BS EN 12697-49:2014

BSI Standards Publication

Bituminous mixtures — Test methods for hot mix asphalt

Part 49: Determination of friction after polishing

National foreword

This British Standard is the UK implementation of EN 12697-49:2014.

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

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Bituminous mixtures - Test methods for hot mix asphalt - Part 49: Determination of friction after polishing

Mélanges bitumineux - Méthodes d'essai pour mélange hydrocarboné à chaud - Partie 49: Détermination du coefficient de frottement après polissage

Asphalt - Prüfverfahren für Heißasphalt - Teil 49: Messung der Griffigkeit nach Polierung

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Foreword

This document (EN 12697-49:2014) 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of an identical text or by endorsement, at the latest by July 2014, and conflicting national standards shall be withdrawn at the latest by July 2014.

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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 for hot mix asphalt — 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 for hot mix asphalt — 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 for hot mix asphalt — 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 for hot mix asphalt — Part 35: Laboratory mixing*

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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*

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

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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 (Torque bond test — TBT, Shear bond test - SBT, Tensile Adhesion Test (TAT)*[1)]

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

prCEN/TS 12697-50, Bituminous mixtures — Test methods for hot mix asphalt — Part 50: Scuffing resistance of surface course[1)]

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1) In preparation.

1 Scope

This European Standard describes a test method to determine the friction at 60 km/h after polishing during a fixed number of passes on surfaces of bituminous mixtures samples.

The samples used are either produced in a laboratory or are cores taken from the site.

NOTE This procedure was previously known as Wehner and Schulze method (see [1]).

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

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

ISO 4662, *Rubber, vulcanized or thermoplastic — Determination of rebound resilience*

ISO 7619-1, *Rubber, vulcanized or thermoplastic — Determination of indentation hardness — Part 1: Durometer method (Shore hardness)*

3 Terms, definitions and symbols

3.1 Terms and definitions

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

3.1.1
pass
application of a single roller of the polishing head, a complete revolution of which is equivalent to three passes of the roller

3.2 Symbols

μ_{FAP} single result of friction

μ_{m} friction coefficient at 60 km/h

μ_{km} mean value of the control plate before and after the friction measurement

μ_{ref} known value of the Laboratory Skid Resistance of the control plate

FAP Friction After Polishing: average of two or more single results μ_{FAP}

Ø diameter in mm

4 Principle

The sample is polished and the friction force is determined. The device comprises a polishing station and a unit for measuring the friction. The polishing station, which is continuously supplied with a mixture of water and quartz powder, contains three polishing rollers that can be lowered and that move across the test surface at a predefined loading force.

In the friction measuring unit, a rotating measuring head is lowered onto the test surface while water is being added. The measuring head is fitted with three sliding blocks and can be declutched electronically. The moment generated by the contact between the rubber sliders and the surface is continuously measured and recorded until the measuring head comes to a standstill. The friction is subsequently calculated from the moment measured at 60 km/h.

5 Equipment

5.1 Test device

5.1.1 General

The test device consists of a unit to polish the sample, a specimen clamping system and a unit for measuring its friction.

5.1.2 Polishing unit

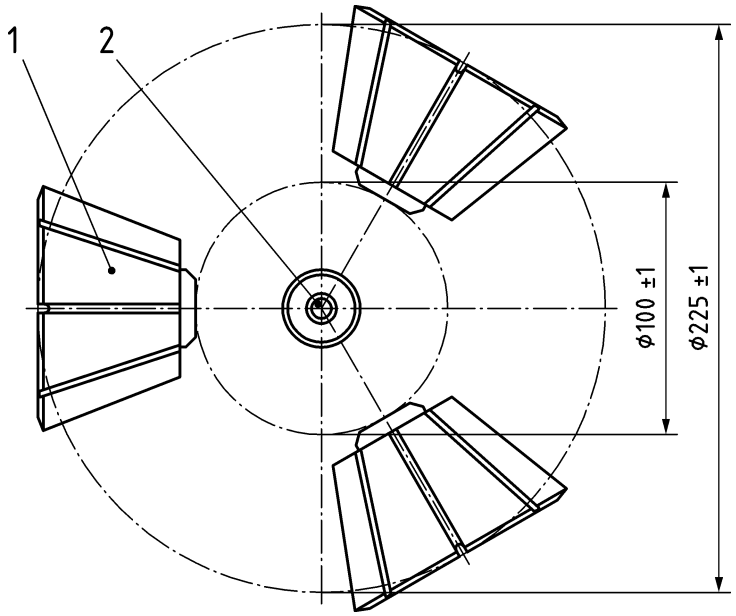
5.1.2.1 General

The polishing unit includes a polishing head with polishing rollers and a water-quartz powder mixture projection system.

