phase shall be determined by taking the average weight of the soil passing through the three specimens at each test phase and a cumulative value shall be determined and plotted on a cumulative curve.

NOTE An example for the calculation is shown in Table 1 and a cumulative curve is shown in Figure 4.

Geotextiles are deemed to act as stable filters for the soil type if the quantity of soil passing (mean value + standard deviation for each specimen) through the filter during the test phases has stabilized. For the test soil as shown in Annex A, the soil passing during the last test phase should not exceed 30 g. The total mass of soil passing during the whole test should not exceed 300 g. Sample B, as shown in Figure 4, shall be deemed to be a stable filter.

11 Test report

The test report shall include the following information:

a) the reference number and year of publication of this International Standard, i.e. ISO 10772:2012;

b) the identification of the sample, date of receipt and date of testing;

c) the type of test soil used in the test. The soil parameters, plasticity I_P, cohesion c_u, uniformity and grading curve must be stated;

NOTE The soil parameters, plasticity, cohesion, uniformity and grading curve can be tested in accordance with ISO/TS 17892-4, ISO/TS 17892-8 and ISO/TS 17892-12.

d) average value, standard deviation 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/m^2 and coefficient of variation in per cent, to one decimal place;

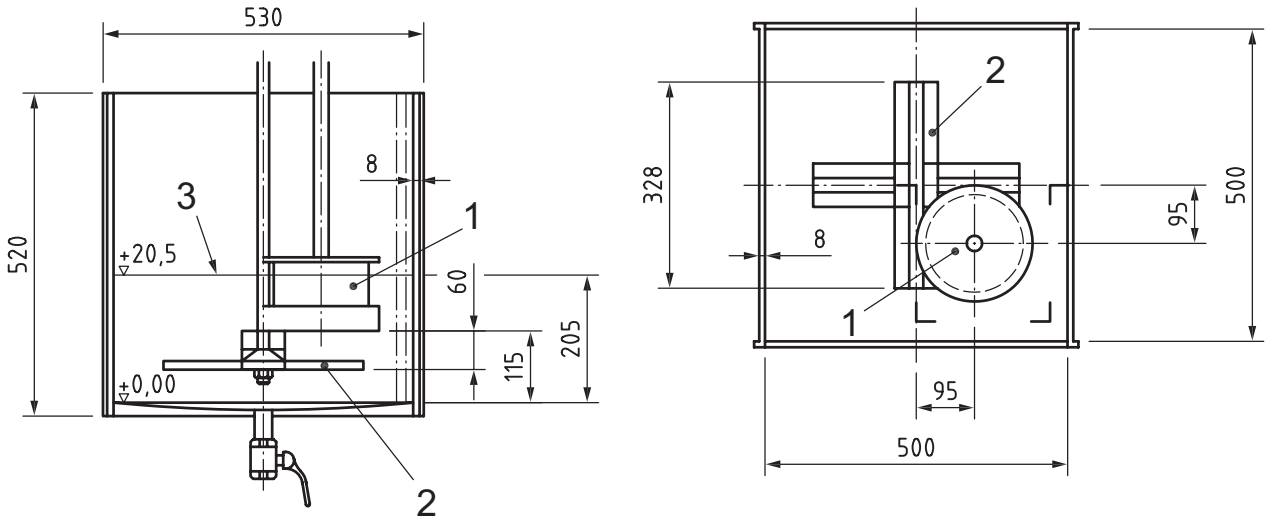
e) if required, the grading curve of the soil passing through the filter;

f) the average value of the three specimens for the soil passing value S_{pv} and the corresponding cumulative curve of soil passing through the filter;

g) the water temperature at the beginning and the end of the test;

h) any deviation from the test apparatus or test method as described in this International Standard.

