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Bitumen and bituminous binders — Determination of the tensile properties of bituminous binders by the tensile test method

bsi.

National foreword

This British Standard is the UK implementation of EN 13587:2016. It supersedes BS EN 13703:2003 (dual numbered as BS 2000-515:2003) and BS EN 13587:2010 (dual numbered as BS 2000-519:2010) which are withdrawn.

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Bitumen and bituminous binders - Determination of the tensile properties of bituminous binders by the tensile test method

Bitumes et liants bitumineux - Détermination des caractéristiques de traction des liants bitumineux par la méthode d'essai de traction

Bitumen und bitumenhaltige Bindemittel - Bestimmung der Streckeigenschaften von bitumenhaltigen Bindemitteln mit dem Zugprüfverfahren

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European foreword

This document (EN 13587:2016) has been prepared by Technical Committee CEN/TC 336 "Bituminous binders", the secretariat of which is held by AFNOR/BNPé.

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of an identical text or by endorsement, at the latest by May 2017, and conflicting national standards shall be withdrawn at the latest by May 2017.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 13587:2010 and EN 13703:2003.

This document contains the following changes compared to EN 13587:2010:

— updated normative references;

— additional terms and definitions;

— deleting determination of deformation energy by EN 13703;

— introduction of calculation methods of deformation energy in the standard;

— updated bibliography;

— combining time frame EN 13589 with EN 13587;

— renaming "conventional energy" into "cohesion energy";

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1 Scope

This European Standard specifies a method for determining the tensile properties of a bituminous binder, in particular those of a polymer modified bitumen, by means of a tensile test.

NOTE The tensile properties, more particularly the tensile stress, the elongation and energy, at the yield point and on fracture, are customarily used as a criterion for assessing the quality of these materials.

WARNING — The use of this European Standard may involve hazardous materials, operations and equipment. This European Standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this European Standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

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 58, *Bitumen and bituminous binders — Sampling bituminous binders*

EN 12594, *Bitumen and bituminous binders — Preparation of test samples*

EN ISO 527 (all parts), *Plastics — Determination of tensile properties*

ISO 5893, *Rubber and plastics test equipment — Tensile, flexural and compression types (constant rate of traverse) — Specification*

3 Terms and definitions

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

3.1
tensile force
force undergone by a specimen subjected to extension, expressed in Newton (N)

3.2
elongation
increase in length of a specimen, expressed in metres

Note 1 to entry: Elongation is also expressed in % from the initial length. It is calculated as [(new length – initial length)/initial length] × 100.

3.3
brittle break
rupture happening at the beginning of the test before the flowing threshold when the stress-strain curve is still linear

3.4
flow threshold
first maximum of the stress-strain curve

3.5
deformation energy
E_i
energy in joules (J) supplied by test pieces, until displacement, *i*, of the moving element

3.6
cohesion energy
E^*_i
quotient of deformation energy, E_i (in joules) and the initial cross section of the test pieces (in square centimetres)

4 Principle

A specimen, held by its ends between two jaws, is extended in a chamber, regulated at the test temperature, at constant speed until a given elongation or fracture is achieved. In general, stress and elongation are noted at the flowing threshold, at an elongation of 400 % and at breaking.

The deformation energy (E_i) is determined from the recordings of the tensile curves (see Figure A.1) obtained according to chapter 7, by calculating the area delimited by:

— the abscissa axes corresponding to elongations;

— the recorded curve (force versus elongation);

— a parallel to the ordinates axis which passes by a given elongation or the breaking point (see Figure A.2).

Cohesion energy (E^*_i) is obtained as a quotient of the deformation energy at 400 % elongation (250 mm for H2 type specimen final length) and the initial cross-area of the test specimens.

5 Apparatus

Usual laboratory equipment and glassware, together with the following:

5.1 Test machine, in accordance with ISO 5893.

5.1.1 The machine shall be capable of maintaining a constant speed of the moving element at the speed chosen for the test to an accuracy of within 2 % of the chosen speed.

5.1.2 The specimen attachment device (located on the stationary part and on the moving part) shall:

— ensure sufficient clamping of the specimen heads throughout the entire test, to prevent slipping;

— not exert, on any part of the ends of the specimen, localized stresses liable to cause tearing or fracture of the specimen.

5.1.3 The equipment shall permit the following measurements to be made:

— tensile force applied on the specimen over the range 1 N to 500 N to an accuracy of ± 1 %;

— elongation of the specimen, either by following the movement of the attachment points or by means of an optical extensometer over the range 0 mm to not less than 250 mm to an accuracy of ± 1 mm.

5.1.4 Optical extensometer.

If an optical extensometer is used its reflector devices shall be positioned on the bituminous specimen as near as possible to the specimen heads.

The distance between the two reflector devices is approximately 45 mm to 50 mm.

The type of extensometer used shall be recorded in the test report.

5.2 Temperature controlled chamber, capable of maintaining the specimen and the attachment device at the specified temperature throughout the test to an accuracy of ± 0,5 °C, provided with a means of checking the test temperature. The control thermometer shall be placed near the specimen.

