SLOVENSKI STANDARD
oSIST prEN 12697-26:2016

01-januar-2016

Bitumenske zmesi - Preskusne metode - 26. del: Togost

Bituminous mixtures - Test methods - Part 26: Stiffness

Asphalt - Prüfverfahren - Teil 26: Steifigkeit

Mélanges bitumineux - Méthodes d'essai pour enrobés à chaud - Partie 26 : Rigidité

Ta slovenski standard je istoveten z: **prEN 12697-26**

ICS:

93.080.20 Materiali za gradnjo cest Road construction materials

oSIST prEN 12697-26:2016 **en,fr,de**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

DRAFT
prEN 12697-26

November 2015

ICS 93.080.20

Will supersede EN 12697-26:2012

English Version

Bituminous mixtures - Test methods - Part 26: Stiffness

Mélanges bitumineux - Méthodes d'essai pour enrobés à chaud - Partie 26 : Rigidité

Asphalt - Prüfverfahren - Teil 26: Steifigkeit

This draft European Standard is submitted to CEN members for enquiry. It has been drawn up by the Technical Committee CEN/TC 227.

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.

This draft European Standard was established by CEN in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and United Kingdom.

Recipients of this draft are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

Warning : This document is not a European Standard. It is distributed for review and comments. It is subject to change without notice and shall not be referred to as a European Standard.

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

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

Ref. No. prEN 12697-26:2015 E

Contents

Page

European foreword

This document (prEN 12697-26:2015) 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 CEN Enquiry.

This document will supersede EN 12697-26:2012.

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

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

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

— 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*

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

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

— EN 12697-18, *Bituminous mixtures — Test methods — Part 18: Binder drainage*[1)]

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

— EN 12697-20, *Bituminous mixtures — Test methods for hot mix asphalt — Part 20: Indentation using cube or cylindrical specimens (CY)*

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

— EN 12697-22, *Bituminous mixtures — Test methods for hot mix asphalt — Part 22: Wheel tracking*

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

— EN 12697-24, *Bituminous mixtures — Test methods — Part 24: Resistance to fatigue*[1)]

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

— EN 12697-26, *Bituminous mixtures — Test methods — Part 26: Stiffness*[1)]

— 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*

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

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

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

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

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

1) In preparation

— EN 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*

— EN 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*

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

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

— EN 12697-40, *Bituminous mixtures — Test methods for hot mix asphalt — Part 40: In situ drainability*

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

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

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

— EN 12697-44, *Bituminous mixtures — Test methods for hot mix asphalt — Part 44: Crack propagation by semi-circular bending test*

— EN 12697-45, *Bituminous mixtures — Test methods for hot mix asphalt — Part 45: Saturation ageing tensile stiffness (SATS) conditioning test*

— EN 12697-46, *Bituminous mixtures — Test methods for hot mix asphalt — Part 46: Low temperature cracking and properties by uniaxial tension tests*

— EN 12697-47, *Bituminous mixtures — Test methods for hot mix asphalt — Part 47: Determination of the ash content of natural asphalts*

— EN 12697-48, *Bituminous mixtures — Test methods — Part 48: Interlayer bonding*[1)]

— EN 12697-49, *Bituminous mixtures — Test methods for hot mix asphalt — Part 49: Determination of friction after polishing*

— CEN/TS 12697-50, *Bituminous mixtures — Test methods — Part 50: Resistance to scuffing*[1)]

— EN 12697-51, *Bituminous mixtures — Test methods — Part 51: Surface shear strength test*[1)]

— CEN/TS 12697-52, *Bituminous mixtures — Test methods — Part 52: Conditioning to address oxidative ageing*[1)]

— EN 12697-53, *Bituminous mixtures — Test methods — Part 53: Cohesion increase by spreadability-meter method*[1)]

Compared with EN 12697-26:2012, the following changes have been made:

a) implementation of a real haversinusoidal load in Annex C;

b) implementation of several technical corrections in all annexes;

c) adjustment of procedures in all the tests;

d) application of the correct wording within all the test procedures.

1 Scope

This European Standard specifies the methods for characterizing the stiffness of bituminous mixtures by alternative tests, including bending tests and direct and indirect tensile tests. The tests are performed on compacted bituminous material under a sinusoidal loading or other controlled loading, using different types of specimens and supports.

