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BSI Standards Publication

Bituminous mixtures — Test methods

Part 50: Resistance to scuffing

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National foreword

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CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels

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European foreword

This document (CEN/TS 12697-50:2016) has been prepared by Technical Committee CEN/TC 227 “Road materials”, the secretariat of which is held by DIN.

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1 Scope

This European Technical Specification specifies a test method for determining the resistance to scuffing of asphalt mixtures which are used in surface layers and are loaded with high shear stresses in road or airfield pavement. These shear stresses occur in the contact area between tyre and pavement surface and can be caused by cornering of the vehicle. Due to these shear stresses, material loss will occur at the surface of these layers. The test is normally performed on asphalt layers with a high amount of air voids (e.g. porous asphalt), but can also be applied on other asphaltic mixtures. Test specimens are used either produced in a laboratory or cut from the pavement.

NOTE The test is developed to determine the resistance to scuffing for noise reducing surface layers where raveling is the normative damage criterion. The test can also be performed on other surface mixtures with a high resistance to permanent deformation. In case a mixture has a low resistance to permanent deformation, rutting can occur during the test. This can influence the test results.

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

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

3 Principle

Laboratory compacted asphalt specimens or asphalt specimens cut from a pavement is fixed in a test facility. In this facility, the asphalt material is loaded simultaneously with both normal and shear stresses. Due to these stresses, material loss will occur from the surface of the slab. This material loss depends on the resistance to scuffing of the tested asphalt mixture: the higher the resistance, the less material will disappear.

To determine the resistance to scuffing, two slabs or (set of) cores shall be tested. The average of both test results is reported as the resistance to scuffing.

In this Technical Specification four different kinds of loading facilities are described:

— The ARTe (the Aachener Raveling Tester);

— The DSD (the Darmstadt Scuffing Device);

— The RSAT (the Rotating Surface Abrasion Test) and

— The Triboroute.

4 Terms, definitions, symbols and abbreviations

For the purposes of this document, the following term and definition, symbols and abbreviations apply.

4.1 Terms and definitions

4.1.1
material loss
amount of material that has been lost from the surface of the slab due to the test

Note 1 to entry: The amount of material loss can be determined in 3 different ways:

— Visually and/or by taking pictures;

— by weighing the mass of the slab before and after the test. The difference in mass per area is a measure for the resistance to scuffing of the tested asphalt mixture;

— by scanning the surface of the slab before and after the test. The scans provide a 3D picture from the surface of the slab. After subtracting mathematically the 3D picture after the test from the one before the test, an accurate 3D overview of the material loss can be generated. The calculated volume of this 3D overview of the material loss is a accurate value for the resistance to scuffing of the tested asphalt mixture.

Note 2 to entry: If permanent deformation occurs during the test, the results of the surface scan have to be compensated for this phenomenon.

4.2 Symbols and abbreviations

T is the thickness of the slab, in 0,1 mm;

W is the width of the slab, in 0,1 mm;

L is the length of the slab, in 0,1 mm;

A is the surface of the tested slab, in 0,01 mm^2;

M_0 is the mass of the slab before performing the test, in 1 grams;

M_1 is the mass of the slab after performing the test, in 1 grams;

ΔM is the loss of mass due to performing the test, in 1 grams;

V_0 is the volume of the texture of the slab before performing the test, in 0,1 mm^3;

V_1 is the volume of the texture of the slab after performing the test, in 0,1 mm^3;

ΔV is the loss of volume of the texture of the slab due to performing the test, in 0,1 mm^3.

5 Preparation of test specimens

5.1 General

To determine the resistance to scuffing of an asphalt mixture, 2 slabs or 2 (sets of) cores of that material shall be tested. The average of both test results shall be considered to determine the resistance to scuffing.

5.2 Compaction of the slabs

In the scuffing device, asphalt slabs or (sets of) cores shall be tested. These slabs or (sets of) cores shall be prepared according to EN 12697-33 or can be cut from pavements.

5.3 Dimensions of the specimens

The test can be performed on specimens with various dimensions. However, standard dimensions of the slabs are (500 ± 20) mm by (500 ± 20) mm or (500 ± 20) mm by (320 ± 20) mm. Cores shall have a standard diameter of (150 ± 2) mm. The thickness of the specimen can vary between 30 mm and 80 mm.

NOTE Also larger slabs or cores can be prepared which are fit to the correct dimensions by sawing.

5.4 Age of the specimens

Prior to the start of testing, the specimen shall be stored on a flat surface at a temperature of not more than 20 °C for between 14 days and 42 days from the time of their manufacture. In the case of samples requiring cutting, the cutting shall be performed no more than 8 days after compaction of the asphalt. The time of manufacture for these samples is the time when they are cut.

NOTE Not only fresh asphalt mixtures can be tested, also aged specimens can be examined in the scuffing test. In literature several aging procedure can be found. The choice of a proper aging procedure depends on the characteristics of the tested material.

5.5 Dimensions and bulk density of the specimens

The dimensions of the slab shall be determined according to EN 12697-29. The length, L, and width, W, of the slab are measured at four positions of the slab, equally divided over the area. The accuracy of the measurements shall be 0,1 mm. The average of the four individual measurements are respective the length, L, and width, W, of the slab.

The thickness, T, of the slab shall be determined at eight points. Each point shall be taken 100 mm from the edge of the slab using a vernier calliper. All eight point shall be equally divided over the surface of the slab. The accuracy of each measurement shall be 0,1 mm. The maximum difference between the eight individual measurements shall be 2,5 mm. If not, the specimen shall not be tested. The average of the eight measurements is the thickness, T, of the slab.

If cores are tested, the diameter and thickness of each core shall be determined according to EN 12697-29 using a vernier calliper. The diameter, D, and the thickness, T, are measured at four positions of the slab, equally divided over the area. The accuracy of the measurements shall be 0,1 mm. The average of the four individual measurements shall be deemed to be the diameter of the core.

The bulk density of the slab or the core shall be determined according to EN 12697-6 using the bulk density by dimensions procedure. Before measuring the mass, M_0, of the slab, the specimen shall be dried to constant mass in air at a relative air humidity of less than 80 % at a temperature not more than 20 °C. A test specimen shall be considered to be dry after at least 8 h drying time and when two weighings performed minimum 4 h apart differ by less than 0,1 %.

6 Loading devices

The resistance to scuffing can be determined using one of the following test devices:

— The ARTe (the Aachener Raveling Tester) see Annex A;

— The DSD (the Darmstadt Scuffing Device) see Annex B;

— The RSAT (the Rotating Surface Abrasion Test) see Annex C and

— The Triboroute see Annex D.

7 Test results

The results of the tests shall be reported using the results of the visual inspection and/or pictures before and after the test and the material loss per covered area (= *MLpA*). Alternatively, the increase in texture per covered area, ΔV, can be used. The following formulae shall be used:

— Material loss per covered area *MLpA* when slabs are tested determine by

$$MLpA_{\mathrm{i}} = \frac{M_{0,\mathrm{i}} - M_{1,\mathrm{i}}}{W_{\mathrm{i}} L_{\mathrm{i}}} = \frac{\Delta M_{\mathrm{i}}}{W_{\mathrm{i}} L_{\mathrm{i}}} \text{ with i = 1,2} \quad (1)$$

$$MLpA = \frac{\sum_{i=1}^{2} MLpA_{\mathrm{i}}}{2} \quad (2)$$

where

$M_{0,\mathrm{i}}$ is the mass of the slab i (i = 1,2) before performing the test, in 1 g (grams);

$M_{1,\mathrm{i}}$ is the mass of the slab i (i = 1,2) after performing the test, in 1 g (grams);

W_{i} is the width of the slab i (i = 1,2) in 0,1 mm (millimeter);

L_{i} is the length of the slab i (i = 1,2) in 0,1 mm (millimeter.

— Material loss per covered area *ML*p*A* when a (set of) cores are tested determine

$$MLpA_{\mathrm{i}} = \frac{M_{0,\mathrm{i}} - M_{1,\mathrm{i}}}{\frac{1}{4}\pi D_{\mathrm{i}}^{2}} = \frac{\Delta M_{\mathrm{i}}}{\frac{1}{4}\pi D_{\mathrm{i}}^{2}} \text{ with i = 1,2} \quad (3)$$

$$MLpA = \frac{\sum_{i=1}^{2} MLpA_{\mathrm{i}}}{2} \quad (4)$$

where

$M_{0,\mathrm{i}}$ is the mass of the (set of) core i (i = 1,2) before performing the test, in 1 g (grams);

$M_{1,\mathrm{i}}$ is the mass of the (set of) core i (i = 1,2) after performing the test, in 1 g (grams);

D_{i} is the diameter of the (set of) core i (i = 1,2) in 0,1 mm (millimetre).

