
**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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Foreword

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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 12956 was prepared by Technical Committee ISO/TC 221, *Geosynthetics*.

This second edition cancels and replaces the first edition (ISO 12956:1999), which has been technically revised.

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

1 Scope

This International Standard 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 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 10320, *Geotextiles and geotextile-related products — Identification on site*

ISO 565, *Test sieves — Metal wire cloth, perforated metal plate and electroformed sheet — Nominal sizes of openings*

ISO 2591-1, *Test sieving — Part 1: Methods using test sieves of woven wire cloth and perforated metal plate*

3 Symbols

For the purposes of this document, the following symbols apply.

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

3.3

C_u

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

4 Principle

The particle size distribution of a graded granular material (usually soil) is determined after washing through a single layer of the geotextile or geotextile-related product used as a sieve, without load. The characteristic opening size corresponds to a 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) over the period of test.

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 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.

5.1.4 **Specimen clamping device**.

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

NOTE Typical sieving equipment is represented in Figure 1.

5.1.6 **Grid**, with wire of 1 mm in diameter and a mesh size of (10 ± 1) mm to support the specimen during the test, to avoid excessive deformation of the specimen under the weight of the granular material.

5.2 **Granular material**, complying with the following requirements:

- a) It should 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 and the particles shall be essentially round, and sharp-edged flaky particles shall be avoided.
- 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 2.

5.3 **Filter paper**, to collect the passed granular material.

If the graded material contains a silt fraction, the filter paper used should have a maximum opening size of 10 μm .

5.4 **Drying oven**, capable of maintaining temperatures of between 50 °C and 110 °C.

5.5 **Set of sieves**, in accordance with ISO 565, size R 20 (see Annex A).

5.6 **Balance**, for determining the mass of the granular to an accuracy of 0,03 g.

5.7 **Stopwatch**, for measuring time to an accuracy of ± 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.

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 a wetting agent at laboratory temperature and leave it to saturate for at least 12 h. The wetting agent used shall be an aryl alkyl sulfonate at 0,1 % volume.

7.3 Remove the specimen from the 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.

7.4 Determine the dry mass of the granular material to the nearest 0,1 g. Use enough granular material to achieve a mass per specimen equivalent to $(7,0 \pm 0,1)$ kg/m² of exposed sieving area. However, if the amount passing during the test is insufficient, the total amount can be adapted in such a way that enough material is passed to carry out a particle size analysis.

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 quantity of water 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. There shall be no standing water on the specimen.

Maintain the water supply during the whole sieving operation.

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.

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.

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 to an accuracy of 0,1 g the dry mass of the retained granular material. Determine, also, the dry mass of the passed granular material. If the combined 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 vary from the average by more than 25 %, 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 of material passed and lost as indicated in Table 1 or Table 2. Combine the granular material passed through the individual specimens and determine the particle size distribution.

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.

7.16 If the amount of the passed granular material of three specimens is less than the amount required for sieving in accordance with ISO 2591-1, the two remaining specimens shall be tested and Table 2 completed. If the additional testing does not produce the required amount of passed granular material, the amount of granular material per square metre on the exposed sieving area is increased. If a greater granular material mass is chosen, the sieving time shall be increased in proportion to the increase in granular material.

NOTE If the range of O_{90} is known, it suffices for the determination of O_{90} to select the three nearest sieve sizes at either side of the O_{90} .

8 Calculation and expression of results

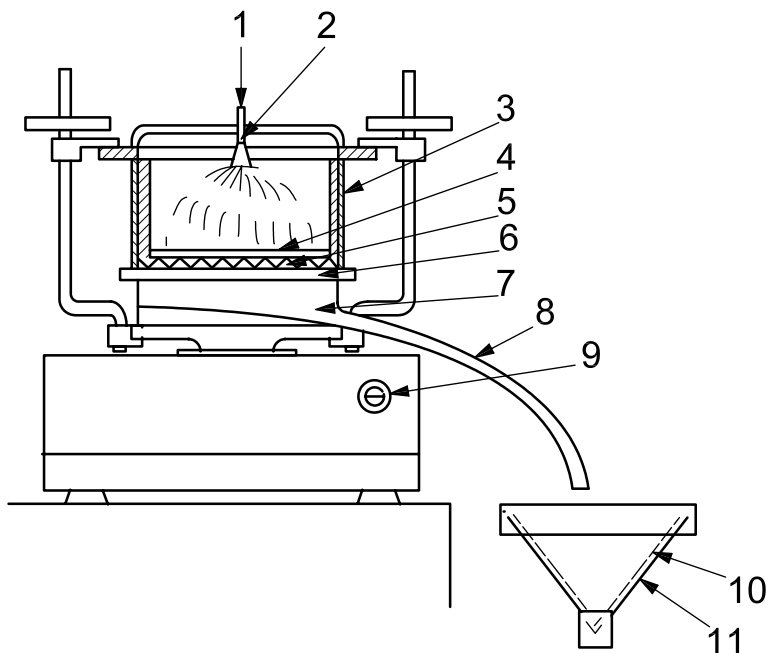
8.1 Plot the cumulative percentage of the passed granular material against the corresponding sieve size on a semi-logarithmic scale, (see Figure B.3). Determine d_{90} by either mathematical or graphical means.

