SLOVENSKI STANDARD
oSIST prEN 14771:2022

01-maj-2022

Bitumen in bitumenska veziva - Ugotavljanje upogibne togosti - Reometer z nosilcem, obremenjenim na upogib (BBR)

Bitumen and bituminous binders - Determination of the flexural creep stiffness - Bending Beam Rheometer (BBR)

Bitumen und bitumenhaltige Bindemittel - Bestimmung der Biegekriechsteifigkeit - Biegebalkenrheometer (BBR)

Bitumes et liants bitumineux - Détermination du module de rigidité en flexion - Rhéomètre à flexion de barreau (BBR)

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Ta slovenski standard je istoveten z: **prEN 14771**

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ICS:

75.140	Voski, bitumni in drugi naftni proizvodi	Waxes, bituminous materials and other petroleum products
91.100.50	Veziva. Tesnilni materiali	Binders. Sealing materials

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2003-01.Slovenski inštitut za standardizacijo. Razmnoževanje celote ali delov tega standarda ni dovoljeno.

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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

DRAFT
prEN 14771

February 2022

ICS 75.140; 91.100.50

Will supersede EN 14771:2012

English Version

Bitumen and bituminous binders - Determination of the flexural creep stiffness - Bending Beam Rheometer (BBR)

Bitumes et liants bitumineux - Détermination du module de rigidité en flexion - Rhéomètre à flexion de barreau (BBR)

Bitumen und bitumenhaltige Bindemittel - Bestimmung der Biegekriechsteifigkeit - Biegebalkenrheometer (BBR)

This draft European Standard is submitted to CEN members for enquiry. It has been drawn up by the Technical Committee CEN/TC 336.

If this draft becomes a European Standard, CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

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

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European foreword

This document (prEN 14771:2022) has been prepared by Technical Committee CEN/TC 336 “Bituminous binders”, the secretariat of which is held by AFNOR.

This document is currently submitted to the CEN Enquiry.

This document will supersede EN 14771:2012.

Compared to EN 14771:2012, the following changes have been made:

a) 5.1.1.1 reworded to provide more clarity;

b) 5.2.1 reworded to provide more clarity;

c) 6.1 Reference to scope added in note;

d) Description reworded to provide more clarity; timing of trimming adjusted;

e) 7.1 Information to discard damaged or distorted specimen added, and in c) wording aligned with 5.1.1.1;

f) Annex A added;

g) Annex B added;

h) Bibliography updated with EN 1427.

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This document is based on ASTM D 6648-01 [1].

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1 Scope

This document specifies a method for the determination of the flexural creep stiffness of bituminous binders in the range of 30 MPa to 1 GPa by means of the bending beam rheometer.

WARNING — The use of this document 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 document to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to use.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. 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 14023, *Bitumen and bituminous binders - Specification framework for polymer modified bitumens*

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at https://www.electropedia.org/
- ISO Online browsing platform: available at https://www.iso.org/obp

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3.1
flexural creep stiffness
S(t)
ratio obtained by dividing the bending stress by the bending strain

Note 1 to entry: The strain will increase with the loading time and therefore the flexural creep stiffness will also be a function of time.

3.2
m-value
absolute value of the slope of the curve of the logarithm of the stiffness versus the logarithm of time

3.3
contact load
P_c
load required to maintain positive contact between the test specimen, supports and the loading shaft

Note 1 to entry: The contact load of 25 mN to 45 mN is used in this method.

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3.4
test load
P_t
load used to determine the stiffness of the bituminous binder being tested

Note 1 to entry: The test load of 930 mN to 1030 mN is used in this method.

4 Principle

The bending beam rheometer is used to measure the mid-point deflection, in three-point bending, of a beam of bituminous binder. A constant load is applied to the mid-point of the test specimen for a defined loading time and the deflection is measured as a function of time. A low temperature liquid bath is used to control the temperature. The stiffness of the test specimen for the specific loading times is calculated from the bending stress and strain.