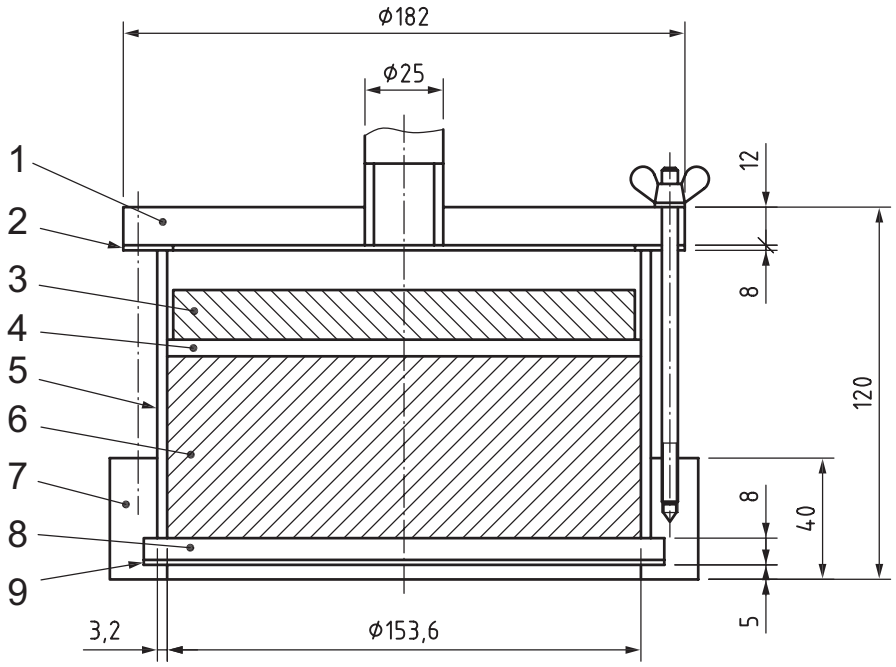
Dimensions in millimetres



Key

1 specimen holder
2 propeller
3 water height

a) Drawing of a single test container — Sectional lateral and top view

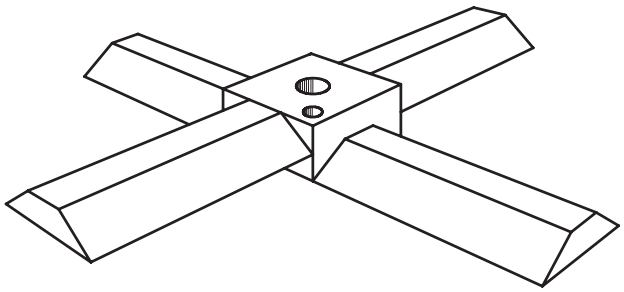