— Increase in texture ΔV per covered area using 3D laser measurements when using slabs or (a set of) cores determine

$$\Delta V_{\mathrm{i}} = \frac{V_{1,\mathrm{i}} - V_{0,\mathrm{i}}}{W_{\mathrm{i}} L_{\mathrm{i}}} \text{ with i = 1,2} \quad (5)$$

$$\Delta V = \frac{\sum_{i=1}^{2} \Delta V_{\mathrm{i}}}{2} \quad (6)$$

where

$V_{0,\mathrm{i}}$ is the volume of the texture of the slab or (a set of) cores i (I = 1, 2) before performing the test, in

0,1 mm^3 (cubic millimetre);

$V_{1,i}$ is the volume of the texture of the slab or (a set of) cores i (I = 1, 2) after performing the test, in 0,1 mm^3 (cubic millimetre);

W_i is the width of the slab or (a set of) cores i (I = 1, 2) in 0,1 mm (millimetre);

L_i is the length of the slab or (a set of) cores i (I = 1, 2) in 0,1 mm (millimetre).

— Increase in texture ΔV per covered area using 3D laser measurements when using (a set of) cores determine

$$\Delta V_i = \frac{V_{1,i} - V_{0,i}}{\frac{1}{4}\pi D_i^2} \text{ with i = 1,2} \quad (7)$$

$$\Delta V = \frac{\sum_{i=1}^{2} \Delta V_i}{2} \quad (8)$$

where

$V_{0,i}$ is the volume of the texture of (a set of) cores i (I = 1, 2) before performing the test, in 0,1 mm^3 (cubic millimetre);

$V_{1,i}$ is the volume of the texture of (a set of) cores i (I = 1, 2) after performing the test, in 0,1 mm^3 (cubic millimetre);

D_i is the diameter of (a set of) cores i (i = 1,2) in 0,1 mm (millimetre).

NOTE Sometimes a substantial part of the scuffing occurs close to the edges of the slab or the core. This phenomenon especially occurs when course graded porous asphalt specimens are tested. In this situation, the increase in volume can be determined for a smaller area of the slab or core. If, for example, a slab of 500 mm by 500 mm shows excessive scuffing close to the edges, ΔV can be determined over an area of 400 mm by 400 mm, skipping the material loss which occurs in the outer strip with a width of 50 mm of the slab. It is essential to mention the considered area in the report.

8 Test report

8.1 General

The test report shall contain not less than the following information:

a) name of organisation carrying out the test;

b) date of the test;

c) reference to this test method and test conditions;

d) characterization and the origin (lab compacted slabs or cut from a pavement) of the tested material;

e) short description of the test facility.

For each specimen tested, report:

f) length, width and thickness of the tested slab, expressed to the nearest 0,1 mm;

g) results of the visual inspection of the surface of the slab before and after the test;

h) mass of the slab before, $M_{0,I}$, and after the test, $M_{1,i}$, expressed to the nearest 1 grams;

i) material loss per covered area $MLpA_{i}$, expressed to the nearest 1 g/mm^{2};

j) if available, the volume of the texture of the surface of the slab before, $V_{0,i}$ and after, $V_{1,I}$, the test in 0,1 mm^{3};

k) if available, the change in volume of the texture of the surface of the slab, ΔV_{i}, in 0,1 mm^{3}.

As an average of the two tested slabs per asphalt mixture:

l) general conclusion about material loss, based on the results of the visual inspection of both slabs;

m) average material loss per covered area, $ML\mathrm{p}A$, expressed to the nearest 1 g/mm^{2};

n) if available, the average change in volume of the texture of the surface of the slab, ΔV, in 0,1 mm^{3}.

8.2 Precision

8.2.1 Repeatability

Currently, repeatability data are not yet available.

8.2.2 Reproducibility

The reproducibility for this test method has not been determined.

Annex A
(normative)

The ARTe

A.1 Equipment

A.1.1 General

In order to create high shear stresses on the surface of an asphalt slab, a special scuffing device shall be used. In this scuffing device, the slab is fixed in a slab fixation box and is moving forwards and backwards. This movement shall be created by mounting the slab and the slab fixation box on a lateral moving table, which is travelling for- and back-wards. During this movement, a set of two wheel tyres shall rotate over the loading table and the asphalt slab, creating large shear stresses due to the combination of the lateral movement of the table and the rotation of the wheel set.

NOTE An example of the test facility is given in Figure A.1 and an overview is shown in Figure A.2.

A.1.2 Lateral moving table

The lateral moving table shall consist of a loading frame on wheels which travels over a fixed distance using rails. By using rails, the table shall move only in one direction.

On the loading frame, on both sides of the specimen, a horizontal surface shall be created. Together with the slab fixation box and the surface of the slab, a horizontal surface shall be created where the set of rotating wheels can move around without creating extra vertical dynamic forces due to jumping of the set of wheels.

The lateral movement of the table shall be realised by using, for example, a belt which is driven by an electro motor. The speed of the moving table does not need to be constant during the test, so acceleration and deceleration is possible. However, during the time the set of wheels is travelling over the slab, the speed of the loading table shall be (0,30 ± 0,03) m/s.

A.1.3 Set of rotating wheels

To create a set of rotating wheels, an electro motor with a vertical axis shall be mounted about mid-length of the rails on a loading frame. This frame shall consist of two vertical bars which are connected by a horizontal bar. The connection between the horizontal bar and the two vertical bars shall not be completely fixed.

NOTE 1 Vertical movement of the horizontal bar is allowed and even necessary to be sure that during the test the set of wheels are always in contact with the asphaltic slab, also when material loss occurs from the slab.

The vertical axis from the electro motor on the horizontal bar shall have a rotation speed of (47 ± 1) rpm. On the vertical axis, two smooth unprofiled PIARC test tyres shall be mounted.

NOTE 2 165 R 15 tyres are also used in the test devices mentioned in CEN/TS 13036-2; detailed information about this tyre can be found in [1].

The tyre pressure shall be (200 ± 10) kPa during the test. Both tyres shall rotate freely when the set of loading wheels does not touch the lateral moving table. The distance between the centre of both tyres shall be (460 ± 5) mm, giving the total area of the slab that will be loaded during the test.

The total mass of the horizontal bar, electro motor and set of rotating wheels shall be (250 ± 5) kg. To prevent any loss of vertical forces during the test, the vertical movement of the horizontal bar shall be as free as possible.

NOTE 3 An example of a cross section of the scuffing device with a set of rotating wheels is given in Figure A.3.

A.1.4 Slab fixation box

The slab shall be built in the lateral moving table in such a way that the surface of the slab and of the lateral moving table are in one horizontal plane.

NOTE 1 In this way, the variation of the vertical force due to jumping of the set of rotating wheels can be limited to acceptable values.

To accomplish the correct setting of the asphalt slab in the lateral moving table, the slab shall be fixed in a slab fixation box.

NOTE 2 To ease the fixation of the slab in the scuffing device, the slab fixation box can be taken from the lateral moving table. This box consists of a large squared bottom plate and four vertical plates. These plates are fixed together in such a way that an undeformable box arises.

NOTE 3 An example of a slab fixation box is given in Figure A.4.

The inner dimensions of the box shall be chosen in such a way that the asphalt slab fits easily in the inner volume of the box. The height of the box shall be chosen so that the surface of the slab fixation box and the lateral moving table are in one horizontal plane when the slab fixation box is built in in the lateral moving table.

To be able to test asphalt slabs with various thicknesses, the surface of the asphalt slab shall be in one horizontal plane with the surface of the lateral moving table. This positioning shall be accomplished by applying various metal and/or wooden plates with the same surface as the asphalt slab between the bottom of the slab fixation box and the slab.

At several points in the vertical walls of the slab fixation box, horizontal holes shall be drilled. These holes shall be provided with screw-threads and bolts. Between the inner walls of the slab fixation box and the asphalt slab, metal or wooden inlays shall be applied. By regularly tightening all screws, the asphalt slab shall be complete fixed in the slab fixation box. Attention shall be paid to the fact that the surface of the inlays between slab and slab fixation box is in one horizontal plane with the lateral moving table. All vertical planes of the asphalt slab shall be completely supported by the inlays. There shall be no gap between the asphalt slab and the inlays.

