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Geotextiles and geotextile-related products — Determination of the characteristic opening size

Géotextiles et produits apparentés — Détermination de l'ouverture de filtration caractéristique

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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Fax: +41 22 749 09 47
Email: copyright@iso.org
Website: www.iso.org

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Foreword

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

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

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

This third edition cancels and replaces the second edition (ISO 12956:2010), which has been technically revised. The main changes compared to the previous edition are as follows:

— the average used in order to select the number of specimens is modified (25 % to 15 %);

— explanations are given for the preparation of knitted tubular geotextiles.

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

Geotextiles and geotextile-related products — Determination of the characteristic opening size

IMPORTANT — The electronic file of this document contains colours which are considered to be useful for the correct understanding of the document. Users should therefore consider printing this document using a colour printer.

1 Scope

This document specifies a method for the determination of the characteristic size of the openings of a single layer of a geotextile or geotextile-related product using the wet-sieving principle.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

ISO 10320, *Geosynthetics — Identification on site*

3 Terms and definitions

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

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

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

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

3.1
d_n
particle size for which n % mass fraction is smaller than the mass of measured particles

3.2
O_{90}
size of opening which is equal to the particle of size d_{90} of the granular material which passes through the geotextile or geotextile-related product, expressed in µm

3.3
C_u
coefficient of uniformity, defined as d_{60}/d_{10}

4 Principle

The principle of the test is to determine the opening size (O_{90}) which corresponds to the specified size of the granular material passed.

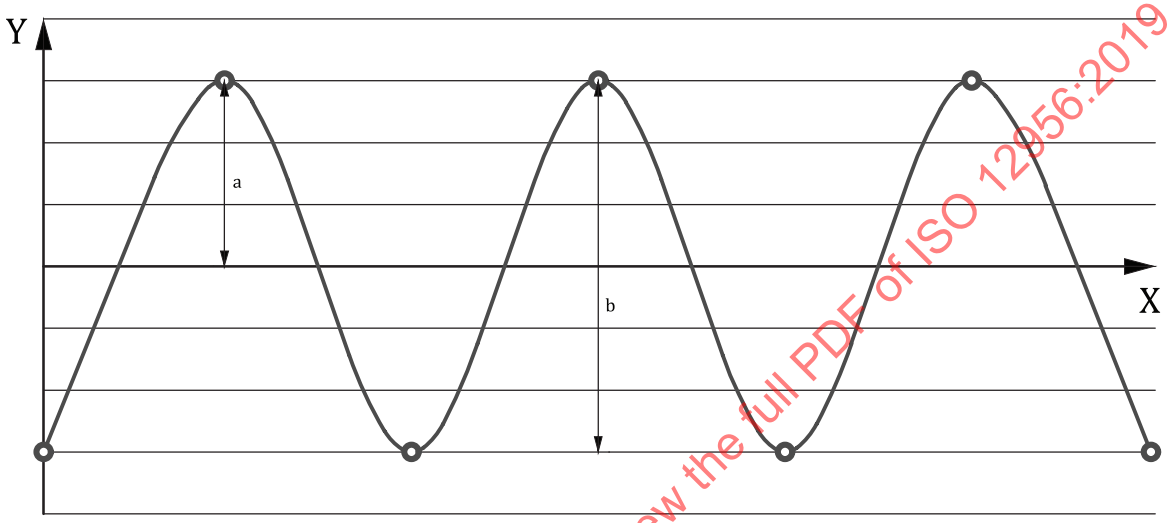
5 Apparatus and materials

5.1 Sieving apparatus, composed of the following elements.

5.1.1 Sieving unit, allowing for the testing of a specimen with an exposed sieving area corresponding to a minimum diameter of 130 mm, complying with the following requirements:

a) sieving device, with a frequency of 50 Hz to 60 Hz;

b) predominantly vertical sieve motion capable of maintaining a 1,5 mm amplitude (3 mm swing height, see Figure 1) over the period of test.



Key

X	time	a	1,5 mm amplitude.
Y	swing height	b	3 mm swing height.