Key

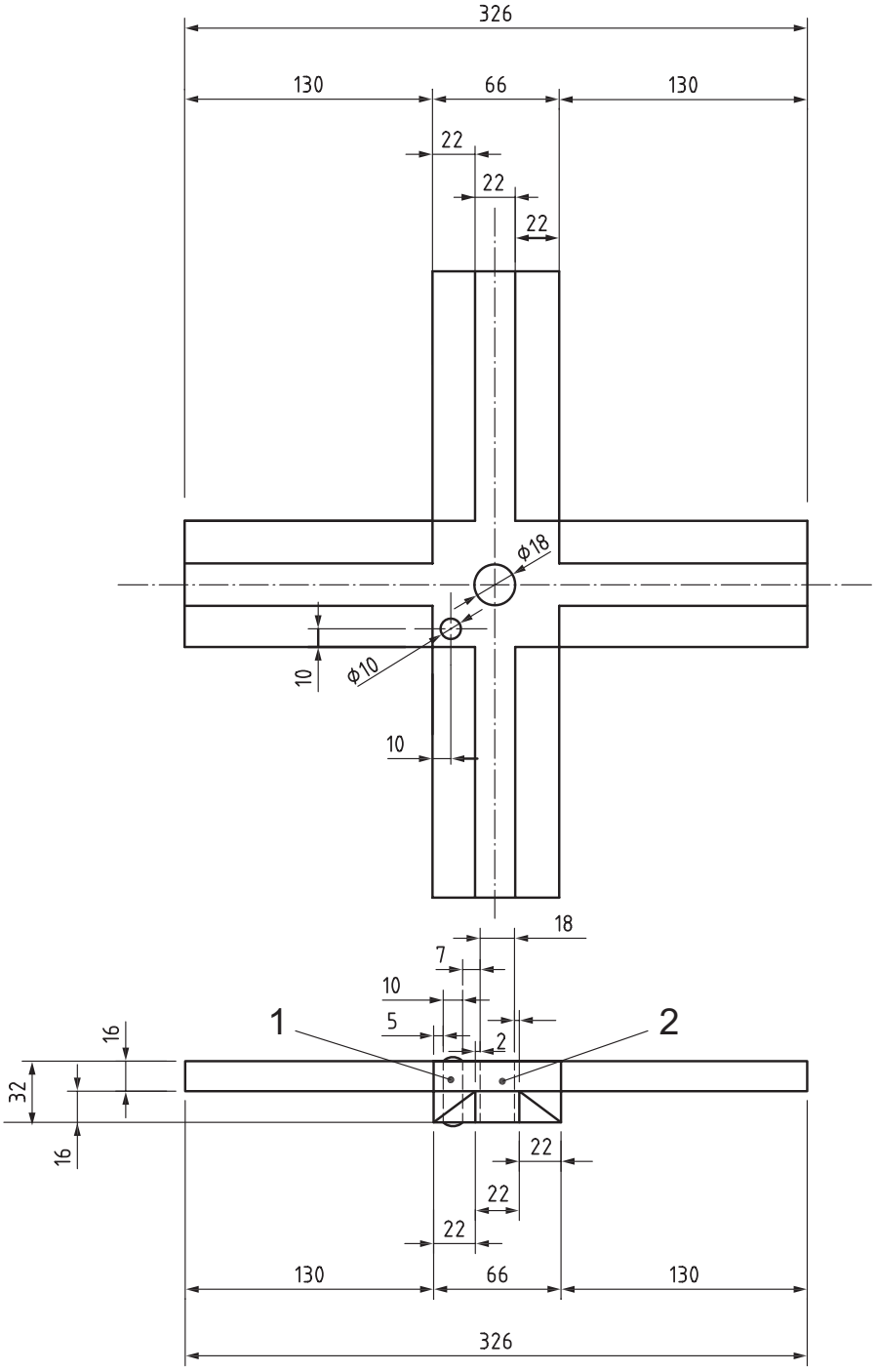
1 transparent plastic
2 rubber seal
3 metal disc (load)
4 geotextile
5 test soil, 1 500 g
6 plastic tube
7 plastic flange
8 geotextile specimen
9 stainless steel mesh

