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Preskusi geometričnih lastnosti agregatov - 5. del: Določevanje odstotka lomljenih površin zrn grobega in mešanega agregata

Tests for geometrical properties of aggregates - Part 5: Determination of percentage of crushed particles in coarse and all-in natural aggregates

Prüfverfahren für geometrische Eigenschaften von Gesteinskörnungen - Teil 5:
Bestimmung des prozentualen Anteils an gebrochenen Körnern in groben
Gesteinskörnungen und Gesteinskörnungsgemischen

Essais pour déterminer les caractéristiques géométriques des granulats - Partie 5 :
Détermination du pourcentage de surfaces cassées dans les gravillons et graves
naturelles

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Tests for geometrical properties of aggregates - Part 5:
Determination of percentage of crushed particles in coarse
and all-in natural aggregates

Essais pour déterminer les caractéristiques
géométriques des granulats - Partie 5 : Détermination
du pourcentage de surfaces cassées dans les gravillons
et cailloux

Prüfverfahren für geometrische Eigenschaften von
Gesteinskörnungen - Teil 5: Bestimmung des
prozentualen Anteils an gebrochenen Körnern in
groben Gesteinskörnungen und
Gesteinskörnungsgemischen

This European Standard was approved by CEN on 26 September 2022.

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European foreword

This document (EN 933-5:2022) 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of an identical text or by endorsement, at the latest by May 2023, and conflicting national standards shall be withdrawn at the latest by May 2023.

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

This document supersedes EN 933-5:1998.

This document has been prepared under a Standardization Request given to CEN by the European Commission and the European Free Trade Association.

In comparison with the previous edition, the following technical modifications have been made:

- a) The title has been revised to better reflect the scope;
- b) Clause 1: Scope has been clarified to show that the standard applies to coarse and all-in natural aggregates, but not to lightweight aggregates.
- c) Clause 3: The definition of a crushed surface has been changed. The definitions of aggregate size and a rounded particle have been deleted. The definition of a rounded surface has been added;
- d) Clause 4: Principle has been amended;
- e) Clause 5: Coloured pencil has been added as optional apparatus to facilitate the procedure of estimating crushed and rounded parts of a particle surface;
- f) Clause 6: Preparation of test portion has been revised;
- g) Clause 7: Procedure has been amended and an illustrating figure has been added;
- h) Clause 8: Calculation and expression of results has been amended;
- i) Clause 9: The lists of required and optional data have been updated;
- j) New informative Annex A, with guidance for estimated mass of various size fractions with about 100 particles, has been added;
- k) New informative Annex B, with example of application of the test procedure, has been added;
- l) Previous Annex A, with example of a test data sheet, has been revised and moved to Annex C.

This document forms part of a series of tests for geometrical properties of aggregates. Test methods for other properties of aggregates are covered by the following European Standards:

- EN 932 (all parts), *Tests for general properties of aggregates*
- EN 1097 (all parts), *Tests for mechanical and physical properties of aggregates*

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- EN 1367 (all parts), *Tests for thermal and weathering properties of aggregates*
- EN 1744 (all parts), *Tests for chemical properties of aggregates*
- EN 13179 (all parts), *Tests for filler aggregate used in bituminous mixtures*

The other parts of the EN 933 series include:

- *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 6: Assessment of surface characteristics - Flow coefficient of aggregates*
- *Part 7: Determination of shell content - Percentage of shells in 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*

Any feedback and questions on this document should be directed to the users' national standards body. A complete listing of these bodies can be found on the CEN website.

According to the CEN-CENELEC Internal Regulations, the national standards organisations 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, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Türkiye and the United Kingdom.

1 Scope

This document specifies the reference method, used for type testing and in case of dispute, for the determination of the percentages of crushed particles, totally crushed particles and totally rounded particles in coarse and all-in natural aggregates. Other methods can be used for other purposes, such as factory production control, provided that an appropriate working relationship with the reference method has been established.

NOTE 1 Examples of advanced test methods can be found in the Bibliography.

This document applies to coarse aggregates comprising particles within size fraction 4/63 mm. It does not apply to lightweight aggregates.

NOTE 2 For coarse aggregate between 4 mm and 20 mm the percentages of crushed surfaces are linked to the flow coefficient and can therefore be used in association with the test method specified in EN 933-6.

Clause 7.1 specifies the procedure for test portions consisting of one size fraction and Clause 7.2 specifies the procedure for test portions consisting of two or more size fractions.

Guidance for the estimated mass of various size fractions with about 100 particles is given in informative Annex A.

Examples of application of the test procedure and an example of a test data sheet are given in informative Annexes B and C.

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.