Figure 1 — Amplitude and swing height

5.1.2 Water supply system.

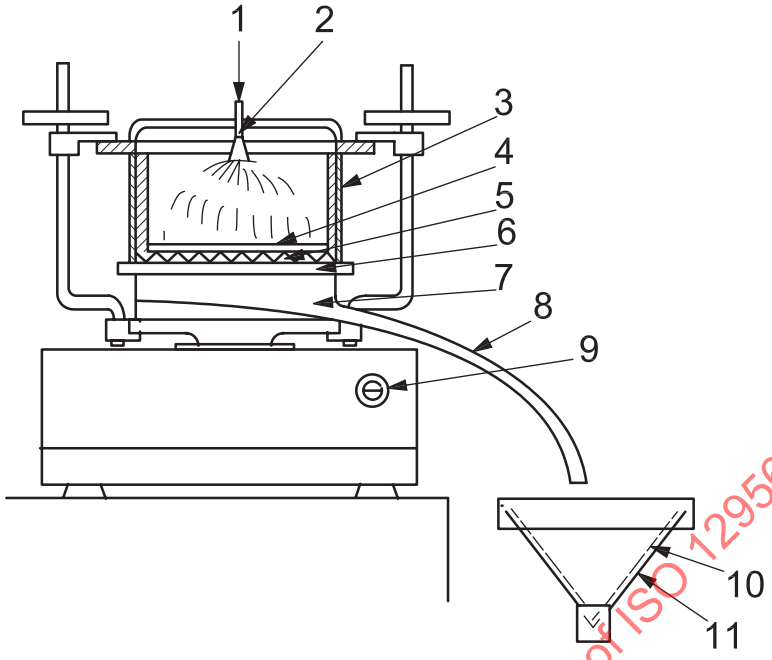
5.1.3 Spray nozzle(s), to ensure even wetting of the test specimen, enclosed in a transparent cylinder and/or covering cap to avoid soil or granular material loss.

It is recommended that the nozzle(s) be capable of a water discharge of approximately 0,5 l/min at a working pressure of about 300 kPa. A valve should be available to regulate the flow of water.

5.1.4 Specimen clamping device, to transmit all the energy to the specimen during sieving.

5.1.5 Pan, affixed to the sieving apparatus, with a connection tube to the device for filtering the water and collecting granular material passing through the specimen.

NOTE Typical sieving equipment is represented in Figure 2.



Key

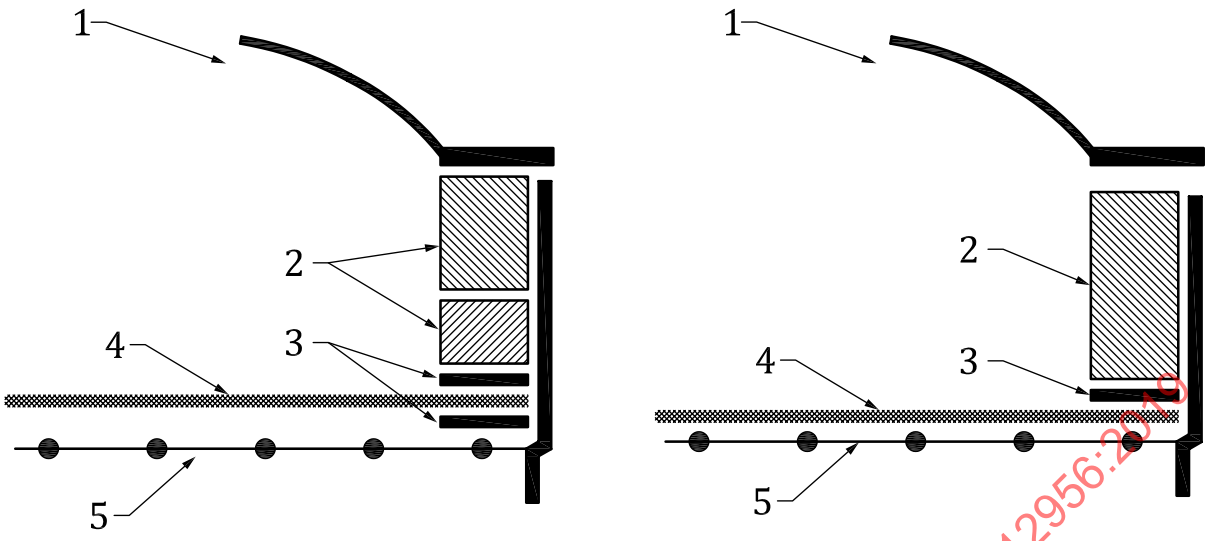
1	water supply	7	pan
2	spray nozzle(s)	8	connection tube
3	specimen clamping device	9	amplitude regulator
4	granular material	10	filter paper
5	specimen	11	collection device
6	support grid		