NOTE 4 For tests on dense graded asphalt mixtures, gypsum can be used to fix the slab in the slab fixation box.

A.1.5 Temperature controlled room

The temperature controlled room shall be ventilated and capable of allowing the temperature of the slab fixation box and the average temperature of the air draught at tens of centimetres from the slab to be fixed at a temperature of (20 ± 2) °C throughout the duration of the test.

A.1.6 Temperature measuring devices

During the test, the temperature of the slab and tyres shall be measured. These devices shall measure the temperatures with an accuracy of 1 °C.

NOTE Infra-red measuring devices can be used.

A.1.7 Electric fan (optional)

An electric fan can be used during the test to cool the slab and the tyres.

A.2 Test procedure

Before starting the test, the slab and the slab fixation box shall be in the temperature controlled room for at least 4 h. In this period, both slab and slab fixation box shall meet the requirements with respect to the test temperature of (20 ± 2) °C. During this acclimatisation period, the slab can be mounted in the slab fixation box. Before mounting the slab, the dimensions L, W and T and the mass M_0 of the slab shall be determined. The surface of the slab shall be inspected visually. During this visual inspection, at least one photo shall be taken of the total area of the slab and any irregularity of the surface shall be recorded. An alternative way is measuring the 3-dimensional texture of the slab surface by means of laser texture measurements. Based on these measurements, the volume V_0 of the texture shall be calculated.

After mounting the slab in the slab fixation box, the slab fixation box shall be mounted in the lateral moving table, making sure that the surface of the lateral moving table, the slab fixation box and the surface of the slab are in one plane. In this way, extra vertical forces due to bouncing of the set of rotating wheels shall be limited.

During the test, the lateral moving table travels 600 times forwards and backwards (so 600 times forward and 600 times backwards) over the slab. During that time, the wheels are rotating with (47 ± 1) rpm. After half the number of load repetitions, the slab fixation box shall be rotated 180° and the bolts in the slab fixation box shall be re-tightened.

NOTE 1 The rotation of the slab is necessary to be sure that the surface of the slab is equally loaded over the whole surface. If, for example, there is some misalignment in the set of rotating wheels or a small difference in tyre pressure, this influence on the ravelling process is eliminated.

After rotation of the slab halfway through the test, the test can be continued until the end.

Due to the high shear stresses in the contact area between tyre and slab surface, both slab and tyres will raise in temperature. The maximum allowed temperature of the slab during the test shall be 25 °C and the temperature of the slab shall never be lower than 18 °C.

NOTE 2 The temperature of the slab and the tyres can be controlled by using an electric fan.

After finishing the test, the slab shall be removed from the slab fixation box. Loose material shall be removed from the surface of the slab using a vacuum cleaner. The surface shall be inspected visually and any differences between the initial and end surface shall be reported. One or more pictures of the surface shall be taken. If available, the three-dimensional texture of the slab surface shall be measured. Based on these measurements, the volume V_1 of the texture of the slab after testing shall be calculated.

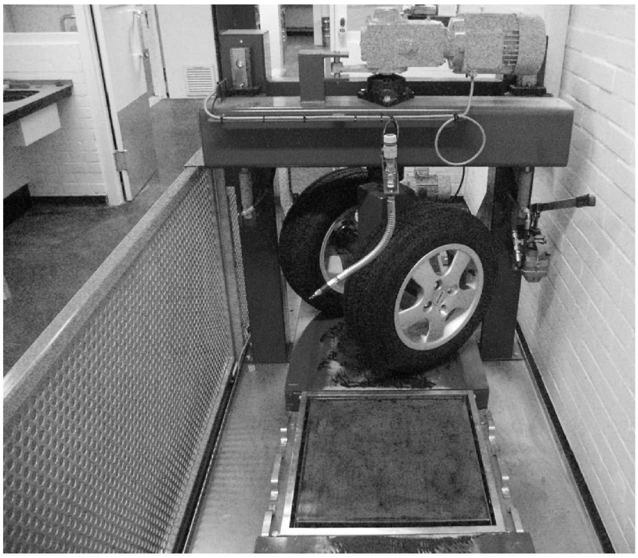


Figure A.1 — Example of the scuffing device

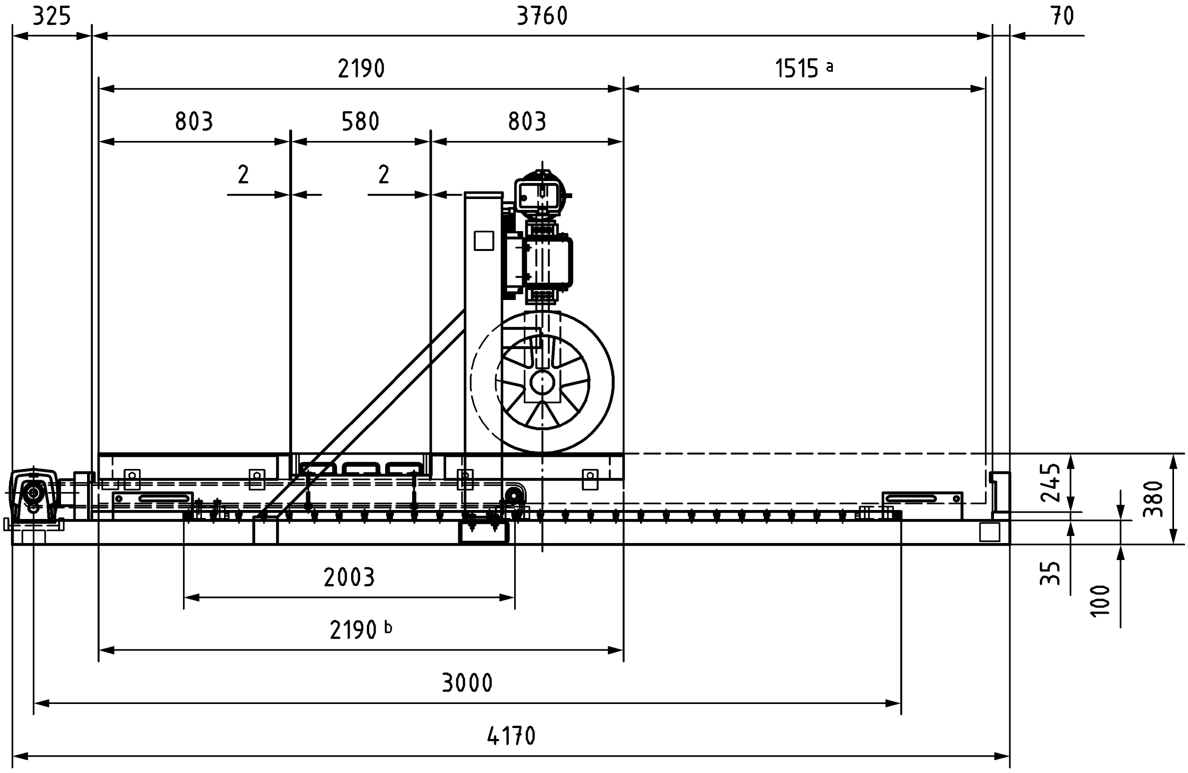


Figure A.2 — Example of a longitudinal view of the scuffing device with the lateral moving table in the left position (the slab fixation box is in the middle of this lateral moving table)