5.1.2.2 Polishing head

A polishing head equipped with three polishing rollers as indicated on Figure 1, able to be lowered onto the test surface with loading force calibrated in static of (392 ± 3) N. The polishing head shall move on the surface of the specimen during the polishing procedure and rotate at a rotation speed of (500 ± 5) r/min.

Dimensions in millimetres



Key

1 polishing roller

2 water quartz powder projection device

Figure 1 — Polishing head (view from below)

5.1.2.3 Polishing rollers

The rollers, as shown in Figure 2, consist of a circular, cone-shaped metal carrier housing covered with an (8,5 ± 0,5) mm thick layer of rubber at the start of the test. Eight profile grooves with a depth of (4,5 ± 0,5) mm and a width of (3,5 ± 0,5) mm are cut into this rubber layer.

The polishing rollers shall have the following characteristics:

— diameter D_1: (36 ± 1) mm and D_2: (80 ± 1) mm;

— height H (56,3 ± 0,1) mm;

— shore hardness (65 ± 3) Shore A at a temperature of (23 ± 2)°C, according to ISO 7619-1.

Dimensions in millimetres

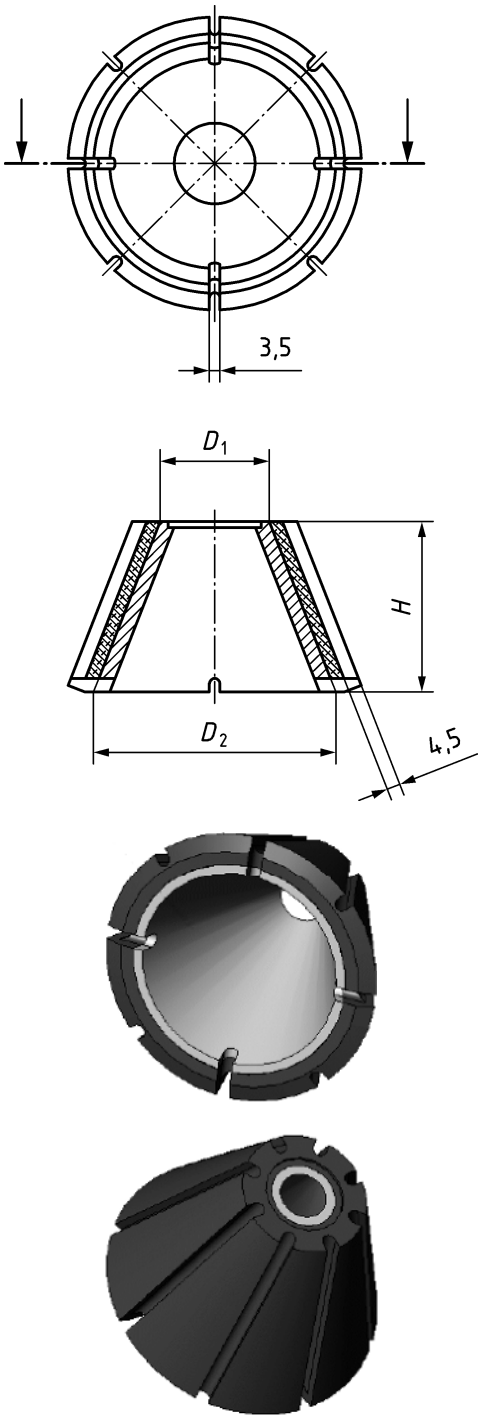


Figure 2 — Polishing rollers — 3D view, cross and longitudinal section

The friction in the bearings of the polishing rollers should be checked periodically according the following procedure:

The torque moment measured on a sample made with a fine aggregate 0,2/0,4 mm during 90 000 passes shall be constant to ± 10 % between 10 000 passes and 85 000 passes.

Any polishing rollers not used should be packed in film and stored in a dark place at a temperature of 4 °C to 10 °C.

When new polishing rollers have been fitted, they shall be conditioned using an (old) test sample and approximately 500 000 passes of the rollers in the polishing unit. The polishing rollers will only stabilise once they have been subject to this load.

The roller linings shall be exchanged, all three at the same time, when they are worn, when they feel sticky, when they show strong signs of rubber wear or when dark traces of wear appear on the test surfaces and at the latest after around 2 10^7 passes per roller.

5.1.2.4 Water-quartz-powder mixture projection device

The water-quartz-powder mixture projection device consists of:

a) A bin with a stirrer to keep the water-quartz-mixture homogenous.

b) A pump with a capacity of (5,0 ± 0,5) l/min to bring the water-quartz-powder mixture through the centre of the polishing head to the surface of the specimen while the polishing action is going on. The diameter of the gun shall be (8,0 ± 0,2) mm.