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

9 Test report

The test report shall include the following information:

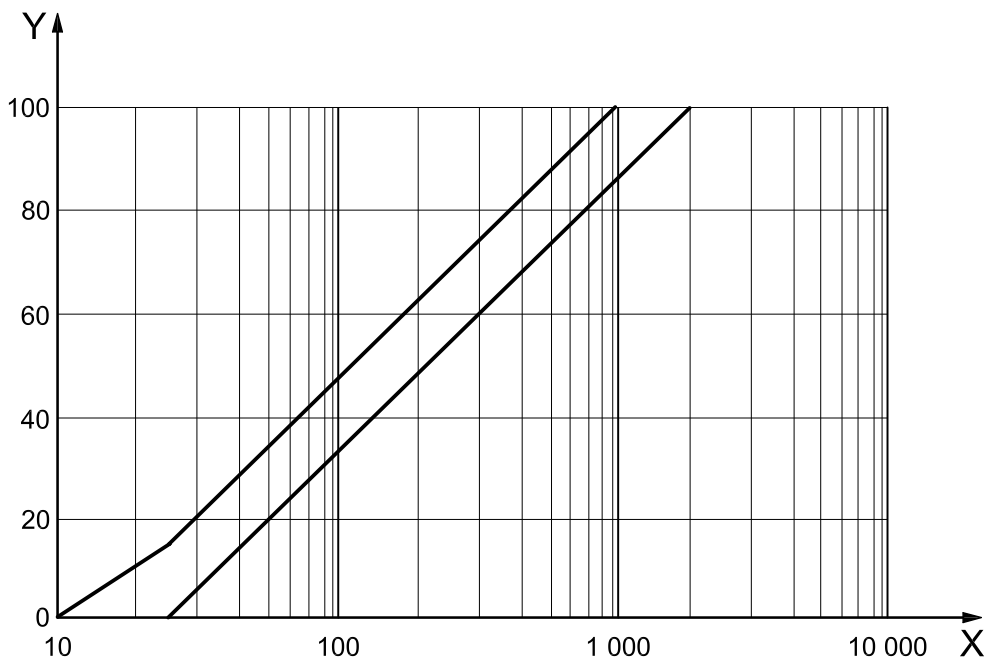
- a) the number and year of publication of this International Standard, i.e. ISO 12956:—;
- b) the test laboratory and, if required, the testing operator;
- c) a description of the tested geotextile or geotextile-related product in accordance with ISO 10320;
- d) details of apparatus used, including a diagram (if required);
- e) the exposed specimen area;
- f) the particle size distribution curve for the granular material used;
- g) for each specimen, if required, 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 2);
- h) the particle size distribution curve of the granular material passing the specimens according to the example in Annex B and, if required, the percentage of each fraction of the combined granular material analysis;
- i) the characteristic opening size, O_{90} , of the specimens;
- j) any deviation from the test method described in this International Standard;
- k) any anomaly in the behaviour of the specimens.



Key

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

Figure 1 — Example of sieving device



Key

- X grain diameter (µm)
 Y % finer

Figure 2 — The required zone of the cumulative percentage of size distribution of the granular material used

Table 1 — Typical data sheet for three specimens

Product designation: _____ Date: _____

Sample designation: _____

Specimen	Granular material			Lost granular material	Passed granular material	$ \bar{p} - p_i $	$\left \frac{\bar{p} - p_i}{\bar{p}} \right \times 100$
	initial (1)	passed (2)	retained (3)	$100[(1) - (2) - (3)] / (1)$ %	$100[(2) / (1)]$ %		
1					$p_1 =$		
2					$p_2 =$		
3					$p_3 =$		
Total				Mean	$p =$		

If maximum $\left| \frac{\bar{p} - p_i}{\bar{p}} \right| \times 100 < 25 \%$, then the data from the three specimens are acceptable.

If maximum $\left| \frac{\bar{p} - p_i}{\bar{p}} \right| \times 100 \geq 25 \%$, then two more specimens shall be tested (see Table 2).