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 933-1, *Tests for geometrical properties of aggregates - Part 1: Determination of particle size distribution - Sieving method*

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

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/ui>
- IEC Electropedia: available at <https://www.electropedia.org/>

3.1

size fraction

d_i/D_i

fraction of an aggregate passing the larger (D_i) of two sieves and retained on the smaller (d_i)

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3.2**test portion** d_0/D_0

sample used as a whole in a single test

3.3**constant mass**

mass determined after successive weighings at least 1 h apart not differing by more than 0,1 %

Note 1 to entry: In many cases constant mass can be achieved after a test portion has been dried for a pre-determined period in a specified oven at $(110 \pm 5) ^\circ\text{C}$. Test laboratories can determine the time required to achieve constant mass for specific types and sizes of sample dependent upon the drying capacity of the oven used.

3.4**crushed surface**

surface of a particle with angular fractured planar faces and often distinct corners and edges

Note 1 to entry: The crushed surface is usually produced by mechanical processing, but it can also consist of the original surface of a gravel particle, formed by geological action (breaking without any subsequent significant wear and weathering of the gravel particle).

3.5**totally crushed particle**

particle with more than 90 % of its surface crushed (tc)

3.6**crushed particle**

particle with more than 50 % of its surface crushed (c)

3.7**rounded surface**

surface of a particle which does not conform to the definition of crushed surface in 3.5

3.8**totally rounded particle**

particle with more than 90 % of its surface rounded (tr)

4 Principle

The test consists of sorting by hand a coarse test portion of natural aggregates into crushed particles, totally crushed particles and totally rounded particles.

The masses of crushed particles, totally crushed particles and totally rounded particles are determined and expressed as percentages of the test portion mass.

5 Apparatus

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

5.1 Test sieves, of nominal size of apertures conforming with EN 933-2.

5.2 Tightly fitting pan and lid, for the sieves.

5.3 Ventilated oven, capable of maintaining a temperature of $(110 \pm 5) ^\circ\text{C}$, or equipment for drying the aggregate which does not cause any particle size breakdown.

5.4 Balance or scale, accurate to 0,1 % of the mass to be weighed.

5.5 Trays.

5.6 Brushes.

5.7 Sieving machine, optional.

5.8 Coloured pencil, optional.

6 Preparation of test portion

The test portion shall consist of size fraction d_0/D_0 , where d_0 and D_0 are determined from the aggregate size d/D of the laboratory sample as follows:

If d in the laboratory sample is smaller than 4 mm, then $d_0 = 4$.

If d in the laboratory sample is equal to or greater than 4 mm, then $d_0 = d$.

If D in the laboratory sample is greater than 63 mm, then $D_0 = 63$ mm.

If D in the laboratory sample is equal to or smaller than 63 mm, then $D_0 = D$.

EXAMPLE 1 If the aggregate size of the laboratory sample is 0/8 mm, the selected size of the test portion will be 4/8 mm.

EXAMPLE 2 If the aggregate size of the laboratory sample is 0/90 mm, the selected size of the test portion will be 4/63 mm.

Samples (laboratory sample and other samples) shall be reduced in accordance with EN 932-2.

The mass of the laboratory sample, M_0 , shall have a minimum value as specified for the test portion in EN 933-1.

Wash the laboratory sample on the d_0 and D_0 sieves. Discard the retained material on the D_0 sieve and the passing material on the d_0 sieve. Dry the retained material d_0/D_0 to constant mass in the oven at $(110 \pm 5) ^\circ\text{C}$.

Sieve the test sample in accordance with EN 933-1, using the d_0 and the D_0 sieve. Discard particles passing the d_0 sieve and particles retained on the D_0 sieve.

If necessary, reduce the size fraction d_0/D_0 in accordance with EN 932-2 to produce the test portion.

Weigh the test portion and record its mass as M_1 .

7 Procedure

7.1 Test portions consisting of one size fraction where $D_0 \leq 2d_0$

The test is carried out on a test portion consisting of one size fraction d_0/D_0 , where $D_0 \leq 2d_0$. The test portion shall contain at least 100 particles.

NOTE 1 In order to reach at least 100 particles in the size fraction, guidance for estimated mass of the test portion containing about 100 particles is given in Annex A, for aggregates with an oven-dried particle density of $2,65 \text{ Mg/m}^3$.

Spread the particles of the test portion on a flat surface and separate them into four particle groups as shown in Figure 1. The term crushed particles includes “totally crushed particles” and “partially crushed particles”. The group “Other particles” shall be kept for validation of results.

NOTE 2 The estimation of the areas of the crushed and rounded parts of the particle surface can be facilitated by marking the dividing lines using a suitable coloured pencil (5.8).

