SLOVENSKI STANDARD
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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 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 cailloux

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EUROPEAN STANDARD

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English Version

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

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This draft European Standard is submitted to CEN members for enquiry. It has been drawn up by the Technical Committee CEN/TC 154.

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Recipients of this draft are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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European foreword

This document (prEN 933-5:2020) has been prepared by Technical Committee CEN/TC 154 "Aggregates", the secretariat of which is held by BSI.

This document is currently submitted to the CEN Enquiry.

This document will supersede EN 933-5:1998.

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 3: The definition of a crushed surface has been changed. The definitions of aggregate size and a rounded particle have been deleted. The definitions of gravel and a rounded surface have been added;

c) Clause 4: Principle has been amended;

d) Clause 5.3: An alternative temperature has been added for the ventilated oven;

e) Clause 6: Preparation of test portion has been revised;

f) Clause 7: Procedure has been amended;

g) Clause 8: Calculation and expression of results has been amended;

h) Clause 9: The lists of required and optional data have been updated;

i) New informative Annex A, with guidance for estimated mass of the test portion, has been added;

j) New informative Annex B, with example of application of the test procedure, has been added;

k) 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*

— 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 EN 933 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 for coarse 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 fillers (air jet sieving)*

— *Part 11: Classification test for the constituents of coarse recycled aggregates*

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 a sample of natural coarse aggregate or all-in aggregate. 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 gravel or to a mixture of natural coarse aggregates containing gravel. The test method specified is applicable to particle sizes between 4 mm and 63 mm.

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.

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

Guidance for estimated mass of the test portion 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:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at https://www.iso.org/obp/ui

3.1
gravel
unconsolidated, natural accumulation of typically rounded rock particles resulting from erosion

Note 1 to entry: The gravel particles are often rounded (e.g. from alluvial deposits), but they can also be angular to sub-rounded in shape (e.g. from moraine deposits).

3.2
particle 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)

3.3
test portion
d_0/D_0
sample used as a whole in a single test

3.4
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 ± 5) °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.

3.5
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).

3.6
totally crushed particle
particle with more than 90 % of its surface crushed (tc)

3.7
crushed particle
particle with more than 50 % of its surface crushed (c)

3.8
rounded surface
surface of a gravel particle which does not conform to the definition of crushed surface in 3.5

3.9
totally rounded particle
gravel particle with more than 90 % of its surface rounded (tr)

4 Principle

The test consists of sorting by hand a test portion of 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, thermostatically controlled to maintain a temperature of (110 ± 5) °C or (40 ± 5) °C, or equipment for drying the aggregate which does not cause any particle size breakdown.

5.4 Balance or scale, of suitable capacity, readable to ± 0,1 % of the mass to be weighed.

5.5 Trays.

5.6 Brushes.

5.7 Sieving machine, optional.

6 Preparation of test portion

The test portion shall consist of particle size fraction d_0/D_0, where d_0 is d if $d \geq 4$ mm, or 4 mm if $d < 4$ mm. D_0 is D if $D \leq 63$ mm, or 63 mm if $D > 63$ mm.

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

The mass of the laboratory sample, M_0, should 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 ± 5) °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 particle size fraction where $D_0/d_0 \leq 2$

The test is carried out on a test portion consisting of one particle size fraction d_0/D_0, where $d_0/D_0 \leq 2$. 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 apparent particle density of 2,65 Mg/m³.

Spread the particles of the test portion on a flat surface and separate the totally crushed, the remaining crushed (partial crushed) and the totally rounded particles (Figure 1). The residual other particles must be kept for validation of the results.

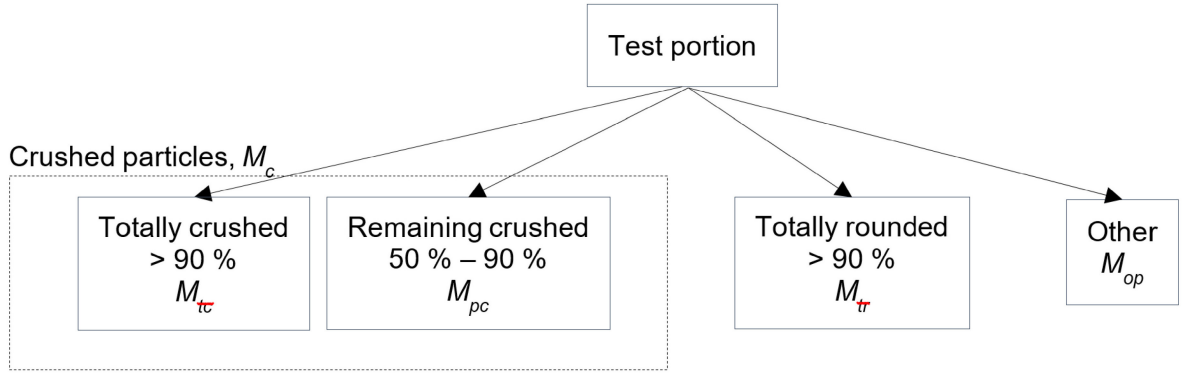

Figure 1 — Sorting particles from the test portion

Weigh and record on a test data sheet, the masses Mtc, Mpc, Mtr and Mop. The other particles are kept for validation of the mass results.

NOTE 2 An example of application of the test procedure is given in B.1.

NOTE 3 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 particle size fractions

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

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

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

If necessary, reduce a particle size fraction in accordance with EN 932-2. Record the mass of each reduced particle 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 particle 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 particle 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} differs by more than 1 % from the mass m_i of each individual particle size fraction, the test shall be repeated.

8 Calculation and expression of results

8.1 Test portions consisting of one particle size fraction

Calculate the mass of the crushed particles according to:

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

Calculate the percentage by mass of totally crushed particles (C_{tc}), crushed particles (C_c) and totally rounded particles (C_{tr}) in the test portion in accordance with the following formulae:

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

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

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

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.

8.2 Test portions consisting of two or more particle size fractions

Calculate the mass of the crushed particles in each particle size fraction according to:

$$M_{ci} = M_{tci} + M_{pci} \quad (5)$$

Calculate the percentages by mass of totally crushed particles (C_{tci}), crushed particles (C_{ci}) and totally rounded particles (C_{tri}) in each particle size fraction d_i/D_i.

Calculate the overall mean values C_{tc}, C_c and C_{tr} for the remaining size fractions of the three individual C values C_{tci}, C_{ci} and C_{tri} in accordance with the following formulae:

$$C_{tc} = \frac{\sum\left(M_{1i}\frac{m_{tci}}{m_i}\right)}{\sum M_{1i}} \times 100 \quad (6)$$

$$C_c = \frac{\sum\left(M_{1i}\frac{m_{ci}}{m_i}\right)}{\sum M_{1i}} \times 100 \quad (7)$$

$$C_{tr} = \frac{\sum\left(M_{1i}\frac{m_{tri}}{m_i}\right)}{\sum M_{1i}} \times 100 \quad (8)$$

where