The procedure is used to rank bituminous mixtures on the basis of stiffness, as a guide to relative performance in the pavement, to obtain data for estimating the structural behaviour in the road and to judge test data according to specifications for bituminous mixtures.

As this standard does not impose a particular type of testing device the precise choice of the test conditions depends on the possibilities and the working range of the used device.

For the choice of specific test conditions, the requirements of the product standards for bituminous mixtures should be respected.

The applicability of this document is described in the product standards for bituminous mixtures.

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 12697-7, *Bituminous mixtures - Test methods for hot mix asphalt - Part 7: Determination of bulk density of bituminous specimens by gamma rays*

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

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

EN 12697-31, *Bituminous mixtures - Test methods for hot mix asphalt - Part 31: Specimen preparation by gyratory compactor*

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

3 Terms, definitions and symbols

3.1 Terms and definitions

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

3.1.1
stiffness modulus
relationship between maximum applied stress and maximum measured elastic strain and expressed as

$$E = \frac{\sigma}{\varepsilon}$$

3.1.2
complex modulus
relationship between stress and strain for a linear visco-elastic material submitted to a sinusoidal load wave form at time, t, where applying a stress $\sigma \times \sin(\omega \times t)$ results in a strain $\varepsilon \times \sin(\omega \times (t - \Phi))$ that has a phase angle, Φ, with respect to the stress

Note 1 to entry: The amplitude of strain and the phase angle are functions of the frequency, f, and the test temperature, θ.

Note 2 to entry: The stress strain ratio defines the complex modulus E^* as:

$$E^* = |E^*| \times (\cos(\Phi) + i \times \sin(\Phi)) \quad (1)$$

The complex modulus is characterized by a pair of two components. This pair can be expressed in two ways: the real component E_1 and the imaginary components E_2:

$$E_1 = |E^*| \times \cos(\Phi) \quad (2)$$

$$E_2 = |E^*| \times \sin(\Phi) \quad (3)$$

the absolute value of the complex modulus $|E^*|$ and the phase angle, Φ:

$$|E^*| = \sqrt{{E_1}^2 + {E_2}^2} \quad (4)$$

$$\Phi = \arctan\left(\frac{E_2}{E_1}\right) \quad (5)$$

Note 3 to entry: This second characterization is more often used in practice. In linear elastic multi-layer calculations for instance the E^* modulus is generally used as input value for Young's modulus.

Note 4 to entry: For purely elastic materials, the phase angle is zero and then the complex modulus reduces to the Young's modulus. This happens when bituminous materials are at very low temperatures. Then the complex modulus reaches its highest possible value, noted E_∞.

3.1.3
secant modulus
relationship between stress and strain at the loading time, *t*, for a material subjected to controlled strain rate loading:

$$E(t) = \frac{\sigma(t)}{\varepsilon(t)} \tag{6}$$

with stress, $\sigma(t)$, and strain, $\varepsilon(t)$, at time t

Note 1 to entry: The strain law is

$$\varepsilon(t) = \alpha_i \times t^n \tag{7}$$

where α_i and n are constants.

Note 2 to entry: Several successive tests can be carried out on the same specimen for different values of α_i. For linear visco-elastic materials, the secant modulus obtained for different values of α_i t the same temperature depends on the loading time, *t*, only.

3.2 Symbols

For the purposes of this document, the following symbols apply:

a_i constant

E the stiffness (modulus), in megapascals (MPa);

E^* the complex modulus, in megapascals (MPa);

E_1 the real component of the complex modulus, in megapascals (MPa);

E_2 the imaginary component of the complex modulus, in megapascals (MPa);

E_∞ the highest possible value of the complex modulus, in megapascals (MPa);

F the loading force, in newtons (N);

h the mean thickness of the specimen, in millimetres (mm);

H the height of a cylindrical specimen, in millimetres (mm);

l_0 the original length of the measurement area in millimetres (mm);

Δl the elongation of the measurement area in micrometers (µm);

L the span length between outer supports in bending tests, in millimetres (mm);

n constant

t the loading time, in seconds (s);

Θ the test temperature, in degrees celsius (°C);

z the displacement, in millimetres (mm);

f the test frequency in Hertz (Hz);

σ the applied stress, in megapascals (MPa);

ε the applied strain, in micrometer per meter or in microstrain (µm/m);

ω the angular speed, in radians per second (rad/s);

Φ the phase angle, in degrees (°);

γ the form factor which is a function of specimen size and form (1/mm or mm^{-1});

μ the mass factor which is a function of the mass of the specimen and the mass of the movable parts that influence the resultant force by their inertial effects (in g);

ν the Poisson's ratio;

$\emptyset$ the diameter of a cylindrical specimen, in millimetres (mm).

