BS EN 12697-16:2016

BSI Standards Publication

Bituminous mixtures — Test methods

Part 16: Abrasion by studded tyres

bsi.

National foreword

This British Standard is the UK implementation of EN 12697-16:2016. It supersedes BS EN 12697-16:2004 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee B/510/1, Asphalt products.

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

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Asphalt - Prüfverfahren für Heißasphalt - Teil 16: Abrieb durch Spikereifen

This European Standard was approved by CEN on 23 January 2016.

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European foreword

This document (EN 12697-16:2016) has been prepared by Technical Committee CEN/TC 227 “Road materials”, the secretariat of which is held by DIN.

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of an identical text or by endorsement, at the latest by October 2016, and conflicting national standards shall be withdrawn at the latest by October 2016.

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 12697-16:2004.

Compared with EN 12697-16:2004 the following changes have been made:

a) Scope: Clarification regarding application of the Method. NOTES regarding use of polymer-modified bitumen or rubber modified bitumen added.

b) 4.2 Apparatus: Clarified that sample collar shall consist of stainless steel. Completed with important parts about measuring stroke height and installation of equipment; needed measurements to the manufacturer of equipment; dimension for new sample collar and NOTE for old equipment; defined quality of stainless steel balls and weight of steel ball set with tolerances; added normative text regarding the importance of fixed rubber plate without bubbles; added normative text regarding when rubber plate needs to be replaced; tightened accuracy of balance from 0,3 to ± 0,1 g; and corrections of Figure 1 (including key) and Figure 2 (including key). Figure 1 and Figure 2 placed in order due to the actual clause.

c) 4.3 Test specimen: paragraphs added.

d) 4.4 Conditioning: Completed with maximum conditioning time and minor editorial changes.

e) 4.5 Determination of abrasion: Completed with defined procedure for how to handle test when water flow is interrupted; additional notes; and minor editorial changes for inconsistencies. In 4.5.1 added that tape shall be water proof or similar. In 4.5.3 Checkpoint added regarding condition of rubber plate.

f) 4.6 Calculation: Changed for calculation of rounded abrasion value; unit for bulk density; and minor editorial changes.

g) 4.7 Test report: Clarified and minor editorial changes. In 4.7 f) Added that also individual values shall be reported.

h) 4.8 Precision: Updated based on results in the Nordic research project in NordFoU.

This European standard is one of a series of standards as listed below:

— EN 12697-1, *Bituminous mixtures — Test methods for hot mix asphalt — Part 1: Soluble binder content*

— EN 12697-2, *Bituminous mixtures — Test methods — Part 2: Determination of particle size distribution*

— EN 12697-3, *Bituminous mixtures — Test methods for hot mix asphalt — Part 3: Bitumen recovery: Rotary evaporator*

— EN 12697-4, *Bituminous mixtures — Test methods — Part 4: Bitumen recovery: Fractionating column*

— EN 12697-5, *Bituminous mixtures — Test methods for hot mix asphalt — Part 5: Determination of the maximum density*

— EN 12697-6, *Bituminous mixtures — Test methods for hot mix asphalt — Part 6: Determination of bulk density of bituminous specimens*

— EN 12697-7, *Bituminous mixtures — Test methods for hot mix asphalt — Part 7: Determination of bulk density of bituminous specimens by gamma rays*

— EN 12697-8, *Bituminous mixtures — Test methods for hot mix asphalt — Part 8: Determination of void characteristics of bituminous specimens*

— EN 12697-10, *Bituminous mixtures —Test methods for hot mix asphalt — Part 10: Compactability*

— EN 12697-11, *Bituminous mixtures — Test methods for hot mix asphalt — Part 11: Determination of the affinity between aggregate and bitumen*

— EN 12697-12, *Bituminous mixtures — Test methods for hot mix asphalt — Part 12: Determination of the water sensitivity of bituminous specimens*

— EN 12697-13, *Bituminous mixtures — Test methods for hot mix asphalt — Part 13: Temperature measurement*

— EN 12697-14, *Bituminous mixtures — Test methods for hot mix asphalt — Part 14: Water content*

— EN 12697-15, *Bituminous mixtures — Test methods for hot mix asphalt — Part 15: Determination of the segregation sensitivity*

— EN 12697-16, *Bituminous mixtures — Test methods — Part 16: Abrasion by studded tyres*

— EN 12697-17, *Bituminous mixtures — Test methods for hot mix asphalt — Part 17: Particle loss of porous asphalt specimen*