5.1.3 Specimen clamping system

At the bottom-plate a clamp which provides a proper fixation of the specimen with a diameter of at least 225 mm or parallelepiped samples with at least the following dimensions: 320 mm × 260 mm and a thickness of not more than 50 mm.

5.1.4 Friction measuring unit

5.1.4.1 General

The friction measuring device includes a declutching rotating head with three sliding blocks spaced at angles of (120 ± 5)°.

5.1.4.2 Rotating head

A rotating head equipped with three sliding blocks as indicated on Figure 3, able to reach at least a rotation speed of 50 r/s and to apply a static force of (253 ± 3) N.

The inertia moment of the rotating head shall be (3,4 ± 0,5) Nm.

Dimensions in millimetres

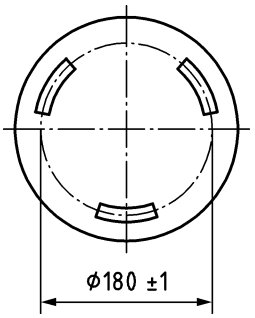


Figure 3 — Measuring head (view from below)

5.1.4.3 Moment measuring system

The unit shall be equipped with a system able to measure the moment to ± 1 Nm during the braking procedure.

5.1.4.4 Rotation speed measurement system

The rotating head shall be equipped with a system able to measure the speed of rotation to ± 2 r/s during the braking procedure.

5.1.4.5 Sliding blocks for friction measuring

The sliding blocks consist of a ring segment-shaped metal carrier with a clamping device to which a rubber lining with a thickness of (5 ± 1) mm has been applied.

The characteristics of a sliding block are as follows:

— width (14,5 ± 0,1) mm;

— average length (30 ± 1) mm of the flat surface in contact with the test specimen, measured as average of L_1, L_2 as indicated Figure 4;

— shore hardness (65 ± 3), Shore A at a temperature of (23 ± 2) °C according to ISO 7619-1.

The resilience of the slider rubber shall be verified using the criteria specified in Table 1.

Table 1 — Properties of the rubber of a sliding block

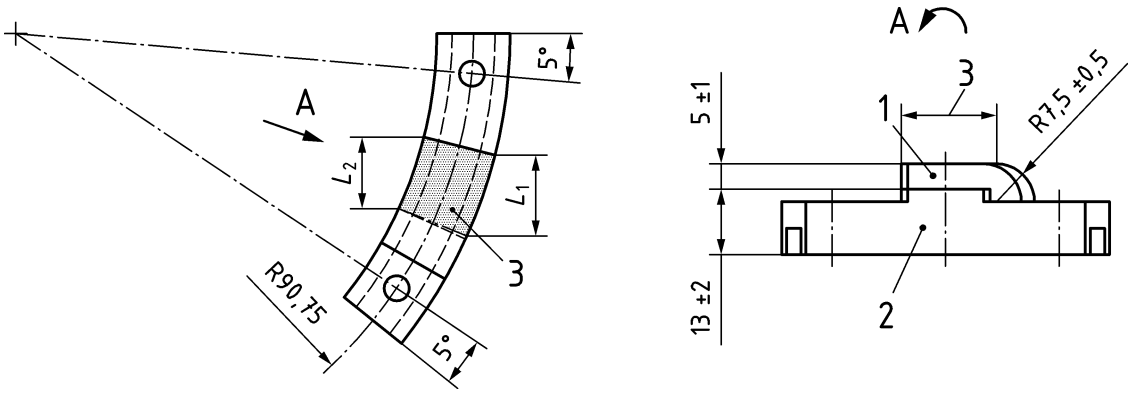
	Temperature				
	0 °C	**10 °C**	**20 °C**	**30 °C**	**40 °C**
Resilience (%)[a]	43 to 49	58 to 65	66 to 73	71 to 77	74 to 79
[a] Lüpke rebound test in accordance with ISO 4662.					

If it is necessary to verify the resilience of the rubber, it should be noted that the Lüpke rebound test is not suitable for testing rubber sheet. The test specified in ISO 4662 is a suitable alternative.

Store the sliding blocks and any sheet rubber in a dark place at a temperature of 4 °C to 10 °C for less than two years. Before each measurement, the sliding blocks shall be conditioned to room temperature. Record the date of first use of each sliding block.

If a sliding block is in use one year after the date of first use, either withdraw it from use or confirm that it continues to conform to the criteria specified in Table 1.

