



SLOVENSKI STANDARD
SIST EN 1097-2:1999

01-oktober-1999

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Tests for mechanical and physical properties of aggregates - Part 2: Methods for the determination of resistance to fragmentation

Prüfverfahren für mechanische und physikalische Eigenschaften von Gesteinskörnungen - Teil 2: Verfahren zur Bestimmung des Widerstandes gegen Zertrümmerung

Essais pour déterminer les caractéristiques mécaniques et physiques des granulats - Partie 2: Méthodes pour la détermination de la résistance a la fragmentation

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Ta slovenski standard je istoveten z: EN 1097-2:1998

ICS:

91.100.15 Mineralni materiali in izdelki Mineral materials and products

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en

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EUROPEAN STANDARD
 NORME EUROPÉENNE
 EUROPÄISCHE NORM

EN 1097-2

April 1998

ICS 91.100.20

Descriptors: aggregates, tests, physical properties, mechanical properties, mechanical strength, fragmentation

English version

**Tests for mechanical and physical properties of aggregates -
 Part 2: Methods for the determination of resistance to
 fragmentation**

Essais pour déterminer les caractéristiques mécaniques et
 physiques des granulats - Partie 2: Méthodes pour la
 détermination de la résistance à la fragmentation

Prüfverfahren für mechanische und physikalische
 Eigenschaften von Gesteinskörnungen - Teil 2: Verfahren
 zur Bestimmung des Widerstandes gegen Zertrümmerung

This European Standard was approved by CEN on 25 March 1998.

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 Central Secretariat or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

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Foreword

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

This standard forms part of a series of tests for mechanical and physical 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 933	Tests for geometrical properties of aggregates
EN 1367	Tests for thermal and weathering properties of aggregates
EN 1744	Tests for chemical properties of aggregates
prEN 13179	Tests for filler aggregate used in bituminous bound fillers

The other parts of EN 1097 will be:

EN 1097-1	Tests for mechanical and physical properties of aggregates Part 1: Determination of the resistance to wear (micro-Deval)
prEN 1097-3	Tests for mechanical and physical properties of aggregates Part 3: Determination of loose bulk density and voids
prEN 1097-4	Tests for mechanical and physical properties of aggregates Part 4: Determination of the voids of dry compacted filler
prEN 1097-5	Tests for mechanical and physical properties of aggregates Part 5: Determination of the water content by drying in a ventilated oven
prEN 1097-6	Tests for mechanical and physical properties of aggregates Part 6: Determination of particle density and water absorption
prEN 1097-7	Tests for mechanical and physical properties of aggregates Part 7: Determination of the particle density of filler - Pycnometer method
prEN 1097-8	Tests for mechanical and physical properties of aggregates Part 8: Determination of the polished stone value
prEN 1097-9	Tests for mechanical and physical properties of aggregates Part 9: Method for the determination of the resistance to wear by abrasion from studded tyres: Nordic test
prEN 1097-10	Tests for mechanical and physical properties of aggregates Part 10: Water suction height

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 October 1998, and conflicting national standards shall be withdrawn at the latest by December 1999.

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 the United Kingdom.

1 Scope

This European Standard specifies procedures for the determination of the resistance of coarse aggregate to fragmentation. Two methods are defined:

- a) the Los Angeles test (reference method);
- b) the impact test (alternative method).

NOTE: The impact test can be used as an alternative to the Los Angeles test but a correlation with the Los Angeles test should first be established to avoid double testing and ensure mutual recognition of results. The Los Angeles test (reference method) should be used in cases of dispute.

This European Standard applies to natural or artificial aggregates used in building and civil engineering.

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.

EN 932-1 : 1996	Tests for general properties of aggregates - Part 1: Methods for sampling https://standards.iteh.ai/catalog/standards/sist/112159e-77f4-4243-91fa-140dc4bbc55/sist-en-1097-2-1999
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 933-1:1997	Tests for geometrical properties of aggregates - Part 1: Determination of particle size distribution - Sieving method
EN 933-2 : 1995	Tests for geometrical properties of aggregates - Part 2: Determination of particle size distribution - Test sieves, nominal size of apertures
prEN 1097-6	Tests for mechanical and physical properties of aggregates - Part 6: Determination of particle density and water absorption
EN 10025 : 1993	Hot rolled products of non-alloy structural steels Technical delivery conditions (includes amendment A1:1993)

3 Definitions

For the purposes of this standard the following definitions apply.

3.1 Los Angeles coefficient, LA: The percentage of the test portion passing a 1,6 mm sieve after completion of the test.

3.2 impact value: The value *SZ* which gives a measure of the resistance of aggregates to dynamic crushing. It is equal to one fifth of the sum of the mass percentages of the tested sample passing through 5 specified test sieves when tested in accordance with clause 6.