— EN 12697-18, *Bituminous mixtures — Test methods for hot mix asphalt — Part 18: Binder drainage*

— EN 12697-19, *Bituminous mixtures — Test methods for hot mix asphalt — Part 19: Permeability of specimen*

— EN 12697-20, *Bituminous mixtures — Test methods for hot mix asphalt — Part 20: Indentation using cube or cylindrical specimens (CY)*

— EN 12697-21, *Bituminous mixtures — Test methods for hot mix asphalt — Part 21: Indentation using plate specimens*

— EN 12697-22, *Bituminous mixtures — Test methods for hot mix asphalt — Part 22: Wheel tracking*

— EN 12697-23, *Bituminous mixtures — Test methods for hot mix asphalt — Part 23: Determination of the indirect tensile strength of bituminous specimens*

— EN 12697-24, *Bituminous mixtures — Test methods for hot mix asphalt — Part 24: Resistance to fatigue*

— EN 12697-25, *Bituminous mixtures — Test methods for hot mix asphalt — Part 25: Cyclic compression test*

— EN 12697-26, *Bituminous mixtures — Test methods for hot mix asphalt — Part 26: Stiffness*

— EN 12697-27, *Bituminous mixtures — Test methods for hot mix asphalt — Part 27: Sampling*

— EN 12697-28, *Bituminous mixtures — Test methods for hot mix asphalt — Part 28: Preparation of samples for determining binder content, water content and grading*

— EN 12697-29, *Bituminous mixtures — Test method for hot mix asphalt — Part 29: Determination of the dimensions of a bituminous specimen*

— EN 12697-30, *Bituminous mixtures — Test methods for hot mix asphalt — Part 30: Specimen preparation by impact compactor*

— EN 12697-31, *Bituminous mixtures — Test methods for hot mix asphalt — Part 31: Specimen preparation by gyratory compactor*

— EN 12697-32, *Bituminous mixtures — Test methods for hot mix asphalt — Part 32: Laboratory compaction of bituminous mixtures by vibratory compactor*

— EN 12697-33, *Bituminous mixtures — Test methods for hot mix asphalt — Part 33: Specimen prepared by roller compactor*

— EN 12697-34, *Bituminous mixtures — Test methods for hot mix asphalt — Part 34: Marshall test*

— EN 12697-35, *Bituminous mixtures — Test methods — Part 35: Laboratory mixing*

— EN 12697-36, *Bituminous mixtures — Test methods for hot mix asphalt — Part 36: Determination of the thickness of a bituminous pavement*

— EN 12697-37, *Bituminous mixtures — Test methods for hot mix asphalt — Part 37: Hot sand test for the adhesivity of binder on precoated chippings for HRA*

— EN 12697-38, *Bituminous mixtures — Test methods for hot mix asphalt — Part 38: Common equipment and calibration*

— EN 12697-39, *Bituminous mixtures — Test methods for hot mix asphalt — Part 39: Binder content by ignition*

— EN 12697-40, *Bituminous mixtures — Test methods for hot mix asphalt — Part 40: In situ drainability*

— EN 12697-41, *Bituminous mixtures — Test methods for hot mix asphalt — Part 41: Resistance to de-icing fluids*

— EN 12697-42, *Bituminous mixtures — Test methods for hot mix asphalt — Part 42: Amount of foreign matter in reclaimed asphalt*

— EN 12697-43, *Bituminous mixtures — Test methods for hot mix asphalt — Part 43: Resistance to fuel*

— EN 12697-44, *Bituminous mixtures — Test methods for hot mix asphalt — Part 44: Crack propagation by semi-circular bending test*

— EN 12697-45, *Bituminous mixtures — Test methods for hot mix asphalt — Part 45: Saturation Ageing Tensile Stiffness (SATS) conditioning test*

— EN 12697-46, *Bituminous mixtures — Test methods for hot mix asphalt — Part 46: Low temperature cracking and properties by uniaxial tension tests*

— EN 12697-47, *Bituminous mixtures — Test methods for hot mix asphalt — Part 47: Determination of the ash content of natural asphalts*

— prEN 12697-48, *Bituminous mixtures — Test methods for hot mix asphalt — Part 48: Interlayer Bonding*

— EN 12697-49, *Bituminous mixtures — Test methods for hot mix asphalt — Part 49: Determination of friction after polishing*

— FprCEN/TS 12697-50, *Bituminous mixtures — Test methods — Part 50: Resistance to scuffing*[1)]

— FprCEN/TS 12697-51, *Bituminous mixtures — Test methods — Part 51: Surface shear strength test*

— prEN 12697-52, *Bituminous mixtures — Test methods — Part 52: Conditioning to address oxidative ageing*[1)]

— prEN 12697-53, *Bituminous mixtures — Test methods — Part 53: Cohesion increase by spreadability-meter method*[1)]

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, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

1) Currently at Enquiry stage.

