SLOVENSKI STANDARD
SIST EN 12697-5:2010

01-februar-2010

Nadomeġļ a:
SIST EN 12697-5:2004+A1:2007

Bitumenske zmesi - Preskusne metode za vroļ e asfaltne zmesi - 5. del: Ugotavljanje najveļ je gostote

Bituminous mixtures - Test methods for hot mix asphalt - Part 5: Determination of the maximum density

Asphalt - Prüfverfahren für Heißasphalt - Teil 5: Bestimmung der Rohdichte

Mélanges bitumineux - Essais pour enrobés à chaud - Partie 5: Masse volumique réelle (MVR) des matériaux bitumineux

Ta slovenski standard je istoveten z: **EN 12697-5:2009**

ICS:

93.080.20	Materiali za gradnjo cest	Road construction materials

SIST EN 12697-5:2010 **en,fr,de**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 12697-5

December 2009

ICS 93.080.20

Supersedes EN 12697-5:2002+A1:2007

English Version

Bituminous mixtures - Test methods for hot mix asphalt - Part 5: Determination of the maximum density

Mélanges bitumineux - Méthodes d'essai pour mélange hydrocarboné à chaud - Partie 5: Masse volumique réelle (MVR) des matériaux bitumineux

Asphalt - Prüfverfahren für Heißasphalt - Teil 5: Bestimmung der Rohdichte

This European Standard was approved by CEN on 10 October 2009.

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This European Standard exists 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 Management Centre has the same status as the official versions.

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Ref. No. EN 12697-5:2009: E

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Foreword

This document (EN 12697-5:2009) 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of an identical text or by endorsement, at the latest by June 2010, and conflicting national standards shall be withdrawn at the latest by June 2010.

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

This document supersedes EN 12697-5:2002+A1:2007.

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*

EN 12697-11, *Bituminous mixtures — Test methods for hot mix asphalt — Part 11: Determination of the affinity between aggregates 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 for hot mix asphalt — Part 18: Binder drainage*

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 Marshall specimen*

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 for hot mix asphalt — Part 24: Resistance to fatigue*

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

EN 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 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 mixtures 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*

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 pre-coated 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 coarse foreign matter in reclaimed asphalt*

EN 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: Crack propagation by semi-circular bending test*

prEN 12697-45, *Bituminous mixtures — Test methods for hot mix asphalt — Part 45: Saturation Ageing Tensile Stiffness (SATS) Conditioning Test*

prEN 12697-46, *Bituminous mixtures — Test methods for hot mix asphalt — Part 46: Low Temperature Cracking and Properties by Uniaxial Tension Tests*

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

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

WARNING — The method described in this standard may require the use of dichloromethane (methylene chloride), this solvent is hazardous to health and is subject to occupational limits as detailed in relevant legislation and regulations.

Exposure levels are related to both handling procedures and ventilation provision and it is emphasised that adequate training should be given to staff employed in the usage of these substances.

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

1 Scope

This European Standard specifies test methods for determining the maximum density of a bituminous mixture (voidless mass). It specifies a volumetric procedure, a hydrostatic procedure and a mathematical procedure.

The test methods described are intended for use with loose bituminous materials containing paving grade bitumens, modified binders or other bituminous binders used for hot mix asphalt. The tests are suitable for both fresh or aged bituminous materials.

NOTE 1 Samples may be supplied as loose material or as compacted material; the latter should be separated first.

NOTE 2 General guidance on selection of a test procedure to determine the maximum density of a bituminous mixture is given in Annex A.

2 Normative references

The following referenced documents are indispensable for the application 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 1097-6, *Test for mechanical and physical properties of aggregates — Part 6: Determination of particle density and water absorption*

EN 12697-1, *Bituminous mixtures — Test methods for hot mix asphalt — Part 1: Soluble binder content*

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 ISO 3838, *Crude oil and liquid or solid oil petroleum products — Determination of density or relative density — Capillary-stoppered pyknometer and graduated bicapilary pyknometer methods (ISO 3838:2004)*

3 Terms and definitions

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

3.1
maximum density
mass per unit volume without air voids of the bituminous material at a known test temperature

3.2
bulk density
mass per unit volume (including the air voids) of a specimen at a known test temperature

3.3
apparent particle density
ratio of the oven dried mass of a sample of aggregate to the volume it occupies in water including any internal sealed voids but excluding water accessible voids

3.4
particle density on an oven dried basis of aggregate
ratio of the oven dried mass of a sample of aggregate to the volume it occupies in water including any internal sealed voids and water accessible voids

3.5
loose bulk density of aggregate
quotient obtained when the mass of dry aggregate filling a specified container without compaction is divided by the capacity of that container

4 Principle

The maximum density, together with the bulk density, is used to calculate the air voids content of a compacted sample and other volumetric-related properties of a compacted bituminous mixture.

In the volumetric and hydrostatic procedures, the maximum density of bituminous mixture is determined from the volume of the sample without voids and from its dry mass.

In the volumetric procedure, the volume of the sample is measured as the displacement of water or solvent by the sample in a pyknometer.

In the hydrostatic procedure, the volume of the sample is calculated from the dry mass of the sample and from its mass in water.

In the mathematical procedure, the maximum density of a bituminous mixture is calculated from its composition (binder content and aggregate content) and the densities of the constituent materials.

5 Materials

5.1 De-aired water (freshly de-aired and cooled) or organic solvent, suitable to dissolve bituminous binders (for the volumetric and hydrostatic procedures).

5.2 Dispersion agent, e.g. 7 % of Nonylphenolpolyglcolether (7 groups of Ethoxyl) in water.

5.3 Boiling water.

6 Apparatus

6.1 Tools to clean samples (if required).

6.2 Ventilated cabinet, capable of drying the sample and maintaining a uniform temperature within (110 ± 5) °C in the vicinity of the test sample(s).