Figure 2 — Example of sieving apparatus

5.1.6 Grid, with wire between 1 mm and 2,5 mm in diameter and a mesh size of (10 ± 1) mm, with a minimum of 90 % opening area to support the specimen during the test, to avoid excessive deformation of the specimen under the weight of the granular material.

5.1.7 Sealant, in order to avoid loss of granular material.

NOTE Examples of sealant positions are represented in Figure 3.



a) Example with two rubber rings **b) Example with one rubber ring**

Key

1 cover
2 PVC or metallic ring
3 rubber ring
4 specimen
5 support grid

Figure 3 — Examples of sealant positions

5.1.8 Cover, fully transparent or equipped with a transparent window to permit observation and check that there is no water accumulation on the surface of the specimen during the test.

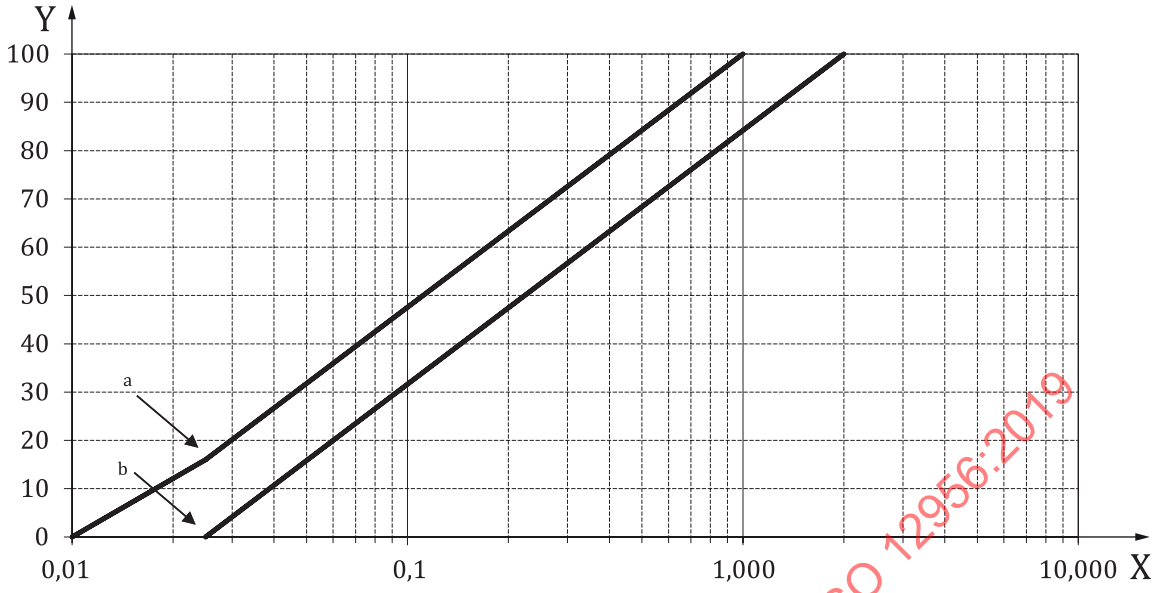
5.2 Granular material, complying with the following requirements:

a) It shall be cohesion-less, i.e. particles shall not aggregate in water. If there is no visible agglomeration of particles during the test, the results are acceptable. If not, the test has to be performed again.

b) It shall not be gap-graded, the particles shall be essentially round and sharp-edged flaky particles shall be avoided. Mostly spherical, untreated glass beads are an acceptable material, as long as they meet the requirement for particle size distribution.

c) $3 \leq C_u \leq 20$.

d) To improve the accuracy of the characteristic opening size determination, the granular material shall be such that $d_{20} \leq O_{90} \leq d_{80}$; the zone for the graded granular material and the range of O_{90} values which are applicable are given in Figure 4. Annex B gives a theoretical curve (Figure B.1) which optimises the accuracy of O_{90} values, especially for small O_{90} values; the values are given in Table B.1.



