BRITISH STANDARD

BS EN 933-5:1998
Incorporating Amendment No. 1 and Corrigendum No. 1

Tests for geometrical properties of aggregates —

Part 5: Determination of percentage of crushed and broken surfaces in coarse aggregate particles

The European Standard EN 933-5:1998, with the incorporation of amendment A1:2004, has the status of a British Standard

ICS 91.100.15

BSI British Standards

National foreword

This British Standard is the official English language version of EN-933-5:1998, including amendment A1:2004 and corrigendum May 2005.

The start and finish of text introduced or altered by amendment is indicated in the text by tags [A1⟩ ⟨A1]. Tags indicating changes to CEN text carry the number of the CEN amendment. For example, text altered by CEN amendment A1 is indicated by [A1⟩ ⟨A1].

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 international/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.

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

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Summary of pages

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

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Amendments issued since publication

Amd. No.	Date	Comments
15524	6 April 2005	See national foreword
15664 Corrigendum No. 1	11 May 2005	Errors omitted from previous amendment to Scope, subclauses **3.9**, **5.4**, **8.2.1** and Annex A

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EUROPEAN STANDARD
NORME EUROPÉENNE
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English version

Tests for gometrical properties of aggregates — Part 5: Determination of percentage of crushed and broken surfaces in coarse aggregate particles

(includes amendment A1:2004)

Essais pour déterminer les caractéristiques géométriques des granulats —
Partie 5: Détermination du pourcentage de surfaces cassées dans les gravillons
(inclut l'amendement A1:2004)

Prüfverfahren für geometrische Eigenschaften von Gesteinskömungen —
Teil 5: Bestimmung des Anteils an gebrochenen Kömern in groben Gesteinskömungen
(enthält Änderung A1:2004)

This European Standard was approved by CEN on 26 December 1997; amendment A1 was approved by CEN on 16 September 2004.

CEN

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

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

Ref. No. EN 933-5:1998 + A1:2004 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 July 1998, and conflicting national standards shall be withdrawn at the latest by December 1999.

This European 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 *Tests for filter aggregate used in bituminous mixtures* is in preparation.

The other parts of EN 933 will be:

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 course aggregates*.

Part 7, *Determination of shell content — Percentage of shells in course 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)*.

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Foreword to amendment A1

This document (EN 933-5:1998/A1:2004) has been prepared by Technical Committee CEN/TC 154, Aggregates, the Secretariat of which is held by BSI.

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Contents

1 Scope

This European Standard specifies a method for the determination of the percentage of particles with crushed and broken surfaces in a sample of natural coarse aggregate. It applies to gravel or mixed aggregate containing gravel.

The test method specified in this part of this European Standard is applicable to particle size fractions d_i/D_i where $D_i \leq 63$ mm and $d_i \geq 4$ mm.

〈A1〉 NOTE 1 For aggregate sizes with $D > 63$ mm and/or $d < 4$ mm the test may be carried out on particle size fractions d_i/D_i where $D_i \leq 63$ mm and $d_i \geq 4$ mm.

NOTE 2 For coarse aggregate between 4 mm and 20 mm the percentage of crushed or broken surfaces is linked to the flow coefficient and can therefore be used in association with the test method specified in EN 933-6. 〈A1〉

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

prEN 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 Definitions

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

3.1
aggregate size
a designation of aggregate in terms of lower (d) and upper (D) sieve sizes

NOTE This designation accepts the presence of some particles which will be retained on the upper sieve (oversize) and some which will pass the lower sieve (undersize).

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
the sample used as a whole in a single test

3.4
constant mass
successive weightings 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 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
totally crushed or broken particle
particle with more than 90 % of its surface crushed or broken (tc)

3.6
crushed or broken particle
particle with more than 50 % of its surface crushed or broken (c)

3.7
rounded particle
particle with 50 % or less of its surface crushed or broken (r)

3.8
totally rounded particle
particle with more than 90 % of its surface rounded (tr)

3.9
crushed or broken surfaces
facets of a particle of gravel produced by crushing or broken by natural forces and bounded by sharp edges. ▌A1⟩ If both the surface and the edges of a particle of crushed or broken gravel are worn or weathered then it shall be considered as rounded for the purposes of this test method. ⟨A1▐

4 Principle

The test consists of sorting particles by hand, from a test portion of coarse aggregates into:

— crushed or broken particles, including totally crushed or broken particles;

— rounded particles, including totally rounded particles.

The mass of each of these groups is determined and expressed as a percentage of the test portion mass.

Totally crushed or broken particles and totally rounded particles are then sorted by hand from crushed or broken particles and rounded particles and the mass of these groups is determined and expressed as a percentage of the test portion mass.

5 Apparatus

Unless otherwise stated, all apparatus shall conform to the general requirements of prEN 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 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 sample shall be reduced in accordance with the requirements of prEN 932-2.

Dry the sample at (110 ± 5) °C to constant mass, Weigh and record the mass as M_o.

Sieve on appropriate test sieves agitating with sufficient vigour to ensure complete separation of particles greater than 4 mm. Discard the particles retained on the 63 mm test sieve and those passing the 4 mm test sieve.

If necessary further reduce the sample in accordance with prEN 932-2 to produce a test portion. Record the mass of the test portion as M_1. The mass of the test portion shall be as specified in Table 1.