6.3 Suitable tools to loosen and separate the sample, e.g. spatula.

6.4 Balance, accurate to at least 0,1 g.

6.5 Thermometer, of suitable accuracy.

6.6 Water-bath, capable of maintaining the water at a uniform temperature within ± 0,2 °C in the vicinity of the test sample(s). The water-bath shall contain a grid to permit submersion of the pyknometer or container to around 20 mm below the upper edge of pyknometer or container and to allow the water to circulate. The volume of the bath shall be at least three times that of the pyknometer/container.

6.7 Vibrating table, or other means to shake the pyknometer or container during the evacuation of air.

6.8 Pyknometer (for the volumetric procedure) of suitable size, with an accurately fitting head piece. The volume of the pyknometer shall be such that the sample occupies up to 2/3 of its volume. The volume of the pyknometer shall be regularly calibrated in accordance with Annex C.

NOTE For the safety of operatives, the pyknometer should be made of plastic rather than glass.

6.9 Vacuum system (for the volumetric procedure), with manometer or calibrated vacuum gauge, capable of evacuating air from the pyknometer to a residual pressure of 4 kPa or less.

6.10 Container (for the hydrostatic procedure), capable of being suspended in water. The shape of the container shall be such that the sample can be immersed completely when filling the container with water; the sample shall occupy up to 2/3 of the containers volume which shall be not less than $3{,}0 \times 10^{-3}$ m^3.

6.11 Vacuum desiccator or other vacuum vessel (for the hydrostatic procedure), capable of accommodating the pyknometer or container.

6.12 Rubber mallet (optional) (for calibration of the pyknometer).

7 Sampling

7.1 Samples of bituminous material shall be obtained in accordance with EN 12697-27.

7.2 Samples shall have a mass, expressed in grams (g), of at least 50 times the numerical value of the nominal maximum particle size of the aggregates in millimetres (mm) (i.e. the largest specified sieve size of the mixture) with a minimum of 250 g.

8 Preparation of Sample

8.1 Bulk samples

Obtain a test sample from a bulk sample after homogenising by riffling or quartering in accordance with EN 12697-28.

8.2 Samples from finished material

Samples of compacted material shall be cleaned by brushing or washing before being placed in the ventilated cabinet, at a temperature of (110 ± 5) °C, dried to constant mass and then separated.

NOTE Constant mass is obtained when the change of mass between two determinations at an interval of at least 30 min is less than 0,1 % (by mass).

8.3 Sample separation

Samples shall be loosened and separated into coarse particles and agglomerations. Agglomerations shall not be larger than 6 mm. If the material is not sufficiently soft to separate manually, warm it on a tray in an oven at a temperature not exceeding 110 °C, but only until it can be properly handled.

9 Procedure

9.1 General

All masses shall be determined in grams (g) to the nearest 0,1 g. The volume of the pyknometer shall be determined in m³ to the nearest $0{,}5 \times 10^{-6}$ m^3.

9.2 Procedure A: Volumetric procedure

9.2.1 Weigh the empty pyknometer including the head piece (m_1) of known volume (V_p).

NOTE The volume of the pyknometer can be determined in accordance with Annex C.

9.2.2 Place the dry test sample into the pyknometer and bring it to ambient temperature, then weigh again, together with the head piece (m_2).

9.2.3 Fill the pyknometer with de-aired water or solvent, up to a level 30 mm or more below the head joint.

9.2.4 Evacuate the entrapped air by applying a partial vacuum that results in a residual pressure of 4 kPa or less for (15 ± 1) min.

NOTE The evacuation of air in accessible pores is important. Evacuation can be assisted by stirring, rotating or vibrating the pyknometer on a vibrating table. When using water, adding a small amount of a dispersion agent (two drops only) can facilitate air evacuation. When using solvent, stirring and vibrating without applying a vacuum should be used. The de-aired water can be replaced by boiled water. For some mixtures, it may be necessary to determine an optimum time for applying the vacuum by varying the time of increments of 1 min or 2 min from 15 min and identifying the value corresponding to the highest maximum density. In such cases, the time under vacuum should be included in the test report.

9.2.5 Fix the head piece or stopper after carefully filling the pyknometer with de-aired water or solvent (ensuring no air is introduced) almost to the reference mark of the head piece or to the stopper.

9.2.6 When using water, place the pyknometer in a water-bath at the known uniform test temperature (± 1,0 °C) for at least 30 min, but no longer than 180 min, in order to bring the temperature of the sample and of the water in the pyknometer to the same level as that of the water in the water-bath.

NOTE The pyknometer may be placed in a cabinet at known test temperature for at least 60 min in order to bring the temperature of the sample and the water in the pyknometer to the test temperature (± 1,0 °C).

9.2.7 When using solvent, place the pyknometer in a water-bath at known uniform test temperature (± 0,2 °C) for at least 60 min, but not longer than 180 min, in order to bring the temperature of the sample and of the solvent in the pyknometer to the same level as that of the water in the water-bath.

9.2.8 The water in the water-bath shall reach up to approximately 20 mm below the edge of the pyknometer.

9.2.9 Fill the pyknometer up with the water or solvent and adjust the level to the measuring mark. The container with water or solvent shall be brought to the test temperature in a water-bath.

9.2.10 Take the pyknometer out of the water-bath, wipe the outside dry and weigh it immediately (m_3).

9.3 Procedure B: Hydrostatic procedure

9.3.1 Determine the mass of the empty container in air (m_1) and when submerged in water (m_2).

9.3.2 Place the test sample into the dried container and bring it to ambient temperature, then determine the mass of the container plus test sample in air (m_3).