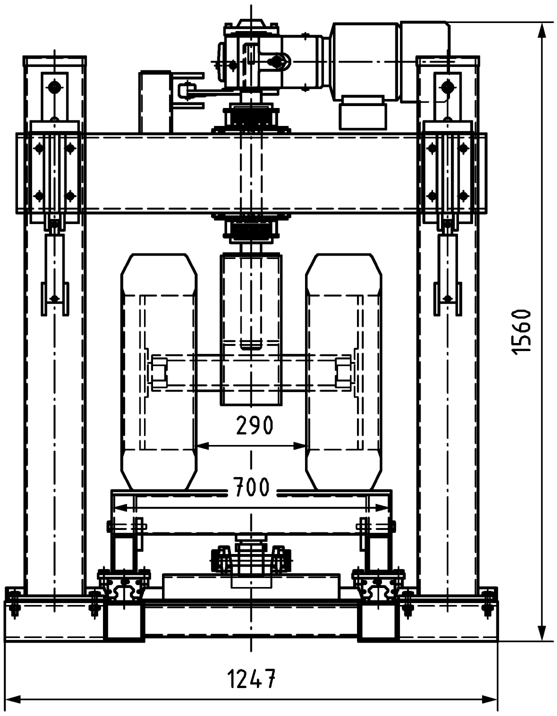


Figure A.3 — Example of the set of rotating wheels of the scuffing device

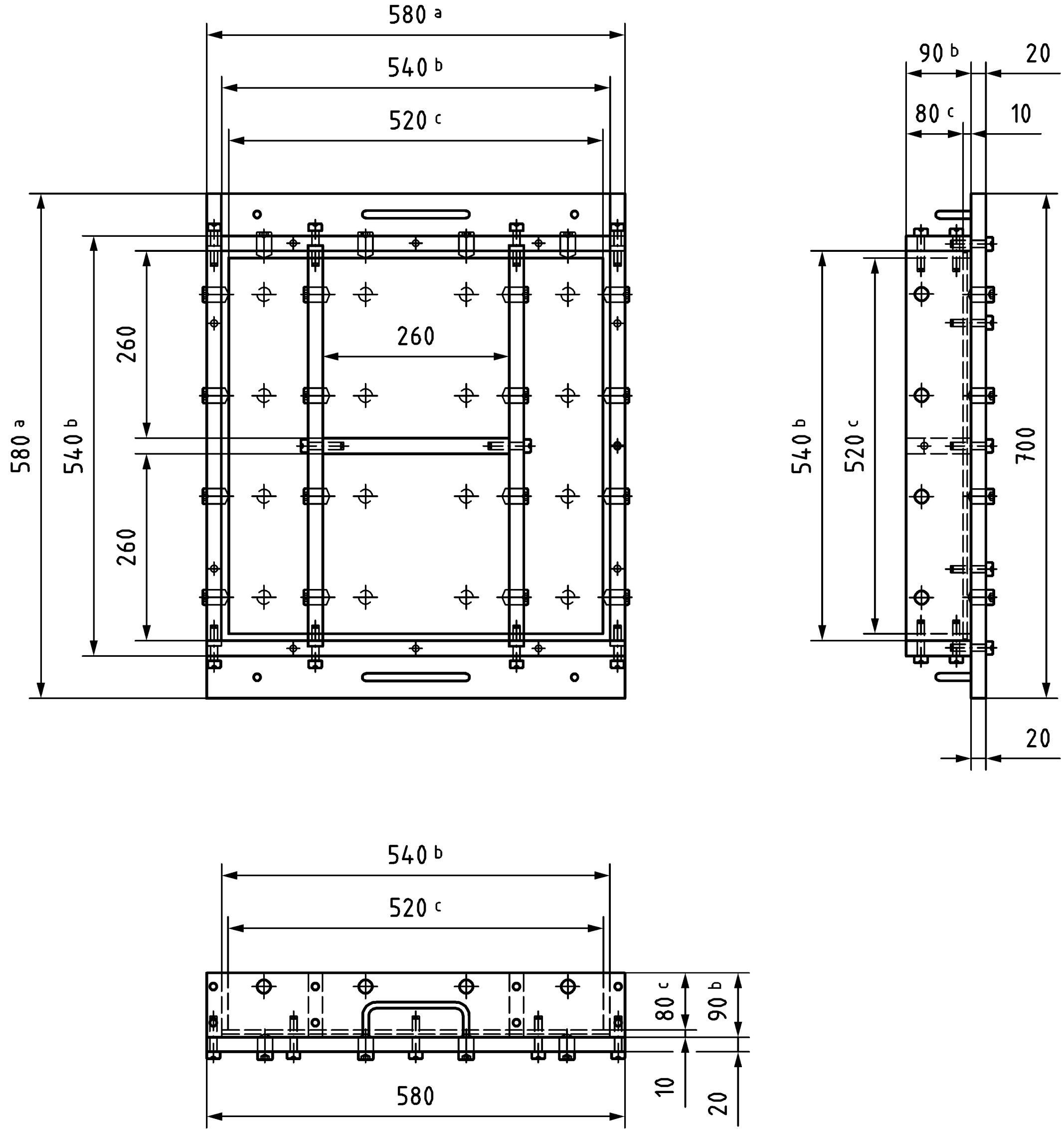


Figure A.4 — Example of the slab fixation box of the scuffing device

Annex B
(normative)

The Darmstadt device

B.1 Equipment

B.1.1 General

To determine shear stress resistance on asphalt surface courses, a special machine shall be applied. In this machine, the asphalt specimen shall be attached in a fixture oscillating 180 °, which shall be mounted on a horizontal table moving back and forth. During this movement, a test tyre under load shall be lowered onto the specimen.

NOTE Figure B.1 shows an example of such a machine. Figure B.2 shows a system drawing.

B.1.2 Lateral moving table

The horizontal table shall be guided by a rail through which the table is movable. Powered with an electric motor linked with the table via scotch yoke, the feed speed shall be held constant at 0,04 m/s during the test. The rail shall be fixed on a foundation via framework.

On top of the table there shall be a fixture for the specimen that is turning about the axis with an oscillating amplitude of 180°. Rotational angular velocity shall be kept at 5 turns per minute and can be applied through the same electric motor that powers the table.

B.1.3 Test tyre

The test tyre shall be a pneumatic tyre without tread (10*4.5-5, slick) mounted onto an axis held by a fork carriage and freely turnable.

NOTE The fork carriage can be held vertically by a pneumatic cylinder. This provides the possibility to apply load to the asphalt specimen through the test tyre.

Vertical load shall be chosen to apply a pressure of 0,25 N/mm^2. With the aforementioned tyre size, a vertical load of (1000 ± 10) N is necessary.

Tyre pressure shall be (300 ± 10) kPa.

The test tyre shall be fixed in place horizontally. Rolling movement and shear stress shall be exclusively from the back and forth movement of the table and the oscillating fixture under the surface tension of the test tyre.

B.1.4 Asphalt specimen fixture

The under B.1.3 aforementioned fixture shall hold an asphalt specimen of 260 mm by 260 mm, which is secured with adjustable screw. To avoid tension within the specimen, the screws shall be be tightened by hand.

B.1.5 Heating/temperature

Underneath the fixture a heating element shall be positioned, which heats the specimen during testing. An adjusted, constant room temperature shall not be used due to the short testing time. The heating element shall heat the specimen so that a surface temperature of (40 ± 1) °C can be measured throughout the whole test.

B.1.6 Vacuum wipe-off apparatus

The apparatus for vacuuming and wiping off the surfaces of tyre and asphalt specimen shall be positioned in such a way that loose grains can be removed. Shear stress applied through loose grains on the specimen or material sticking to the tyre has to be avoided.

For vacuuming, an industrial vacuum cleaner with 1800 W to 2500 W of power shall be used.

Optionally, the wiping off apparatus can be used to remove material from the slick tyre and can be implemented through some kind of broom.

B.1.7 Temperature measurements

Before and after testing the asphalt specimen, the surface temperature shall be measured with an accuracy of 1 °C. For this measurement, surface contact thermometers can be used. Additionally, the temperature of the fixture shall be monitored.

B.1.8 Oven

Before testing, the asphalt specimen shall be heated to (40 ± 1) °C in an oven or in the fixture.

B.2 Test procedure

Specimens shall have a standard size of (260 ± 5) mm by (260 ± 5) mm, to which the aforementioned specimens (with a size of 260 mm by 320 mm) shall be cut down. The usual thickness of the specimens shall be 40 mm. For cutting the specimens prepared in a laboratory, cutting shall not be only done from one side. On the long side (320 mm), 30 mm shall be cut off at each end. During testing, shear stresses shall be applied to the middle of the specimen on a circular plane with a diameter of about 200 mm.

Before testing starts, the asphalt specimens shall be photographed for later visual evaluation. The asphalt specimen shall be heated to (40 ± 1) °C. Heating shall be done in an oven, optionally heating can be done directly in the fixture of the testing machine. Heating time needed in the fixture is about 2,5 h to achieve a constant specimen temperature of (40 ± 1) °C throughout the whole testing period. The scuffing test shall only begin when surface temperature of the asphalt specimen is (40 ± 1) °C in at least 4 spots.

