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Bituminous mixtures - Test methods - Part 51: Surface shear strength test

Asphalt - Prüfverfahren - Teil 51: Scherfestigkeitsprüfung für Asphaltdecken

Mélanges bitumineux - Méthodes d'essai - Partie 51: Essai de résistance de liaison au cisaillement

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Asphalt - Prüfverfahren - Teil 51: Scherfestigkeitsprüfung für Asphaltdecken

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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Foreword

This document (FprCEN/TS 12697-51:2014) has been prepared by Technical Committee CEN/TC 227 “Road materials”, the secretariat of which is held by DIN.

This document is currently submitted to the Formal Vote.

1 Scope

This Technical Specification describes a test method for measuring the surface shear strength for airfield surface courses, which is a measure of the robustness of asphalt surface courses against shearing. The surface shear strength will depend on the depth of the surface course together with the properties of the surface course material. The binder course material and any bonding agent applied between the two layers may have an influence on the test result for, in particular, ultra-thin surface course.

NOTE The test was designed for use on airfield runways and taxiways.

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*

3 Terms and definitions

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

3.1
surface shear strength
torsional strength around the circumference of loading within the surface course and, possibly, a combination of the rotational shear strength between layers of an asphalt pavement and the torsional strength around the circumference of loading within the binder course

Note 1 to entry: The surface shear strength will depend on the thickness of the surface course together with the properties of the surface course material, the binder course material and any bonding agent applied between the two layers.

Note 2 to entry: The depth of the surface course will determine the extent to which the test measures the rotational shear strength between layers of an asphalt pavement or the torsional strength around the circumference of loading within the surface course. The greater the thickness, the less the test will measure rotational shear strength between layers.

Note 3 to entry: If the thickness of the surface course is sufficiently shallow and the torsional strength of the binder course is sufficiently less than that of the surface course, the failure plane could go through the binder course.

3.2
surface course
top layer of an asphalt pavement

3.3
binder course
layer below the surface course, irrespective of whether it was originally intended to be the binder course and whether or not it is an asphalt layer

4 Principle

A 100 mm diameter plate is bonded to the surface course and rotated using a torque meter to determine the torsional strength of the top layer and, in the case of ultra-thin surface courses, the rotational shear strength between layers. The test can be carried out either *in situ* or in the laboratory using a nominal 200 mm

diameter core which may be subjected to curing conditions. The *in situ* test is done without the necessity to core into the substrate. A curing procedure can be used to assess the effect of moisture in the development of surface shear strength with time.

5 Apparatus

5.1 Torque meter, fitted with a reading gauge that indicates the maximum torque obtained. The device shall be calibrated over a range of 0 Nm to 350 Nm with a scale accurate and readable to at least 10 Nm. The device shall be fitted with a socket fitting allowing steel plates to be fitted and removed.

5.2 Metal plates, each having a diameter of (95 ± 5) mm and a thickness of (14 ± 2) mm. The plate shall incorporate a fitting enabling it to be couples to the torque meter.

NOTE 1 Mild steel has been found suitable for the plate.

NOTE 2 Fittings of 12,7 mm and 19,05 mm have been found to be suitable for the fitting.

5.3 Thermometer, capable of measuring temperatures from room temperature to 100 °C, readable to 0,1 °C and accurate to 0,5 °C.

5.4 Steel rule, readable to 1 mm.

5.5 Callipers, for measurement of the diameter of the metal plate, if necessary.

5.6 Watch or timer, accurate and readable to 1 s.

5.7 Adaptors and extension rods (optional).

5.8 Core cutting apparatus, suitable for cutting 200 m diameter cores in bituminous and cementitious materials (laboratory testing only).

NOTE Air cooled coring may be necessary for some mixtures.

5.9 Mould, for confining specimens (laboratory testing only).

5.10 Spirit level (laboratory testing only).

5.11 Oven or refrigerated incubator (laboratory testing and conditioning procedure only).

5.12 Water bath, of suitable size to accommodate at least one specimen and thermostatically controlled such that a temperature of (20 ± 0,5) °C can be maintained (conditioning procedure only).

6 Materials

6.1 Adhesive of sufficient stiffness to avoid failure within the adhesive or at the interfaces between the adhesive and the asphalt layers.

NOTE Rapid-setting epoxy resins have been found to be suitable. Polyester resins that are used for repair of a variety of materials have also been found suitable as adhesive.

6.2 Mounting material, such as rapid-hardening mortar, concrete or grout (laboratory testing only).

7 Procedure

7.1 Site

The location to be tested, either *in situ* or where cores are to be taken for laboratory testing, shall be visually uniform in texture and effectively free of detritus and oil deposits; if this is not the case, the visual appearance shall be recorded.

7.2 *In situ* procedure

7.2.1 Use the adhesive agent to secure the metal plate to the surface, taking care to ensure that the plate is parallel to the surface and that the adhesive coats its whole surface, excess being removed around the circumference. Three metal plates, placed within 1 m of each other and at least 100 mm apart, shall be tested at each location of testing.

The section area for testing and the number of tests within each section should be defined depending on the importance of the site in terms of traffic and use.

The tests may be carried out on a separate trial section or previous results may be acceptable as a type test.

7.2.2 When the adhesive has developed sufficient strength to avoid a failure occurring within the adhesive, fit the torque meter to the metal plate, using adaptors and extension rods as appropriate.

NOTE As a guide, resin adhesives are available that set sufficiently to be sanded after 20 min at 20 °C.

7.2.3 Record the temperature to ± 0,5 °C at approximately the interface between the adhesive and the surface course by drilling a hole of c.10 mm deep at the location of testing. The target temperature for carrying out the test shall be 20 °C.

