

Tests for geometrical properties of aggregates

Part 1. Determination of particle size distribution — Sieving method

The European Standard EN 933-1 : 1997 has the status of a
British Standard

ICS 91.100.20

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National foreword

This British Standard is the English language version of EN 933-1 : 1997.

The UK participation in its preparation was entrusted by Technical Committee B/502, Aggregates, to Subcommittee B/502/6, Test methods, which has the responsibility to:

- aid enquirers to understand the text;
- present to the responsible European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;
- monitor related international and European developments and promulgate them in the UK.

It is also included in a package of European Standards declared by CEN/TC 154. Although it states in the foreword to the EN that the date of withdrawal of conflicting national standards is not later than February 1998, this has now been superseded by a date of withdrawal of 1 December 1999 for all conflicting national standards covered by the CEN/TC 154 package. Because of the timing of the announcement of the confirmation of the CEN/TC 154 package, it was not possible to alter the date of withdrawal quoted in the ratified text of the EN.

This part of this European Standard will supersede BS 812 : Part 103 : Section 103.1 : 1985.

A list of organizations represented on this committee can be obtained on request to its secretary.

Cross-references

The British Standards which implement international or European publications referred to in this document may be found in the BSI Standards Catalogue under the section entitled 'International Standards Correspondence Index', or by using the 'Find' facility of the BSI Standards Electronic Catalogue.

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Summary of pages

This document comprises a front cover, an inside front cover, the EN title page, pages 2 to 8, an inside back cover and a back cover.

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Descriptors: Aggregates, tests, geometric characteristics, grain size, grain size analysis, sieve analysis, specimen preparation

English version

**Tests for geometrical properties of aggregates —
Part 1: Determination of particle size distribution —
Sieving method**

Essais pour déterminer les caractéristiques
géométriques des granulats —
Partie 1: Détermination de la granularité — Analyse
granulométrique par tamisage

Prüfverfahren für geometrische Eigenschaften von
Gesteinskörnungen —
Teil 1: Bestimmung der Korngrößenverteilung —
Siebverfahren

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Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

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European Committee for Standardization
Comité Européen de Normalisation
Europäisches Komitee für Normung

Central Secretariat: rue de Stassart 36, B-1050 Brussels

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Ref. No. EN 933-1 : 1997 E

Foreword

This European Standard has been prepared by Technical Committee CEN/TC 154, *Aggregates*, the Secretariat of which is held by BSI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by February 1998, and conflicting national standards shall be withdrawn at the latest by February 1998.

This Standard forms part of a series of tests for geometrical properties of aggregates. Test methods for other properties of aggregates will be covered by Parts of the following European Standards:

- EN 932 *Tests for general properties of aggregates*
 EN 1097 *Tests for mechanical and physical properties of aggregates*
 EN 1367 *Tests for thermal and weathering properties of aggregates*
 EN 1744 *Tests for chemical properties of aggregates*

A European Standard *Test for filler aggregate used in bituminous mixtures*, is in preparation.

The other Parts of EN 933 will be:

- Part 2: *Determination of particle size distribution — Test sieves, nominal size of apertures*
 Part 3: *Determination of particle shape — Flakiness index*
 Part 4: *Determination of particle shape — Shape index*
 Part 5: *Determination of crushed and broken surfaces in coarse aggregate particles*
 Part 6: *Determination of texture/shape — Flow coefficient of coarse aggregates*
 Part 7: *Determination of shell content — Percentage of shells for coarse aggregates*
 Part 8: *Assessment of fines — Sand equivalent test*
 Part 9: *Assessment of fines — Methylene blue test*
 Part 10: *Determination of fines — Grading of fillers (air jet sieving)*

According to the CEN/CENELEC Internal Regulations the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

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1 Scope

This Part of this European Standard specifies a method, using test sieves, for the determination of the particle size distribution of aggregates. It applies to aggregates of natural or artificial origin, including lightweight aggregates, up to 63 mm nominal size, but excluding filler.

NOTE. The determination of the grading of fillers will be specified in prEN 933-10: *Tests for geometrical properties of aggregates: Part 10: Determination of fines — Grading of fillers.*

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references, the latest edition of the publication referred to applies.

prEN 932-2	<i>Tests for general properties of aggregates Part 2: Methods for reducing laboratory samples</i>
prEN 932-5	<i>Tests for general properties of aggregates Part 5: Common equipment and calibration</i>
EN 933-2 : 1995	<i>Tests for geometrical properties of aggregates Part 2: Determination of particle size distribution — Test sieves, nominal size of apertures</i>
prEN 1097-6	<i>Tests for mechanical and physical properties of aggregates Part 6: Determination of particle density and water absorption</i>
ISO 3310-1 : 1990	<i>Test sieves — Technical requirements and testing Part 1: Test sieves of metal wire cloth</i>
ISO 3310-2 : 1990	<i>Test sieves — Technical requirements and testing Part 2: Test sieves of perforated metal plate</i>

3 Definitions

For the purposes of this standard, the following definitions apply:

3.1 test portion

The sample used as a whole in a single test.