Key

X particle diameter (mm)
Y % fines
a (25 µm; 16 %).
b (25 µm; 0 %).

Figure 4 — Required zone of the cumulative percentage of size distribution of the granular material used

5.3 Filter paper, to collect the passed granular material.

The filter paper used should have a maximum opening size of 10 µm.

5.4 Drying oven, capable of maintaining temperatures up to 110 °C.

5.5 Set of sieves, in accordance with Table A.1.

5.6 Balance, for determining the mass of the granular to a maximum permissible measurement error of 0,03 g.

5.7 Stopwatch, for measuring time to a maximum permissible measurement error of ±0,1 s.

6 Test specimens

6.1 Handling

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

6.2 Selection

Take specimens from the sample in accordance with ISO 9862.

6.3 Number and dimensions

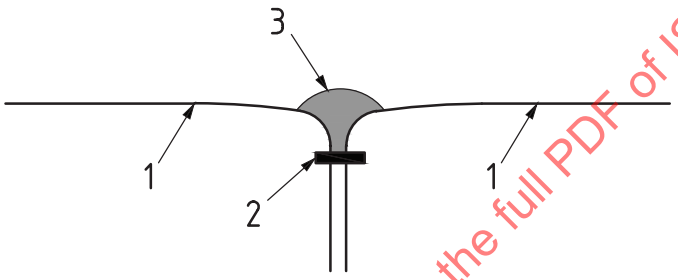
Cut five test specimens from the sample, each of the dimensions suitable for the sieve apparatus to be used.

Care should be taken when preparing specimens for woven materials to ensure that the structure is not affected by the cutting. The use of a thermal cutting device can be helpful.

Samples with a width smaller than the sieve diameter may be prepared as follows for testing per this test method:

— If the width is more than 85 % of the cell diameter (i.e. sleeve of a prefabricated vertical drain), a mask may be applied on the edges to extend the specimen beyond the external diameter of the sieve. A high adhesion tape, such as those used in the construction industry, has been found satisfactory. The tape should overlap on the specimen by 10 mm ± 2 mm, to leave a strip of at least ±160 mm in width of the product available for testing. If it is not possible to separate the geotextile from other parts of the product, the geotextile should be sampled before its lamination to the core.

— If the width is less than 85 % of the cell diameter (i.e. envelope of small diameter pipes), a large test specimen shall be prepared by stitching together two (or more) strips, until a sufficient width is available for testing. The assembly shall be done using a "T" shaped stitch (Figure 5). The stitched area shall then be sealed with a sealant that is not sensitive to water and does not retain glass beads on its surface, i.e. epoxy, as shown in Figure 5.



Key

1 strips of geotextile (2 shown)
2 thread
3 glue

Figure 5 — Assembly of multiple strips of a narrow geotextile sample

When special preparation is needed for a geotextile, by stitching strips together or by applying a mask, extra care shall be given to the sealing of the edges. This can require the use of a closed cell foam ring or other suitable technique depending on the product being tested and particular feature of the specimen holder.

NOTE The opening size of a knitted geotextile can be sensitive to stress. For such products, Annex C defines a standard procedure to normalize the condition of the geotextile for testing purposes.

6.4 Specimen condition

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

7 Procedure

7.1 Determine and record the mass of the dry specimen to the nearest 0,1 g. The specimen is considered dry when there is a reduction in mass of less than 0,1 % between consecutive measurements with a time interval of 600 s. Drying should be carried out at a temperature of 70 °C or less, if the temperature affects the material.

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

7.3 Remove the specimen from water and place it flat and without tension in the clamping device. Place the clamping device on the sieving apparatus. The specimen should be horizontal to avoid accumulation of granular material at one location on the specimen. The specimen should be secured in such a way that the granular material cannot pass between the specimen and the side of the sieve during testing by using sealant.