1 Scope

This European Standard describes two test methods (method A and method B) for determining the susceptibility of abrasion by studded tyres, tested on cylindrical specimens of bituminous mixtures. The test methods are applicable to bituminous mixtures with aggregate with upper sieve size not exceeding 22 mm.

The tests are applicable to laboratory produced specimens or cores drilled from a slab or pavement.

NOTE 1 Method A originates from the 'Prall'-method, which has been improved by comprehensive Nordic research work. The method correlates with abrasion in the field when using paving grade bitumen. According to Nordic experience by method A the correlation between laboratory and abrasion in field is not established when polymer modified bitumen or rubber modified bitumen, etc. is used.

NOTE 2 Method B originates from Finnish experience and is suitable also when polymer modified bitumen is used. The correlation between laboratory and abrasion in field is not established when rubber is used.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 12697-6, *Bituminous mixtures - Test methods for hot mix asphalt - Part 6: Determination of bulk density of bituminous specimens*

EN 12697-27, *Bituminous mixtures - Test methods for hot mix asphalt - Part 27: Sampling*

EN 12697-30, *Bituminous mixtures - Test methods for hot mix asphalt - Part 30: Specimen preparation by impact compactor*

EN 12697-31, *Bituminous mixtures - Test methods for hot mix asphalt - Part 31: Specimen preparation by gyratory compactor*

EN 12697-32, *Bituminous mixtures — Test methods for hot mix asphalt — Part 32: Laboratory compaction of bituminous mixtures by vibratory compactor*

EN 12697-33, *Bituminous mixtures — Test methods for hot mix asphalt — Part 33: Specimen prepared by roller compactor*

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

3 Terms and definitions

For the purposes of this document, the following term and definition applies.

3.1
abrasion
loss of mass by abrasive action

Note 1 to entry: Expressed as volume loss in millilitres (ml).

4 Method A

4.1 Principle

A cylindrical specimen having a diameter of 100 mm and a height of 30 mm is brought to a temperature of 5 °C. The specimen is worn by abrasive action during 15 min by 40 steel spheres. The loss of volume in millilitre is recorded and is reported as the abrasion value.

4.2 Apparatus

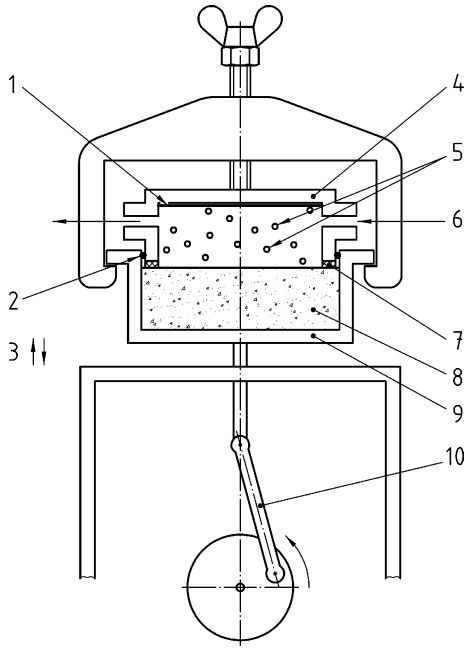
Abrasion apparatus according to Figure 1, including a stroke, (43 ± 1) mm, and a connection rod, length (200 ± 5) mm.

The stroke height shall be measured in a way that possible backlash is included in the stroke height.

The equipment shall be mounted on a concrete foundation, the mass should be at least 300 kg, or be attached to a concrete floor. If rubber feet are used, they shall be of such quality that the equipment does not come into self-oscillation.

4.2.1 Sample collar of stainless steel for test specimen with inner diameter 102,0 ± 0,2 mm, to enable fitting of specimens made by EN 12697-30, and inner height at least 35 mm. Thickness about 6 mm. (Figure 1).

NOTE The measurement for inner diameter is required on new manufactured equipment. Some earlier made equipment may have an inner diameter that is smaller than the tolerance requirement but it does not have influence on the wearing surface area, however the smaller diameter may limit the possibility to enable fitting of specimens made by EN 12697–30.



