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Preskusi mehanskih in fizikalnih lastnosti agregatov - 2. del: Metode določevanja odpornosti proti drobljenju

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

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

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

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Essais pour déterminer les caractéristiques mécaniques et physiques de 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

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SIST EN 1097-2:2010

Contents

Page

Foreword 4

1 Scope 6

2 Normative references 6

3 Terms and definitions 6

4 Apparatus 7
4.1 General apparatus 7
4.2 Additional apparatus required for the determination of resistance to fragmentation by the Los Angeles test method 7
4.3 Additional apparatus required for the determination of resistance to fragmentation by the impact test method 9

5 Determination of resistance to fragmentation by the Los Angeles test method 9
5.1 Principle 9
5.2 Preparation of test portion 9
5.3 Test procedure 10
5.4 Calculation and expression of results 10
5.5 Test report 10

6 Determination of resistance to fragmentation by the impact test method 10
6.1 Principle 10
6.2 Preparation of test specimens 11
6.3 Test procedure 11
6.4 Calculation and expression of results 12
6.5 Test report 12

Annex A (normative) Determination of the resistance to fragmentation of aggregates for railway ballast 13

Annex B (informative) Alternative narrow range classifications for the Los Angeles test 16

Annex C (informative) The impact tester: Construction, operation and safety requirements 17
C.1 General 17
C.2 Construction 17
C.3 Lifting device 17
C.4 Sample holder 18
C.5 Anvil 19
C.6 Base plate and dampers 19
C.7 Safety requirements and testing 20
C.8 Checking of impact tester 20

Annex D (informative) Checking of the impact tester 27
D.1 General 27
D.2 Checklist 27
D.3 Apparatus and test agents 27
D.4 Procedure 29

Annex E (informative) Precision 31
E.1 General 31
E.2 Los Angeles test 31
E.3 Impact test 31

Annex F (informative) Worked example of calculation of impact value *SZ* 32

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(standards.iteh.ai)
SIST EN 1097-2:2010
https://standards.iteh.ai/catalog/standards/sist/67ec3706-9726-4f46-902e-b81e729ec822/sist-en-1097-2-2010

SIST EN 1097-2:2010

Annex G (informative) **Alternative narrow range classification for the Los Angeles test of 16/32 mm recycled aggregates** **33**

Bibliography **34**

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SIST EN 1097-2:2010
https://standards.iteh.ai/catalog/standards/sist/67ec3706-9726-4f46-902e-b81e729ec822/sist-en-1097-2-2010

SIST EN 1097-2:2010

Foreword

This document (EN 1097-2:2010) 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 September 2010, and conflicting national standards shall be withdrawn at the latest by September 2010.

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 1097-2:1998.

This standard forms part of a series of tests for mechanical and physical 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 933 (all parts), *Tests for geometrical 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*

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— EN 13179 (all parts), *Tests for filler aggregate used in bituminous mixtures*

EN 1097, *Tests for mechanical and physical properties of aggregates*, consists of the following parts:

— *Part 1: Determination of the resistance to wear (micro-Deval)*

— *Part 2: Methods for the determination of resistance to fragmentation*

— *Part 3: Determination of loose bulk density and voids*

— *Part 4: Determination of the voids of dry compacted filler*

— *Part 5: Determination of the water content by drying in a ventilated oven*

— *Part 6: Determination of particle density and water absorption*

— *Part 7: Determination of the particle density of filler — Pyknometer method*

— *Part 8: Determination of the polished stone value*

— *Part 9: Determination of the resistance to wear by abrasion from studded tyres — Nordic test*

— *Part 10: Determination of water suction height*

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,

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Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

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SIST EN 1097-2:2010
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SIST EN 1097-2:2010

1 Scope

This European Standard describes the reference method, the Los Angeles test, used for type testing and in case of dispute (and an alternative method, the impact test) for determining the resistance to fragmentation of coarse aggregates and aggregates for railway ballast (Annex A). 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.

This European Standard applies to natural, manufactured or recycled aggregates used in building and civil engineering.

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 932-1, *Tests for general properties of aggregates — Part 1: Methods for sampling*

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*

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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*

SIST EN 1097-2:2010
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EN 1097-6:2000, *Tests for mechanical and physical properties of aggregates — Part 6: Determination of particle density and water absorption*

EN 10025-2:2004, *Hot rolled products of structural steels — Part 2: Technical delivery conditions for non-alloy structural steels*

3 Terms and definitions

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

3.1
Los Angeles coefficient
LA
percentage of the test portion passing a pre-determined sieve after completion of the test

3.2
impact value
SZ
value SZ which gives a measure of the resistance of aggregates to dynamic crushing, and is equal to one fifth of the sum of the mass percentages of the tested sample passing through five specified test sieves when tested in accordance with Clause 6

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

SIST EN 1097-2:2010

3.4
test portion
sample used as a whole in a single test

3.5
laboratory sample
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 ± 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 Apparatus

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

4.1 General apparatus

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

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Table 1 — Test sieves

Test	Aperture size mm
Los Angeles	1,6; 10; 11,2 (or 12,5); 14
Impact test [a]	0,2; 0,63; 2; 5; 8; 10; 11,2; 12,5

[a] 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.

