BRITISH STANDARD

BS EN
1097-1 : 1996

Tests for mechanical and physical properties of aggregates

Part 1. Determination of the resistance to wear (micro-Deval)

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The European Standard EN 1097-1 : 1996 has the status of a British Standard

ICS 91.100.20

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Committees responsible for this British Standard

The preparation of this British Standard was entrusted to Technical Committee B/502, Aggregates, upon which the following bodies were represented:

Association of Consulting Engineers
Association of Lightweight Aggregate Manufacturers
British Aggregate Construction Materials Industries
British Cement Association
British Iron and Steel Producers' Association
British Precast Concrete Federation Ltd.
British Ready Mixed Concrete Association
Department of the Environment
Department of the Environment (Building Research Establishment)
Department of Transport (Highways Agency)
Electricity Association
Institute of Concrete Technology
Institution Civil Engineers
Institution of Structural Engineers
Sand and Gravel Association Limited
Society of Chemical Industry

The following bodies were also represented in the drafting of the standard, through subcommittees and panels:

British Civil Engineering Test Equipment Manufacturers' Association
County Surveyors' Society
Department of Trade and Industry (National Measurement Accreditation Service)

This British Standard, having been prepared under the direction of the Sector Board for Building and Civil Engineering, was published under the authority of the Standards Board and comes into effect on 15 December 1996

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Amd. No.	Date	Text affected

The following BSI references relate to the work on this standard:
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National foreword

This British Standard has been prepared by Technical Committee B/502 and is the English language version of EN 1097-1 : 1996 *Tests for mechanical and physical properties of aggregates Part 1: Determination of the resistance to wear (micro-Deval)*, published by the European Committee for Standardization (CEN).

It forms part of a group of European Standards dealing with test methods for aggregates which are being developed by CEN/TC 154 to verify requirements which will be specified in European product standards for aggregates for various end uses.

NOTE. It is the intention that this standard will be included in a package of European Standards to be declared by CEN/TC 154.

Cross-reference

Publication referred to	Corresponding British Standard
ISO 5725 : 1986	BS 5497 *Precision of test methods* Part 1 : 1987 *Guide for the determination of repeatability and reproducibility for a standard test method by inter-laboratory tests*

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EUROPEAN STANDARD

NORME EUROPEÉENE

EUROPÄISCHE NORM

EN 1097-1

May 1996

ICS 91.100.20

Descriptors: Aggregates, samples, tests, mechanical properties, wear tests

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 Gesteinskörungen — Teil 1: Bestimmung des Widerstands gegen Verschleiß (micro-Deval)

This European Standard was approved by CEN on 1996-07-12. 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 CEN Central Secretariat has the same status as the official versions.

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CEN

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

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

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Foreword

This European Standard has been prepared by Technical Committee CEN/TC 54, 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 January 1997, and conflicting national standards shall be withdrawn at the latest by January 1997.

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	*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*

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 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	*Method for the determination of the resistance to wear by abrasion from studded tyres: Nordic test*
Part 10	*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, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

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1 Scope

This European Standard specifies a procedure for measuring the resistance to wear of a sample of aggregate. 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 or artificial aggregates used in building or civil engineering.

2 Normative references

This European Standard incorporates by dated or by 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 to test portions*
prEN 932-5	*Tests for general properties of aggregates Part 5 : Common equipment and calibration*
prEN 933-1 : 1992	*Tests for geometrical properties of aggregates Part 1: Determination of particle size distribution – Sieving method*
ISO 3290 : 1975	*Rolling bearings – Bearing parts – Balls for rolling bearings*
ISO 4788 : 1980	*Laboratory glassware – Graduated measuring cylinders*
ISO 5725 : 1986	*Precision of test methods – Determination of repeatability and reproducibility for a standard test method by inter-laboratory tests.*

3 Definitions

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

3.1 test portion

The sample used as a whole in a single test.

3.2 test specimen

When a test method requires more than one determination of a property, the test specimen is the sample used in a single determination.

3.3 laboratory sample

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

3.4 constant mass

Successive weighings at least 1 h apart do not differ 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 M_{DE}. Annex A 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 prEN 932-5.

5.1 Standard 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 *Set of 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 prEN 932-2.

5.1.6 *Graduated glass measuring cylinder (or cylinders)*, conforming to ISO 4788 : 1980, or other means of measuring (2,5 ± 0,05) l of water.