Before the scuffing test, the asphalt specimen shall be weighted. The specimen shall then be fixed in the fixture. Screws shall be tightened by hand so that the material of the asphalt specimen is not compressed.

After fixation, the test temperature (40 ± 1) °C and the number of double shear load cycles shall be established. The asphalt specimen shall be put under load by lowering the test tyre and applying (1,000 ± 10) N of pressure through the pneumatic pressure cylinder. When the targeted pressure is reached, the test shall be started.

NOTE 1 It is important to start testing directly when the pressure is reached to prevent unwanted deformation of the asphalt specimen.

Simultaneously to the movement of the table and the oscillating fixture, the vacuuming of lose grains takes place. Wiping off shall be done as required.

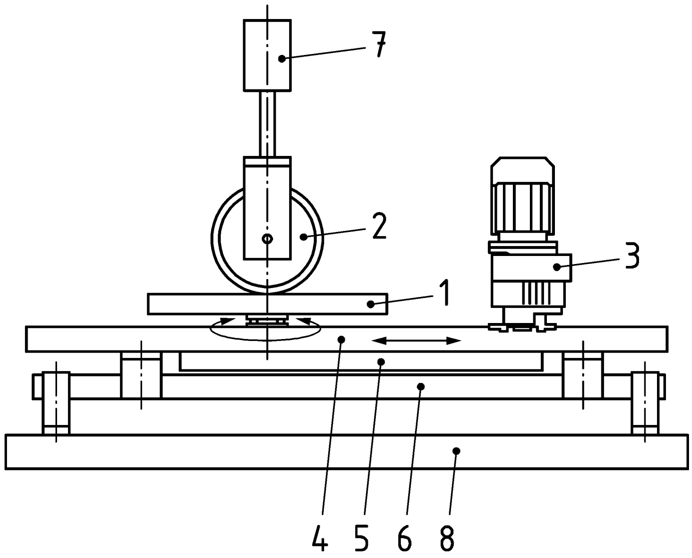
NOTE 2 It is extremely important to remove all lose grains from the surface of the asphalt specimen as this could lead to additional mechanical stress to the surface, whereby measurements could be obscured.

After finishing the specified double shear load cycles, the specimen shall be moved to its starting position. The tyre shall then be unloaded and raised. Residue and lose grains shall be removed from the asphalt specimen and the tyre.

Another photograph shall be taken for visual comparison with the first photograph.

NOTE 3 Experiments on specimens with water permeable asphalt showed that the duration of testing is strongly dependent on the type of bitumen used. On asphalt with relatively soft bitumen, grain loss appears very fast on the surface of asphalt specimens. Experiments with soft bitumen had to be quit after 10 double shear load cycles with a lot of mass loss. To determine a link between number of applied double shear load cycles and mass loss, it is advised to monitor mass loss after every second double shear load cycle.

Figure B.1 — Example of the Darmstadt Scuffing Device



Key

1	sample fixturing
2	test wheel
3	three-phase motor with front gear box
4	base plate
5	actuator
6	guide carriage
7	pressure cylinder (pneumatic)
8	supporting structure

Figure B.2 — System drawing of the Darmstadt Scuffing Device

Annex C
(informative)

The Rotating Surface Abrasion Test (RSAT)

C.1 General

The RSAT method was developed to reproduce the scuffing damage as it occurs on real life pavement roads. The basis was not only the damage as it occurs in cornering due to friction forces, but specifically the normal damage on straight road sections.

When a tyre load rolls over a road, the tyre tread is continuously deformed. This is the „flat-band" effect: the tread is normally curved and only the contact area of the tread with the road surface is flat. These deformations result in shear stress (transverse and lateral) in the contact area. Therefore, the load pattern on the road surface of a rolling tyre is a combination of shear and normal stresses in the contact area. These stresses cause fatigue effects in the asphalt surface and lead, in time, to aggregate loss from the pavement surface.

These stress components were modelled in the RSAT method. The relationship between these components in the development of the test was optimised by varying the vertical angle of the wheel, the wheel load and the rotating motion. At the end of the duration of the test of 24 h, the visual damage should resemble the damage of the pavement surface at the end of its real service life.

C.2 Equipment

C.2.1 Motion mechanism

The motion mechanism shall be in compliance with a standard wheel tracking device with sliding bearings, linear ball bearing such as SKF 102.0090.500 or equivalent. The motion of the wheel in relation to the test specimen shall be as shown in Figure C.1. The motion of the arm shall be constant, with the guiding arms playing a part in ensuring constancy. The rotation of the test specimen shall be caused by the turning forces of the tyre-road action. In order to stimulate the shear stresses, the slab shall be blocked in one direction by a brake.

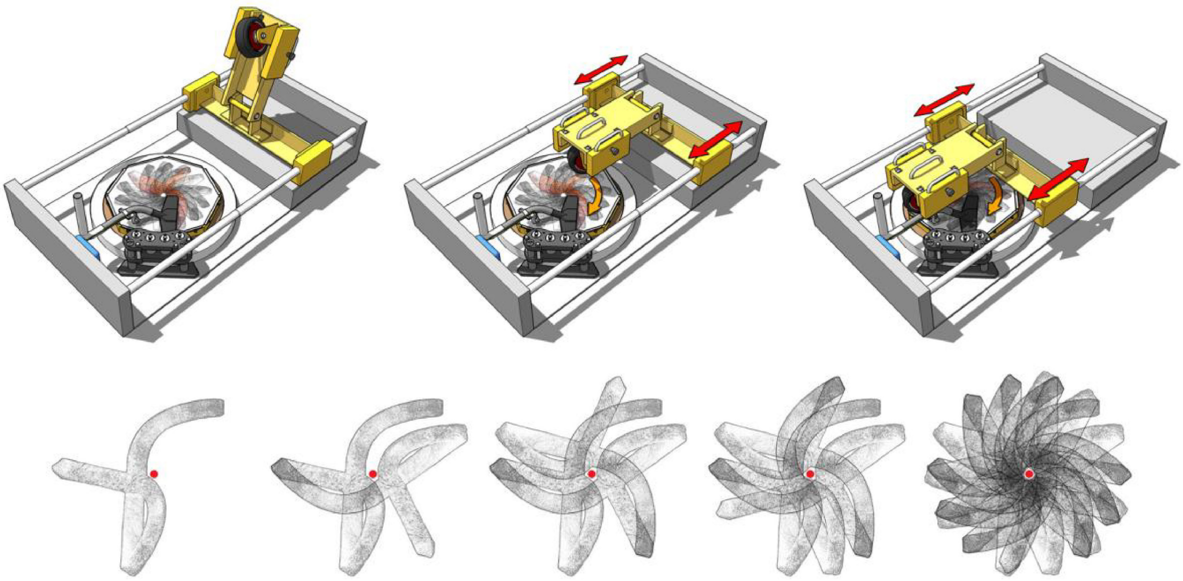


Figure C.1 — The RSAT

C.2.2 Test tyre

The wheel shall have a solid cast iron rim into which the rubber tyre is pressed. The tyre shall be made of solid rubber and have the following properties:

— Width (50 ± 2) mm;

— thickness (32 ± 2) mm;

— inner diameter 140 mm;

— outer diameter 200 mm;

— hardness 80 IRHD.

The hardness shall be measured with ISO 48.

