SLOVENSKI STANDARD
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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)

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

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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EUROPEAN STANDARD

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This European Standard was approved by CEN on 27 November 2023.

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

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Contents

Page

European foreword

This document (EN 1097-1:2023) 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of an identical text or by endorsement, at the latest by June 2024, and conflicting national standards shall be withdrawn at the latest by June 2024.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 1097-1:2011.

In comparison with the previous edition, the following technical modifications have been made:

a) The European foreword, the Scope, the Terms and definitions and the Test report content have been updated according to the current rules;

b) Lightweight aggregates have been included in the *Scope;*

c) The Normative references have been extended with EN 933-2, and ISO 3290-1 has been moved to the Bibliography;

d) The definition of M_{DE} or $M_{DE,RB}$ has been added in Clause 3;

e) In Clause 5, the description of the micro-Deval apparatus has been clarified. In addition, the requirement on steel balls to comply with ISO 3290-1 has been deleted since it was too sharp compared with the specified diameter tolerance. A new Note with reference to ISO 3290-1 has been added. A new Note about the hardness of steel ball diameters has been added. Two optional apparatus, a gauge and a magnet, have been added;

f) In the test procedure, amount of water is expressed in mass instead of volume. Subsequently, EN ISO 4788 *Laboratory glassware* has been deleted from Clause 2, Graduated glass cylinder has been deleted from Clause 5 Apparatus, and B.2 Apparatus has been deleted;

g) The formulae for calculation of M_{DE} and $M_{DE,RB}$ have included the actual initial masses instead of 500 g resp. 10 000 g;

h) The tested size fraction of the aggregate has been moved from optional data to required data;

i) Annex A has been completed to contain full text, not only the clauses expressing additions or modifications to main text clauses. Formula (A.1) has been changed and instructions to report the mean value have been added in A.6;

j) In Annex C, the term “range classification” has been replaced by the term “size fraction”;

k) New informative Annexes D and E have been added and specify methods for determination of the wear of fine aggregates.

l) In addition, the Principle and Annex C have been simplified and the Bibliography has been supplemented.

This document 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*

— 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 include:

— *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*

— *Part 11: Determination of the compressibility and of the compressive strength of lightweight aggregates*

Any feedback and questions on this document should be directed to the users' national standards body. A complete listing of these bodies can be found on the CEN website.

According to the CEN-CENELEC Internal Regulations, the national standards organisations 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, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Türkiye and the United Kingdom.

1 Scope

This document specifies 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) by abrasion in the micro-Deval apparatus. Other methods can be used for other purposes, such as factory production control, provided that an appropriate working relationship with the relevant reference method has been established.

This document applies to natural, manufactured, recycled or lightweight (LWA) aggregates.

NOTE This document does not apply to all types of LWA.

The reference test is performed with the addition of water. Annex B gives details of how the test can be performed without the addition of water.

Annex A specifies the method to determine the resistance to wear of aggregates for railway ballast without abrasive charge.

Annex C specifies the test performed with alternative narrow size fractions.

Annexes D and E specify methods for determining the wear of fine aggregates.

Precision data for the reference test method are given in Annex F.

Annex A is normative and Annexes B, C, D, E and F are informative.

WARNING – The use of this part of EN 1097 can involve hazardous materials, operations and equipment (such as dust, noise and heavy lifts). It does not purport to address all of the safety or environmental problems associated with its use. It is the responsibility of users of this document to take appropriate measures to ensure the safety and health of personnel and the environment prior to application of this document, and fulfil statutory and regulatory requirements for this purpose.

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 https://www.electropedia.org/

— ISO Online browsing platform: available at https://www.iso.org/obp/ui

3.1
test portion
d_0/D_0
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
sample intended for laboratory testing

3.4
constant mass
mass determined by successive weighings performed at least 1 h apart and 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
micro-Deval coefficient
M_{DE} or $M_{DE,RB}$
coefficient expressing the wear after completion of the test as the mass percentage of the test portion passing the 1,6 mm sieve

Note 1 to entry: M_{DE} is the coefficient for normal weight and lightweight aggregates; $M_{DE,RB}$ is the coefficient for aggregates for railway ballast.

4 Principle

A test portion of a single-sized aggregate, 10 mm to 14 mm, is rotated together with steel balls and water in a steel drum. The contents roll within the drum with an abrading action. After the specified number of revolutions, the contents are removed from the drum and the test portion is sieved on the 1,6 mm sieve.

The micro-Deval coefficient expresses the wear after completion of the test as the mass percentage of the test portion passing the 1,6 mm sieve.

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 Equipment for reducing laboratory samples, as specified in EN 932-2.