7.4 Determine the dry mass of the granular material to a maximum permissible measurement error of ±0,1 g. Prepare granular material for each specimen, to achieve a mass equivalent to (7,0 ± 0,1) kg/m^2 of exposed sieving area.

7.5 Spread the granular material evenly on the specimen.

7.6 Open the water supply and spray water uniformly over the whole specimen. Adjust the water flow with a regulating valve to ensure that granular particles are completely wetted, but do not allow the water level to rise above the granular material.

Adjust the water supply in order to avoid standing water.

7.7 Switch on the sieving device and slowly adjust the amplitude to 1,5 mm (3 mm swing height).

7.8 Collect the granular material which passes through the specimen in the collecting device with the filter paper.

7.9 After a sieving time corresponding to 600 s, switch off the sieving device and turn off the water supply.

7.10 Collect the specimen together with any retained granular material without losing any particles.

7.11 Dry, separately, the passed granular materials (see 7.8) and the specimen with the retained granular material (see 7.10).

7.12 Obtain the dry mass of the retained granular material by weighing the specimen containing the retained granular material and subtracting the dry mass of the specimen. Determine the dry mass of the retained granular material and the dry mass of the passed granular material to a maximum permissive measurement error of +/−0,1 g. If the total mass of the retained and passed granular material deviates more than 1 % from the initial total dry mass, the test is invalid and shall be repeated.

7.13 Repeat 7.1 to 7.12 until three of the five specimens have been tested.

7.14 If any of the masses of granular materials passing through the specimen varies from the average by more than 15 %, then the two remaining specimens shall be tested.

7.15 Tabulate the initial amount of granular material, the material passed and retained, and calculate the percentages in mass of material passed and lost as indicated in Table 1. Combine the granular material passed through the individual specimens and determine the particle size distribution. The granular material lost during the analysis has to be less than 1 %.

NOTE After selection of the required successive sieves as given in ISO 565, size R 20 (see Annex A), guidance for the determination of the particle size distribution of the granular material by sieving is given in ISO 2591-1. An example is given in Annex B with values in Table B.2 and the obtained curve in Figure B.2.

Table 1 — Typical data sheet for three or five specimens

Product designation: _____ Date: _____

Sample designation: _____

Specimen	Granular material g			Lost granular material $100[(1)-(2)-(3)]/(1)$ %	Passed granular material $100[(2)/(1)]$ %	$\lvert\bar{p}-p_i\rvert$ %	$\left\lvert\frac{\bar{p}-p_i}{\bar{p}}\right\rvert \times 100$ %
	Initial (1)	Passed (2)	Retained (3)				
1					p_1 =		
2					p_2 =		
3					p_3 =		
4					p_4 =		
5					p_5 =		
Total				**Mean**	p =		

If maximum $\left\lvert\frac{\bar{p}-p_i}{\bar{p}}\right\rvert \times 100 < 15$ %, then the data from the three specimens are acceptable.

If maximum $\left\lvert\frac{\bar{p}-p_i}{\bar{p}}\right\rvert \times 100 \geq 15$ %, then two more specimens shall be tested.

7.16 If the amount of the passed granular material of three specimens is less than 30 g, the two remaining specimens shall be tested and Table 1 completed. If the additional testing does not produce the required amount of passed granular material, no opening size can be reported.

NOTE If the range of O_{90} is known, selecting the three nearest sieve sizes at either side of O_{90} is sufficient for the determination of O_{90}.

8 Calculation and expression of results

8.1 Plot the cumulative percentage of the passed granular material against the corresponding sieve size on a semi-logarithmic scale (see Figure B.2). Determine d_{90} by either mathematical or graphical means.

8.2 The characteristic opening size, O_{90}, of the geotextile or geotextile-related product under examination is equal to d_{90} of the particle size distribution curve of the passed granular material, i.e. $O_{90} = d_{90}$.