Dimensions in millimetres



Key

1 rubber lining

2 metallic base

3 contact surface for measuring the average length

Figure 4 — Shape of the rubber, Sliding block (plan view and cross section)

5.1.4.6 5.1.4.6 Water projection system

The friction measuring unit shall be equipped with a system able to spray water on the specimen with a flow volume of (20 ± 2) l/min when the measuring head is at the braking stage.

5.2 Glass-control plate

Glass control plate with a textured surface (ornamental wire glass 521 mm − 7 mm) with a friction μ_{ref}. μ_{ref} is the average of at least 50 measurements on the control plate, determined before the start of the test according to 7.3.1.

5.3 Sand-blasting-equipment

A sand blasting equipment for the preparation of the samples with a round nozzle of approximately 6,3 mm diameter, able to blast corundum 0,5/1 mm with a compressed air at a pressure of (6,0 ± 0,3) bar.

The distance between the nozzle and the specimen shall be (70 ± 5) mm and the angle between the compressed air direction and the surface of the specimen shall be approximately 75°.

6 Other materials

6.1 Quartz powder

The type of the Quartz-powder less than 0,063 mm is “Millisil W6” from Quarzwerke Frechen.[2)]

NOTE Address of Company: Quarzwerke Frechen, Hauptverwaltung Kaskadenweg 40, 50226 Frechen, Germany.

2) "Millisil W6 is the tradename of a product supplied by Quarzwerke Frechen. This information is given for the convenience of users of this European Standard and does not constitute an endorsement by CEN of the product named. Equivalent products may be used if they can be shown to lead to the same results.

6.2 Water quartz powder mixture

The water-quartz-powder mixture consists of a mixture of quartz powder < 0,063 mm of the “Millisil W6” and water at a mixing ratio of (60 ± 2) g quartz powder per litre of water.

6.3 Corundum

The sieve size of corundum shall be 0,5/1 mm, complying with the grading specified in Table 2.

Table 2 — Grading requirements for corundum

Sieve size mm	**Total passing** %
2,00	100
1,00	90 to 100
0,710	30 to 40
0,500	0 to 15
0,400	0 to 5
0,250	0 to 5

NOTE Corundum delivered by Baustoff-Prüfsysteme Wennigsen GmbH — Werner-von-Siemens-Str. 1, D-30974 Wennigsen — Germany has been shown to be suitable for the procedure.

7 Test method

7.1 Preparation of the specimens

7.1.1 Specimens prepared in the laboratory

Asphalt test specimens, produced in a laboratory, shall be prepared using a roller compactor in accordance with EN 12697-33. The test specimens may either be used as plates or as a base for drill cores with a diameter ∅ of about 225 mm or parallelepiped specimens with the following approximate dimensions: 320 mm × 260 mm and a thickness of not more than 50 mm.

The specimens shall be stored on a plane support at a temperature of (5 ± 3) °C during at least 120 min.

The surface of the specimens shall be dried by blowing air over them.

Sandblast each elementary area of the surfaces to be tested with the sand blast system. Any binder residue shall be removed from the asphalt surface. Care shall be taken that the surface is evenly sand-blasted and that the blasting period is comparable for all specimens of the same series. A sand blasting period of (120 ± 10) s on each area has been shown to be suitable.

Store the specimens at room-temperature on a plane rigid support with the surface for testing upwards.

7.1.2 Specimens taken from the site

Drill cores shall be removed according to EN 12697-27. The diameter of the drill cores shall be at least 225 mm and compatible with the clamping device. When drilling and removing the drill cores from the drill hole, care shall be taken that the surface and especially the edges are not damaged, as any chipping can adversely affect the results. Damaged areas shall not be part of tested areas.

The test specimen should have a height of around 50 mm to enable it to be mounted properly in the clamping device. The lower part of the drill core that is too high shall be sawn off and discarded.

Drill cores taken from roads that have been subject to traffic for extended periods usually do not require preliminary treatment by sand-blasting.

Store the specimen at room-temperature with the surface for testing on a plane rigid support with the surface for testing upwards.

7.2 Polishing procedure

The polishing head with the polishing rollers and the clamping device shall be carefully cleaned to remove any quartz powder that may adhere to them. The roller bearings shall be checked for free movement and exchanged when movement becomes difficult or when there is friction in the bearings.

The rollers shall comply with the requirements in 5.1.2.3.

The water/quartz powder mixture may be contaminated by the wearing of the surface and the rubber lining of the roller. The mixture shall be checked before testing and replaced if necessary and at least after every five specimens or 500 000 passes.

The test specimen is horizontally fastened in the clamping device of the polishing unit.