3.2 constant mass

Successive weighings after drying at least 1 h apart not differing by more than 0,1 %.

NOTE. In many cases constant mass can be achieved after a test portion has been dried for a pre-determined period in a specified oven (see 5.3) at $(110 \pm 5) ^\circ\text{C}$. Test laboratories may determine the time required to achieve constant mass for specific types and sizes of sample dependent upon the drying capacity of the oven used.

4 Principle

The test consists of dividing up and separating, by means of a series of sieves, a material into several particle size classifications of decreasing sizes. The aperture sizes and the number of sieves are selected in accordance with the nature of the sample and the accuracy required.

The method adopted is washing and dry sieving. When washing may alter the physical properties of a lightweight aggregate, dry sieving shall be used and the procedure specified in 7.1 shall not be applied.

NOTE. Dry sieving is also an alternative method which may be used for aggregates free from particles which cause agglomeration. In cases of dispute, washing and sieving is the preferred method.

The mass of the particles retained on the various sieves is related to the initial mass of the material. The cumulative percentages passing each sieve are reported in numerical form and when required in graphical form (see annex A).

5 Apparatus

Unless otherwise stated, all apparatus shall conform to the general requirements of prEN 932-5.

5.1 *Test sieves*, with apertures as specified in prEN 933-2 and conforming to the requirements of ISO 3310-1 and ISO 3310-2.

5.2 *Tightly fitting pan and lid*, for the sieves.

5.3 *Ventilated oven*, thermostatically controlled to maintain a temperature of $(110 \pm 5) ^\circ\text{C}$, or other suitable equipment for drying the aggregates, if it does not cause any particle size breakdown.

5.4 *Washing equipment*.

5.5 *Balances or scales*, accurate to $\pm 0,1$ % of test portion mass.

5.6 *Trays*, brushes.

5.7 *Sieving machine*, (optional).

6 Preparation of test portions

Samples shall be reduced in accordance with prEN 932-2 to produce the required number of test portions.

NOTE. It may be necessary to moisten samples containing substantial amounts of fines before reduction to minimize segregation and loss of dust.

The mass of each test portion shall be as specified in table 1 for aggregates of density between 2,00 mg/m³ and 3,00 mg/m³.

Aggregate size <i>D</i> (maximum) mm	Test portion mass (minimum) kg
63	40
32	10
16	2,6
8	0,6
≤ 4	0,2

NOTE 1. For aggregates of other sizes, the minimum test portion mass may be interpolated from the masses given in table 1.

NOTE 2. If the test portion mass does not comply with table 1, the particle size distribution obtained does not comply with this standard, and this shall be stated in the report sheet.

NOTE 3. For aggregates of particle density less than 2,00 mg/m³ or more than 3,00 mg/m³ (see prEN 1097-6) an appropriate correction shall be applied to the test portion masses given in table 1 based on the density ratio, in order to produce a test portion of approximately the same volume as those for aggregates of normal density.

Sample reduction shall yield a test portion of mass larger than the minimum but not of an exact predetermined value.

Dry the test portion by heating at a temperature of (110 ± 5) °C to constant mass. Allow to cool, weigh and record the mass as *M*₁.

For some types of aggregate, drying at 110 °C binds particles together sufficiently strongly to prevent separation of single particles during subsequent washing and/or sieving procedures. For such aggregates the procedure given in annex B shall be adopted.

7 Procedure

7.1 Washing

Place the test portion in a container and add sufficient water to cover the test portion.

NOTE 1. A storage period of 24 h under water is helpful in breaking down lumps. A dispersion agent may be used.

Agitate the sample with sufficient vigour to result in complete separation and suspension of the fines.

Wet both sides of a 63 μm sieve reserved for use in this test only, and fit a guard sieve (e.g. 1 mm or 2 mm) on top. Mount the sieves in such a way that the suspension passing the test sieve can be run to waste or, when required, collected in a suitable vessel. Pour the contents of the container onto the top sieve. Continue washing until the water passing the 63 μm test sieve is clear.

