BRITISH STANDARD

BS EN
1097-9:1998

Tests for mechanical and physical properties of aggregates —

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

The European Standard EN 1097-9:1998 has the status of a British Standard

ICS 91.100.20

National foreword

This British Standard is the English language version of EN 1097-9:1998. It is included in a package of European Standards declared by CEN/TC 154.

The UK participation in its preparation was entrusted by Technical Committee B/502, Aggregates, to Subcommittee B/502/6, Test methods, which has the responsibility to:

— aid enquirers to understand the text;

— present to the responsible European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;

— monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this committee can be obtained on request to its secretary.

Cross-references

The British Standards which implement international or European publications referred to in this document may be found in the BSI Standards Catalogue under the section entitled "International Standards Correspondence Index", or by using the "Find" facility of the BSI Standards Electronic Catalogue.

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Summary of pages

This document comprises a front cover, an inside front cover, the EN title page, pages 2 to 6, an inside back cover and a back cover.

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EUROPEAN STANDARD

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English version

Tests for mechanical and physical properties of aggregates — Part 9: Determination of the resistance to wear by abrasion from studded tyres — Nordic test

Essais pour déterminer les propriétés mécaniques et physiques des granulats — Partie 9: Méthode pour la détermination de la résistance à l'usure par abrasion provoqueé par les pneus à crampons — Essai scandinave

Prüfverfahren für mechanische und physikalische Eigenschaften von Gesteinskörnungen — Teil 9: Bestimmung des Widerstandes gegen Verschleiß durch Spikereifen — Nordische Prüfung

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

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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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CEN

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

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

Ref. No. EN 1097-9:1998 E

Foreword

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

The test procedure specified in this standard has been developed in Finland, Norway and Sweden, where studded tyres are frequently used during cold seasons.

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).*

EN 1097-2, *Tests for mechanical and physical properties of aggregates — Part 2: Methods for the determination of resistance to fragmentation.*

EN 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 — Pyknometer method.*

prEN 1097-8, *Tests for mechanical and physical properties of aggregates — Part 8: Determination of the polished stone value.*

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.

Contents

1 Scope

This European Standard specifies the test procedure for the simulation of the abrasive action of studded tyres on coarse aggregates used in a surface layer.

The test is applicable to crushed and uncrushed natural and artificial aggregates with a size fraction of 11,2 mm to 16,0 mm.

NOTE Deviations from this size range will not give consistent results.

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.*

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, *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.*

ISO 683-14:1992, *Heat-treatable steels, alloy steels and free-cutting steels — Part 14: Hot-rolled steels for quenched and tempered springs.*

ISO 2604-2:1975, *Steel products for pressure purposes — Quality requirements — Part 2: Wrought seamless tubes.*

ISO 3290:1975, *Rolling bearings — Bearing parts — Balls for rolling bearings.*

ISO 3310:1990, *Test sieves — Technical requirements and testing.*

ISO 4788:1980, *Laboratory glassware — Graduated measuring cylinders.*

ISO 5725:1986, *Precision of test methods — Determination of repeatability and reproducibility by inter-laboratory tests.*

3 Definitions

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

3.1

test specimen

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

3.2

laboratory sample

a reduced sample derived from a bulk sample for laboratory testing

3.3

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 specimen 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

A sample of a single-sized aggregate, 11,2 mm to 16,0 mm, is rotated together with steel balls and water in a steel drum. Three ribs, which are mounted on the interior of the drum, improve the mixing of the aggregate particles and the steel balls. 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 aggregate portion is sieved on the 2 mm sieve to measure the wear as a percentage loss.

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 specimen.

5.1.2 *Set of sieves*, 2,0 mm – 8 mm – 11,2 mm – 14,0 mm – 16,0 mm, conforming to EN 933-2.

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*, as specified in prEN 932-2.

5.1.6 *Graduated glass measuring cylinder (or cylinders)*, conforming to ISO 4788:1980, or other means of measuring (2,00 ± 0,01) l of water.

5.2 Special apparatus

5.2.1 *Testing machine.* A typical testing machine is detailed in Figure 1 with essential characteristics as specified in **5.2.2** to **5.2.7**.

5.2.2 *A watertight hollow drum*, closed at one end, having an inside diameter of (206,5 ± 2,0) mm and an internal length measured from the inside of the base to the inside of the lid of (335 ± 1) mm. The drum shall be made of a seamless steel tube conforming to grade TS 5 of ISO 2604-2:1975, with a minimum wall thickness of 6,0 mm.