3.3 test specimen: The sample used in a single determination when a test method requires more than one determination of a property.

3.4 test portion: The sample used as a whole in a single test.

3.5 laboratory sample: A reduced sample derived from a bulk sample for laboratory testing.

3.6 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 4.1.3) 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 Apparatus

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

4.1 General apparatus

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4.1.1 Test sieves, conforming to EN 933-2 with aperture sizes as specified in table 1.

4.1.2 Balance, capable of weighing the test portion to an accuracy of 0,1 % of the mass of the test portion.

4.1.3 Ventilated oven, controlled to maintain a temperature of $(110 \pm 5)^\circ\text{C}$.

Table 1: Test sieves

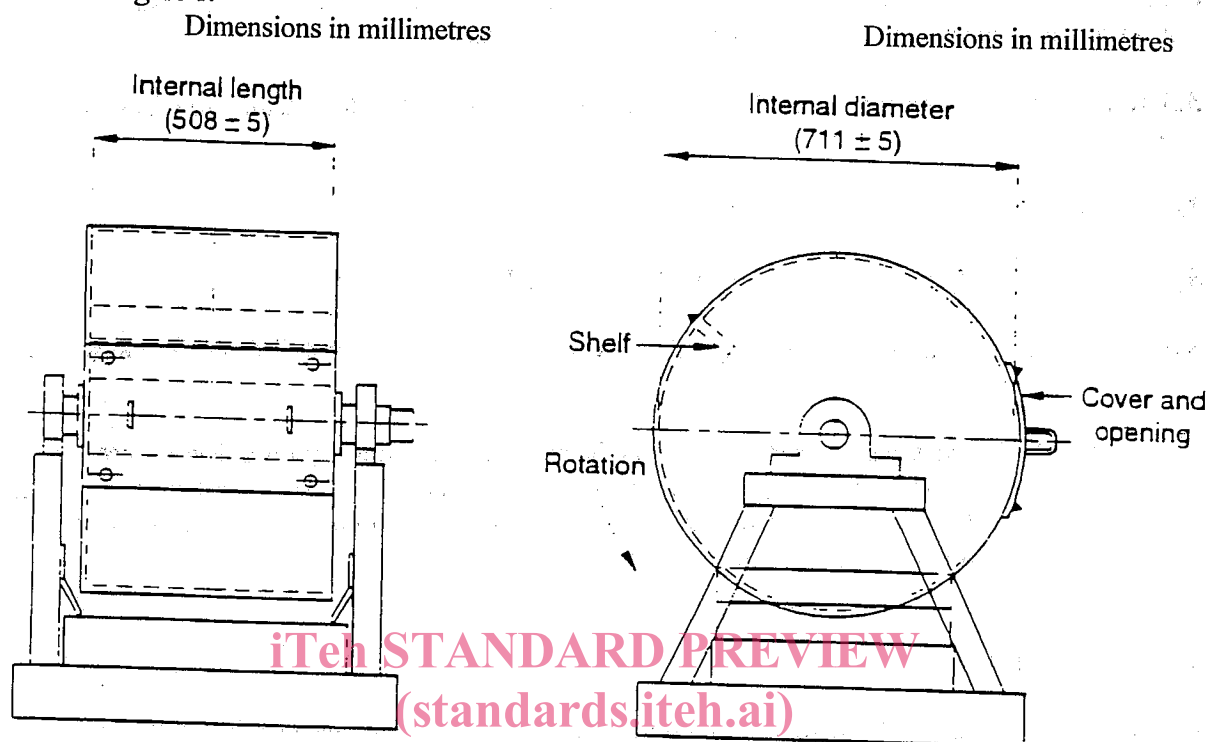
Test	Aperture size mm
Los Angeles	1,6, 10 11,2 (or 12,5) 14
Impact test (see Note)	0,2 0,63 2 5 8 10 11,2 12,5
NOTE: For the impact test, because of the tolerances in the sieve openings, the same 8 mm test sieve used for the preparation of the test portion should again be used for the evaluation of the test.	

4.2 Additional apparatus required for the determination of resistance to fragmentation by the Los Angeles test method

4.2.1 Equipment, for reducing the laboratory sample to a test portion, as described in prEN 932-2.

4.2.2 Los Angeles test machine, comprising the following essential parts.

NOTE: An example of a machine that has been found to be satisfactory is shown in figure 1.



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Figure 1: Typical Los Angeles testing machine

4.2.2.1 Hollow drum, made of structural steel plate ($12^{+1}_{-0,5}$) mm thick conforming to grade

S275 of EN 10025 : 1993 which has been selected to be formed without undue stress, and can be welded without significant distortion. The drum shall be closed at both ends. It shall have an internal diameter of (711 ± 5) mm and an internal length of (508 ± 5) mm. The drum shall be supported on two horizontal stub axles fixed to its two end walls but not penetrating inside the drum; the drum shall be mounted so that it rotates about a horizontal axis.