9 Test report

The test report shall include the following information:

a) reference to this document, i.e. ISO 12956:2019;

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

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

d) details of apparatus used, including a sketch or a drawing (if required);

e) the exposed specimen area,

f) the nature (sand, crushed sand particles, glass beads), and whole particle size distribution curve for the granular material used; give C_u;

g) for each specimen, the dry mass of initial granular material, of passed and retained granular material and the percentage lost and passed granular material (see Table 1 and/or Table B.2);

h) the particle size distribution curve of the granular material passing the specimens (see example in Annex B) and, if required, the percentage of each fraction of the total granular material analysis, the percentage of loss granular material during the sieving;

i) the characteristic opening size, O_{90}, of the specimens;

j) any deviation from the test method described in this document;

k) any anomaly in the behaviour of the specimens.

Annex A
(normative)

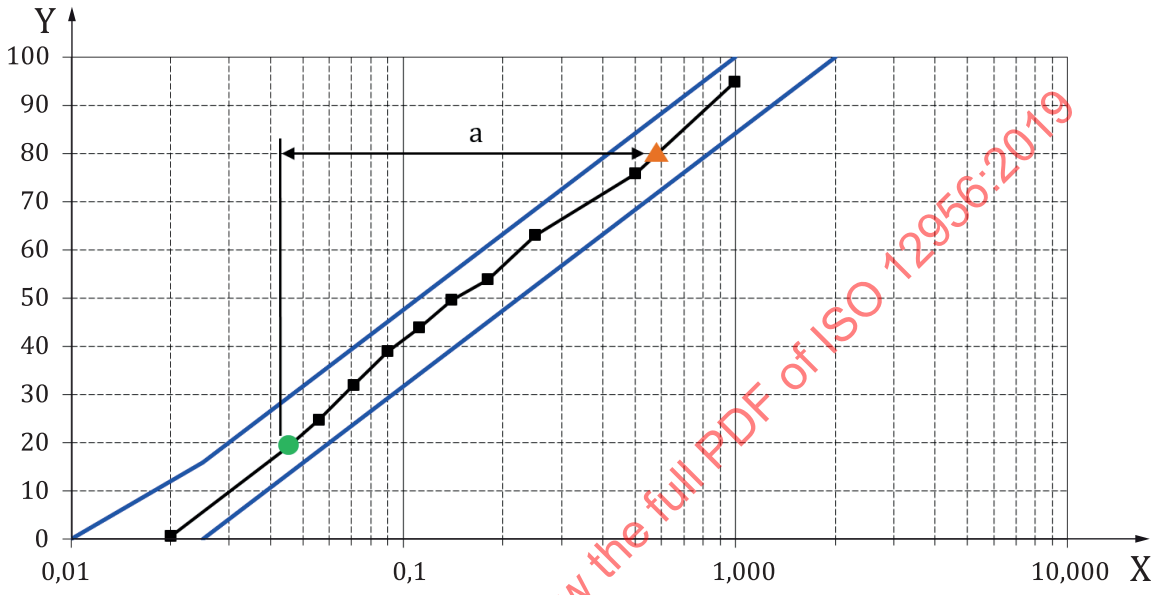
Mesh sizes

Table A.1 — Mesh sizes of sets of test sieves in accordance with ISO 565, size R 20

µm			mm			
20	80	280	1,00	3,55	12,5	45,0
25	90	315	1,12	4,00	14,0	50,0
28	100	355	1,25	4,50	16,0	56,0
32	112	400	1,40	5,00	18,0	63,0
36	125	450	1,60	5,60	20,0	71,0
40	140	500	1,80	6,30	22,4	80,0
45	160	560	2,00	7,10	25,0	90,0
50	180	630	2,24	8,00	28,0	100
56	200	710	2,50	9,00	31,5	112
63	224	800	2,80	10,0	35,5	125
71	250	900	3,15	11,2	40,0	

Annex B
(informative)

Example of the determination of the characteristic opening size



Key

X grain diameter (mm)

Y % fines

a Range of measurable O_{90} values.