The drum shall be closed by a flat lid at least 8 mm thick and fitted with watertight and dust seals. The drum shall rotate on a horizontal axis, e.g. placed on two shafts as shown in Figure 1.

5.2.3 *Three ribs*, each with a length of (333 ± 1) mm, shall be equally spaced around the internal circumference of the cylinder. The three ribs shall be removable, having an initial profile as shown in Figure 2, and be made of hard and tough steel, e.g. spring steel conforming to ISO 683-14:1992.

Each rib shall be rigidly secured to the drum with at least three M4 countersunk fixings.

Before first use, the ribs shall be preground in the drum for (25 ± 1) h using an aggregate with a Nordic abrasion value of not more than 6,0 prepared in accordance with clause **6**. Each rib shall be replaced when, or before, its mass is less than 15,0 g less than its mass before it was preground.

5.2.4 *Abrasive charge*, consisting of ball bearings, (15,0 $^{+0,1}_{-0,5}$) mm diameter, of hardness between 62 HRC and 65 HRC, as specified in ISO 3290:1975.

NOTE The diameter of the balls can be checked quickly by passing them over parallel bars 14,5 mm apart.

5.2.5 *Motor*, capable of driving the drum at a regular speed of rotation of (90 ± 3) r/min.

5.2.6 *Counter*, or other suitable device which automatically stops the rotation after (5 400 ± 10) revolutions.

5.2.7 Gauge, (optional) to control minimum ball size, e.g. two parallel bars (14,6 ± 0,1) mm apart.

5.2.8 *Magnet*, (optional) for removal of the charge from the aggregate test sample after abrasion.

NOTE A magnet which is too strong should not be used as the balls can become magnetized.

6 Preparation of test specimens

The mass of the sample sent to the laboratory shall be large enough for the preparation of at least four test specimens.

The grading of the test specimen shall have (65 ± 1) % passing the 14,0 mm sieve, i.e. (35 ± 1) % of the test specimen shall consist of particles in the 14,0 mm to 16,0 mm size range.

Sieve the laboratory sample using the 11,2 mm, 14,0 mm and 16,0 mm sieves to give separate fractions in the ranges 11,2 mm to 14,0 mm and 14,0 mm to 16,0 mm. Wash each fraction separately, in accordance with **7.1** 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 11,2 mm to 16,0 mm laboratory sample which complies with (65 ± 1) % passing the 14,0 mm sieve.

Reduce the modified laboratory sample prepared from the mixed fractions to test specimen size in accordance with the requirements of prEN 932-2.

The test specimen shall have a mass (in grams) defined in accordance with the following equation:

$$m_i = \frac{1000\rho_s}{2,66} \pm 5$$

where

m_i is the initial dry mass of the test specimen (in grams);

ρ_s is the pre-dried particle density, in accordance with prEN 1097-6 (in megagrams per cubic metre).

7 Procedure

Place the test specimen in the drum. Add sufficient steel balls to give a charge of (7 000 ± 10) g and add (2,00 ± 0,01) l of water.

Fit the lid to the drum. Rotate the drum at a speed of (90 ± 3) r/min for (5 400 ± 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.

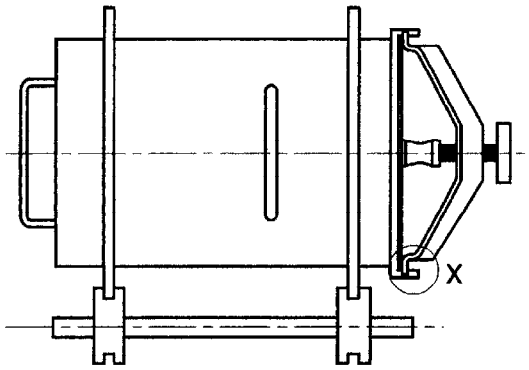
Empty the material and all the washings onto the 14,0 mm sieve which is nested with the 2,0 mm sieve protected by an 8,0 mm guard sieve. Wash the material in a stream of clean water.