b) Drawing of a specimen container with test soil — Sectional view

Figure 1— Drawing of a single test container and a specimen container



a) Drawing propeller



Key

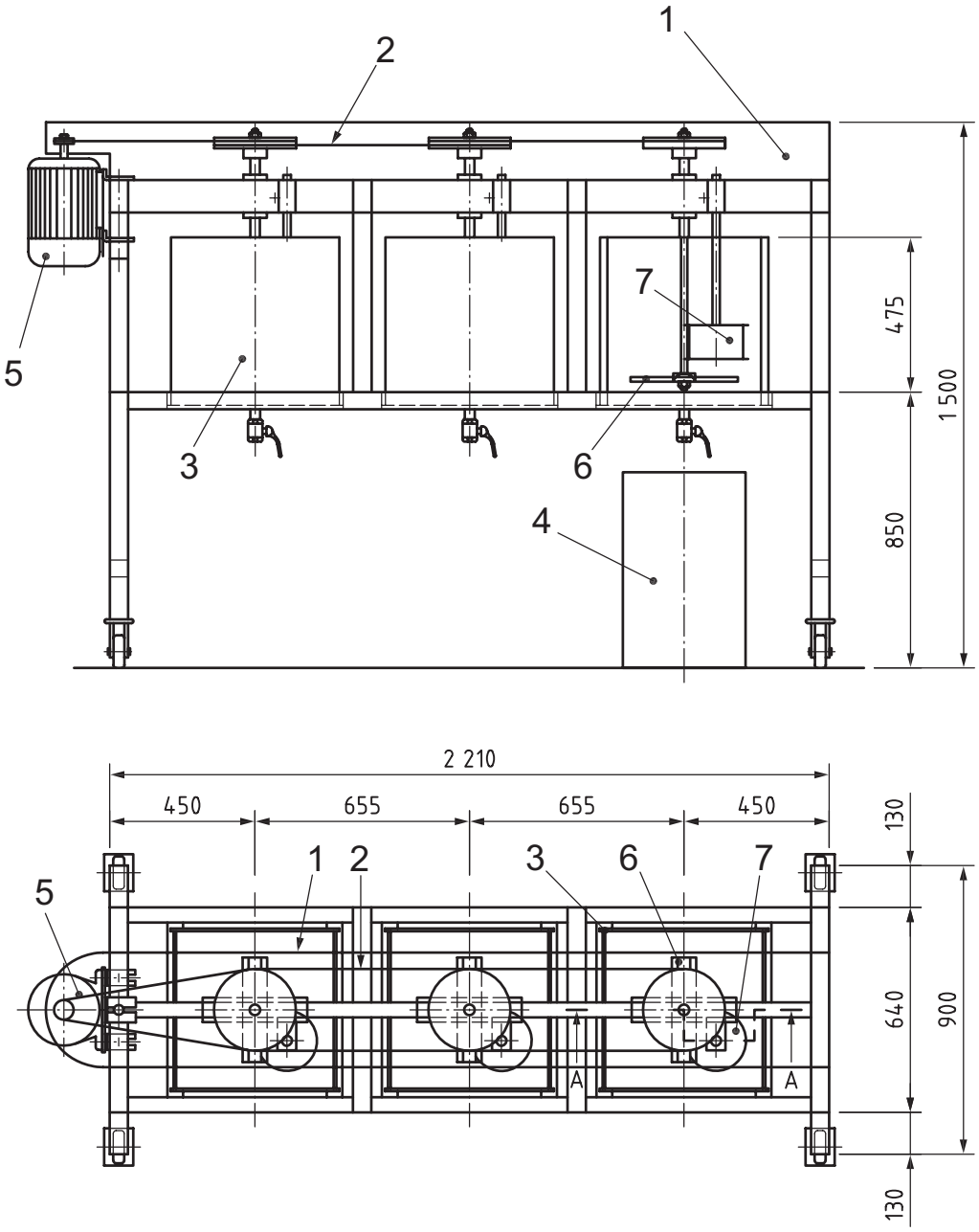
1 fixing pin, 10 mm diameter

2 bore, 18 mm diameter

b) Drawing propeller — Lateral view and top view

Figure 2 — Drawing propeller

Dimensions in millimetres



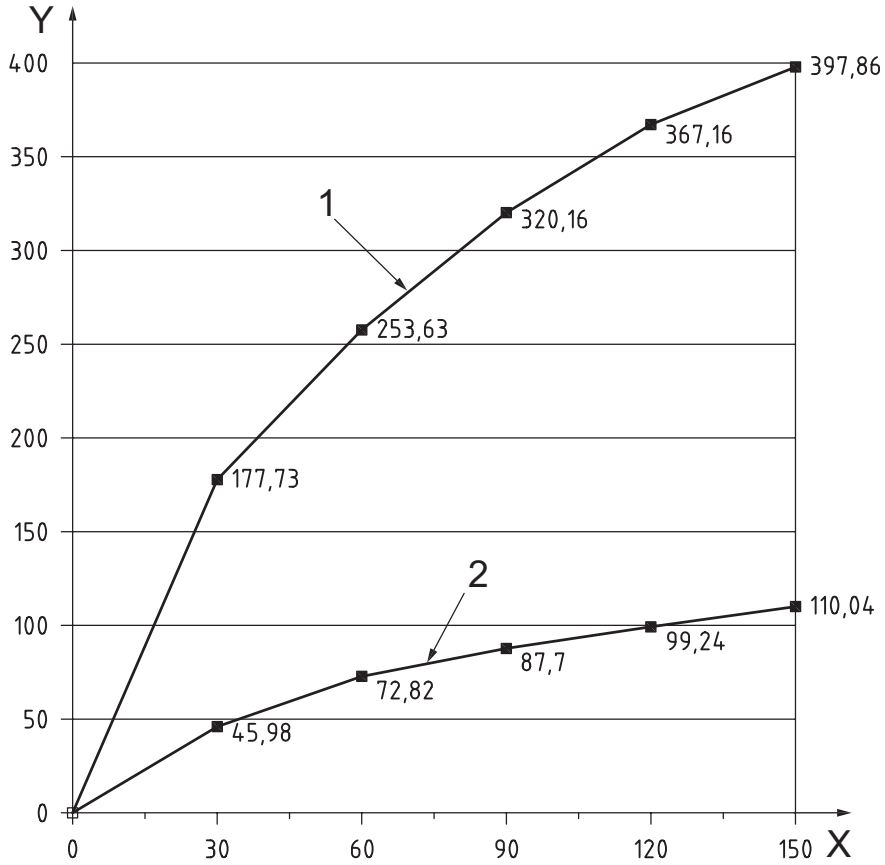
Key

1 guard
2 v-belt 10/6
3 test container
4 vessel for the water collection
5 electric motor
6 propeller
7 specimen container

Figure 3 — Drawing test apparatus with three-test container — Lateral and top view

Table 1 — Example of soil passing evaluation

Specimen	Soil passing for each test phase [g]					
	30 min	60 min	90 min	120 min	150 min	Total
1	182,4	84,3	66,7	49,6	32,0	415,0
2	163,6	66,5	53,6	42,3	28,4	354,4
3	187,2	88,9	67,3	49,1	31,7	424,2
Average value	177,7	79,9	62,5	47,0	30,7	397,9
Standard deviation					2,0	37,9
