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Preskusi mehanskih in fizikalnih lastnosti agregatov - 1. del: Določevanje odpornosti proti obrabi (mikro Deval)

Tests for mechanical and physical properties of aggregates - Part 1: Determination of the resistance to wear (micro-Deval)

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Prüfverfahren für mechanische und physikalische Eigenschaften von Gesteinskörnungen - Teil 1: Bestimmung des Widerstandes gegen Verschleiß (Micro-Deval)

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Essais pour déterminer les caractéristiques mécaniques et physiques des granulats - Partie 1: Détermination de la résistance à l'usure (micro-Deval)

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ICS:

91.100.15 Mineralni materiali in izdelki Mineral materials and products

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EUROPEAN STANDARD
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EUROPÄISCHE NORM

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English Version

Tests for mechanical and physical properties of aggregates - Part 1: Determination of the resistance to wear (micro-Deval)

Essais pour déterminer les caractéristiques mécaniques et
physiques des granulats - Partie 1: Détermination de la
résistance à l'usure (micro-Deval)

Prüfverfahren für mechanische und physikalische
Eigenschaften von Gesteinskörnungen - Teil 1:
Bestimmung des Widerstandes gegen Verschleiß (Micro-
Deval)

This European Standard was approved by CEN on 11 December 2010.

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 CEN-CENELEC Management Centre 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 CEN-CENELEC Management Centre has the same status as the official versions.

CEN members are the national standards bodies of 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, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

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

Management Centre: Avenue Marnix 17, B-1000 Brussels

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Foreword

This document (EN 1097-1:2011) 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 2011, and conflicting national standards shall be withdrawn at the latest by July 2011.

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 replaces EN 1097-1:1996.

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 the following European Standards:

- EN 932 (all parts), *Tests for general properties of aggregates*;
- EN 933 (all parts), *Tests for geometrical 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 1097 will be:

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

EN 1097-1:2011 (E)**1 Scope**

This European Standard describes the reference method used for type testing and in case of dispute for determining the resistance to wear of coarse aggregates (main text) 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. The sample is normally tested in a wet condition, but the test may also be carried out in a dry condition. This European Standard applies to natural, manufactured or recycled aggregates used in building or 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 932-2, *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 933-1:1997, *Tests for geometrical properties of aggregates — Part 1: Determination of particle size distribution — Sieving method*

EN ISO 4788, *Laboratory glassware — Graduated measuring cylinders (ISO 4788:2005)*

ISO 3290-1, *Rolling bearings — Balls — Part 1: Steel balls*

3 Terms and definitions

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

3.1**test portion**

sample used as a whole in a single test

3.2**test specimen**

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

3.3**laboratory sample**

reduced sample derived from a bulk sample for laboratory testing

3.4**constant mass**

mass determined by successive weightings performed at least 1 h apart and 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.

4 Principle

The test determines the micro-Deval coefficient which is the percentage of the original sample reduced to a size smaller than 1,6 mm during rolling.

The test consists of measuring the wear produced by friction between the aggregates and an abrasive charge in a rotating drum under defined conditions.

When rolling is complete, the percentage retained on a 1,6 mm sieve is used to calculate the micro-Deval coefficient.

The test method described in this European Standard is the reference method and is carried out with dry aggregate with the addition of water to give a value of MDE. Annex B gives details of how the test can be performed without the addition of water, to give a value of M_{DS} .

NOTE A lower value of the micro-Deval coefficient indicates a better resistance to wear.

5 Apparatus

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

5.1 General apparatus

5.1.1 Balance, capable of weighing both the test specimen and the charge to an accuracy of 0,1 % of the mass of the test portion.