C.2.3 Wheel load and contact pressure

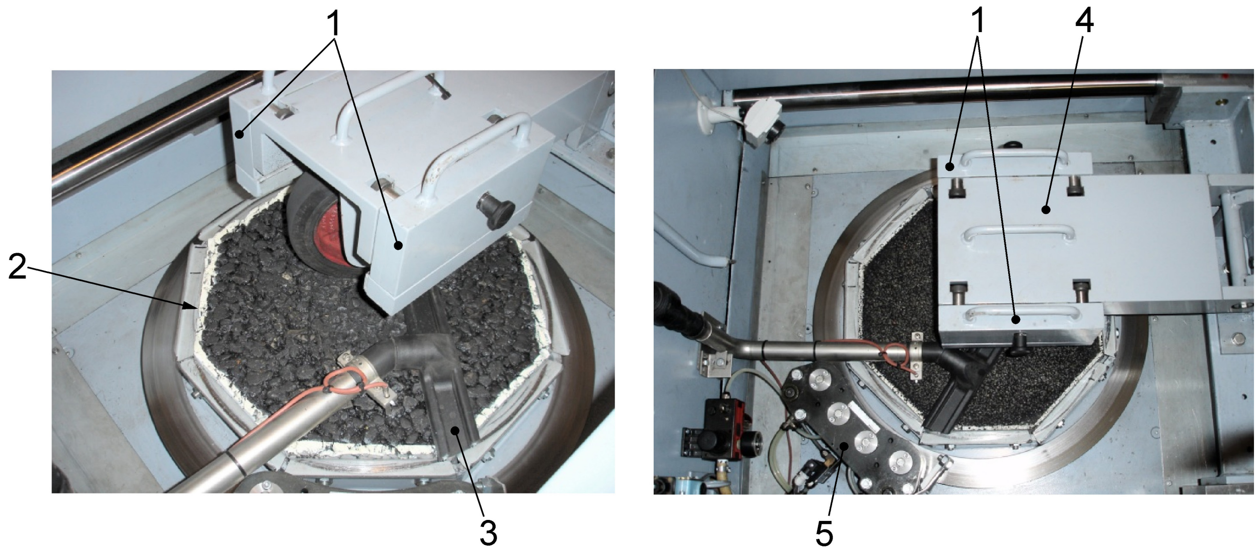
The mass on the wheel shall consist of the weight of the wheel and the wheel arm, plus an extra load on the wheel in the shape of two metal blocks. The total weight shall be (35,0 ± 0,1) kg.

The contact surface shall be checked by placing a loaded wheel on millimetre paper. The tyre shall be equipped with a medium that leaves an impression on the paper, which shall be repeatable several times. The contact surface area of the tyre shall be determined as the area that has been impressed, measured in square millimetres.

The contact pressure on the slab shall be the total mass divided by the contact area (loaded) of the tyre. The measured contact pressure shall be (0,60 ± 0,01) N/mm^2.n The contact pressure shall be in the same range as that of truck tyres. The contact area shall be chosen to keep the surface temperature by friction in control during the test. A temperature increase shall be limited to 2 °C.

C.2.4 Wheel arm guide

The wheel arm guide shall keep the wheel in the desired angle with the path of (33,7 ± 0,1)°. It shall also serve as a carrier to carry the extra load over onto the wheel (Figure C.2). It shall be attached to the main frame by means of a maintenance free bearing, rotation bearing.



Key

1 extra mass

2 slab holder

3 vacuum cleaner

4 wheel arm guide

5 braking mechanism

Figure C.2 — Wheel arm guide, wheel, weight and slab holder of RSAT equipment

C.2.5 Attachment of the wheel to the wheel arm

The attachment of the wheel shall be very precise so that the wheel is able to spin around without resistance. The attachment shall be by means of a maintenance-free bearing to the axle. The wheel shall be able to spin around without resistance and shall not have any slack horizontally or vertically.

C.2.6 Rotation hinge (wheel arm guide)

The rotation hinge shall secure the wheel horizontally relative to the slab holder. Vertically, the rotation hinge shall enable the wheel to follow the surface of test specimen freely when unloaded. The bearings in the rotation hinge shall be maintenance free.

C.2.7 Slab holder test specimen RSAT

The slab holder for the test specimen shall keep the test specimen in its place during the testing with the use of clamps and bolts.

NOTE This control is done to prevent the test specimen to move inside the slab holder while performing the test.

During testing, the force shall be controlled with a torque wrench. All bolts shall initially be tightened at 20 degrees, then tightened further with a specific torque with a force of 6 Nm.

The test specimen shall be placed on a rubber sheet with a thickness of 3 mm.

C.2.8 Bearing and rotary axle, consisting of a ring bearer

A ring bearing directly below the slab holder shall keep the slab constantly supported, free to rotate, and stable.

C.2.9 Braking mechanism

The braking mechanism to stop the return motion shall be a pneumatic brake, which is directly attached to the slab holder (Figure C.3). Two sensors attached to the guide arm activate the pneumatic break.

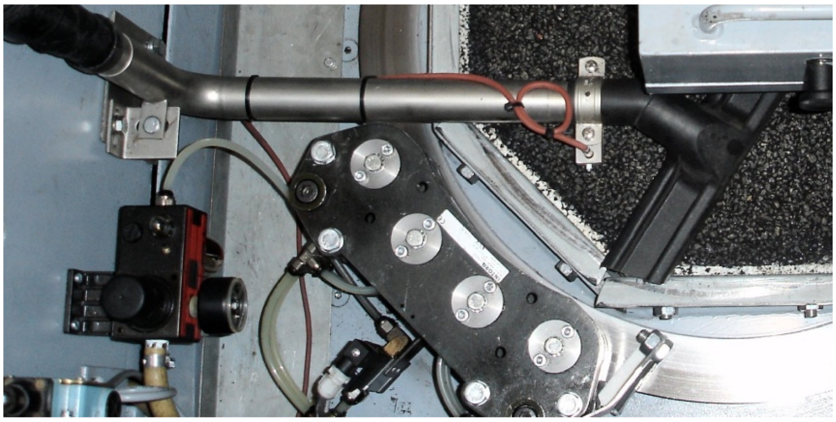


Figure C.3 — The pneumatic brake

C.2.10 Asphalt specimen fixture

Either slabs or cores can be tested.

The slab shall be an octagon shape. The length and width shall be approximately 500 mm × 500 mm. The thickness can vary between 30 mm and 60 mm.

Cores shall have a diameter of (150 ± 1 mm) and a height between 30 mm and 60 mm. Three cores can be tested in one test. The cores shall be fixed in an octagon shaped mould.

Figure C.4 — Two different RSAT plates, each with three cores

NOTE It is of great importance that the top of the cores lie exactly in the same plain or level of the surface of the wooden RSAT plate itself.

C.2.11 Vacuum wipe-off apparatus

The RSAT shall be equipped with a vacuum cleaner (Figure C.4). The suction nozzle of the vacuum cleaner shall be placed above the test specimen and shall be in operation constantly during the testing.

NOTE 1 The purpose of the vacuum cleaner is to collect the lose aggregates lost by the test specimen. It is extremely important to keep the specimen surface free from material (tyre rubber and minerals). This cleanliness will influence the results.

The air flow containing the extracted material (mineral aggregates and rubber powder) shall be led by a centrifugal separator. In this device, the mineral parts shall be separated by density from the rubber powder. The mineral shall be collected via an air slot every 5 min and weighed by a balance. The balance shall be connected to a computer so that the mineral loss of the test plate shall be recorded automatically during the test period of 24 h.

NOTE 2 Stone loss development over the duration of the test period gives information about the type of damage.

C.3 Test temperature

C.3.1 Heating/temperature

The test temperature shall be between (−10 ± 1) °C and (25 ± 1) °C. The standard test procedure is (20 ± 1) °C.

C.3.2 Temperature measurements

The test temperature shall be constantly monitored by placing the installation in a climate chamber and monitoring the temperature by means of two sensors placed on the top and on the bottom of the climate chamber. The surface temperature of the test specimen shall be constantly monitored with infra-red thermometer.

NOTE It is advised to keep the door of the climate chamber closed as much as possible. In order to check the process a camera need to be installed inside the climate chamber. Also, it is possible to check the correct testing procedure at all times without opening the climate chamber.

For the fabrication of the RSAT test specimen, a wooden mould shall be made according to the following sizes and specifications. The sizes of the mould are given in Figure C.5.

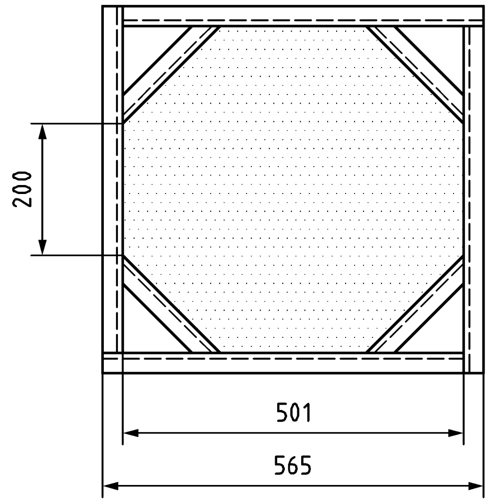


Figure C.5 —Schematically representation of the mould

The thickness of the specimen shall be 30 mm when an asphalt mixture with a maximum nominal aggregate size of 11 mm is tested; for mixtures with a maximum nominal aggregate size larger than 11 mm the specimen thickness shall be 45 mm.

