



SLOVENSKI STANDARD

SIST EN 933-1:2012

01-maj-2012

Nadomešča:

SIST EN 933-1:1999

SIST EN 933-1:1999/A1:2005

Preskusi geometričnih lastnosti agregatov - 1. del: Ugotavljanje zrnivosti - Metoda sejanja

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

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

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

Ta slovenski standard je istoveten z: EN 933-1:2012

ICS:

91.100.15 Mineralni materiali in izdelki Mineral materials and products

SIST EN 933-1:2012

en,fr,de

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EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 933-1

January 2012

ICS 91.100.15

Supersedes EN 933-1:1997

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

This European Standard was approved by CEN on 29 October 2011.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CEN member.

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Foreword

This document (EN 933-1:2012) 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of an identical text or by endorsement, at the latest by July 2012, and conflicting national standards shall be withdrawn at the latest by July 2012.

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

This document supersedes EN 933-1:1997.

EN 933 — Tests for geometrical properties of aggregates, consists of the following parts:

- Part 1: Determination of particle size distribution — Sieving method;*
- *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 percentage of crushed and broken surfaces in coarse aggregate particles;*
- *Part 6: Assessment of surface characteristics — Flow coefficient of 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: Assessment of fines — Grading of filler aggregates (air jet sieving);*
- *Part 11: Classification test for the constituents of coarse recycled aggregate.*

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

EN 933-1:2012 (E)**1 Scope**

This European Standard describes the reference washing and dry sieving method used for type testing and in case of dispute, for determination of the particle size distribution of aggregates. For other purposes, in particular factory production control, other methods may be used, provided that an appropriate working relationship with the reference method has been established. It applies to all aggregates, including lightweight aggregates, up to 90 mm nominal size, but excluding filler.

NOTE 1 The determination of the grading of fillers is specified in EN 933-10 *Assessment of fines — Grading of filler aggregates (air jet sieving)*.

NOTE 2 Dry sieving without washing may be used for aggregates free from particles which cause agglomeration.

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.

EN 932-2, *Tests for general properties of aggregates — Part 2: Methods for reducing laboratory samples*

EN 932-5, *Tests for general properties of aggregates — Part 5: Common equipment and calibration*

EN 933-2, *Tests for geometrical properties of aggregates — Part 2: Determination of particle size distribution — Test sieves, nominal size of apertures*

ISO 3310-1, *Test sieves — Technical requirements and testing — Part 1: Test sieves of metal wire cloth*

ISO 3310-2, *Test sieves — Technical requirements and testing — Part 2: Test sieves of perforated metal plate*

3 Terms and definitions

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

3.1**aggregate**

granular material used in construction which may be natural, manufactured or recycled

3.2**test portion**

sample used as a whole in a single test

3.3**constant mass**

mass determined by successive weighings performed at least 1 h apart and 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 ± 5) °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 and separating a material into several particle size classifications of decreasing sizes by means of a series of sieves. 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 can alter the physical properties of a lightweight aggregate, dry sieving shall be used and the procedure specified in 7.1 shall not be applied.

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 D).

5 Apparatus

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

5.1 *Test sieves*, with apertures as specified in EN 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 ± 5) °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 EN 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 minimise segregation and loss of dust.

The size of each test portion shall be as specified in Table 1.

Table 1 — Minimum size of test portions

Aggregate size D (maximum) mm	mass of aggregates kg	volume of lightweight aggregates (litres)
90	80	-
32	10	2,1
16	2,6	1,7
8	0,6	0,8
≤ 4	0,2	0,3

NOTE 1 For aggregates of other sizes below 90 mm, the minimum test portion mass may be interpolated from the masses given in Table 1 using the following formulae: $M = (D/10)^2$

where M = minimum mass of test portion in kg

D = aggregate size in mm

NOTE 2 The precision of the test method may be reduced if the test portion size is less than the value in Table 1. In such a case, the test portion size should be stated in the test report (9.2).