5.1.2 Test sieves: 1,6 mm, 8 mm, 10 mm, 11,2 mm (or 12,5 mm) and 14 mm.

5.1.3 Ventilated oven, controlled to maintain a temperature of (110 ± 5) °C.

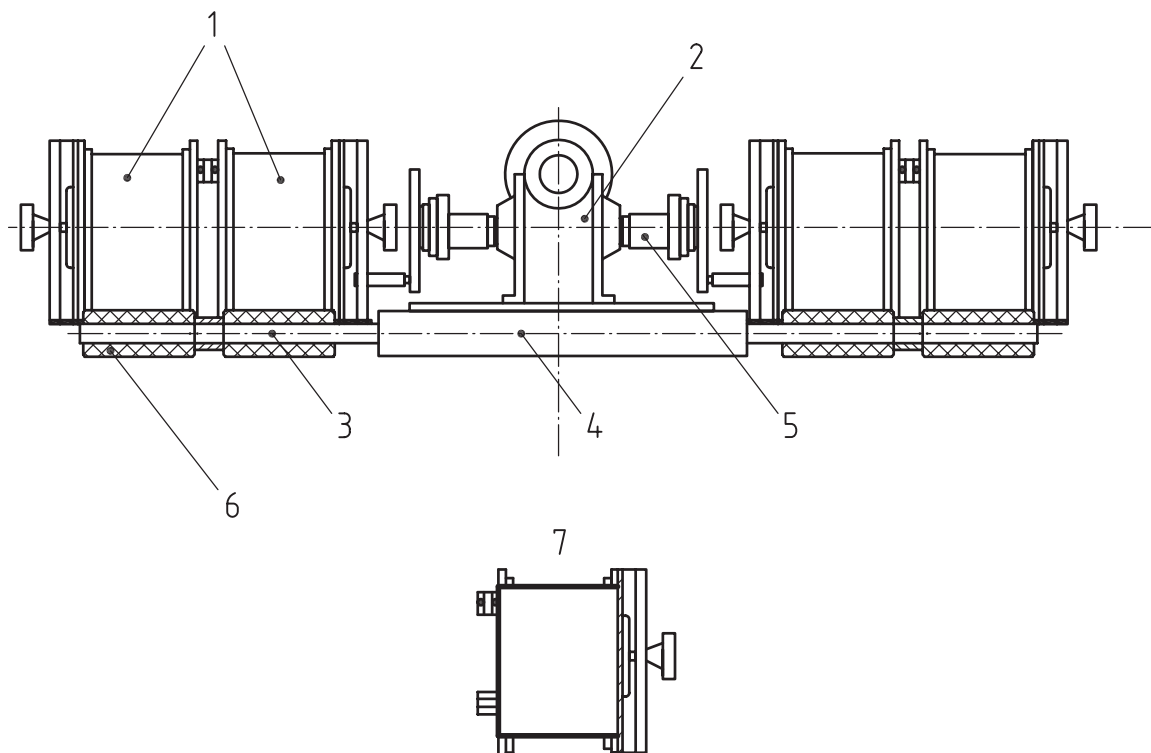
5.1.4 Means of washing the sieved sample.

5.1.5 Equipment for reducing the laboratory samples to a test portion, as described in EN 932-2.

5.1.6 Graduated glass measuring cylinder (or cylinders), conforming to EN ISO 4788, or other means of measuring $(2,5 \pm 0,05)$ l of water.

5.2 Additional apparatus required for the determination of the micro-Deval coefficient of aggregate

5.2.1 A typical micro-Deval apparatus as shown in Figure 1. A micro-Deval apparatus shall have the following essential characteristics as specified in 5.2.2, 5.2.3, 5.2.4, 5.2.5 and 5.2.6.

**Key**

- 1 drums
- 2 electric motor and reduction gearing
- 3 fixed shaft
- 4 frame
- 5 flexible coupling
- 6 drive wheel
- 7 cross section of a drum

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Figure 1 — Diagram of typical apparatus

5.2.2 It shall consist of one of four hollow drums, closed at one end, having an inside diameter of (200 ± 1) mm and an internal length measured from the base to the inside of the lid of (154 ± 1) mm. The drums shall be made of stainless steel at least 3 mm thick which are placed on two shafts which rotate on a horizontal axis.

5.2.3 The insides of drums shall be free of protrusions resulting from welding or the method of attachment. The drums shall be closed by flat lids at least 8 mm thick and fitted with watertight and dust tight seals.

5.2.4 The abrasive charge shall consist of steel balls complying with ISO 3290-1 $(10 \pm 0,5)$ mm in diameter.

NOTE The diameter of the balls can be checked quickly by passing them over parallel bars 9,5 mm apart.

5.2.5 A suitable motor (a capacity of about 1 kW is typical) to drive the drums at a regular speed of rotation of $(100 \pm r/\text{min})$.

5.2.6 A counter or other device shall be fitted, which automatically stops the motor after the specified number of revolutions.

6 Preparation of the test specimens

The mass of the sample sent to the laboratory shall have at least 2 kg of particles in the 10 mm to 14 mm size range.

NOTE Alternative size fractions for different end uses are given in Annex C. Testing other size fractions may produce results different from those obtained using the 10/14 mm size fraction and the size fraction used should be given in the test report.

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

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

Sieve the laboratory sample using the 10 mm, 11,2 mm (or 12,5 mm) and 14 mm sieves to give separate fractions in the range 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 7.1 of EN 933-1:1997, and dry them in the oven at $(110 \pm 5) ^\circ\text{C}$ to constant mass.

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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 requirements given in paragraph 2 of this clause.

Reduce the modified laboratory sample prepared from the mixed fractions to test portion size in accordance with the requirements of EN 932-2. The test portion shall consist of two test specimens, each having a mass of (500 ± 2) g.

7 Test procedure

Place each test specimen into a separate drum. Add $(5\,000 \pm 5)$ g of steel balls to each drum.

NOTE When testing alternative size fractions according to Annex C, the mass of ball load in Table C.1 should be used.

Add $(2,5 \pm 0,05)$ l of water to each drum.

Fit a lid to each drum, and place each drum on the two shafts.

Rotate the drums at a speed of (100 ± 5) min⁻¹ for $(12\,000 \pm 10)$ revolutions.

After the test, collect the aggregate and the steel balls in a pan, taking care to avoid the loss of any aggregate. Using a washing bottle, carefully wash the inside of the drum and the lid, and retain the washings.

Empty the material and all the washings on to the 1,6 mm sieve protected by an 8 mm guard sieve. Wash the materials in a stream of clean water.