4 Principle

Suitable shaped samples are deformed in their linear range, under repeated loads or controlled strain rate loads. The amplitudes of the stress and strain are measured, together with the phase difference between stress and strain. Based on measured stress and strain desired moduli can be calculated."

5 Sample preparation

5.1 Age of the specimens

Prior to the start of testing, the specimens shall be stored on a flat surface at a temperature of not more than 20 °C for between 14 d and 42 d from the time of their manufacture. In the case of samples requiring cutting and/or gluing, the cutting shall be performed no more than 8 d after compaction of the asphalt and the gluing shall be performed at least 2 weeks from cutting. The time of manufacture for these samples is the time when they are cut.

5.2 Drying of the specimen

After sawing and before gluing and/or testing, the specimens 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 %.

5.3 Dimensions and bulk density of the specimens

The dimensions of the specimens shall be measured according to EN 12697-29.

The bulk density shall be determined in accordance with EN 12697-6 or EN 12697-7. The bulk density of each specimen shall not differ by more than 1 % from the average apparent density of the batch. Otherwise, the specimen shall be rejected.

5.4 Number of test specimens

For all the mentioned tests, the minimum amount of specimens that need to be tested to get one test result is 4 specimens. The average of these results determine the stiffness modulus for the tested mix or section.

6 Checking of the testing equipment

The complete testing equipment shall be checked periodically with at least one reference specimen with a known stiffness modulus (modulus and phase lag). To check the test equipment for Annexes A, B, C, or D, the bending moment (*E.I*) of the specimen(s) shall be chosen to be equal to the bending moment of a normal asphalt test specimen (adopting a stiffness modulus for the asphalt in the range of 3 GPa to

14 GPa); for Annex E and Annex F an appropriate checking specimen with a known stiffness between 3 GPa and 14 GPa shall be used. The reference specimen shall be tested at not less than 6 frequencies and 2 deflection levels. The back-calculated stiffness moduli shall be within 2 % with respect to the known modulus and within 1,0° for the known phase lag. If, due to the electronic components or mechanical equipment, systematic deviations (or larger deviations) of:

— the stiffness modulus is observed, all electronic components and mechanical equipment shall be checked for proper working and no procedure for the back-calculation software is permitted;

— the phase angle is observed, a correction procedure for the back-calculation software is permitted.

The geometry of the reference specimen should be selected so that it will lead to a mass comparable with the mass of an asphalt specimen. The clamping of the reference specimen should be equal to the procedure for an asphalt specimen. A reference material with a phase lag unequal to zero is preferred but a material like aluminium (*E* around 70 GPa, phase lag is zero) is also acceptable.

7 Test methods

7.1 General

The following test methods can be adopted by use of the relative form and mass factor (see Clause 9). The testing procedures that shall be followed are described in Annexes A, B, C, D, E and F. If other test procedures are used to characterize stiffness properties of bituminous mixtures, the equivalence shall first by verified by comparison with one of these procedures and a statement on that equivalence shall be attached to test reports.

NOTE Inter-laboratory tests have shown that the following mentioned bending tests are in good agreement provided that the equipment is carefully calibrated and that some basic guidelines are strictly followed.

7.2 Tests with sinusoidal or pulse loading

7.2.1 Bending tests

The bending test options are:

— 2PB-TR: test applying two point bending to trapezoidal specimens, see Annex A;

— 2PB-PR: test applying two point bending to prismatic specimens, see Annex A;

— 3PB-PR: test applying three point bending to prismatic specimens, see Annex B;

— 4PB-PR: test applying four point bending to prismatic specimens, see Annex B.

7.2.2 Indirect tensile test

The indirect tensile test options are:

— IT-CY: test applying indirect tension to cylindrical specimens, see Annex C;

— CIT-CY: test applying cyclic indirect tension to cylindrical specimens, see Annex F.