NOTE 3 For aggregates of particle density higher than 3,00 Mg/m³ (see EN 1097-6), an appropriate correction should 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.

NOTE 4 For lightweight aggregates complying with EN 13055, use the volume column to choose the appropriate minimum size of test portions. The volumes for other aggregate sizes may be interpolated.

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

Dry the test portion by heating at a temperature of $(110 \pm 5) ^\circ\text{C}$ 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.

For all-in aggregates with D equal to 31,5 mm or larger, the procedure described in Annex A may be used.

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 0,063 mm 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 on to the top sieve. Continue washing until the water passing the 0,063 mm test sieve is clear.

NOTE 2 Care should be taken to prevent overloading, overflowing or damaging the 0,063 mm test sieve or the guard sieve. For some aggregates, it will be necessary to pour only the suspended fines from the container onto the 0,063 mm 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 0,063 mm test sieve is clear.

Dry the residue retained on the 0,063 mm sieve at $(110 \pm 5) ^\circ\text{C}$ 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 0,063 mm 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. Shake each sieve manually ensuring no material is lost by using a pan and lid for example.

NOTE 2 The effectiveness of mechanical sieving is influenced by the aggregate type, the sieving time, the loading on the sieve and the parameters of the shaking movement such as amplitude and frequency. The mechanical sieving time should hence be carefully chosen.

Transfer all the material which passes each sieve onto the next sieve in the column before continuing the operation with that sieve. Sieve overloading shall be avoided.

NOTE 3 To avoid overloading of sieves, the fraction of normal weight aggregates retained at the end of the sieving operation on each sieve (expressed in grams) should 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 overloading occurs, one of the following procedures shall be used:

- a) divide the fraction into smaller portions 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.

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The sieving process shall be considered as finished when additional sieving does not lead to a change of mass of the retained material on any sieve by more than 1,0 % by mass.

NOTE 4 Depending on the aggregate characteristics, the sieving process may be considered completed when the retained material does not change more than 1,0 % during 1 min.

NOTE 5 For lightweight aggregates, no more than one layer of particles should be retained on each sieve at the end of the sieving operation.

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, R_i, R_n .

Weigh the screened material, if any, remaining 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 0,063 mm sieve exclusive.

Calculate the percentage of fines f passing the 0,063 mm 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 0,063 mm sieve, in kilograms;

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

$$\text{For dry sieving } f = \frac{100P}{M_1}$$

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.

8.3 Precision

The following precision values have been issued from the document “*The proposed CEN method for the determination of the particle size distribution of aggregates. Sieve test on sand. Results of the 1996/7 Cross-Testing Experiment*” of the European Project No. 134.

The repeatability r_1 and reproducibility R_1 values have been determined on the basis of two repetitions of tests carried out on each of the three fine aggregate fractions, a 0/0,4 and two 0/2 mm fractions, in 17 laboratories from nine European countries. Each laboratory has prepared (using a riffle box) and successively tested two different masses of samples, 200 g and 30 g.

For any sieve size of the basic set comprised between 0,063 and 4 mm, the precision values can be stated as follows:

$$r_1 = 0,042 \sqrt{X(100,0 - X)}$$

$$R_1 = 0,086 \sqrt{X(100,0 - X)}$$

where

X represents the average of the cumulative percent passing the actual sieve size.

It is highlighted that precision is highly dependent on the loading of individual sieves, overloaded sieves leading to degraded precision data and lightly loaded sieves leading to better precision data.

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9 Test report

9.1 Required data

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The test report shall include the following information:

- a) reference to this European Standard;
- b) identification of the sample;
- c) identification of the laboratory;
- d) sample reception date;
- e) method of analysis (washing and sieving or dry sieving);
- f) cumulative percentage of the mass of the test portion passing each of the sieves to the nearest single decimal place for the 0,063 mm sieve and to the nearest whole number for other sieves.

9.2 Optional data

The test report may include the following information:

- a) name and location of the sample source;
- b) description of the material and of the sample reduction procedure;
- c) graphical presentation of results (see Annex D);
- d) sampling certificate;