BRITISH STANDARD

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Bituminous mixtures — Test methods for hot mix asphalt —

Part 23: Determination of the indirect tensile strength of bituminous specimens

The European Standard EN 12697-23:2003 has the status of a British Standard

ICS 93.080.20

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British Standards

National foreword

This British Standard is the official English language version of EN 12697-23:2003.

The UK participation in its preparation was entrusted to Technical Committee B/510, Road materials, to Subcommittee B/510/1, Coated macadam and hot asphalt, which has the responsibility to:

— aid enquirers to understand the text;

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

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

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

Mélanges bitumineux - Méthodes d'essai pour enrobés à chaud - Partie 23: Détermination de la résistance à la traction indirecte des éprouvettes bitumineuses

Asphalt - Prüfverfahren für Heißasphalt - Teil 23: Bestimmung der indirekten Zugfestigkeit von Asphalt-Probekörpern

This European Standard was approved by CEN on 7 May 2003.

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Management Centre: rue de Stassart, 36 B-1050 Brussels

Contents

Foreword

This document (EN 12697-23:2003) 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of an identical text or by endorsement, at the latest by January 2004, and conflicting national standards shall be withdrawn at the latest by August 2005.

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 12697-9, *Bituminous mixtures — Test methods for hot mix asphalt — Part 9: Determination of the reference density.*

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

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

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

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.*

prEN 12697-16, *Bituminous mixtures — Test methods for hot mix asphalt — Part 16: Abrasion by studded tyres.*

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

prEN 12697-18, *Bituminous mixtures — Test methods for hot mix asphalt — Part 18: Binder drainage from porous asphalt.*

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

prEN 12697-20, *Bituminous mixtures — Test methods for hot mix asphalt — Part 20: Indentation using cube or marshall specimen.*

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

prEN 12697-22, *Bituminous mixtures — T est methods for hot mix asphalt — Part 22: Wheel tracking.*

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

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

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

prEN 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 methods for hot mix asphalt — Part 29: Determination of the dimensions of a bituminous specimen.*

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

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

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

prEN 12697-33, *Bituminous mixtures — Test methods for hot mix asphalt — Part 33: Specimen preparation slab compactor.*

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

prEN 12697-35, *Bituminous mixtures — Test methods for hot mix asphalt — Part 35: Laboratory mixing.*

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

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

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

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

prEN 12697-40, *Bituminous mixtures — Test methods for hot mix asphalt — Part 40: Void content, compaction and hydraulic conductivity of material in the layer.*

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

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

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

prEN 12697-44, *Bituminous mixtures — Test methods for hot mix asphalt — Part 44: Binder content of mixtures with modified binders.*

This European Standard forms a part of a series of tests for mechanical and physical properties of bituminous mixtures.

The applicability of this European Standard is described in the product standards for bituminous materials, prEN 13108.

It does not replace any existing European Standard.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Slovakia, Spain, Sweden, Switzerland and the United Kingdom.

1 Scope

This European Standard specifies a test method for determining the (splitting) indirect tensile strength of cylindrical specimens of bituminous mixtures.

NOTE Determination of the water sensitivity of bituminous specimens in accordance with prEN 12697-12 is based on determination of the indirect tensile strength in accordance with this test method.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

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

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

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

prEN 12697-30, *Bituminous mixtures – Test methods for hot mix asphalt – Part 30: Specimen preparation, impact compactor.*

prEN 12697-31*, Bituminous mixtures – Test methods for hot mix asphalt – Part 31: Specimen preparation gyratory compactor.*

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

prEN 12697-33, *Bituminous mixtures - Test methods for hot mix asphalt - Part 33: Specimen preparation slab compactor*

prEN 12697-34, *Bituminous mixtures – Test methods for hot mix asphalt – Part 34: Marshall test.*

3 Terms and definitions

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

3.1
indirect tensile strength, ITS
maximum (calculated) tensile stress applied to a cylindrical specimen loaded diametrically until break at the specified test temperature and speed of displacement of the compression testing machine

3.2
cylindrical specimen
laboratory-made (e.g. gyratory or impact-compacted) cylindrical moulded specimen or core taken from a bituminous layer or slab

3.3
precision
the closeness of agreement between independent test results obtained under stipulated conditions

NOTE 1 Precision depends only on the distribution of random errors and does not relate to the true value or the specified value.