Table 2 — Typical data sheet for five specimens

Product designation: _____ Date: _____

Sample designation: _____

Specimen	Initial granular material	Passed granular material	Retained granular material	Lost granular material	Passed granular material
	(1) g	(2) g	(3) g	% $100[(1) - (2) - (3)] / (1)$	% $100[(2) / (1)]$
1					
2					
3					
4					
5					
Total				Mean	



Annex A (normative)

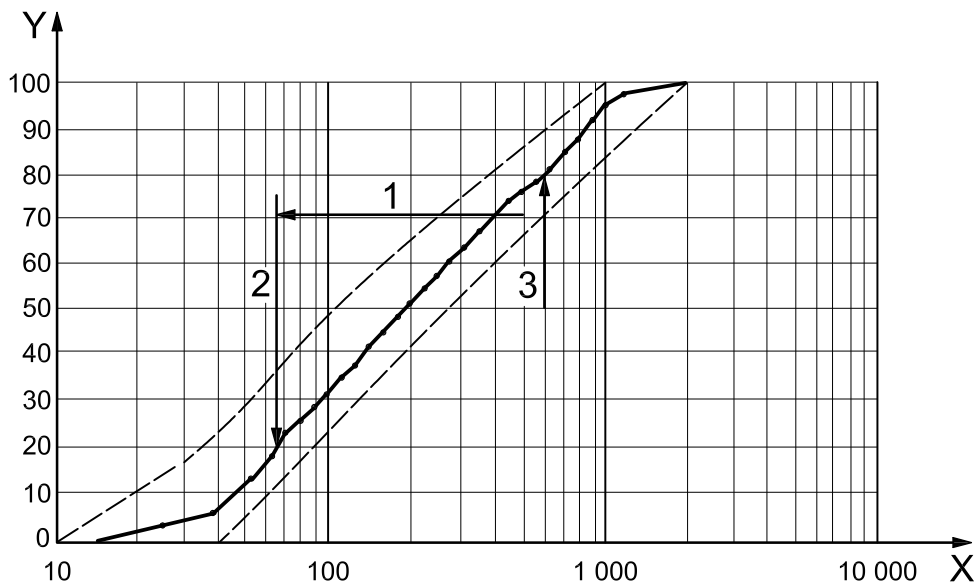
Mesh sizes

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 diameter (μm)
- Y % finer
- 1 range of measurable O_{90} values
- 2 $d_{20} = 67 \mu\text{m}$
- 3 $d_{80} = 583 \mu\text{m}$

Figure B.1 — Particle size distribution curve

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

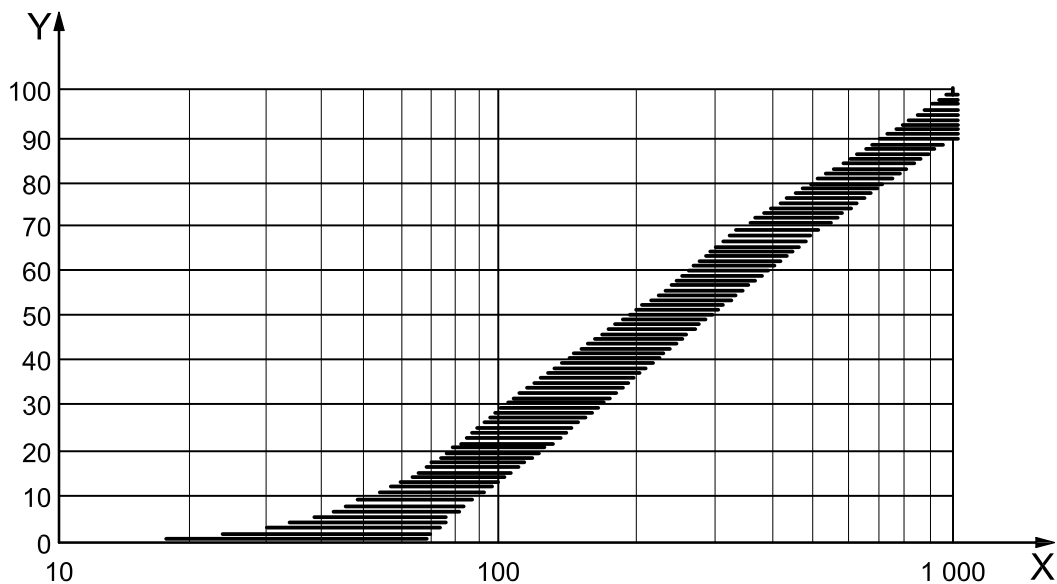
Sieving analysis					
Sieve size	Σ	Sieve size	Σ	Sieve size	Σ
μm	%	μm	%	μm	%
63	42,5	160	72,1	400	90,5
71	46,2	180	74,5	450	92,1
80	50,2	200	77,2	500	94,2
90	53,3	224	79,8	560	96,4
100	57,6	250	81,1	630	98,6
112	61,3	280	83,2	710	99,3
125	64,6	315	86,2	800	99,8
140	66,8	355	88,3		

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).