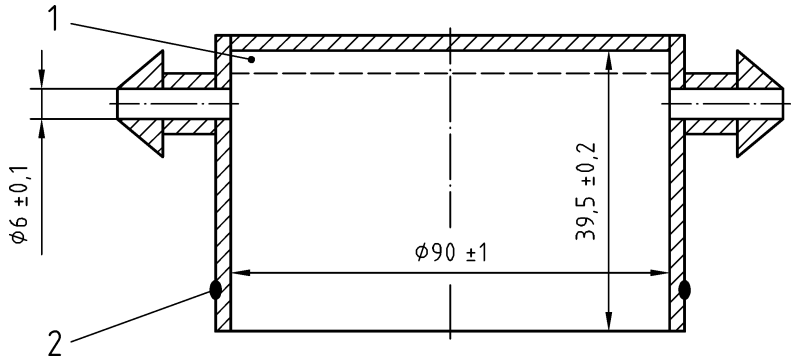
Key

1	rubber plate	6	inlet/ outlet for cooling water
2	O-ring	7	flat rubber ring
3	stroke	8	specimen
4	lid	9	sample collar
5	steel spheres	10	connection rod

Figure 1 — Abrasion apparatus, in general

4.2.2 Lid to abrasion apparatus of stainless steel with ports for water flow. The lid shall have an inner diameter 90 ± 1 mm and inner height 39,5 ± 0,2 mm. Thickness about 6 mm to enable tight fitting (with o-ring) into the sample collar. Diameter of the outlet ports Ø 6,0 ± 0,1 mm. (Figure 2).

Dimensions in millimetres



Key

1 rubber plate

2 O-ring

Figure 2 — Lid of stainless steel

4.2.3 Steel clamp to fasten the lid on top of the machine adjustable by means of the screw at the top.

4.2.4 Spheres made of stainless steel according to ISO 3290-1 with a diameter between 11,50 mm and 12,01 mm. The hardness, expressed in HRC, shall be 58-65 and the weight of 40 steel balls shall be between 265 and 285 g.

NOTE The diameter of the spheres can be checked quickly by passing them over parallel bars 11,50 mm apart.

4.2.5 Flat rubber ring (Nitrile Butadiene Rubber (NBR) or similar), to protect the edges of the specimen (see Figure 1), outer diameter (102,0 ± 0,2) mm, internal diameter (87,4 ± 0,2) mm and thickness 6,3 ± 0,1 mm.

4.2.6 O-ring (Nitrile Butadiene Rubber (NBR) or similar) for the groove outside of the cylindrical part of the lid (see Figure 2), internal diameter 90,0 mm, diameter of cross section 3,0 mm.

4.2.7 Rubber plate (Polychloroprene or similar) with diameter (90,0 ± 1,0) mm, thickness (2,0 ± 0,2) mm. The rubber plate shall be glued firmly without bubbles at the underside of the lid (see Figure 2). The rubber plate shall be replaced when it becomes damaged or brittle.

NOTE The rubber plate undergoes continuous quality degradation over time and during use.

4.2.8 Water reservoir for cooling water and for adjustment of specimen temperature to 5 ± 1 °C.

4.2.9 Balance of appropriate capacity, at least 3 kg, able to weight with an accuracy of at least ± 0,1 g.

4.2.10 Water pump with capacity not less than 2,0 l/min.

4.3 Test specimen

4.3.1 The cylindrical test specimens shall have a diameter of (100 ± 2) mm. The specimens shall be either laboratory-produced in accordance with EN 12697-30, EN 12697-31, or EN 12697-32, or cores drilled from the road according to EN 12697-27, or cores drilled from slabs produced in accordance with EN 12697-33.

4.3.2 The upper aggregate sieve size of the bituminous mixture shall not exceed 22 mm.

4.3.3 Make at least four specimens with a diameter of (100 ± 2) mm.

To be able to complete test in case of failure (see 4.5.5), it is recommended to prepare six specimens.

4.3.4 Cut the specimens to a height of (30 ± 2) mm. When cutting, avoid damaging the edges of the specimen. The end surfaces shall be made as even and parallel as possible with a maximum of 2 mm difference in height.

NOTE The dimensions can be checked in accordance with EN 12697–29.

4.3.5 Determine the bulk density according to EN 12697-6.

4.4 Conditioning

4.4.1 Condition the specimens for at least 5 h in water of temperature 5 ± 1°C. Max conditioning time is 72 h.

4.4.2 Remove the specimen from the water, dry the surface, removing any drops adhering to it by wiping with a damp chamois.