NOTE 2 The measure of precision is usually expressed in terms of imprecision and computed as a standard deviation of the test results. Less precision is reflected by a larger standard deviation.

NOTE 3 "Independent test results" means results obtained in a manner not influenced by any previous result on the same or similar test object. Quantitative measures of precision depend critically on the stipulated conditions. Repeatability and reproducibility conditions are particular sets of extreme conditions.

3.4
repeatability
precision under repeatability conditions

3.5
repeatability conditions
conditions in which independent test results are obtained with the same method on identical test items in the same laboratory by the same operator using the same equipment within short intervals of time

3.6
repeatability limit
value less than or equal to which the absolute difference between two test results obtained under repeatability conditions may be expected to be within probability of 95 %

NOTE The symbol used for repeatability limit is r.

3.7
reproducibility
precision under reproducibility conditions

3.8
reproducibility conditions
conditions in which test results are obtained with the same method on identical test items in different laboratories with different operators using different equipment

3.9
reproducibility limit
value less than or equal to which the absolute difference between two test results obtained under reproducibility conditions may be expected to be with a probability of 95 %

NOTE The symbol used for reproducibility limit is R.

3.10
single test result
value obtained by applying the standard test method fully, once to a single specimen; it may be the mean of two or more observations or the result of a calculation from a set of observations as specified by the standardised test method

4 Principle

The cylindrical specimen to be tested is brought to the specified test temperature, placed in the compression testing machine between the loading strips, and loaded diametrically along the direction of the cylinder axis with a constant speed of displacement until it breaks. The indirect tensile strength is the maximum tensile stress calculated from the peak load applied at break and the dimensions of the specimen.

5 Apparatus

5.1 Compression testing machine

Compression testing machine, Marshall-type conforming to prEN 12697-34, or similar apparatus, having a recommended minimum capacity of 28 kN and capable of applying loads to test specimens at a constant rate of deformation of (50 ± 2) mm/min after a transitory period less than 20% of the loading time. The rate of deformation is to be maintained.

NOTE For testing at low standard temperature (5 °C), an ordinary 28 kN Marshall compression testing machine as described above may probably not be able to produce sufficient load, especially when 150 mm or 160 mm specimens are tested. In such cases, high-load 40 kN Marshall compression testing machines or other, more powerful types should be preferred. When testing 160 mm diameter modified asphalt specimens a load capacity up to as much as 320 kN may be required. However, when determining the indirect tensile strength at 25 °C as part of determining the water sensitivity of bituminous specimens in accordance with prEN 12697-12, the standard 28 kN Marshall compression testing machine may be sufficient. Compression testing machines with S-shaped load cell may be more prone to horizontal movements and therefore less suitable.

5.2 Testing head with loading strips

Testing head for indirect tensile strength test equipped with loading strips of hardened steel having a concave surface with a radius of curvature corresponding to the nominal radius of the specimen (see Figure 1).

Loading strips for testing of cylindrical specimens shall have a radius of curvature fitting the specimen under test and a width as shown in Table 1.

Table 1 — Loading strip width

	Dimensions mm		
Specimen diameter	100 ± 3	150 ± 3	160 ± 3
Loading strip width	12,7 ± 0,2	19,1 ± 0,2	20,0 ± 0,2

The loading strips shall have a length of at least the length of the specimen to be tested.

NOTE 1 It is recommended that the edges of the loading strips are rounded by grinding to remove the sharp edges in order not to cut the sample during testing.

NOTE 2 Exactly fitting loading strips may be obtained using the values in Table 2.