Table 1 — Mass of test portions

Upper aggregate size *D* mm	Test portion mass (minimum) kg
63	45
32	6
16	1
8	0,1

NOTE For other aggregate sizes D, appropriate test portion masses may be interpolated from those given in Table 1.

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

Carry out the test on each particle size fraction d_i/D_i where $D_i \leq 2d_i$.

Samples for which $D > 2d$ shall first be separated into particle size fraction d_i/D_i where $D_i \leq 2d_i$.

7 Procedure

7.1 Test portion where $D \leq 2d$

Spread the particles of the test portion on a flat surface and separate the particles by hand into the following two groups:

— crushed or broken particles (c) including the totally crushed or broken particles (tc);

— rounded particles (r) including the totally rounded particles (tr).

Weigh each group and record the masses as M_c and M_r.

Spread the crushed or broken particles (c) on a flat surface and separate by hand the totally crushed or broken particles (tc) from the others. Weigh the totally crushed or broken particles (tc) and record the mass as M_{tc}.

Spread the rounded particles (r) on a flat surface and separate by hand the totally rounded particles (tr) from the others. Weigh the totally rounded particles (tr) and record the mass as M_{tr}.

7.2 Test portions where $D > 2d$

Separate the test portion into particle 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 particle size fraction as M_i and calculate and record the percentage by mass of each particle size fraction d_i/D_i to the test portion mass M_1 as V_i.

Discard any size fraction d_i/D_i which comprises less than 10 % of M_1.

NOTE 1 Remaining size fraction d_i/D_i which contains less than 100 particles should, if required, be recorded in the test report.

NOTE 2 Size fractions d_i/D_i which contain an excessive number of particles can be further reduced in accordance with prEN 932-2.

NOTE 3 Size fractions can be further reduced if they consist of significantly more than 200 particles.

Record the mass of particles to be tested in each remaining particle size fraction d_i/D_i as M_{1i} and sort the particles in each of these remaining size fractions separately in accordance with **7.1**.

Record the masses of crushed or broken particles, rounded particles, totally crushed or broken and totally rounded particles in each of these size fractions d_i/D_i as M_{ci}, M_{ri}, M_{tci} and M_{tri} respectively.

8 Calculation and expression of results

8.1 Test portions where $D \leq 2d$

Record the masses M_1 and M_c, M_r, M_{tc} and M_{tr} on a test data sheet (see example given in Annex A) and calculate the percentage C of particles in each group in accordance with the following equation:

$$C_{(c,r,tc \text{ or } tr)} = \frac{M_{(c,r,tc \text{ or } tr)}}{M_1} \times 100$$

where

$M_{(c,r,tc \text{ and } tr)}$ are the masses of crushed or broken particles, rounded particles, totally crushed or broken 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 where $D > 2d$

8.2.1 *Size fractions not reduced*

If no size fractions have been reduced calculate the percentage of each particle in each group in accordance with the following equations:

$$C_{(c,r,tc \text{ or } tr)} = \frac{\sum M_{(ci,ri,tci \text{ or } tri)}}{\sum M_{1i}} \times 100$$

where

$\sum M_{(ci,ri,tci \text{ or } tri)}$ is the sum of the masses of crushed or broken, rounded, totally crushed or broken and totally rounded particles in the size fractions tested, in grams;

$\sum M_{1i}$ is the sum of the masses in the size fractions tested, in grams.

Record the values to the nearest whole number.

8.2.2 *Reduced size fractions*

If any size fractions have been reduced calculate the percentages by mass of particles in each of the groups (ci, ri, tci or tri) in each particle size fraction d_i/D_i.

Calculate the weighted mean value of the overall percentage in each group in accordance with the following equation:

$$C_{(c,r,tc \text{ or } tr)} = \frac{\sum (V_i C_{(ci,ri,tci \text{ or } tri)})}{\sum V_i}$$

where

$C_{(ci,,ri,tci \text{ and } tri)}$ are the percentages by masses of the crushed or broken particles, rounded particles, the totally crushed or broken particles and the totally rounded particles in the particle size fraction i;

V_i is the percentage by mass of particle size fraction i in the sample tested.

Record the values to the nearest whole number.

9 Test report

9.1 Required data

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) percentage of C_{tc}, C_c, C_{tr} and C_r to the nearest whole number;

f) where applicable, weighted mean percentages by mass of each group to the nearest whole number and the values of d_i and D_i of the particle size fractions tested.

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) mass of sample M_0;

d) any size fraction d_i/D_i with less than 100 particles;

e) mass of test portion M_1;

f) mass of M_{tc}, M_c, M_{tr} and M_r;

g) sampling certificate, if available;

h) date of test.

Annex A (informative)
Example of a test data sheet

EN 933-5 Identification of the sample:	Laboratory: Date: Operator:

M_0 = g

Particle size fraction d/D where $D \leq 2d$ mm	**Mass M_1** g	**Masses** g		**Percentages to the nearest whole number**	
		M_c	M_r	C_c	C_r
		Including M_{tc}	Including M_{tr}	Including C_{tc}	Including C_{tr}

Validation of mass retention:

$100 \quad \frac{M_1 - (M_c + M_r)}{M_1} =$	< 1 %

NOTE When a particle size fraction d_i/D_i has been reduced, an appropriate test data sheet should be used and the weighted mean values calculated as specified in **8.2**.

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