4.4.3 Determine the mass of the saturated, surface wiped specimen in air immediately after drying, M_1

4.5 Determination of abrasion

4.5.1 Place the specimen in the test chamber. Laboratory-produced specimens shall be tested on a cut surface. Cores from the road however shall be tested on uncut upper surface. Make sure that the specimen is tight to the chamber-wall, otherwise put water proof tape or similar around the test specimen.

4.5.2 Place the flat rubber ring on the specimen, and the steel spheres in the ring.

4.5.3 Check the condition of rubber plate (see 4.2.7). Fasten the lid onto the test chamber.

4.5.4 Adjust the amount of cooling water to (2,0 ± 0,2) l/min.

If water is recycled during testing care shall be taken that the water is clean from fines.

4.5.5 Start the abrasion apparatus and let it work for 15 min ± 10 s at 950 ± 10 r/min. If there is a stop in the outcoming waterflow the testing shall be stopped. The test is invalid and a new specimen shall be tested.

4.5.6 Dismantle the apparatus. Remove the specimen from the apparatus and flush it in cold water. Remove the specimen from the water and dry the surface, removing any drops adhering to it by wiping with a damp chamois.

4.5.7 If aggregate detaches from the specimen edges when removing it from the test chamber they shall be included in (M_2) according to 4.5.8. Loose stones found in the chamber after the test shall not be included in M_2, but the weight shall be noted (see 4.7.h).

4.5.8 Determine the mass of the saturated, surface wiped specimen in air immediately after drying (M_2).

4.6 Calculation

Calculate the abrasion value according to the formula below.

$$Abr_{\mathrm{A}} = \frac{(M_1 - M_2)}{\rho_{\mathrm{bssd}}} \quad (1)$$

where

Abr_{A} is the abrasion value, in millilitres (ml), rounded to one decimal;

M_1 is the mass of water stored specimen surface dry in air before abrasion, in grams (g), rounded to one decimal;

M_2 is the mass of water stored specimen surface dry in air after abrasion, in grams (g), rounded to one decimal;

ρ_{bssd} is the bulk density of specimen according to 4.3.5, in $\mathrm{Mg/m^3}$, rounded to 3 decimals.

4.7 Test report

The test report shall include the following information:

a) identification number and type of mixture;

b) reference to this European Standard;

c) sample preparation method used, including reference to relevant document;

d) date and time of testing and name of operator;

e) reference to this test method;

f) average bulk density and the individual values with 3 decimals;

g) average abrasion value of four specimens with no decimal, and the individual values with one decimal;

h) any observation which may have an influence on the evaluation.

4.8 Precision

The repeatability, *r*, is 15 %.

The reproducibility, *R*, is 27 %.

NOTE The precision data were obtained from a round robin test within the Nordic countries (NordFoU) in 2014.

5 Method B

5.1 Principle

A cylindrical specimen having a diameter of 100 mm and a height of at least 45 mm is brought to a temperature of 5 °C. The specimen is worn wet by three studded tyres during 2 h. The loss in millilitres is recorded and is reported as the abrasion value.

5.2 Apparatus

5.2.1 Abrasion apparatus, according to Figure 3, having a rotation unit with three studded rubber tyres placed in circle 120° apart, and a magnetic plate to hold the specimen.