5 Apparatus

5.1 Bending Beam Rheometer (BBR), consisting of a loading frame with test specimen supports, a controlled temperature liquid bath and a data acquisition system.

5.1.1 The loading frame, consisting of a set of sample supports, a blunt-nosed shaft to apply the load to the mid-point of the test specimen, a load cell mounted in line with the loading shaft, a means for zeroing the load applied to the specimen, a means for applying a constant load to the test specimen and a deflection measuring transducer attached to the loading shaft. A schematic picture of the device is shown in Figure 1.

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5.1.1.1 The loading system, which shall be capable of applying a contact load of 25 mN to 45 mN to the test specimen and maintaining a constant test load from within the range of 930 mN to 1 030 mN with a tolerance of ± 10 mN. The rise time from the contact load to the test load shall be less than 0,5 s. Details of the loading pattern are shown in Figure 2.

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5.1.1.2 The loading shaft, which shall be continuous and in line with the load cell and deflection measuring transducer with a spherically shaped end (6,3 ± 0,3) mm in radius.

5.1.1.3 The load cell, which shall have a minimum capacity of no less than 2,0 N and a resolution of at least 2,5 mN.

5.1.1.4 The LVD-transducer, or other suitable device to measure the deflection of the test specimen that shall have a linear range of at least 6 mm, and be capable of resolving linear movement of 2,5 µm.

5.1.1.5 The sample supports, which shall consist of two non-corrosive metal supports with a (3,0 ± 0,3) mm contact radius and spaced 101 mm to 103 mm apart. The spacing of the supports shall be measured to 0,3 mm (see Figure 3).

5.1.2 A temperature measurement device, used as a calibrated temperature transducer that shall be capable of measuring the temperature with an accuracy of ± 0,1 °C over the range of - 36 °C to 0 °C. The measuring head shall be mounted within 50 mm of the mid-point of the test specimen.

5.1.3 A liquid bath, capable of maintaining the desired test temperature near the test sample within ± 0,2 °C during isothermal conditioning and during the test procedure in the range of - 36 °C to 0 °C. Bath

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liquid shall not affect the properties of the bituminous binder being tested. The density of the liquid shall not exceed 1 050 kg/m^3 at the test temperature.

NOTE 95 % (volume fraction) ethanol, or methanol have been found to be suitable as a bath liquid.

5.1.3.1 A bath agitator, which shall be used for maintaining the required temperature homogeneity with agitation intensity so that the fluid currents do not disturb the testing process.

5.1.3.2 A circulating bath, an optional separate bath unit, cooling the test bath liquid.

5.1.4 A data acquisition and control system, which resolves loads to at least 2,5 mN, test specimen deflection to at least 2,5 µm, and bath liquid temperature to the nearest 0,1 °C. The software shall control the measuring system and record time, load deflection and temperature during the test. All the load and deflection readings shall be an average of at least five points within ± 0,2 s of the reporting time.

5.2 Test specimen moulds, with the interior dimensions (6,4 ± 0,1) mm wide, (12,7 ± 0,1) mm deep and (127 ± 5) mm long, fabricated from a suitable metal as shown in Figure 4. The thickness of the two end pieces used for each mould shall not vary from each other in thickness by more than 0,1 mm.

NOTE Small errors in thickness of the test specimen can have a large effect on the calculated modulus because the calculated modulus is a function of the thickness raised to the third power.

5.2.1 Plastic strips, or strips from silicone paper or similar material that does not adhere to the test specimen and does not interact with the bituminous binder, to cover those sections of the test specimen moulds which will come in contact with test specimen during their preparation, except for the end pieces.

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6 Preparation of test samples

6.1 General

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NOTE BBR testing can be done on all types of binders and stages (see scope); typically, BBR testing is carried out on long-term aged binders.

Take the laboratory sample in accordance with EN 58, taking all necessary safety precautions, and ensuring that the test sample is representative of the laboratory sample from which it is taken. Ensure that the laboratory sample is homogeneous and is not contaminated (see EN 1425).