The sides of the test specimen shall be parallel. After sawing, the test specimen shall be cleaned with compressed air to remove water and sand caused by the sawing.

The bottom of the mould shall be fabricated from plywood. In order to prevent sliding between the test specimen and the mould

— apply a coat of glue(epoxy) in the bottom of the mould;

— scatter a handful of uniform grained sand on the epoxy;

— remove excess (loose) sand;

— spray an adhesive bituminous layer to cover the sand.

After compaction, the test specimen shall cure for at least 14 days before testing.

Before starting the test, the slab shall be taped off at 5 mm from the edges. The edge exposed shall then be sprayed with road paint.

NOTE This prevents possible damage not caused by the test, from being measured.

The test specimen shall be mounted into the slab holder using the following procedure:

— The test specimen shall be placed at the right height. Where appropriate, the excess height can be filled out using plywood sheets;

— on top of the fill out sheets, a rubber mat of (5 ± 1) mm shall be attached;

— the test specimen shall be placed on top of this sheet;

— between the test specimen and the edge of the slab holder, steel plates shall be placed to keep the specimen in position (the centre of the test specimen shall correspond to the centre of the slab holder).

— the steel plates shall be pushed against the test specimen by adjusting bolts, to thoroughly enclose and secure the entire test specimen;

— all bolts shall be tightened at 20 degrees with a torque wrench. After that, the bolts shall be tightened again with a torque of 6 Nm.

— after the warming up procedure, all bolts shall be checked with a torque wrench to ensure that the test specimen is still enclosed by the steel plates.

After mounting of the specimen in the test facility, the specimen shall be stored for a period of 14 h to 18 h at testing temperatures.

A new wheel shall be used for each test. Before starting the test, the specimen shall be preloaded with the new wheel for a period of at least 1 h applying a minimum load of 20 kg. After this warming-up period, the specimen shall be completely cleaned by removing all loose aggregate parts and rubber powder. The removed material (stones and rubber from the wheel) caused by the warming up period shall not be included in the measurement of the scuffing damage. The vacuum cleaner shall be emptied before starting the test.

The standard test temperature shall be (20 ± 1)˚C.

NOTE Samples, cut from existing pavements, are often tested at (5 ± 1) ˚C.

The movement of the wheel over the specimen is presented in Figure C.1. One run shall be defined as a full rotation of the flywheel. During this full rotation, the wheel shall move forward and backward and forward again (up and down).

The total wheel load shall be (35,0 ± 0,1) kg. A total 86600 wheel runs In 24 h shall be applied on the specimen, equally divided over the length of the test. The test shall be stopped when too much damage occurs on the specimen.

During the test, all loose material shall be removed from the surface of the specimen using a vacuum cleaner. By separating mineral aggregates from the rubber (see C.2.11), the aggregate loss during the test shall be determined.

Annex D
(informative)

The TRD (TriboRoute Device)

D.1 Equipment

D.1.1 General

NOTE The device called a tribometer for road surfacing material named TriboRoute Device (acronym TRD) is a test bench with one perpendicular axe positioned on a stiff and heavy base.

The TRD shall be composed of: a braced vertical column supporting the load applicator and mounted on a classical hydraulic press, and a roller-mounted horizontal table. This table shall be able to accommodate a parallelepiped specimen (185 mm by 247 mm) or an in situ core sample up to 300 mm in diameter. The test of resistance to tangential forces shall consist of applying an average load that represents the loading of a truck tyre on the surfacing material. The sliding of tread rubber shall be obtained through the vertical displacement rate.

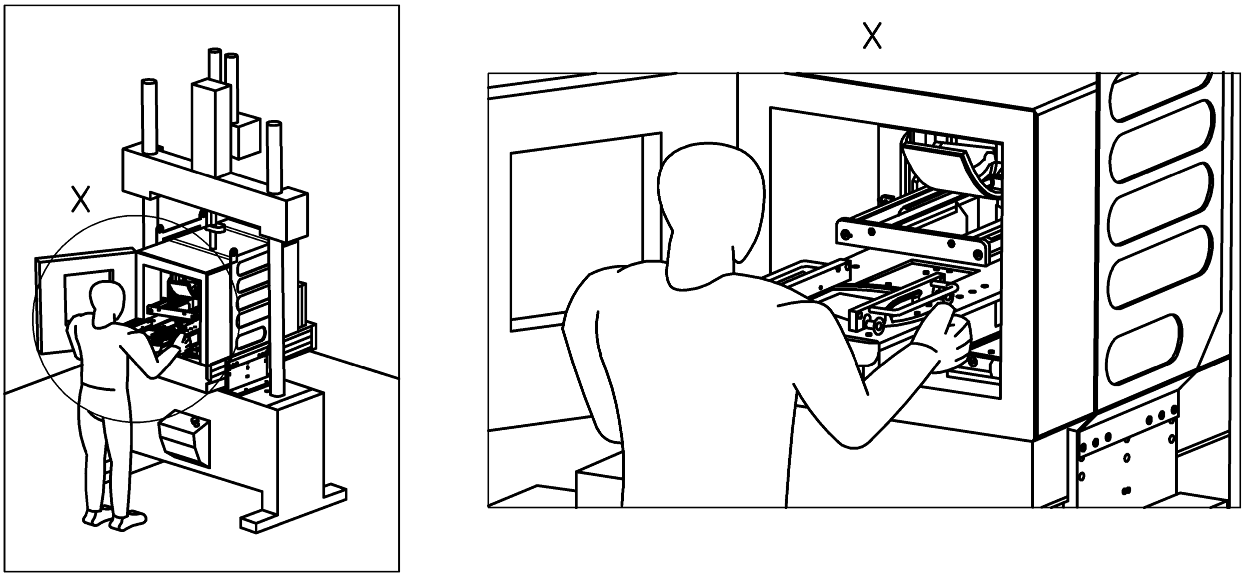
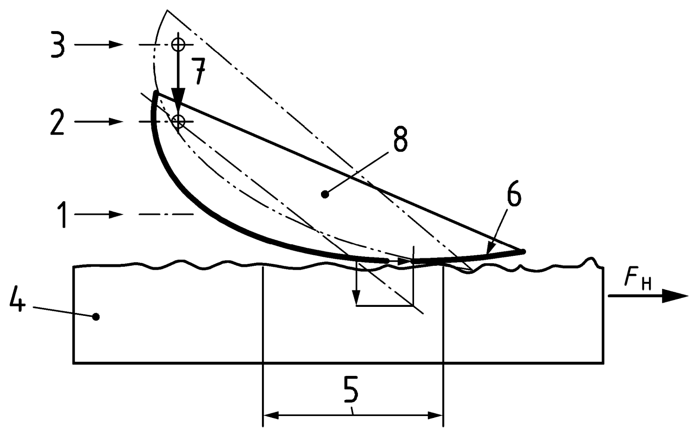


Figure D.1 — Example of the TRD mounted on a classical hydraulic press

D.1.2 Load applicator

The load applicator representing the tyre shall be a logarithmic shaped block (LSB) (Patent No. FR 06 50 054) with a width of 140 mm covered by an 8 mm thick rubber layer with rheological characteristics close to those of tyre treads. This rubber shall display diamond-shaped sculptures and its hardness at room temperature shall be approximately 68 Shore degrees. Its resistance to abrasion and wear shall not exceed 90 mm^3 in accordance with DIN 53516.



Key

1	lower position
2	current position
3	upper position
4	specimen (185 mm × 247 mm)
5	loaded zone
6	sculpted tire tread (68° Shore)
7	applied load (TriboRoute Device)
	a) TRD-CF sinusoidal force imposed $F_V = F_0 + \Delta \sin (w \cdot t)$
	b) TRD-CD monotonic displacement rate
8	logarithmic shaped block (LSB)
F_H	measured force

Figure D.2 — Principle of test using a logarithmic shaped block (LSB) as load applicator representing the tyre

D.1.3 Lateral moving table

The horizontal table shall be guided by a rail through which the table is movable. The table shall be equipped with an automatic system to monitor the mass loss of the specimen during the test. The table shall also be equipped with a force sensor placed at the end position of the rail. The horizontal force acting on the sample shall also be recorded throughout the test, providing information on the mechanical contact between the LSB and the surfacing material.

D.1.4 Asphalt specimen fixture

The specimen shall be verified as being dry prior to being positioned on the test bench.