NOTE 2. Care should be taken to prevent overloading, overflowing or damaging the 63 μm test sieve or the guard sieve. For some aggregates it will be found necessary to pour only the suspended fines from the container onto the 63 μm guarded test sieve, continuing to wash the coarse residue in the container and decanting the suspended fines onto the guard sieve until the water passing the 63 μm test sieve is clear.

Dry the residue retained on the 63 μm sieve at (110 ± 5) °C to constant mass. Allow to cool, weigh and record as *M*₂.

7.2 Sieving

Pour the washed and dried material (or directly the dry sample) into the sieving column. The column comprises a number of sieves fitted together and arranged, from top to bottom, in order of decreasing aperture sizes with the pan and lid.

NOTE 1. Experience has shown that washing does not necessarily remove all the fines. It is therefore necessary to incorporate a 63 μm test sieve in the series.

Shake the column, manually or mechanically, then remove the sieves one by one, commencing with the largest aperture size opening and shake each sieve manually ensuring no material is lost by using, for example, a pan and lid.

Transfer all the material which passes each sieve onto the next sieve in the column before continuing the operation with that sieve.

NOTE 2. The sieving process may be considered completed when the retained material does not change more than 1,0 % during 1 min of this sieving operation.

To avoid overloading of sieves, the fraction retained at the end of the sieving operation on each sieve (expressed in grams) shall not exceed:

$$\frac{A \times \sqrt{d}}{200}$$

where:

- A* is the area of the sieve, in square millimetres;
- d* is the aperture size of the sieve, in millimetres.

If any of the fractions retained exceeds this amount, one of the following procedures shall be used:

- a) divide the fraction into smaller portions than the specified maximum and sieve these one after the other;
- b) divide the portion of the sample passing the next largest sieve with the aid of a sample divider or by quartering, and continue the sieve analysis on the reduced test portion, making due allowance in subsequent calculations for the reductions.

7.3 Weighing

Weigh the retained material for the sieve with the largest aperture size and record its mass as R_1 .

Carry out the same operation for the sieve immediately below and record the mass retained as R_2 .

Continue with the same operation for all the sieves in the column, in order to obtain the masses of the various lots of retained materials and record these masses as $R_3, R_4, \dots, R_i, \dots, R_n$.

Weigh the screened material, if any, remains in the pan and record its mass as P .

8 Calculation and expression of results

8.1 Calculations

Record the various masses on a test data sheet, an example of which is given in annex C.

Calculate the mass retained on each sieve as a percentage of the original dry mass M_1 .

Calculate the cumulative percentage of the original dry mass passing each sieve down to the 63 μm sieve exclusive.

Calculate the percentage of fines (f) passing the 63 μm sieve in accordance with the following equation:

$$f = \frac{(M_1 - M_2) + P}{M_1} \times 100$$

where:

M_1 is the dried mass of the test portion, in kilograms;

M_2 is the dried mass of the residue retained on the 63 μm sieve, in kilograms;

P is the mass of the screened material remaining in the pan, in kilograms.

8.2 Validating the results

If the sum of the masses R_i and P differs by more than 1 % from the mass M_2 , the test shall be repeated.

9 Test report

9.1 Required data

The test report shall include the following information:

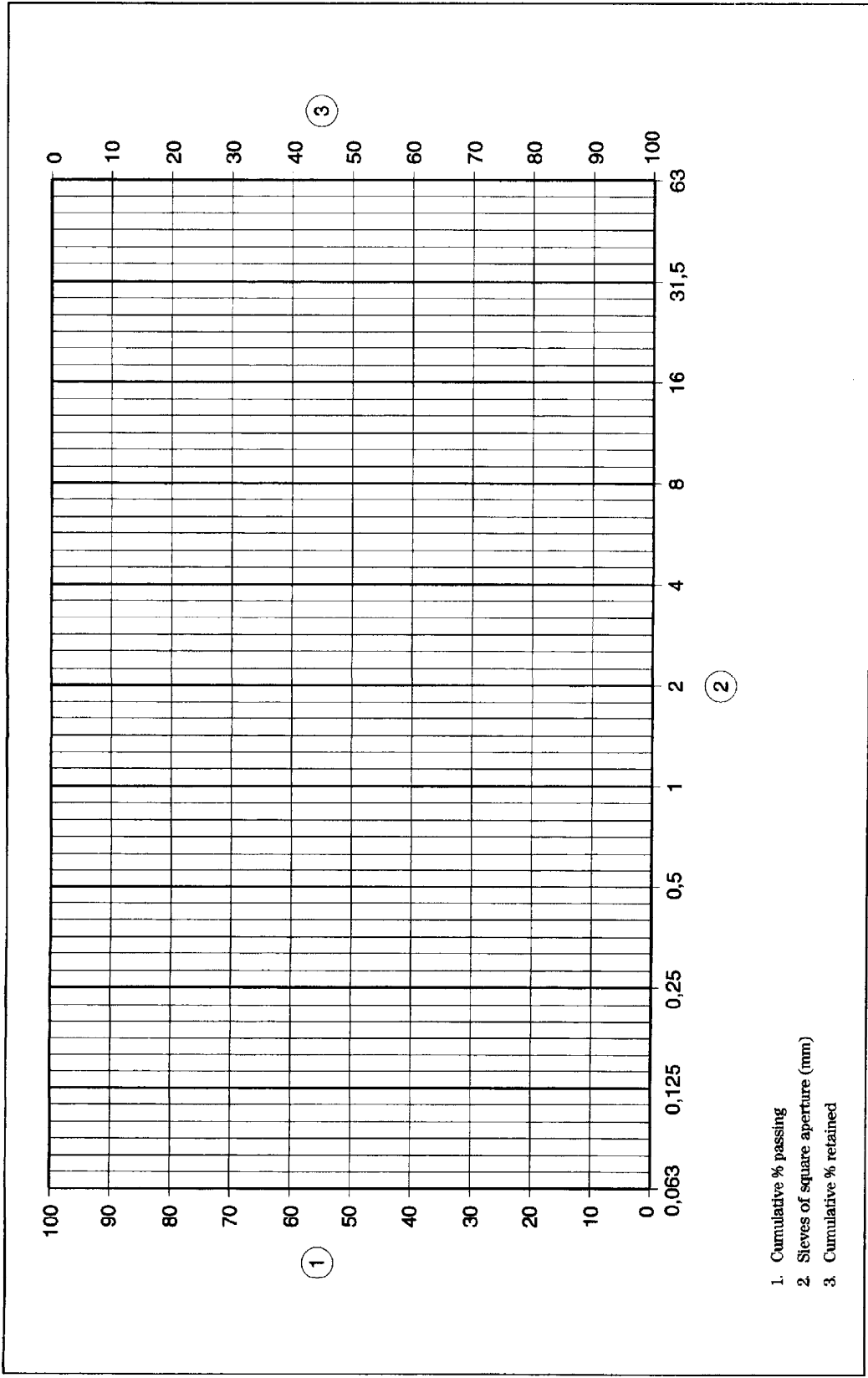
- reference to this European Standard;
- identification of the sample;
- identification of the laboratory;
- sample reception date;
- method of analysis (washing and sieving or dry sieving);
- cumulative percentage of the mass of the test portion passing each of the sieves to the nearest single decimal place for the 63 μm sieve and to the nearest whole number for other sieves.

9.2 Optional data

The test report may include the following information:

- name and location of the sample source;
- description of the material and of the sample reduction procedure;
- graphical presentation of results (see annex A);
- sampling certificate;
- mass of test portion;
- date of test.

Annex A (informative)
Graphical presentation of results



Annex B (normative)

Method of test for aggregates unsuitable for oven drying

For aggregates unsuited to oven drying at 110 °C the required number of test portions shall be obtained in duplicate and their masses recorded. The moisture content of one of each duplicate pair of test portions shall be determined by oven drying at (110 ± 5) °C. The other test portion shall be tested by the washing and sieving method without pre-drying. The initial dry mass of this second test portion shall be calculated on the assumption that the duplicate test portions have identical moisture contents and recorded as M_1' .

Annex C (informative)

Example of test data sheet

Particle size distribution — Sieving method: EN 933-1	Laboratory:
Identification of the sample	Date:
	Operator:
Method used: washing and sieving/dry sieving (delete as appropriate)	

Total dry mass $M_1 =$ (or $M_1' =$ see annex B)

Dry mass after washing $M_2 =$

Dry mass of fines removed by washing $M_1 - M_2 =$

Sieve aperture size mm	Mass of material retained (R_i) kg	Percentage of material retained $R_i/M_1 \times 100$	Cumulative percentages passing $100 - (R_i/M_1 \times 100)$
	R_1 R_2		(to nearest whole number)
Material in the pan $P =$			

$$\text{Percentage fines } (f) \text{ passing the } 63 \mu\text{m sieve} = \frac{(M_1 - M_2) + P}{M_1} \times 100$$

(to nearest single decimal)

$\Sigma R_i + P =$		Remarks:
$\frac{M_2 - (\Sigma R_i + P)}{M_2} \times 100 =$	< 1 %	

The dry mass of the test portion should be recorded as M_1 when determined directly or as M_1' when calculated from a duplicate test portion.

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