An opening (150 ± 3) mm wide shall be provided, preferably over the whole length of the drum, to facilitate insertion and removal of the sample after the test. During the test, the opening shall be sealed so that it is dustproof, by using a removable cover which enables the inside surface to remain cylindrical.

The cylindrical inner surface shall be interrupted by a projecting shelf, placed between 380 mm and 820 mm from the nearest edge of the opening. The distance shall be measured along the inside of the drum in the direction of rotation. The shelf shall have a rectangular cross section (length equal to that of the drum, width (90 ± 2) mm, thickness (25 ± 1) mm) and it shall be placed in a diametrical plane, along a generating line, and shall be rigidly fixed in place.

The shelf shall be replaced when its width at any point wears to less than 86 mm and, its thickness at any point along the front edge, wears to less than 23 mm.

The base of the machine shall be supported directly on a level concrete or stone block floor.

NOTE: The removable cover should be made of the same steel as the drum. The projecting shelf should be made of the same steel or a harder grade.

4.2.2.2 Ball load, consisting of 11 spherical steel balls, each with a diameter of between 45 mm and 49 mm (see annex A). Each ball shall weigh between 400 g and 445 g, and the total load shall weigh between 4690 g and 4860 g.

NOTE: The nominal mass of the charge with new balls is 4840 g. A positive tolerance of 20 g allows for manufacturing variation and a negative tolerance of 150 g allows for ball wear in use.

4.2.2.3 Motor, imparting a rotational speed to the drum of between 31 r/min and 33 r/min.

4.2.2.4 Tray, for recovering the material and the ball load after testing.

4.2.2.5 Revolution counter, which will automatically stop the motor after the required number of revolutions.

4.3 Additional apparatus required for the determination of resistance to fragmentation by the impact test method

4.3.1 Impact tester, see annex B.

4.3.2 Equipment for testing the accuracy of the impact tester, see annex C.

NOTE: Annexes B and C are informative and do not contain any normative provisions for the application of this European Standard. However, it is strongly recommended that all the informative provisions of these annexes be observed when carrying out the test specified in clause 6.

4.3.3 Brush and bowls

5 Determination of resistance to fragmentation by the Los Angeles test method

5.1 Principle

A sample of aggregate is rolled with steel balls in a rotating drum. After rolling is complete, the quantity of material retained on a 1,6 mm sieve is determined.

5.2 Preparation of the sample for testing

The mass of the sample sent to the laboratory shall have at least 15 kg of particles in the 10 mm to 14 mm size range.

The test shall be carried out on aggregate passing the 14 mm test sieve and retained on the 10 mm test sieve. In addition, the grading of the test portion shall comply with one of the following requirements:

- a) between 60 % and 70 % passing a 12,5 mm test sieve; or
- b) between 30 % and 40 % passing a 11,2 mm test sieve.

NOTE: The additional grading requirements allow the test portion to be created from product sizes other than 10/14 (see annex A).

Sieve the laboratory sample using the 10 mm, 11,2 mm (or 12,5 mm) and 14 mm test sieves to give separate fractions in the ranges 10 mm to 11,2 mm (or 12,5 mm) and 11,2 mm (or 12,5 mm) to 14 mm. Wash each fraction separately, in accordance with clause 6 of EN 933-1:1997, and dry them in the oven at (110 ± 5) °C to constant mass.

Allow the fractions to cool to ambient temperature. Mix the two fractions to provide a modified 10 mm to 14 mm laboratory sample which complies with the appropriate additional grading requirement given above.

Reduce the modified laboratory sample prepared from the mixed fractions to test portion size in accordance with prEN 932-2. The test portion shall have a mass of (5000 ± 5) g.

5.3 Test procedure

Check that the drum is clean before loading the sample. Carefully place the balls in the machine, then the test portion. Replace the cover and rotate the machine for 500 revolutions, at a constant speed between 31 r/min and 33 r/min.

Pour the aggregate into a tray placed under the apparatus, taking care that the opening is just above the tray in order to avoid losing any material. Clean out the drum, removing all fines, paying particular attention around the projecting shelf. Carefully remove the ball load from the tray, taking care not to lose any aggregate particles.

Analyze the material from the tray in accordance with EN 933-1:1997 by washing and sieving using a 1,6 mm sieve. Dry the portion retained on the 1,6 mm sieve at a temperature of (110 ± 5) °C until a constant mass is achieved.

5.4 Calculation and expression of results

Calculate the Los Angeles coefficient LA from the following equation:

$$LA = \frac{5000 - m}{50}$$

where:

m is the mass retained on a 1,6 mm sieve, in grams.