d_{20} = 47 µm

d_{80} = 581 µm

Figure B.1 — Example of particle size distribution curve and optimized curve

Table B.1 — Particle size analysis of the granular material used

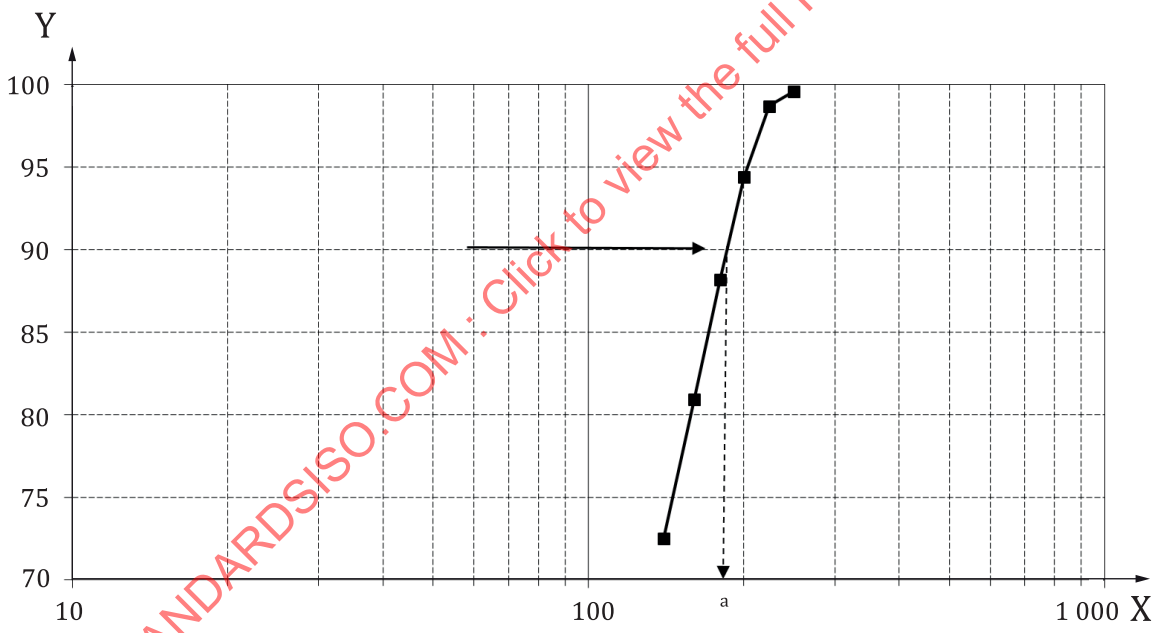
Sieving analysis					
Sieve size	Cumulative percentage	Sieve size	Cumulative percentage	Sieve size	Cumulative percentage
µm	%	µm	%	µm	%
63		160		400	
71	31,9	180	53,9	450	
80		200		500	75,9
90	39,0	224		560	
100		250	63,0	630	
112	43,9	280		710	
125		315		1 000	94,9
140	49,6	355		2 000	100

The amounts of granular material passed through three specimens are given in Table B.2. From the relation between the mean percentage of passed granular material and O_{90} (see Figure B.2), O_{90} is found to be about 200 µm. The sieves are then selected from both sides of the expected O_{90} value. These sieve sizes are 250 µm, 224 µm, 200 µm, 180 µm, 160 µm and 140 µm (see Annex A).

Table B.2 — Sieve analysis of the granular material that passed through the specimens

Sieve opening µm	Mass empty sieve g	Mass sieve and granular material g	Retained granular material g	Cumulative mass passed granular material g	Cumulative percentage passed granular material %
Bottom	2 561,65	2 643,39	81,74		
140	553,48	562,99	9,51	81,74	72,5
160	556,23	564,41	8,18	91,25	80,9
180	544,98	551,93	6,95	99,43	88,2
200	562,64	567,51	4,87	106,38	94,4
224	562,64	563,65	1,01	111,25	98,7
250	563,01	563,50	0,49	112,26	99,6
Total			112,75	112,75	100,0

If the total mass of the material used for the sieve analysis is 113,01 g, the granular material lost during the analysis is (113,01 − 112,75)/113,01 × 100 = 0,23 %, which is less than the maximum acceptable limit of 1 %, and the test is valid. The cumulative percentage of the passed granular material plotted against the corresponding sieve size is shown in Figure B.2. From this curve, it is seen that the characteristic opening size O_{90} = 186 µm.



Key

X diameter (µm)

Y cumulative percentage passed (%)

[a] d_{90} = 186 µm.

Figure B.2 — Cumulative curve of the granular material passed through the specimens and determination of O_{90}