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Bituminous mixtures - Test methods - Part 5: Determination of the maximum density

Asphalt - Prüfverfahren - Teil 5: Bestimmung der Rohdichte

Mélanges bitumineux - Méthodes d'essai - Partie 5: Masse volumique réelle (MVR)

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Bituminous mixtures - Test methods - Part 5: Determination of the maximum density

Mélanges bitumineux - Méthodes d'essai - Partie 5: Masse volumique réelle (MVR)

Asphalt - Prüfverfahren - Teil 5: Bestimmung der Rohdichte

This European Standard was approved by CEN on 9 November 2018.

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European foreword

This document (EN 12697-5:2018) has been prepared by Technical Committee CEN/TC 227 “Road materials”, the secretariat of which is held by BSI.

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of an identical text or by endorsement, at the latest by June 2019 and conflicting national standards shall be withdrawn at the latest by June 2019.

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 12697-5:2009.

The following is a list of significant technical changes since the previous edition:

— the title no longer makes the method exclusively for hot mix asphalt;

— [3.1] The term “bituminous material” amended to “bituminous mixture” in line with other parts;

— [4] New NOTE explaining when use of solvent is not suitable;

— [5.1] Demineralized water added as an option, including [9.2.3], [9.2.5], [9.3.3];

— [6.4] Amended description of accuracy for balance;

— [6.8] The NOTE has been converted to regular text;

— [7.2] Added description of loose samples and minimum thickness for cored samples for consistency with EN 12697-6;

— [7.3] New subclause and NOTE introduced, describing recording of thickness before cutting and cutting of cored samples;

— [7.4] New subclause describing recording of thickness after cutting and description on when a cut sample shall be regarded as representative with respect to the original thickness;

— [8.2] NOTE 2 added, explaining extended drying time to constant weight when waterabsorbing additives are used; previous NOTE renumbered to "NOTE 1";

— [9.2.3] New NOTE explaining when use of solvent is not suitable;

— [9.4.1] Subclause amended to include also the proportion of additives in total mass;

— [10.1.2] Formula (1) amended according to corrigendum EN 12697-5:2009/AC:2012;

— [10.3] Density of water amended to the nearest “0,0001” Mg/m^3 in accordance with [10.1.2]. Change includes also [10.2], [B.5.5] and [C.7];

— [10.4] Symbols for binder density and binder content changed to harmonise with other standards

— [10.4.1 and 10.4.2] Formula (4) and (5) amended to include also the proportion of additive; paragraph added, explaining that completely dry state is to be considered for additives absorbing water;

— [A.2.5] New subclause describing when use of solvent is not suitable; explanatory NOTE added;

— [Annex B] Symbols for binder density and binder content changed in order to harmonize with other standards.

A list of all parts in the EN 12697 series can be found on the CEN website.

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, 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, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Introduction

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 emphasized that adequate training should be given to staff employed in the usage of these substances.

1 Scope

This document 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 mixtures containing paving grade bitumens, modified binders or other bituminous binders used for bituminous mixtures. The tests are suitable for both fresh and aged bituminous mixtures.

Samples may be supplied as loose material or as compacted material; it is advised to separate the latter first.

NOTE 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 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 1097 (all parts), *Tests for mechanical and physical properties of aggregates*

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

EN 12697-27, *Bituminous mixtures — Test methods — 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 petroleum and liquid or solid petroleum products — Determination of density or relative density — Capillary-stoppered pyknometer and graduated bicapillary pyknometer methods (ISO 3838)*

3 Terms and definitions

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:

— Electropedia I.E.C. available at http://www.electropedia.org/

— ISO Online browsing platform: available at http://www.iso.org/obp

3.1
maximum density
mass per unit volume without air voids of the bituminous mixture

3.2
bulk density
mass per unit volume including the air voids of a specimen

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.

NOTE The use of solvent is not suitable for mixtures containing additives that absorb water, e.g. zeolites (see Annex A) or additives that are solved by solvent.

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), demineralized water 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, with an accuracy of at least 0,1 g for masses up to 5 kg, and 1 g for masses over 5 kg.

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.

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 mixture shall be obtained in accordance with EN 12697-27.

7.2 Loose 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. Samples from cores shall have a minimum thickness of the greater of 20 mm and two times the maximum nominal size of the aggregate.

7.3 For cores, record the thickness of all layers in the as received condition. If the layers are of variable thickness, record both the minimum and maximum thicknesses. If either or both of the ends have a surface that is rough, cut those ends, removing any rough ends that would underestimate the bulk density. Cut the core at each interface between different layers perpendicular to the axis of the core such that there is no material remaining of any other layer in each slice. More extensive cutting may be undertaken if the remaining sample still complies with the sample size requirements imposed by any subsequent test procedure.

NOTE This operation may require two cuts with a slither to discard when the joints between layers are not perpendicular to the axis of the core.

7.4 Record the thickness of each cut layer. The sample for any shall be regarded as representative of the whole layer if it constitutes at least 80 % of the original minimum thickness.

8 Preparation of Sample

8.1 Bulk samples

Obtain a test sample from a bulk sample after homogenizing 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 1 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).

NOTE 2 For mixtures containing additives that absorb water (e.g. zeolites) the drying to constant mass will generally take more time.

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 m^3 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, demineralized water or solvent, up to a level 30 mm or more below the head joint.

NOTE The use of solvent is not suitable for mixtures containing additives that absorb water (e.g. zeolites) or additives that are solved by solvent.

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.

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.