Remove a sufficient amount of the laboratory sample, if necessary using a warmed knife, and transfer it to a suitable container. Melt the sample according to EN 12594.

Raise the material to the required temperature of not more than 100 °C above the expected softening point (see EN 1427). For polymer modified bitumen follow the procedure provided by the supplier. If no other guidance is provided by the supplier for polymer modified bitumen according to EN 14023 the temperature shall be within 180 °C to 200 °C. The temperature shall not exceed 200 °C irrespective of the softening point. The laboratory sample shall be taken in accordance with EN 58 and prepared in accordance with EN 12594.

6.2 Preparation of moulds

Spread a very thin layer of petroleum-based grease onto the interior faces of the dry and clean metal mould sections. Press the plastic strips against the metal faces to force out any air bubbles. Cover the inside faces of the two end pieces with a thin film of de-moulding agent to prevent bituminous binder from sticking to the metal end pieces. Assemble the mould as shown in Figure 4 using O-rings to hold the pieces of the mould together. Ensure plastic sheeting fits so that no raised edges occur on the cast beam.

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NOTE 1 Plastic sheeting 0,08 mm to 0,15 mm thick have been found suitable. Transparency film sold for use with laser printers has been found suitable for this purpose.

NOTE 2 Polyvinyl alcohol and glycerol are found to be suitable as de-moulding agents, but silicone-based de-moulding agents can affect the binder stiffness.

NOTE 3 Careful pre-heating of moulds up to 80 °C before filling in the sample is acceptable.

6.3 Preparation of test specimen

Pour hot binder (see section 6.1) into the metal mould that is at room temperature. Slightly overfill the mould. Pour the binder continuously towards the other end in a single pass.

Store all the test specimens in their moulds at room temperature prior to testing for 45 min to 60 min, but a maximum of 3 days. Only before testing, trim the exposed face of the cooled specimen flush with the top of the mould using a hot knife or a heated spatula.

NOTE 1 If the test is done at several temperatures, it can be practical to have longer times between pouring and testing, which might effect the precision of the test.

Just prior to de-moulding, cool the mould containing the test specimen in a cold chamber or liquid bath for no longer than 5 min in order to stiffen the test specimen so it can be readily de-moulded without distortion. In no cases shall the sample be exposed to a de-moulding temperature less than the test temperature.

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At least two specimens per test temperature shall be tested.

NOTE 2 Excessive cooling can cause unwanted hardening of the binder and affect the test result.

During de-moulding, the specimen should be handled with care to prevent distortion. A warped test specimen might affect the measured values.

NOTE 3 Binders with very high viscosity can be poured into slightly pre-heated moulds to prevent the binder cooling too quickly and to ensure a more uniform specimen.

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The moulds should in no case be heated to a temperature higher than that of the binder to be poured.

7 Procedure

7.1 Measurement

Clean the supports, loading head and bath liquid of any dust and coatings as necessary.

Check the adjustment of contact load and test load prior to testing each set of test specimens. Refer to the operating instructions of the apparatus for checking and calibration.

Select the first test temperature according to the expected stiffness level. Set the temperature control device to the desired test temperature and allow the apparatus to equilibrate. The bath liquid shall be at the test temperature ± 0,2 °C. Check that the temperature of the bath is stable for a minimum period of 20 min.

NOTE 1 Typical start temperatures are - 10 °C, - 12 °C, - 16 °C or - 18 °C, and typically applied differences between test temperatures are 6 °C.

After de-moulding, immediately place the test specimen in the testing bath and condition it at the testing temperature for (60 ± 2) min before starting the test. Damaged or distorted specimen should be discarded.

NOTE 2 The mould base bar is a good support for the specimen.

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Place the test specimen on the supports so that the width of the specimen as moulded will be the thickness of the test specimen (see Figure 5).