NOTE This point becomes particularly important should the specimen have been stored in water, e.g. using EN 12697-12.

The next sequence shall consist of: inserting the specimen into the clamping device, firmly fastening it to the test bench table, and placing a thermocouple near the specimen surface.

D.1.5 Heating/temperature

The temperature of the enclosure shall be adjusted to match the test value and then the air temperature shall be monitored via the probe installed near the sample surface. The air temperature shall not vary by more than 2 °C either way of the designated test temperature. The specimen shall be packed at this precise temperature for 2 h to 3 h before undergoing the test. The specimen temperature shall be held at this specified test value, to within ± 2 °C.

D.1.6 Vacuum wipe-off apparatus

The apparatus for vacuuming and wiping off the surfaces of logarithmic shaped block and surface specimen shall be positioned in such a way that loose grains can be removed. Shear stress applied through loose grains on the specimen or material sticking to the LSB shall be avoided.

An industrial vacuum cleaner with 2500 W of power shall be used for vacuuming. As an option, the wiping-off apparatus shall be used to remove material from the slick tyre, implemented through some kind of broom.

D.2 Test procedure

D.2.1 Specimen preparation

Test samples shall originate either from the laboratory production of a 400 mm × 600 mm slab using a one- or two-pneumatic wheel compactor (EN 12697-33) or from a borehole core extracted onsite with a 300 mm diameter. Specimen thickness *T* shall not exceed 150 mm.

NOTE 1 A thickness between 50 mm and 100 mm is the advised dimension for these ravelling tests.

NOTE 2 All types of aggregates are capable of satisfying the needs specific to ravelling tests. Nonetheless, a few recommendations merit consideration at this point:

— The hardness of aggregates introduced should be guaranteed. In a study intended to evaluate the effect of bituminous binder for example, it is necessary to avoid working with softer rocks (i.e. soft limestone or other rocks displaying the slightest brittleness).

— As for requirements inherent in the scale effect specific to the loading surface, aggregate size *D* will be limited in the grading curve to 10 mm.

The specimen fabrication step shall follow the conventional laboratory methodology for asphalt mixtures. For a very thin asphalt concrete (VTAC), a high level of compaction shall be applied to the smooth cylinder in order to ensure surface flatness.

D.2.2 Control of the specimen surface characteristics

To carry out scuffing tests under adequate conditions, quality controls shall be performed on the sample surface obtained following compaction. As a preliminary step, it shall be verified that the surface is free of any greasy matter or other product capable of interfering with mechanical contact between the rubber pad and the target surface.

In order to ensure uniform contact with the sample surface and, hence, a uniform load distribution, plate surface flatness shall be inspected using a metal ruler fitted with a bubble level. The plate shall be positioned onto a rigid horizontal frame, on which the flatness condition of the upper plate surface shall be evaluated.

The variation in compactness shall be controlled by means of a gamma-densitometer according to the Technical Specification.

The macro-texture of the slab shall be verified so as to ensure its homogeneity. The occurrence of mastic disaggregation or uneven distribution shall be assessed visually. During this visual inspection, at least one photograph shall be taken of the total area of the slab and any irregularity of the surface shall be recorded. A more thorough examination may be conducted to quantify the texture level using either sand patch test or a laser profilometer.

NOTE Quantification of this texture level proves beneficial when comparing various plates manufactured using different aggregate sources.

D.2.3 Test performance

D.2.3.1 General

The TRD shall be used in controlled force or in imposed displacement rate.

a) For those textures whose average depth is more than 0,5 mm (EN 12697-1), the TRD shall be used in controlled force (TRD-CF).

b) For those textures whose average is less than or equal to 0,5 mm, the TriboRoute device shall be used in controlled displacement rate (TRD-CD). The controlled displacement rate offers another possibility to apply a tangential force to the specimen surface.

Before starting the test, the slab and the slab fixation box shall be in the temperature controlled room for at least 2 h. In this period, both slab and slab fixation box shall meet the requirements with respect to the test temperature of (20 ± 2) °C. During this conditioning period, the slab can be mounted in the slab fixation box. Before mounting the slab, the dimensions L, W and T and the mass M_0 of the slab shall be determined.

D.2.3.2 Test performed with controlled force (TRD-CF)

The test protocol shall comprise three phases, one of which concerns removing debris potentially produced during the loading steps [D.1]:

— The pre-loading phase:

The pad shall be placed into contact with the material surface by applying an imposed displacement and then driving the force higher in order to continue loading on the sample, until reaching the required average vertical force. The necessary attachment time shall average 40 s. Attachment conditions shall be correlated with the state of the material surface, as well as with contact material stiffness and test temperature.

— Cyclic loading phase:

Once the recommended limit has been reached, a sinusoidal loading shall be imposed with an amplitude set at 1/3 of the average force, so as to ensure that the pad is well attached (i.e. at a stable sliding speed and with as much friction as possible). The average vertical load shall then be set at 2500 N with an amplitude of 833 N to reproduce an apparent contact pressure equivalent to that generated by a truck with a loading frequency equal to 1 Hz. The LSB loads a surface of the specimen denoted A.

— LSB rising phase:

The LSB shall be returned to the upper position, which serves to free space roughly 15 mm underneath the LSB for the purpose of removing any stripped aggregates eventually present, using a using a vacuum cleaner. This phase shall last approximately 10 s. Once the surface has been cleaned, the test shall be repeated with the same cyclic contact force. This procedure, described with all three phases, shall then be repeated for the number of times necessary to obtain a specified degree of degradation. The cumulated number of cycles shall be limited to a maximum of 10000 cycles. This test shall be carried out on at least two specimens.

D.2.3.3 Test performed with controlled displacement rate (TRD-CD)

This test protocol shall be for a simple monotonic test which the displacement rate is fixed to 0,035 m/s. The test protocol shall comprise two phases, one of which concerns removing debris potentially produced during the loading step:

— Monotonic loading phase:
The LSB into contact with the material surface shall be moved by applying an imposed displacement rate. The resulting force shall be variable, adjusted until reaching the required average vertical force (2500 N). The vertical displacement rate shall be imposed until the lower position of the LSB.

— LSB rising phase:
The LSB shall be returned to the upper position, which serves to free space roughly 15 mm underneath the LSB for the purpose of removing any stripped aggregates eventually present, using the vacuum cleaner. Once the surface has been cleaned, the test shall be repeated with the same movement. This procedure, described here, shall then be repeated for the number of times necessary to obtain a specified degree of degradation. The cumulated number of cycles shall be limited to a maximum of 10000 cycles. This test shall be carried out on at least two specimens.

NOTE Experiments on specimens showed that the duration of testing is strongly dependent on the type of bitumen used [D.1]. On asphalt with relatively soft bitumen, grain loss appears very fast on the surface of the asphalt specimens. Experiments with soft bitumen had to be quit after 1500 cycles with a lot of mass loss. To determine a link between number of applied load cycles and mass loss, it is recommended to monitor mass loss after every 500 load cycle.

Bibliography

[1] PIARC Strategic Theme 1, C1 Committee: Surfaces characteristics. Technical document 'Specification for a standard test tyre for friction coefficient measurement of a pavement surface: Smooth test tyre (1)', March 2004, PIARC

[2] ROOT VIKTOR. 'Entwicklung eines Prüfverfahrens zur Beurteilung des Beurteilung des Widerstandes von Asphaltdeckschichten gegen Schubbeanspruchungen an der Oberfläche, Dissertation, Schriftenreihe des Instituts für Verkehrs', Technische Universität Darmstadt, 2008

[3] VAN BOCHOVE G.G. 'Porous asphalt (two-layered) — optimising and testing', E&E Congress 2000, Barcelona

[4] HARTJES J.M., VOSKUILEN J.L.M. *Classification of asphalt mixtures by means of the RSAT test*. CROW Infradagen, the Netherlands, 2008 [(in Dutch)]

[5] Hamlat S., Hammoum F., Hicher P-Y., Terrier J-P. (2007), 'Laboratory evaluation of the resistance to tangential forces of road surfacing materials', BLPC, n°267, April–June 2007, 49–60

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

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

[8] CEN/TS 13036-2, *Road and airfield surface characteristics — Test methods — Part 2: Assessment of the skid resistance of a road pavement surface by the use of dynamic measuring systems*

[9] ISO 48, *Rubber, vulcanized or thermoplastic — Determination of hardness (hardness between 10 IRHD and 100 IRHD)*

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