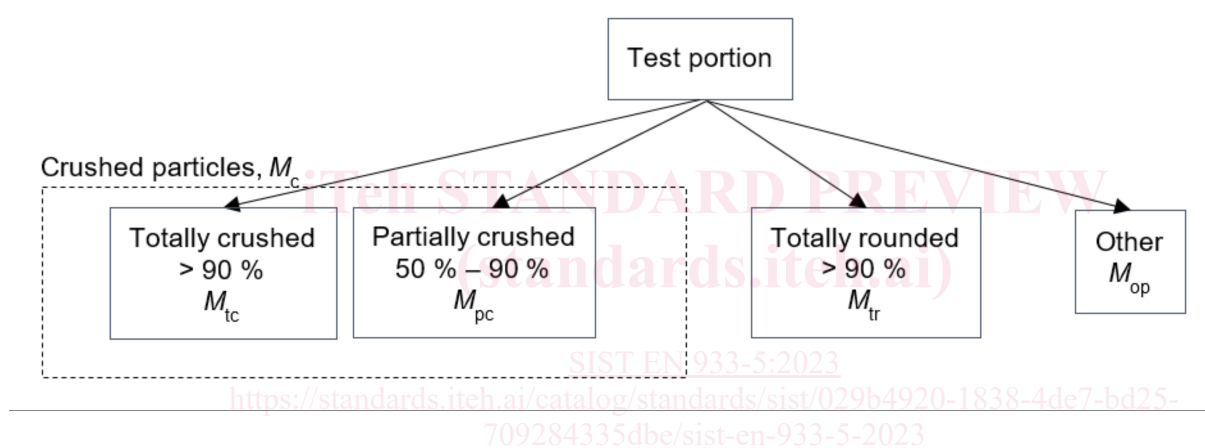


Figure 1 — Sorting particles in the test portion into four particle groups

Weigh and record on a test data sheet, the masses M_{tc} , M_{pc} , M_{tr} and M_{op} .

NOTE 3 An example of application of the test procedure is given in B.1.

NOTE 4 An example of a test data sheet is given in Annex C.

If the sum of the masses M_{tc} , M_{pc} , M_{tr} and M_{op} differs by more than 1 % from the mass M_1 , the test shall be repeated.

7.2 Test portions consisting of two or more size fractions

Separate the test portion with mass M_1 into size fractions d_i/D_i where $D_i \leq 2d_i$ by sieving in accordance with EN 933-1.

Record the mass of each size fraction as M_{1i} and estimate the number of particles in each size fraction using Annex A. Each size fraction shall contain at least 100 particles.

NOTE 1 In order to reach at least 100 particles in the size fraction, guidance for estimated mass of the test portion containing about 100 particles is given in Annex A, for aggregates with an oven-dried particle density of $2,65 \text{ Mg/m}^3$.

If necessary, reduce a size fraction in accordance with EN 932-2. Record the mass of each reduced size fraction as m_i .

Record and discard any size fraction d_i/D_i which comprises less than 10 % of M_1 .

Any remaining size fraction d_i/D_i which contains less than 100 particles shall be recorded in the test report.

Sort the particles in each of the remaining size fractions in accordance with 7.1.

Weigh and record on a test data sheet the masses M_{tci} , M_{pci} , M_{tri} and M_{opi} , in each size fraction. If the mass of size fraction d_i/D_i is reduced, weigh and record the reduced masses m_{tci} , m_{pci} , m_{tri} and m_{opi} in this size fraction.

NOTE 2 An example of application of the test procedure is given in B.2.

NOTE 3 The example of a test data sheet in Annex C can be used as a basis.

If the sum of the masses M_{tci} , M_{pci} , M_{tri} and M_{opi} , or the sum of m_{tci} , m_{pci} , m_{tri} and m_{opi} , differs by more than 1 % from the mass of each individual size fraction, M_{1i} or m_i , the test shall be repeated.

8 Calculation and expression of results

8.1 Test portions consisting of one size fraction

Calculate the mass of the crushed particles according to Formula (1):

$$M_c = M_{tc} + M_{pc} \quad (1)$$

Calculate the mass percentage of totally crushed particles (C_{tc}), crushed particles (C_c) and totally rounded particles (C_{tr}) in the test portion in accordance with the Formulae (2), (3) and (4):

$$C_{tc} = \frac{M_{tc}}{M_1} \times 100 \quad (2)$$

$$C_c = \frac{M_c}{M_1} \times 100 \quad (3)$$

$$C_{tr} = \frac{M_{tr}}{M_1} \times 100 \quad (4)$$

where

M_{tc} , M_c and M_{tr} are the masses of totally crushed particles, crushed particles and totally rounded particles in the test portion, in grams;

M_1 is the mass of the test portion, in grams.

Record the values to the nearest whole number.