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

5.1.3 Test sieves, 1,6 mm, 8 mm, 10 mm, 11,2 mm (or 12,5 mm) and 14 mm, which shall conform to EN 933-2.

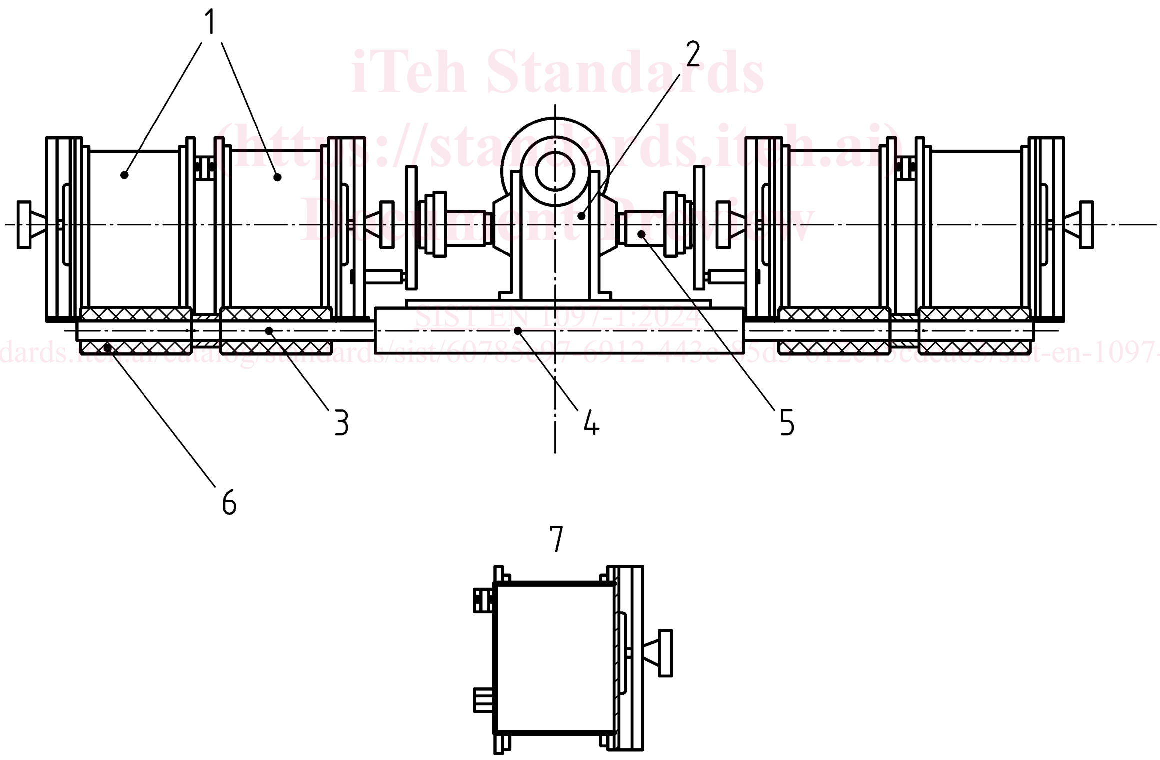
5.1.4 Ventilated oven, controlled to maintain a temperature of (110 ± 5) °C.

5.1.5 Washing bottle.

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

5.2.1 Micro-Deval apparatus, comprising the following essential parts.

NOTE An example of an apparatus that has been found to be satisfactory is shown in Figure 1.



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

Figure 1 — Typical micro-Deval apparatus

5.2.1.1 Hollow drums, made of stainless steel at least 3 mm thick and closed at one end. They shall be closed by flat lids at least 8 mm thick and fitted with watertight and dust tight seals.

The drums shall have an internal diameter of (200 ± 1) mm and an internal length measured from the base to the inside of the lid of (154 ± 1) mm. The inner surface of the drums shall be free of protrusions resulting from welding or the method of attachment.

The drums shall be placed on two fixed shafts which rotate about a horizontal axis.

5.2.1.2 Abrasive charge, consisting of steel balls (10,0 ± 0,5) mm in diameter.

NOTE 1 The lower limit of deviation is a working tolerance limit. The upper limit of deviation is a manufacturing tolerance limit.

NOTE 2 Steel bearing balls compliant with ISO 3290-1 [1] are also compliant with this document.

NOTE 3 Steel ball diameter can be checked quickly by passing the balls over parallel bars 9,5 mm apart.

NOTE 4 A hardness of the steel balls between HRC 52 and HRC 67 is suitable.

5.2.1.3 Motor, imparting a rotational speed to the drums of (100 ± 5) r/min.

NOTE A motor capacity of about 1 kW is suitable.

5.2.1.4 Revolution counter, which will automatically stop the motor after the specified number of revolutions.

5.2.2 Gauge (optional), to control minimum ball size, fitted with slots $\left(9,5^{+0,1}_{-0,0}\right)$ mm.

5.2.3 Magnet (optional), for removal of the steel balls from the aggregate test specimen after abrasion.

6 Preparation of test portion

The test portion shall consist of two test specimens, each having a mass of (500 ± 3) g. Record the mass, m_1, for each test specimen.

NOTE Alternative size fractions d_0/D_0 for certain end uses are specified in Annex C. Testing other size fractions can produce results different from those obtained using the 10/14 mm size fraction.

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 conform to 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 on the sieve defining the lower limit of the size fraction. Dry the fractions to constant mass at (110 ± 5) °C.

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.