5.2.2 Rubber tyre, diameter (90 ± 3) mm, width (25 ± 3) mm, compact rubber, hardness (50 ± 5) Shore A.

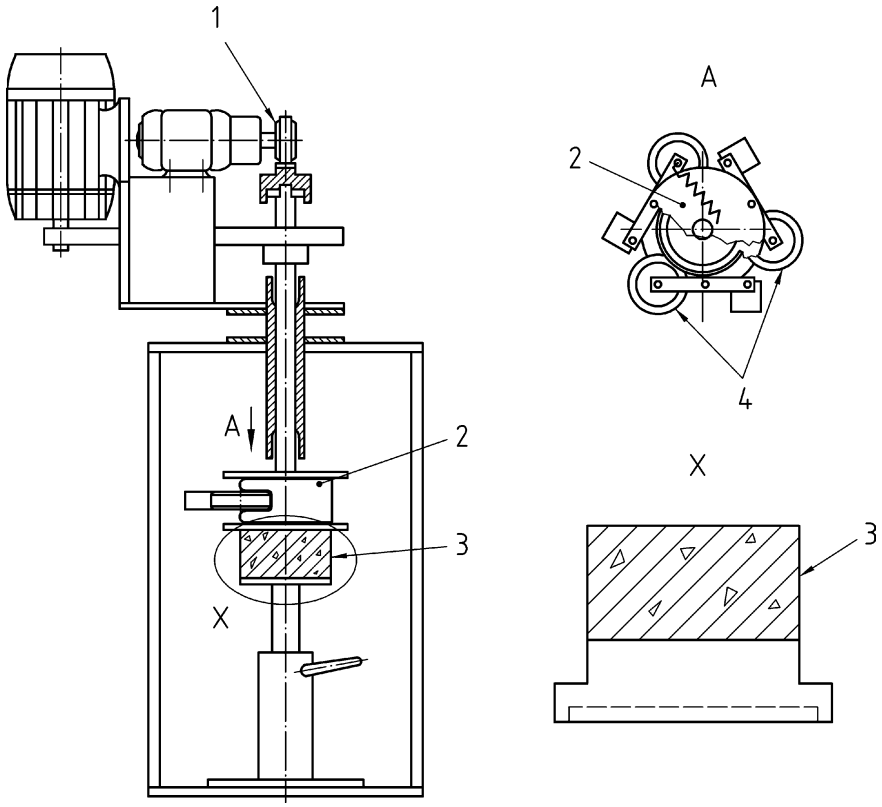
The three tyres shall be positioned so that one is in direction of rotation, one tyre deviating +(5 ± 1)° from rotation, and one tyre deviating −(5 ± 1)° from rotation.

5.2.3 Studs, 30 per tyre, with protrusion of (1,50 ± 0,15) mm for a single stud, (1,50 ± 0,05) mm mean value. Studs shall be placed in accordance with Annex A.

5.2.4 Tyre load, (75 ± 5) N spring force on the surface of the specimen.

Tyre load shall be measured in accordance with Annex B. The tyres shall have a vertical movement, stroke: ± (5 ± 1) mm (up and down) from central position, moving 1 cycle per (25 ± 2) s.

5.2.5 Rotator, with a speed of (520 ± 5) revolutions/min, in total (62 400 ± 600) r.



Key

1 electric engine (5 mm up and down)
2 rotor (520 rev/min)
3 specimen and steel plate
4 three studded tyres, of which one goes straight and the others deviate by 5° in opposite directions

Figure 3 — Abrasion apparatus

5.2.6 Spraying device capable of maintaining water temperatures in the range from 0 °C to 20 °C, accuracy ± 2 °C, and a spraying capacity of (60 ± 5) l/h.

5.2.7 Test chamber to accommodate abrasion apparatus, capable of maintaining air temperatures in the range from 0 °C to 20 °C, accuracy ± 2 °C.

5.2.8 Steel plates of different thicknesses to be glued to test specimens.

5.2.9 Balance of appropriate capacity, at least 4 kg, accurate to 0,1 g.

5.3 Test specimen

5.3.1 The cylindrical test specimens shall have a diameter of (100 ± 1) mm. The specimens shall be either laboratory-produced in accordance with EN 12697-30, EN 12697-31, or EN 12697-32, or cores drilled from the road according to EN 12697-27, or cores drilled from slabs produced in accordance with EN 12697-33.

5.3.2 The maximum aggregate size of the bituminous mixture shall not exceed 22 mm.

5.3.3 If a core from the road has a thickness of less than 45 mm, a test specimen can be made by gluing two equally thick cores together. The original upper surfaces shall be glued together with a thin layer of epoxy glue. If the original upper surfaces are not completely even, the surfaces shall be sawed even before gluing. The very thin epoxy layer shall be positioned in the middle of the wearing area. The use of the two layer specimen shall be noted in the test report.

5.3.4 Prepare at least three specimens according to 5.3.5 to 5.3.7. If the maximum aggregate size is larger than 16 mm, at least four samples shall be tested.

5.3.5 Weigh the steel plate in air M_{p1} to ± 0,5 g, and in water M_{p2} to ± 0,5 g, and record the masses.

5.3.6 Attach by means of epoxy glue a specimen of diameter (100 ± 1) mm and length at least 45 mm to the steel plate.

5.3.7 Weight the steel plate with the specimen in air M_1 to ± 0,5 g, and in water M_2 to ± 0,5 g.

5.4 Conditioning

5.4.1 Bring the specimen to the test temperature (5 ± 2) °C by storing it in the test chamber for at least 5 h.

5.4.2 Adjust the temperature of the wetting water to (5 ± 2) °C.

5.5 Determination of abrasion

5.5.1 To level out the wear of new studs, exchange one of the three tyres at intervals of (24 ± 2) h.

NOTE In this way, there is always one tyre in use in each interval of service: 0 h to 24 h, 24h to 48 h, and 48 h to 72 h.