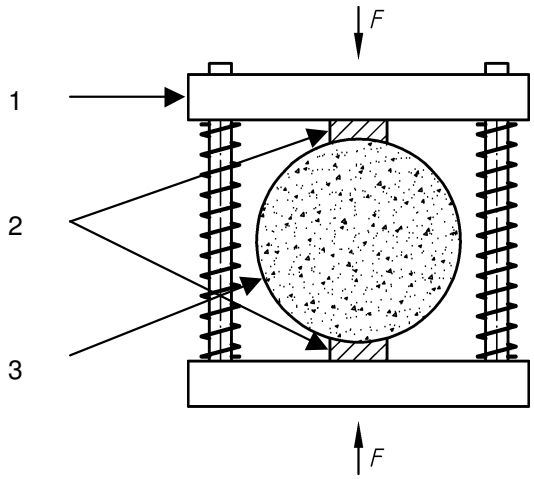
Table 2 — Dimensions of exactly fitted loading strips

Specimen diameter, D mm	Width of the loading strip, W mm	Maximum height difference at the curved side of the loading strip, h mm
100	12,7	0,40
150	19,1	0,61
160	20,0	0,63

Dimensions for the curved side are not exactly specified as narrow tolerances could require loading strip replacement after very few tests. As the importance of exactly fitting loading strips is not considered essential – and slightly larger curvature of loading strips may ease the specimen placement – the height difference values, h stated in Table 2 are only considered informative.

The upper testing head shall be guided to ensure a parallel movement of the loading strips.

NOTE 3 The upper head may be carried by a spring just capable of carrying the head to facilitate the handling of the device.



Key
1 Testing head
2 Loading strips
3 Specimen

Figure 1 — Testing head with loading strips and test specimen

5.3 Measuring device

Measuring device capable of determining load to an accuracy of ± 0,2 kN.

5.4 Water bath

Water bath, thermostatically controlled, or air chamber, capable of maintaining the selected test temperature with an accuracy of ± 1 °C in the vicinity of the sample.

NOTE The test temperature is selected according to 8.1.

5.5 Soft plastic bags

Soft plastic bags or other suitable devices for watertight protection of specimens (only required for water bath conditioning).

6 Sample preparation

6.1 Number of specimen

At least three specimens shall be prepared for each sample tested.

6.2 Dimensions of test specimen

The cylindrical test specimens shall have a diameter of (100 ± 3) mm, (150 ± 3) mm or (160 ± 3) mm. For 100 mm nominal diameter specimens, the maximum aggregate size of the bituminous mixture shall not exceed 22 mm. For 150 mm and 160 mm nominal diameter specimens the maximum aggregate size shall not exceed 40 mm. The specimens shall be cylindrical moulded specimens, laboratory-produced in accordance with prEN 12697-30, prEN 12697-31 or EN 12697-32, or cores taken from a bituminous slab produced in accordance with prEN 12697-33, or cores taken from a bituminous layer in accordance with EN 12697-27.

The specimens shall (unless otherwise specified) have a height of between 35 mm and 75 mm.

6.3 Properties to be selected

The specimen type and dimensions, shall be selected. Laboratory produced specimens shall be compacted in accordance with prEN 12697-30 using 2 x 50 blows or with prEN 12697-31 using 50 gyrations unless a different level of compaction energy is selected. When determining water sensitivity in accordance with prEN 12697-12, the required energy level shall be selected in accordance with that European Standard.

6.4 Grouping of specimen

Specimens which shall be used for comparison of different mixture types or as part of determination of the water sensitivity according to prEN 12697-12 shall be divided into groups having (approximately) same length.

6.5 Visual examination

The specimens shall visually be symmetrical with the curved side even and circular.

6.6 Measurement of dimensions

The height and diameter of each test specimen shall be measured in accordance with EN 12697-29.

7 Conditioning

7.1 Thermal treatment

Bring the test specimen to the test temperature selected according to 8.1 by placing it:

¾ in a water bath:

Protect the specimen from the water by a soft plastic bag or other suitable watertight protection and ensure that the watertight protection is pressed closely to the surface of the specimen to allow adequate heat transmission;

or

¾ in a thermostatically controlled air chamber.

NOTE Vacuum packing of the specimens may be considered suitable to ensure adequate heat transmission.

7.2 Storage

Store the specimens for at least 2 h in the water bath or air chamber for specimens with diameter less than 150 mm and for at least 4 h for specimens with diameter of 150 mm or larger. When using air chamber conditioning to test

temperature, the temperature shall be controlled by placing the test specimens along with a dummy specimen having a built-in temperature indicator.