Coefficient of variation					6,5 %	9,5 %



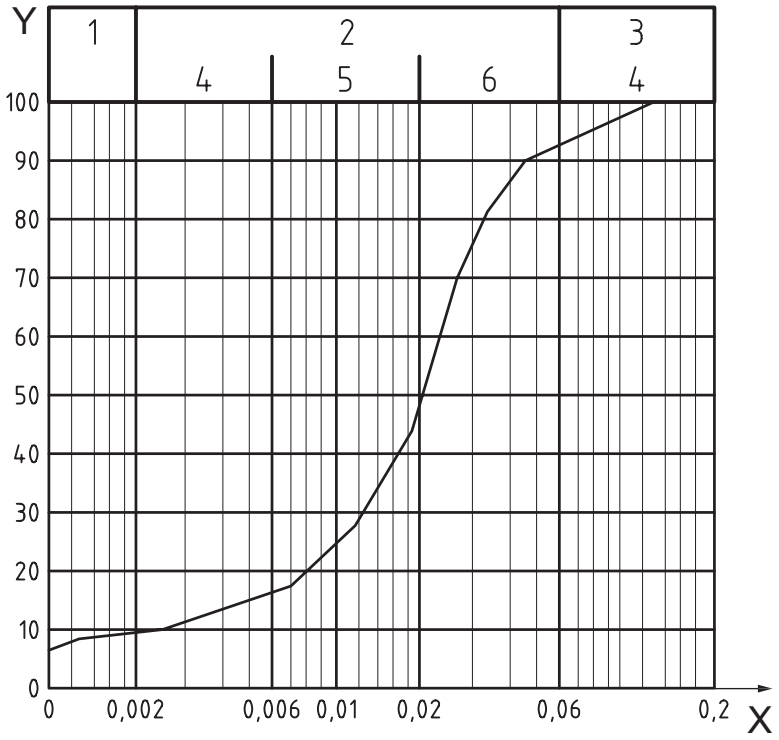
Key

1 Sample A
2 Sample B
X test time (min)
Y soil passing (g)

Figure 4 — Cumulative curves — Samples A and B

Annex A
(informative)

Grading curve



Key

1 clay
2 silt
3 sand
4 fine
5 medium
6 coarse
X grain diameter (mm)
Y percent passing by weight (%)

Figure A.1 — Example for the grading curve of a test soil

Bibliography

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[3] ISO/TS 17892-4, *Geotechnical investigation and testing — Laboratory testing of soil — Part 4: Determination of particle size distribution*

[4] ISO/TS 17892-8, *Geotechnical investigation and testing — Laboratory testing of soil — Part 8: Unconsolidated undrained triaxial test*

[5] ISO/TS 17892-12, *Geotechnical investigation and testing — Laboratory testing of soil — Part 12: Determination of Atterberg limits*

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