Establish the thickness of the test specimen immediately before testing by placing the test specimen on the supports. Apply a contact load of 25 mN to 45 mN to the specimen and record the reading of the displacement transducer. Invert the test specimen and obtain the second reading. If the two readings agree within 1,0 mm, calculate the average. If the two readings differ by more than 1,0 mm, the flatness of the test specimen is suspect and it should be discarded.

The thickness and the width of the sample may be directly measured or the dimensions of the mould may be used. The latter procedure is not as accurate as the direct measurement. The thickness of the test specimen may be taken as the measured thickness of the metal inserts and the width may be taken as the height of the side bar used to mould the test specimen.

After the thickness measurement, check the placement of the test specimen on the test supports and gently position the backside of the test specimen against the alignment pins. Manually apply a contact load of 25 mN to 45 mN to the specimen to ensure the contact between the test specimen and the loading head. The time to apply and adjust the load shall be no greater than 10 s.

With the contact load applied to the specimen, activate the automatic test system, which is programmed to proceed as follows.

a) Apply a setting load of (980 ± 50) mN for (1,0 ± 0,1) s.

b) Reduce the load to the 25 mN to 45 mN and allow the test specimen to recover for (20,0 ± 0,1) s. The operator shall verify that the load on the test specimen returns to 25 mN to 45 mN. If it does not, the test shall be rejected.

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NOTE 3 The verification can be achieved by monitoring the computer screen, if the equipment allows it.

c) Apply a test load from within the range of 930 mN to 1030 mN to the specimen. The load shall be within ± 50 mN of the test load between 0,5 s and 5,0 s, and for the remaining time within ± 10 mN of the test load. Record the test load and the deflection during the test time of 240 s.

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d) Remove the test load and return to the 25 mN to 45 mN contact load.

e) Remove the specimen from the supports and proceed to the next test.

7.2 Deflection in a valid determination

Measurements for which the mid-point deflection of the test specimen is greater than 4,0 mm are suspect. Strains in excess of this value may exceed the linear response of the binder.

Measurements for which the mid-point deflection of the test specimen is less than 0,08 mm are suspect. When the mid-point deflection is too low, the test system resolution may not be sufficient to produce reliable results.

8 Calculation

8.1 General

Generate a plot of the measured load and the measured deflection of the test specimen versus loading time at the intervals of 0,5 s or less, starting with the application of the seating load. The following values shall be calculated.

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8.2 Measured stiffness

Calculate the measured stiffness of the test specimen at loading times of 8,0 s, 15,0 s, 30,0 s, 60,0 s, 120,0 s and 240,0 s from the dimensions of the test specimen, the measured test load and the measured test specimen deflection using Formula (1):

$$S_m(t) = \frac{PL^3}{4bh^3\delta(t)} \quad (1)$$

where

$S_m(t)$ is the flexural creep stiffness at time t, in MPa;

P is the measured test load, in N;

L is the distance between supports, in mm;

b is the width of the test specimen, in mm;

h is the thickness of the test specimen, in mm;

$\delta(t)$ is the deflection of the test specimen at time t, in mm.

Values of load and deflection obtained before 8 s loading time should not be used to calculate stiffness, because the dynamic loading effects might cause misleading results.

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8.3 Calculated stiffness

Fit a second-degree polynominal function to the logarithm of the measured stiffness values versus the logarithm of the loading times using Formula (2):

$$\log S_c(t) = A + B*\log(t) + C*[\log(t)]^2 \quad (2)$$

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where

$S_C(t)$ is the flexural creep stiffness at time t, in MPa;

A, B, and C are regression coefficients;

t is the loading time in s.

Calculate the stiffness values at loading times of 8,0 s, 15,0 s, 30,0 s, 60,0 s, 120,0 s and 240,0 s using the above calculated formula.

8.4 m-value

Calculate the m-value for the same loading times using Formula (3):

$$m(t) = \left| d\log[S(t)] / d\log(t) \right| = \left| B + 2*C*\log(t) \right| \quad (3)$$

where

B and C are regression coefficients determined above;

t is the loading time.