7.2.4 Apply torque to the metal plate at a steady rate so that the torque wrench sweeps an angle at a rate of 90° within (30 ± 15) s measured by the watch or timer. Care shall be taken to ensure that the torque is applied parallel to the core surface to within ± 10°. Apply the torque to the plate until failure occurs or a torque of 400 Nm is exceeded.

7.2.5 Record the value of torque at failure, M, in Newton metres. Any interface that comes apart during the preparation or testing shall be noted.

7.2.6 Examine the material adhering to the metal plate and the resulting failure plane in the pavement and record

— the shape of the failure plane (conical, essentially horizontal, irregular etc.);

— the condition of the failure plane (smooth, planar, rough, etc.);

— the extent of the failure in the material surrounding the metal plate;

— the maximum depth of the failure plane below the top surface of the asphalt;

— the depth of the surface course, if the interface with the binder course is exposed;

— the surface course material type and maximum aggregate size;

— the binder course material type and maximum aggregate size, if exposed.

The failure at the surface sometimes occurs outside the area of the metal plate and should not be of concern because the effect is minimal.

7.3 Laboratory procedure

7.3.1 Cut six (with conditioning) or three (without conditioning) 200 mm diameter cores in accordance with EN 12697-27 from the location to be tested. The cores shall be at least the maximum of 50 mm and twice the surface course thickness in total depth. The coring machine and core cutter shall be such that there is minimal vibration.

7.3.2 The cores shall be removed carefully. Discard any cores that are damaged during removal if the damage impinges into the central 100 mm diameter area or the edge is damaged by at least 6 mm. Record any other damage.

The section area for testing and the number of cores taken within each section should be defined depending on the importance of the site in terms of traffic and use.

The tests may be carried out on cores from a separate trial section or previous results may be acceptable as a type test.

The core holes should be reinstated.

7.3.3 The cores shall be transferred to storage within 48 h and stored at a temperature of 0 °C to 5 °C.

NOTE 5 °C is generally used.

7.3.4 Examine each core and record

— the depth of the surface course;

— the surface course material type and maximum aggregate size;

— the binder course material type and maximum aggregate size.

7.3.5 If conditioning is required, divide the cores into two sets of three (dry and wet sub-sets) and condition each set in accordance with 7.3.12.

NOTE The surfacing material may have aged *in situ* between installation and testing. If the age of the surfacing is less than 2 years, it may be required that conditioning is used to “age” the core samples to equivalence of an *in situ* aged surfacing.

7.3.6 Trim the cores to a length suitable for mounting if appropriate.

7.3.7 Place core in the mould, using the mounting material as a bedding layer if appropriate, so that the upper layer and the bond interface to be tested is (20 ± 10) mm above the rim of the mould. Fill the mould with the mounting material and trim flush with the mould rim. Check that the core is perpendicular to, and the upper surface parallel with, the mould surface using the spirit level.

7.3.8 Use the adhesive to secure the metal plate to the surface of the core, taking care to ensure that the plate is parallel to the surface. Leave at ambient temperature until the adhesive has developed sufficient strength to avoid a failure occurring within the adhesive.

7.3.9 Store the mounted core at the selected temperature, either (35 ± 2) °C or (20 ± 2) °C, for at least 4 h. Start the test not less than 16 h from the assembly or conditioning to the start of the test. Record the storage time and temperature of test.

NOTE Testing at a temperature of (20 ± 2) °C is used for determining the early life surface shear strength when *in situ* testing within the first 48 h is not possible.

7.3.10 Fix or clamp the mould containing the mounted core to a suitably rigid horizontal surface. Fit the torque meter to the metal plate, using adaptors and extension rods as appropriate.

7.3.11 Apply torque to the metal plate at a steady rate so that the torque wrench sweeps an angle at a rate of 90° within (30 ± 15) s measured by the watch or timer. Care shall be taken to ensure that the torque is applied parallel to the core surface to within ± 10°. Apply the torque to the plate until failure occurs or a torque of 400 Nm is exceeded. The test shall be completed within 5 min of removal from storage.

7.3.12 Record the value of torque at failure, *M*, in Newton metres. Any interface that comes apart during preparation shall be noted.

7.3.13 Examine the material adhering to the metal plate and the resulting failure plane in the pavement and record

— the shape of the failure plane (conical, essentially horizontal, irregular etc.);

— the condition of the failure plane (smooth, planar, rough, etc.);

— the extent of the failure in the material surrounding the metal plate;

— the maximum depth of the failure plane below the top surface of the asphalt.

NOTE The failure at the surface sometimes occurs outside the area of the metal plate and should not be of concern because the effect is minimal.

7.3.14 Repeat 7.3.6 to 7.3.13 for each specimen.

7.4 Conditioning procedure

7.4.1 Store the prepared specimens of both the wet and dry subsets in an oven or refrigerated incubator at (20 ± 0,5) °C for (168 ± 2) h.

NOTE Other test temperatures can be used if reported as an exception.

7.4.2 Determine the surface shear strength (7.3.6 to 7.3.13) of just the dry subset samples at a temperature of (20 ± 0,5) °C after the conditioning time has elapsed.

7.4.3 Fully submerge the specimens of just the wet subset in a water bath previously conditioned at (20 ± 0,5) °C. After (168 ± 2) h, remove the specimens from the water bath, surface dry and determine their surface shear strength (7.3.6 to 7.3.13) at a temperature of (20 ± 0,5) °C.

8 Calculation and expression of results

8.1 Calculate the surface shear strength for each specimen using the following formula:

$$SBS = \frac{12 \times M \times 10^6}{\pi \times D^3} \quad (1)$$

where

SBS is the surface shear strength, in kilopascals (kPa);

M is the peak value of applied torque, in Newton metres (Nm);

D is the diameter of the metal plate, in millimetres (mm).