Report the result to the nearest whole number.

NOTE: A statement on the precision of the Los Angeles test is given in annex D.

5.5 Test report

The test report shall affirm that the Los Angeles test was carried out in accordance with this Standard. It shall include the following information:

a) name and origin of sample;

- b) size fractions from which the test portion was obtained;
- c) Los Angeles coefficient *LA*.

6 Determination of resistance to fragmentation by the impact test method

6.1 Principle

The impact value *SZ* gives a measure of the mechanical resistance of aggregates. The grain size fraction 8 mm to 12,5 mm is crushed in the testing machine by 10 blows from a height of 370 mm. The degree of crushing is measured by sieve analysis using 5 specified test sieves.

6.2 Preparation of the sample for testing

6.2.1 A laboratory sample shall be obtained in accordance with EN 932-1. The sample shall contain at least 5 kg of the size fraction 8 mm to 10 mm and 2,5 kg of each of the size fractions 10 mm to 11,2 mm and 11,2 mm to 12,5 mm.

6.2.2 A quantity of the size fractions 8 mm to 10 mm, 10 mm to 11,2 mm and 11,2 mm to 12,5 mm sufficient for at least 3 test specimens (see 6.2.3 and 6.2.4) shall be prepared from the laboratory sample using the sieves specified in 4.1.1. This quantity shall be washed and dried at $(110 \pm 5)^\circ\text{C}$ to constant mass and left to cool to between 15°C and 35°C .

6.2.3 For the impact test, material for at least 3 test specimens shall be recombinated as follows and 3 test specimens shall be tested (see 6.2.4). The test specimens shall be composed of 50 % of the

size fraction 8 mm to 10 mm, 25 % of the size fraction 10 mm to 11,2 mm and 25 % of the size fraction 11,2 mm and 12,5 mm and be weighed to the nearest 0,5 g. The 3 fractions shall be mixed thoroughly prior to weighing of the test specimen as described in 6.2.4.

6.2.4 The mass of the test specimen in kilograms shall be 0,5 times the value of the particle density in megagrams per cubic metre as determined in accordance with prEN 1097-6 on a sample composed as specified in 6.2.3.

If this particle density is known from previous tests, that result can be used.

For each test specimen the quantities, in kilograms, are:

- | | |
|--------------------------------------|-------------------------------------|
| a) size fraction: 8 mm to 10 mm | = 0,25 times the particle density; |
| b) size fraction: 10 mm to 11,2 mm | = 0,125 times the particle density; |
| c) size fraction: 11,2 mm to 12,5 mm | = 0,125 times the particle density. |

The mass of a test specimen prior to the testing shall not differ by more than 1 % from the nominal mass.

6.3 Test procedure

6.3.1 The test specimen shall be poured into the mortar of the impact test machine and its surface roughly evened by hand without jiggling. The pestle shall be pressed by the corresponding device onto the test specimen and the hammer lifted up to a height of 370 mm. The test specimen shall then be subjected to 10 blows by the hammer.

6.3.2 After the blows lift up the pestle and take the mortar out of the apparatus. Then pass the crushed sample carefully into a bowl. Any fine particles adhering to the mortar shall be swept into the bowl with the brush and the test specimen shall subsequently be weighed.

6.3.3 The crushed test specimen shall be sieved in accordance with EN 933-1:1997 on the following 5 sieves specified in 4.1.1, starting with the 8 mm test sieve.

0,2 mm; 0,63 mm; 2 mm; 5 mm; 8 mm.

The fraction retained on the 5 test sieves and the pan shall be weighed to the nearest 0,5 g.

6.3.4 If the total mass of the test specimen after sieving differs from the original mass by more than 0,5 %, the impact test shall be carried out on an further test specimen.

6.4 Calculation and expression of results

Express the mass retained on each of the 5 test sieves and on the pan, for each test specimen, as a percentage of the mass of the test specimen before testing. Calculate from this the percentage masses passing the 5 sieves.

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Add the percentage masses passing each of the 5 test sieves to give the sum of percentage masses M .

Calculate the impact value SZ from the following formula:

$$SZ = M/5 \% \quad (\text{See clause 3 and the worked example given in annex E}).$$

where M is the sum of each of the percentages of the mass passing each of the 5 test sieves.

NOTE: A statement on the precision of the impact test is given in annex D.

6.5 Test report

The test report shall affirm that the test was carried out in accordance with this Standard. It shall include the following information:

- a) name and origin of sample;
- b) size fractions from which the test portion was obtained;
- c) particle density of the size fraction 8 mm to 12,5 mm rounded to 0,01 Mg/m³ and determined in accordance with prEN 1097-6;
- d) test result (impact value SZ , results of single test specimens rounded to 0,01 % and mean value rounded to 0,1 %).