The rotating head of the polishing unit is lowered to the surface of the specimen with a load of (392 ± 3) N. Make the water-quartz-powder mixture projection device work. The temperature of the water/quartz powder mixture shall not exceed 25 °C and shall be regularly checked during the polishing process.

The polishing action is carried out with a velocity of (500 ± 5) r/min.

Stop the polishing action after 90 000 passes and then carry out the procedure described in 7.3.2.

For other applications, the polishing procedure may be stopped at 4 500, 7 500, 15 000, 22 500, 30 000, 45 000, 135 000, 180 000, 225 000 and 270 000 passes and the procedure described in 7.3.2 should be applied after each stop. It shall be mentioned in the test report.

Clean the polishing-rollers and the specimen. Sediment should not be reused.

7.3 Friction measurement

7.3.1 Pre-test check of the measurement device

The sliding blocks shall be checked for possible damage before starting the test.

If the surface of the sliding blocks is worn or deformed (air bubbles, formation of points as a result of friction heat), the sliding blocks shall be exchanged. The set of sliding blocks shall be replaced when the rubber lining is 2 mm thick or less. The entire set of sliding blocks shall be exchanged at once.

The surface to be tested for friction shall be free from polishing agent residues and wear debris before measuring.

Before starting the test, the function of the measuring device shall be tested, using the glass control plate (5.2). The measuring result on the glass control plate shall not deviate from more than 10 % from μ_{ref}. If the result exceeds 10 %, the sliding blocks shall be exchanged.

7.3.2 Friction test

The sliding blocks are first accelerated to a rotation speed of (100 ± 5) km/h while still running freely.

The water projection device shall be working with a water temperature within 8 °C and 16 °C during the braking stage.

The measuring head is lowered to apply a static force of (253 ± 3) N onto the wet surface and left there until they have come to a complete stop.

The moment *M* is recorded to ± 1 Nm over the entire speed range until the blocks have come to a complete stop.

The control plate shall be tested. The measuring result on the control plate shall not deviate from more than 10 % in comparison with the initial measurement.

At least two surfaces/specimens shall be tested to obtain a FAP result.

8 Calculation and expression of the results

8.1 Friction force and friction coefficient

The friction force is calculated from the torque measurements and the friction coefficient is calculated by the ratio of the friction force to the vertical load using the formula:

$$\mu = \frac{M}{253 \times 0{,}9} \tag{1}$$

where

M is the measured moment, in Nm;

μ is the friction coefficient.

A graph of the friction coefficient μ is fitted on the measured points by a 6^{th} order polynomial fitting.

The mean value of the friction coefficient of the fitted graphs at 60 km/h shall be taken as the measuring result μ_m.

The measuring results obtained from the glass control plate before and after the friction measurement shall be averaged μ_{km}.

8.2 Determination of FAP

The friction μ_{FAP} for the specimen, corresponding to a control surface with a friction value of μ_{ref}, results in the following:

$$\mu_{FAP} = \mu_m - \mu_{km} + \mu_{ref} \tag{2}$$

The test result FAP is the average calculated from at least two individual measurements. If the difference between two individual results is greater than 0,03, the test is invalid and an additional specimen shall be tested. This additional result shall be averaged with the closer initial result. The result FAP is given to an accuracy of three digits after the comma.

9 Test report

With reference to this European Standard, the test report shall include the following information:

a) Name and address of the testing laboratory;

b) unique serial number for the test report;

c) name of the client;

d) description and an identification of the specimen, and the date of receipt or production;

e) results of pre-test check and post check of the measuring device with a glass-plate μ_{km}, μ_{ref};

f) single results of the specimens μ_{FAP} and the mean value FAP with two decimals after the comma;

g) the numbers of the rubber-sliders;

h) the date and time of the test;

i) signature of the person accepting technical responsibility for the test report;

j) that the test has been carried out according to this method.

10 Precision

Precision data on bituminous mixtures are specified in Table 3.

Table 3 — Precision data on bituminous mixtures

Type of bituminous mixture	FAP before polishing		FAP after 180 000 passes	
	Repeatability	Reproducibility	Repeatability	Reproducibility
BBTM	0,026	0,052	0,024	0,074
NOTE Data from experience in France 2010.				

Annex A
(informative)

Example of polishing head and friction unit

Key

1	polishing-head
2	friction-measuring r-head
3	polishing rollers
4	specimen mounted in the mould
5	water quartz powder projection device
6	slider blocks

Figure A.1 — Example of polishing head and skid resistance measuring device (Wehner and Schulze machine)

Bibliography

[1] Technical test specifications determining the grip development of surfaces by using the Wehner/Schulze test process (PWS); Road and Traffic Research Association, 2009 edition

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