8 Test procedure

8.1 The test temperature shall be selected in the range between 5 °C and 25 °C with a tolerance of 2 °C.

NOTE The recommended standard test temperature is 5 °C, to obtain a "correct" indirect tensile break line. However, when determining the indirect tensile strength as a part of determination of water sensitivity in accordance with prEN 12697-12, a standard test temperature of 25 °C is recommended.

8.2 Take a conditioned specimen and place it in the testing head. The testing machine shall be placed in a room with temperature between 15 °C and 25 °C.

NOTE It is recommended to clean and lubricate the guide rods of the test head to ensure that the upper test head slides freely over them.

8.3 Align the specimen on the lower loading strip, so that the specimen can be loaded diametrically.

8.4 Start the compression of the specimen. Apply a diametrical load continuously and without shock, at a constant speed of deformation of (50 ± 2) mm/min after a transitory period less than 20% of the loading time, until the peak load is reached, and record the peak load, P_i, applied, where i is the index of the determination. Continue loading until the specimen breaks. Record the type of failure, which is categorised as

a) "clear tensile break" – Specimen clearly broken along a diametrical line, except perhaps for small triangular sections close to the loading strips –

b) "deformation" – Specimens without a clearly visible tensile break line – or

c) "combination" – Specimens with a limited tensile break line and larger deformed areas close to the loading strips.

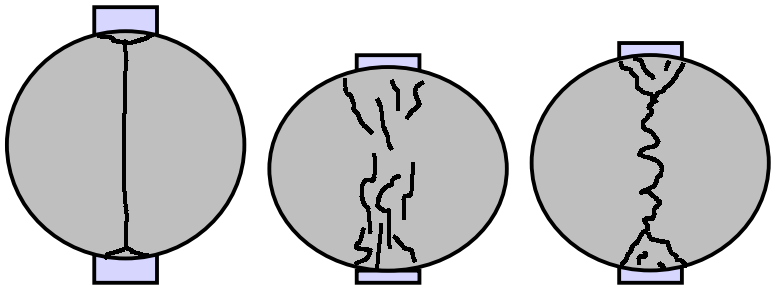


Figure 2 – Types of failure

Break the specimen open and visually inspect the appearance of the surfaces for evidence of cracked or broken aggregates, and record if the aggregates at the surface mainly are broken or intact.

8.5 The test shall be completed within 2 min after the specimen has been taken from conditioning.

8.6 Repeat 8.1 to 8.4, to give one determination of indirect tensile strength as the average of the results obtained on at least three individual specimens.

9 Calculation

For each test specimen calculate the indirect tensile strength, *ITS*, according to the following formula:

$$ITS = \frac{2P}{DH}$$

and determine the average value of the determinations,

where

ITS is the indirect tensile strength, expressed in gigapascals (GPa), rounded to three significant figures;

P is the peak load, expressed in kilonewtons (kN), rounded to three significant figures;

D is the diameter of the specimen, expressed in millimetres (mm), to one decimal place;

H is the height of the specimen, expressed in millimetres (mm), to one decimal place.

10 Test report

The test report shall contain the following information:

a) reference to this European Standard;

b) identification number and type of mixture, date and time of testing;

c) number of test specimens;

d) type of test specimens;

e) average diameter and length of specimens, in millimetres;

f) test temperature;

g) average Indirect tensile strength in gigapascals, rounded to 3 significant figures;

h) type of failure and observations of broken or crushed aggregate;

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

11 Precision

11.1 Accept obtained values if difference in indirect tensile strength on the individual test specimens (part-results) do not differ by more than 17 % of the mean value.

11.2 Test two additional specimens if the results differ by more than 17 % of the mean value. Calculate the standard deviation of all results. Discard extreme-data, defined as individual results causing the standard deviation to be greater than 10 % of the mean value of all results.

NOTE The above-mentioned precision data are obtained from Swedish FAS Method 449-98, which is conducted using 100 mm diameter specimens and a test temperature of 10 °C. Precision data for testing at 5 °C and for testing on 150 mm or 160 mm specimens have not yet been established.

However, improved precision is expected using the specified procedure and test temperature.

Bibliography

FAS Method 449-98: Bituminous pavement and mixture. Determination of tensile strength from indirect tensile test. The Swedish Asphalt Pavement Association, 1998.

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