5.3 Recording device, for force applied and elongation of the test specimen.

5.4 Measurement apparatus, capable of measuring the thickness of the test specimen to an accuracy of ± 0,1 mm.

5.5 Moulds allowing moulding of specimens (see Figure 1), e.g. made in silicone elastomer.

Table 1 — Dimensions of the mould H2 in millimetres

Type of specimen	*A*	*B*	*D*	*F*	*C*	*G*	*R*	*R'*
H2	25 ± 0,5	4,0 ± 0,1	3,0 ± 0,3	75 ± 2	12,5 ± 1,0	12,5 ± 1,0	8,0 ± 0,3	12,5 ± 0,3

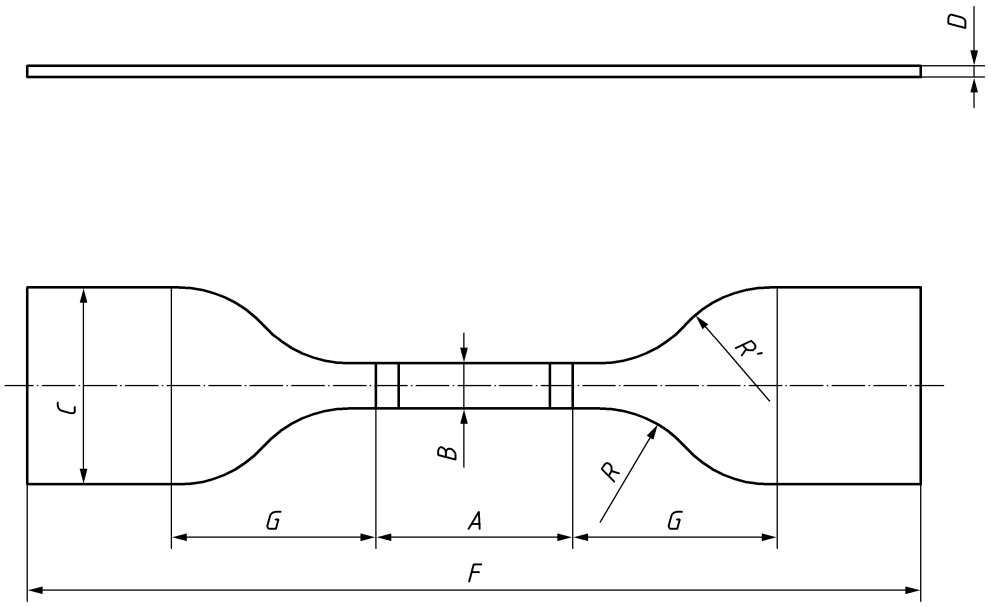

Figure 1 — Dumbbell-shaped binder specimen H2

The reference length or initial length of the H2 specimens is $K_0 = A + 2G$. Specimens of different geometry can be used (if the preparation of H2 specimens is too difficult or impossible) but should be in accordance with the reference standards (i.e. the EN ISO 527- series or ISO 5893); this should be mentioned explicitly in the test report. The results obtained from such specimens can be used only for comparison with a binder tested under the same conditions.

6 Preparation and conservation of samples

Take the sample in accordance with EN 58. Prepare the sample in accordance with EN 12594. Pour a surplus of material directly in the mould and allow the specimens to cool to room temperature for about one hour. Trim of the excess material with a heated spatula.

As an alternative for sample preparation, the dumbbell-shaped specimen can be produced by cutting a thin sheet of the bituminous binder having the correct thickness by a model which will produce a specimen with the dimensions given in Table 1.

Reject specimens exhibiting defects. Keep specimens in their moulds and in a refrigerator at a maximum temperature of 10 °C and for a maximum of 24 h before the test.

7 Procedure

Measure the thickness, D, of the specimen with an accuracy of 0,1 mm.

Set the apparatus to the test temperature.

Maintain the chamber containing the specimen at the test temperature for at least one hour.

Attach the specimen in the attachment device in accordance with the EN ISO 527- series with a distance between the jaws, K_0, of 50 mm ± 0,5 mm for specimens of the H2 type.

Wait five minutes after stabilization of the test temperature ± 0,5 °C and start the test.

Record the force and elongation for the test specimen, as indicated in Clause 8.

Repeat any test in which a brittle break occurs (break before the flowing threshold). After three brittle breaks, in the thin part of the specimen, stop the test and record the binder as “brittle”.

General values of test temperature and test speed are the following:

— Temperature: −20 °C, −15 °C, −10 °C, −5 °C, 0 °C, 5 °C, 10 °C, 15 °C, 20 °C.

— Speed: 1 mm/min, 10 mm/min, 50 mm/min, 100 mm/min, 500 mm/min.

8 Calculation and expression of results

The deformation Energy, E_i, is calculated as the definite integral of force as a function of elongation, see Formula (1).