The size of the top sieve opening is 250 μm and according to ISO 2591-1, the minimum amount of granular material required for round sieves with a diameter of 200 mm is 100 g. The amount of passed granular material used for the sieve analysis is 113,01 g. The mass retained by each selected sieve is given in Table B.3.

Table B.2 — Amounts of granular material passed through the specimens

Specimen	Initial granular material (1) g	Passed granular material (2) g	Retained granular material (3) g	Lost granular material % $100[(1)-(2)-(3)]/(1)$	Passed granular material % $100[(2)/(1)]$	$ \bar{p} - p_i $ %	$\left \frac{\bar{p} - p_i}{\bar{p}} \right \times 100$ %
1	192	104,58	86,67	0,39	$p_1 = 54,5$	1,8	3,4
2	192	99,21	92,78	0,01	$p_2 = 51,7$	1,0	1,9
3	192	99,69	91,61	0,36	$p_3 = 51,9$	0,8	1,5
Total	576	303,48	271,06	Mean = 0,25	$\bar{p} = 52,7$		



Key

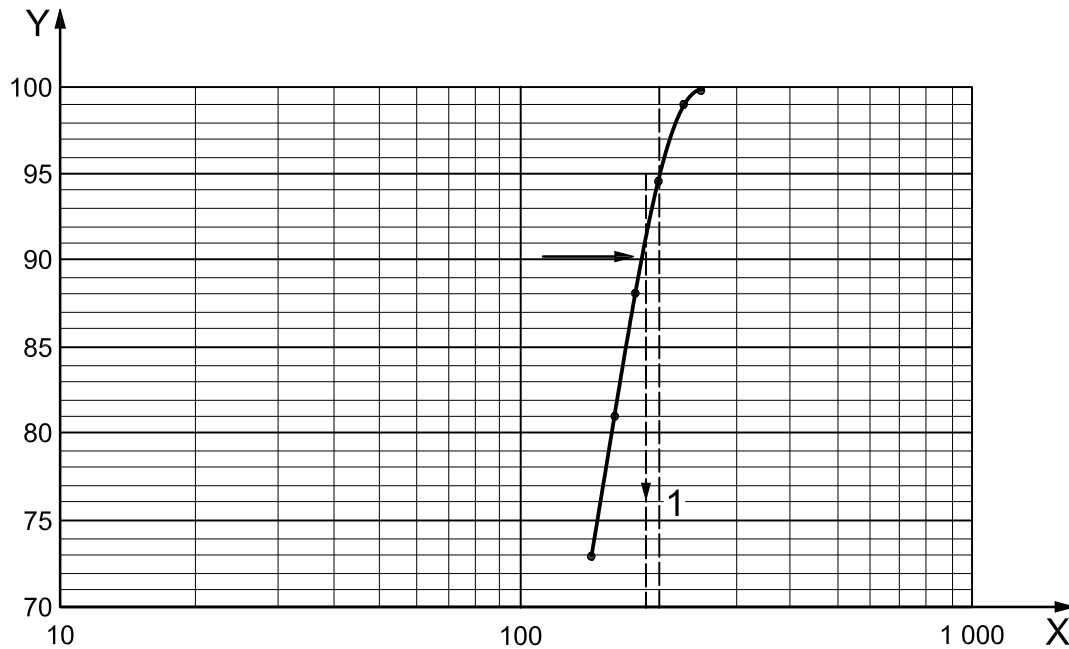
- X O_{90} values (μm)
- Y granular material passed (%)

Figure B.2 — Example of relation between size of geotextile opening and the percentage by weight of granular material which passed through the specimens

Table B.3 — 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	2561,65	2643,39	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

The granular material lost during the analysis is $100 (113,01 - 112,75)/113,01 = 0,23 \%$, 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.3. From this curve, it is seen that the characteristic opening size $O_{90} = 186 \mu\text{m}$.



- Key**
- X diameter (μm)
 - Y cumulative percentage passed (%)
 - 1 $d_{90} = 186 \mu\text{m}$

Figure B.3 — Cumulative curve of the granular material passed through the specimens and determination of O_{90}

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