5.5.2 Pre-wear a specimen for 15 min, if it is tamped, to remove the mortar surface before the actual wear test. Conduct pre-wearing in dry conditions at (5 ± 2) °C. A cored specimen is ready for the wear test at once.

5.5.3 Ensure that the magnetic base plate is clean. If not, clean it.

5.5.4 Install the specimen on the magnetic base plate. Lift the specimen to the correct height and fix it there.

5.5.5 Free the locking rods of the rotator, and secure the contact of the tyres.

5.5.6 Start the machine according to the operating instructions.

5.5.7 Stop the machine after (2 h ± 1 min). Weigh the steel plate with the specimen in air M_3 to ± 0,5 g, and in water M_4 to ± 0,5 g.

5.6 Calculation

Calculate the abrasion value according to the formula below.

$$Abr_{\mathrm{B}} = (M_1 - M_2) - (M_3 + M_4) \quad (2)$$

where

Abr_{B} is the abrasion value, in millilitres (ml), with no decimal;

M_1 is the mass of steel plate with specimen in air before the test, in grams (g);

M_2 is the mass of steel plate with specimen in water before the test, in grams (g);

M_3 is the mass of steel plate with specimen in air after the test, in grams (g);

M_4 is the mass of steel plate with specimen in water after the test, in grams (g).

All masses rounded to one decimal.

Also calculate the bulk density according to the formula below:

$$\rho = \frac{(M_1 - M_{\mathrm{p1}})}{(M_1 - M_{\mathrm{p1}}) - (M_2 - M_{\mathrm{p2}})} \quad (3)$$

where

ρ is the bulk density of specimen, in grams per millilitre (g/ml), rounded to three decimals;

M_{p1} is the mass of the plate in air, in grams (g), rounded to one decimal;

M_{p2} is the mass of the plate in water, in grams (g), rounded to one decimal.

5.7 Test report

The test report shall include the following information:

a) identification number and type of mixture;

b) reference to this European Standard;

c) sample preparation method used, including reference to relevant document;

d) date and time of testing and name of operator;

e) reference to this test method;

f) average abrasion value with no decimal, and average bulk density with three decimals (if test is performed on cores from the road, also report the individual values);

g) any observation which may have an influence on the evaluation;

h) special testing conditions (pre-wearing, curing, if a two layer specimen has been used).

5.8 Precision

The repeatability, *r*, is 15 % by a standard deviation of 5 %.

The reproducibility, *R*, is 20 % by a standard deviation of 7 %.

NOTE The precision data were obtained in Finland in 1995.

Annex A
(normative)

Stud chart

Figure A.1 shows the placing of the studs on the tyres.