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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 ± 5) °C.

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 EN 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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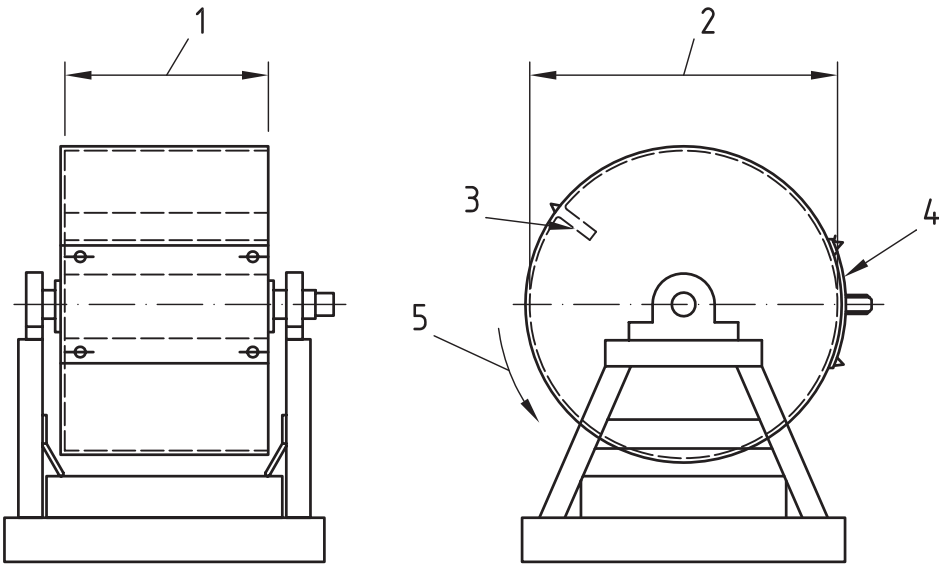

Key

1 internal length (508 ± 5) mm
2 internal diameter (711 ± 5) mm
3 shelf
4 cover and opening
5 rotation

Figure 1 — Typical Los Angeles testing machine

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4.2.2.1 Hollow drum, made of structural steel plate ($12^{+1,0}_{-0,5}$) mm thick conforming to grade S275 of EN 10025-2:2004 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.

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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 B). Each ball shall weigh between 400 g and 445 g, and the total load shall weigh between 4 690 g and 4 860 g.

NOTE The nominal mass of the charge with new balls is 4 840 g. A positive tolerance of 20 g allows for manufacturing variation and a negative tolerance of 150 g allows for ball wear in use.

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4.2.2.3 Motor, imparting a rotational speed to the drum of between 31 min^{-1} and 33 min^{-1}.

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 C.

4.3.2 Equipment for testing the accuracy of the impact tester, see Annex D.

NOTE Annexes C and D 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

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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.

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5.2 Preparation of test portion

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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 1 The additional grading requirements allow the test portion to be created from product sizes other than 10/14 (see Annex B).

NOTE 2 For recycled aggregates, a test procedure for the 16/32 mm size fraction is described in Annex G.

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 EN 933-1, and dry them to constant mass.

NOTE 3 For temperature-sensitive recycled aggregates, a drying temperature of (40 ± 5) °C should be used.

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 EN 932-2. The test portion shall have a mass of (5 000 ± 5) g.

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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 min^{-1} and 33 min^{-1}.

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 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 (or lower, see Note 3 to 5.2) until a constant mass is achieved.

5.4 Calculation and expression of results

Calculate the Los Angeles coefficient *LA* from the following equation:

$$LA = \frac{5\,000 - m}{50}$$

where

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

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Report the result to the nearest whole number.

NOTE A statement on the precision of the Los Angeles test is given in Annex E.

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5.5 Test report

The test report shall include at least the following information:

a) confirmation that the Los Angeles test was carried out in accordance with this standard;

b) number of this standard;

c) name and origin of sample;

d) size fractions from which the test portion was obtained;

e) Los Angeles coefficient *LA*.

6 Determination of resistance to fragmentation by the impact test method

6.1 Principle

A test specimen is placed in a steel cylinder and subjected to ten impacts from a hammer of mass 50 kg, falling from a specified height. The amount of fragmentation caused by the ten impacts is measured by sieving the test specimen using five specified test sieves.