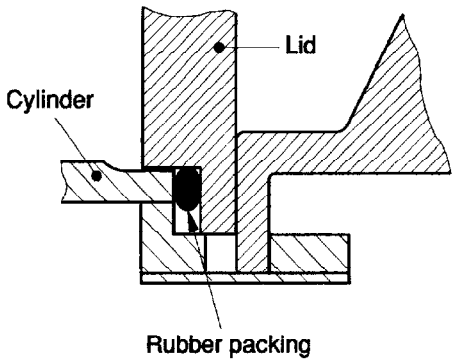
Carefully separate the aggregate particles retained on the 14,0 mm sieve from the steel balls, taking care not to lose any aggregate particles. The aggregate particles can be picked out by hand, or the balls can be removed from the sieve using a magnet.

Place the aggregate particles retained on the 14,0 mm sieve, the 8,0 mm guard sieve and the 2,0 mm sieve onto a tray.

Dry the tray and its contents in the oven at (110 ± 5) °C. Complete the determination of the mass retained on the 14,0 mm, 8,0 mm and 2,0 mm sieves in accordance with EN 933-1. Record the mass retained on each sieve to the nearest gram.

Repeat the above procedure on a second test specimen.

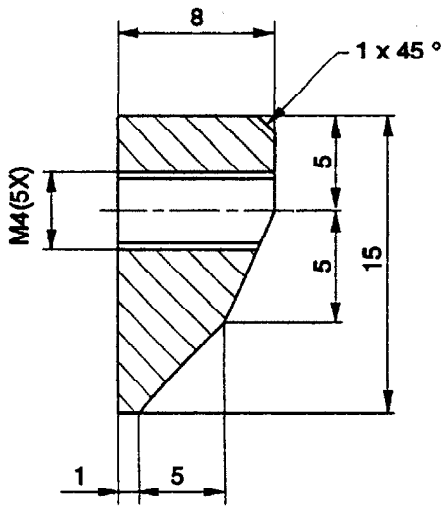




Detail X -Typical lid edge

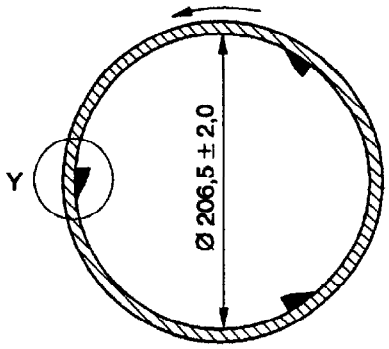
Dimensions in millimetres

Figure 1 — Typical testing machine



Detail Y. Rib detail before pregrinding

With a tolerance of $\pm 0{,}5$ mm



Section of the drum with the three ribs

Figure 2 — The three ribs

8 Calculation and expression of results

Calculate the Nordic abrasion value A_N as follows:

$$A_N = 100(m_i - m_2)/m_i$$

where

m_i is the initial dry mass of the test specimen (in grams);

m_2 is the sum of the dry masses of the three fractions retained on the three sieves (14,0 mm, 8,0 mm and 2,0 mm) after the test (in grams).

Report the Nordic abrasion value to the nearest decimal.

The results of two determinations of the Nordic abrasion value A_N shall be accepted if the difference is smaller than or equal to 7 % of their mean.

If the difference is greater, test two further test specimens. Calculate the standard deviation of the four A_N values and if the standard deviation is greater than 6 %, discard suspect extreme values according to Dixon's test, in accordance with ISO 5725:1986, at the 5 % level.

Calculate the mean of all accepted values.

NOTE A statement on the precision of this test method is given in annex A.

9 Test report

9.1 Required data

The test report shall include the following information:

a) reference to this European Standard;

b) identification of the test laboratory;

c) identification of the sample;

d) Nordic abrasion value.

9.2 Optional data

The test report can include the following information:

a) name and location of the sample source;

b) description of the sample in accordance with EN 932-3;

c) description of the sampling procedure.

Annex A (informative)

Precision

The repeatability (r) and reproducibility (R) have been determined on the basis of interlaboratory studies in the Nordic countries (11 laboratories, eight levels and two test specimens at each level). Interpretation of the test results has been made in accordance with ISO 5725:1986.

For Nordic abrasion values (A_N) from 5 to 16, the precision was as follows:

$r = 0{,}13\,A_N - 0{,}17$

$R = 0{,}14\,A_N + 0{,}27$

Annex B (informative)

Bibliography

EN 932-3:1996, *Tests for general properties of aggregates — Part 3: Procedure and terminology for simplified petrographic description.*

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