Dimensions in millimetres

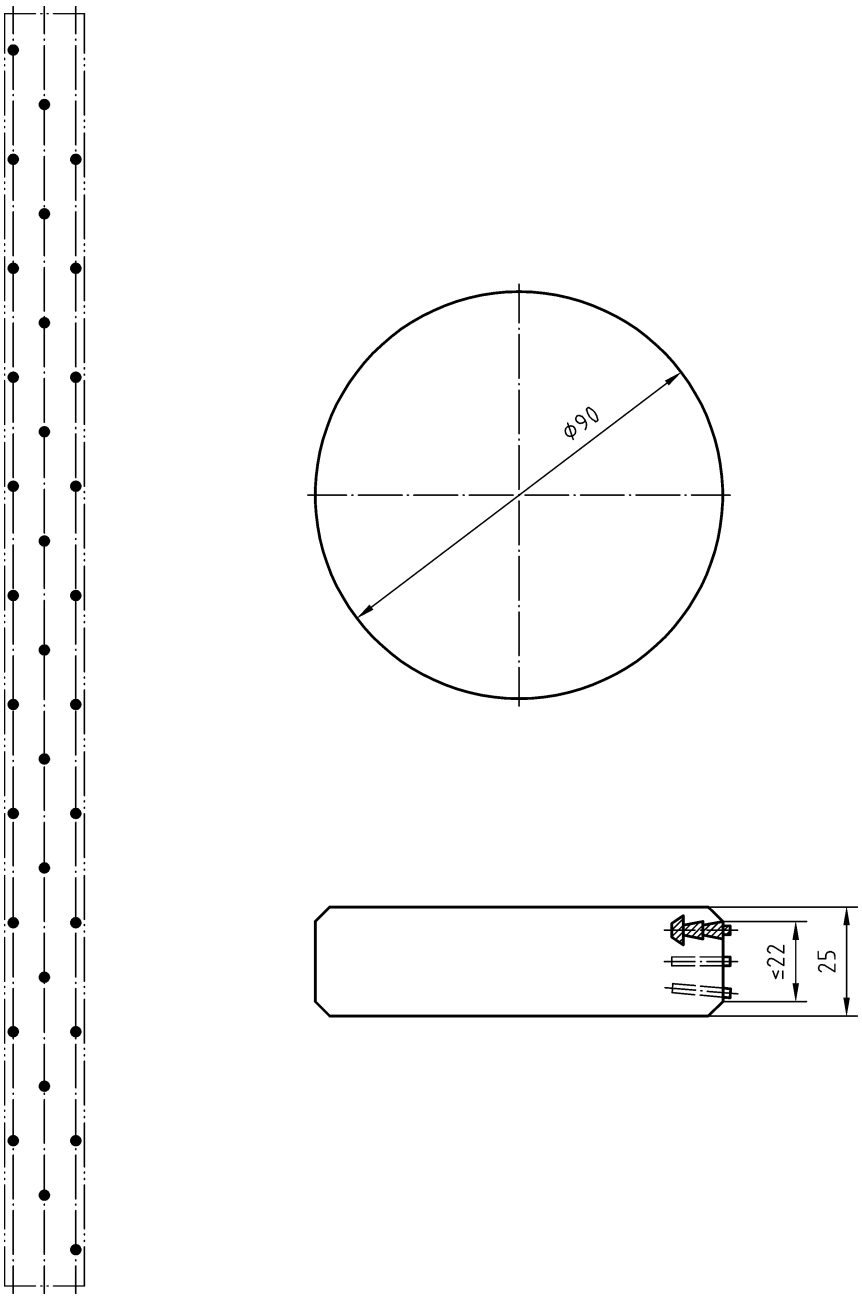


Figure A.1 — Stud chart

Annex B
(normative)

Spring force measurement

B.1 General

The tyres are spring-loaded, each by two springs, which are set between two pins. At the beginning of the test while sample is installed, springs are stretched to the length of 125 mm. Each tyre is loaded with (75 ± 5) N spring force. The spring force is measured for each spring before it is installed in device.

Spring force for two springs together should, as described, be (75 ± 5) N. In practice this means that each spring should give (37,5 ± 2,5) N spring force when it is stretched to the length of 125 mm.

B.2 Measuring the spring force with spring balance or dynamometer

B.2.1 Measuring equipment

B.2.1.1 **Spring balance or dynamometer**, calibrated, with measuring capacity of at least 0 kg to 5 kg and give results after every 100 g (see Figure B.1).

B.2.1.2 **Measuring table**, with a pin and written scale.

NOTE Measuring table can be portable model: piece of wood (length about 300 mm, width 50 mm) having installed pin and “scale”.

The pin should be same kind and size as the pins in the device and the “Scale” should begin from the back side of the pin and there should be written 125 mm in correct point.

B.2.2 Procedure and an example

B.2.2.1 If the measuring table is portable, install it tight on its position.

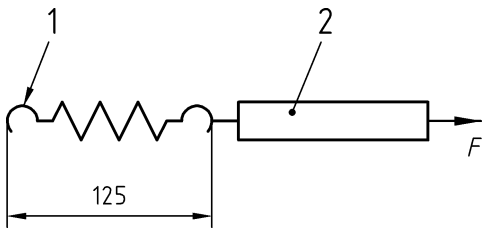
B.2.2.2 Set one spring hook on the pin and another spring hook is set on the hook of the balance.

B.2.2.3 Stretch the spring pulling the balance along the direction of the measuring table and scale. When the spring hook, connected to the balance hook, meets the 125 mm point on the measuring table, ensure that the length of spring is also 125 mm. Read the corresponding pulling force from the balance.

B.2.2.4 If the balance information is, for example, 3 800 g (3,8 kg), multiply it by the gravitational acceleration constant and obtain the spring force as 37,3 N.

NOTE If a dynamometer is used instead of balance, the information is given directly in Newton (N) (see Figure B.1).

Dimensions in millimetres



Key

1 pin

2 dynamometer

Figure B.1 — Measuring the spring force with dynamometer

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