5.2 Special apparatus

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

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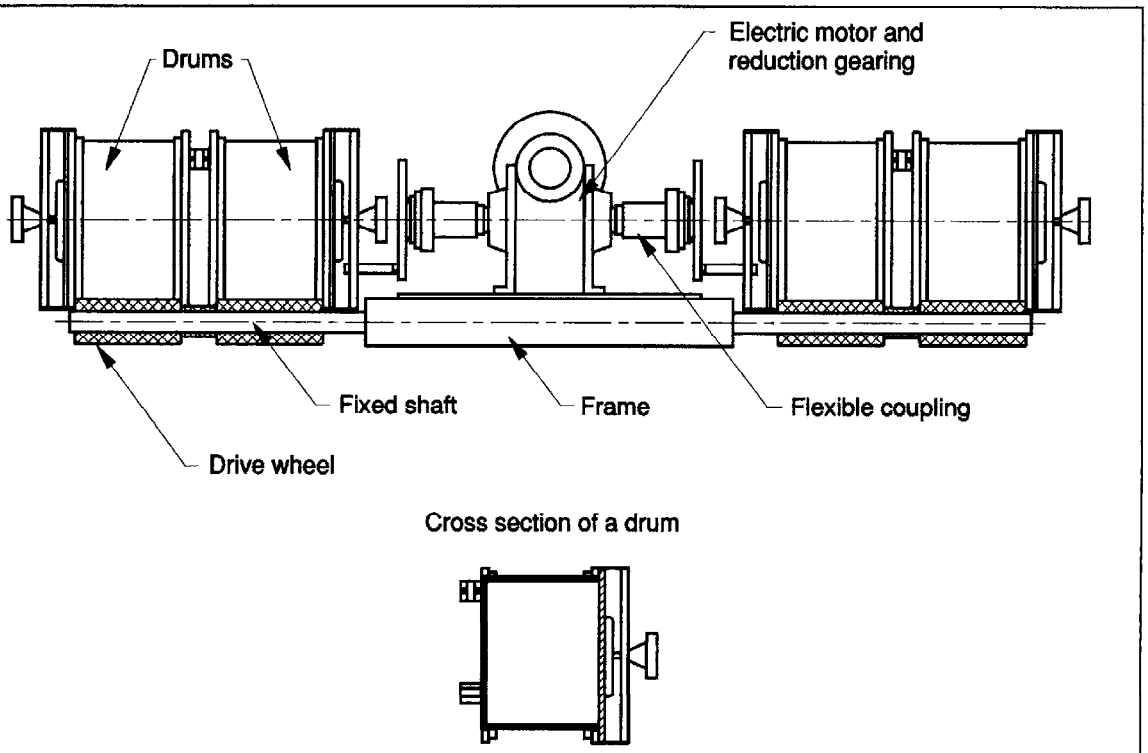

Figure 1. Diagram of typical apparatus

5.2.1 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.

5.2.2 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.

5.2.3 The abrasive charge shall consist of steel balls complying with ISO 3290 (10 ± 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.

5.2.4 A suitable motor (a capacity of about 1 kW is typical) to drive the drums at a regular speed of rotation of (100 ± 5) r/min.

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

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6 Preparation of sample for testing

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.

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 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 prEN 933-1 : 1992, 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 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 prEN 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 sufficient steel balls to each drum to give a charge of (5 000 ± 5) g.

Add (2,5 ± 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 ± 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.

Carefully separate the aggregate particles retained on the 8 mm guard sieve from the steel balls, taking care not to lose any aggregate particles. The aggregate particles may be picked out by hand, or the balls may be removed from the sieve using a magnet.

Place the aggregate particles retained on the 8 mm guard sieve onto a tray. Add the material retained on the 1,6 mm sieve to the same tray.

Dry the tray and its contents in the oven at (110 ± 5) °C. Complete the determination of the mass retained on the 1,6 mm sieve in accordance with prEN 933-1.

Record the mass (m) retained on the 1,6 mm sieve to the nearest gram.

8 Calculation and expression of results

For each test specimen calculate the micro-Deval coefficient, M_{DE}, to the nearest 0,1 units using the following equation:

$$M_{DE} = \frac{500 - m}{5}$$

where

M_{DE} is the micro-Deval coefficient (in the wet condition);

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

Using the values obtained for the two test specimens, calculate the mean value of micro-Deval coefficient. Report the mean value as the micro-Deval coefficient for the sample submitted to the laboratory. Express the mean value to the nearest whole number.

NOTE. A statement on the precision of the micro-Deval test is given in annex B.

9 Test report

The test report shall affirm that the micro-Deval value was determined in accordance with this European Standard.

The test report shall contain at least the following information:

a) name and source of sample;

b) grading class of the sample submitted for testing;

c) the type of test (wet or dry);

d) test result(s) for the test, including the value for each test specimen and the mean value;

e) date of test.

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Annex A (informative)

Determination of micro-Deval coefficient in the dry condition

A.1 Introduction

This annex describes a variation of the method given in this standard, which is carried out without the addition of water to each drum, to give a value of M_{DS}. This method can provide additional information about the characteristics of the test specimen, but should not be used in place of the reference method.

NOTE. The determination of micro-Deval coefficient in the dry condition can be carried out at the same time as the reference method, if the shafts described in **5.2.1** are long enough to hold four drums.

A.2 Apparatus

The apparatus described in clause **5** should be used, except that the means of measuring the volume of added water (see **5.1.6**) is not required.

A.3 Preparation of sample for testing

Two oven dry test specimens should be prepared, each having a mass of (500 ± 2) g, as described in clause **6**.

A.4 Test procedure

The test as described in clause **7** should be carried out, except that water is not added to the test portion in each drum.

A.5 Calculation and expression of results

The micro-Deval coefficient as described in clause **8** should be calculated, except replace M_{DE} with M_{DS}, the micro-Deval coefficient for aggregate in a dry condition.

A.6 Report

The test report should be in accordance with clause **9**, and should state that the test was carried out with the aggregate in a dry condition.

Annex B (informative)

Precision

The repeatability r and reproducibility R have been determined on the basis of two repetitions of tests on each material in 18 laboratories. The precision results stated as follows are based on a single value per test (and not the mean of two values).

The results established for levels 2 to 30 are as follows (wet and dry conditions):

- Repeatability $\quad r = 1 + 0{,}11\,x$
- Reproducibility $\quad R = 1{,}1 + 0{,}25\,x$

where x is the level of the value.

The results were interpreted in accordance with ISO 5725 : 1980.

Annex C (informative) Bibliography

NF P 18 572 : 1990 *Granulats – Essai d'usure micro-Deval.*

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List of references

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