The final results are expressed as cohesion energy, E^*_i, in joules per square centimetre.

Cohesion is calculated dividing the deformation energy, E_i, by the initial cross section of the test specimen expressed in square centimetres. The dimensions of the mould used to cast the specimen will be used to calculate the initial cross section of it.

The end calculation shall correspond to the average of three specimens tested without significant incidents.

For each test specimen, the energy calculation is accomplished from the computerized data of couples force/elongation. This calculation can be done using any specific reprocess data software or computer worksheet. This will be the calculation method to be used preferably.

If the equipment is not connected with a calculation device or computer Formula (1) can also be used:

$$\int_{L_1}^{L_2} f(x)dx = \Delta L \times \left(\frac{F_0}{2} + \frac{F_n}{2} + \sum_{1}^{n-1} F_i \right) \quad (1)$$

where

L_1 is the length at 0,000 m;

L_2 is the length at 400 % elongation or the length at break after flowing threshold;

ΔL is the incremental length between force determinations; normally 0,005 m;

F_0 is the force at 0,000 m;

F_i is the force at (L_1 + i* ΔL);

F_n is the force at break or Force at 400 % elongation;

n is the total amount of force values used in the equation (= $\frac{L_2 - L_1}{\Delta L}$); if needed rounded to the nearest integer value.

The reference length for the calculation of the percentage elongation is K_0, the distance between the attachment points (50 mm for H2 type specimens).

For three significant tests, calculate stress and percentage elongation at the flowing threshold, at fracture, at a percentage elongation of 400 % and at maximum percentage elongation if fracture is not reached.

Give the result as the calculated mean of the three values.

9 Precision

The difference between two single and independent results obtained by different operators working in different laboratories on identical test material would, in the long run, in the normal and correct operation of the test method, exceed the values given in Table 1, in only one case in 20.

Table 2 — Repeatability and reproducibility

Test method	Cohesion	Repeatability r	Reproducibility R
EN 13587 tensile test	$E^*_{0,2}$ (J/cm²)	10 %	30 %

10 Test report

The test report shall contain at least the following information:

a) type and complete identification of the sample under test;

b) reference to this European Standard;

c) specimen preparation method;

d) type of test specimens and the distance K_0 (50 mm for H2 type specimens);

e) test temperature and the speed;

f) number of specimens subjected to the test; and the number of specimens rejected;

g) results of the test (see Clause 8);

h) any deviation, by agreement or otherwise, from the procedure specified;

i) date of the test.

Annex A
(normative)

Cohesion specification criteria

Cohesion energy has been considered as the specification criteria that will allow the evaluation of the cohesion behaviour in bituminous binders.

The values to be compared with the specification tables limits are calculated as follows:

The values for tensile test are expressed as the cohesion corresponding to an elongation of 400 % or 0,200 m (specimen final length of 250 mm for H2 type specimen).

$$E^*_s = E^*_{0,2} \quad \text{(A.1)}$$

where

E^*_s is the value of the cohesion energy to be compared to the limits included in specification tables;

$E^*_{0,2}$ is the cohesion energy corresponding to elongation of 400 % or 0,200 m (for H2 type specimen final length of 250 mm).

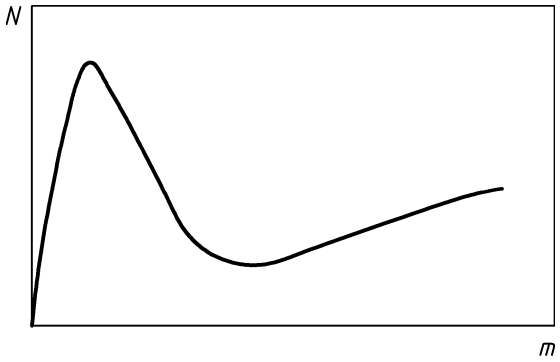

Figure A.1 — Force versus elongation

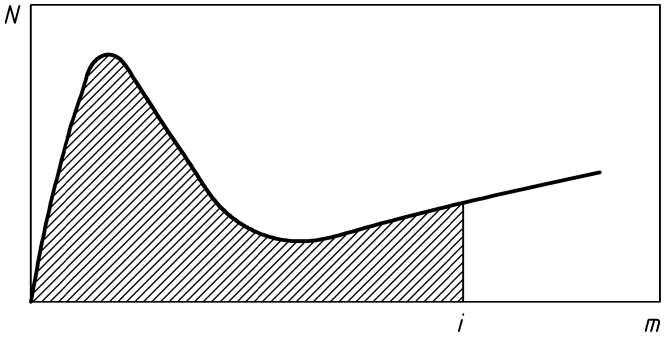

Figure A.2 — Energy for a given elongation

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[1] ISO 5725-2:1994, *Accuracy (trueness and precision) of measurement methods and results — Part 2: Basic method for the determination of repeatability and reproducibility of a standard measurement method*

[2] EN 13589, *Bitumen and bituminous binders — Determination of the tensile properties of modified bitumen by the force ductility method*

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