BS EN 12697-6:2012

BSI Standards Publication

Bituminous mixtures — Test methods for hot mix asphalt

Part 6: Determination of bulk density of bituminous specimens

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National foreword

This British Standard is the UK implementation of EN 12697-6:2012. It supersedes BS EN 12697-6:2003 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee B/510/1, Asphalt products.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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Bituminous mixtures - Test methods for hot mix asphalt - Part 6: Determination of bulk density of bituminous specimens

Mélanges bitumineux - Méthodes d'essai pour mélange hydrocarboné à chaud - Partie 6: Détermination de la masse volumique apparente des éprouvettes bitumineuses

Asphalt - Prüfverfahren für Heißasphalt - Teil 6: Bestimmung der Raumdichte von Asphalt-Probekörpern

This European Standard was approved by CEN on 9 March 2012.

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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-CENELEC Management Centre has the same status as the official versions.

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Foreword

This document (EN 12697-6:2012) 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of an identical text or by endorsement, at the latest by October 2012, and conflicting national standards shall be withdrawn at the latest by October 2012.

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 12697-6:2003+A1:2007.

The significant changes from that document are:

- The density of water at test temperature is now obtained from a formula instead of a table;
- All densities are now expressed in megagram per cubic metre (Mg/m^3) instead of in kilogram per cubic metre (kg/m^3);
- The requirement for the thermometer used in dry, SSD or sealed specimen procedures has been changed;
- The requirement on the drying of specimens has been changed;
- The definition of constant mass has been changed;
- In procedure B, the order of carrying out steps a) to g), when testing damp specimens, has been corrected;
- In procedure B, the Note concerning the saturation period of specimens has been changed and is now limited to a maximum;
- In procedure A, B and C, the specific requirement for the accuracy of the density of water when calculating the bulk density of specimens has been deleted, with the general rule defined in Clause 5 “Materials” being applicable;
- In procedure C, the formula used to calculate “bulk density dry sealed specimen” has been corrected;
- In procedure D, the formula used to calculate “bulk density by dimensions” both of cylindrical and rectangular specimens has been changed in order to be consistent with new density units;
- In the test report, a new paragraph with reference to dimensions of specimens has been added;
- In Annex A, a paragraph regarding specific requirements for particular method to be used for CE marking has been added.

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 method 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 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 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 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 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 mixtures by a 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 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 coarse foreign matter 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*

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

— FprEN 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*

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

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

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, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

1 Scope

This European Standard describes test methods for determining the bulk density of a compacted bituminous specimen. The test methods are intended for use with laboratory compacted specimens or specimens from the pavement after placement and compacting, either by coring or sawing.

This European Standard describes the following four procedures, the choice of which is used being dependent on the estimated content and accessibility of voids in the specimen:

a) bulk density — dry (for specimens with a very closed surface);

b) bulk density — saturated surface dry (SSD) (for specimens with a closed surface);

c) bulk density — sealed specimen (for specimens with an open or coarse surface);

d) bulk density by dimensions (for specimens with a regular surface and with geometric shapes, i.e. squares, rectangles, cylinders, etc.).

NOTE Annex A (informative) gives general guidance on selecting the appropriate procedure.

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 12697-29:2002, *Bituminous mixtures — Test methods for hot mix asphalt — Part 29: Determination of the dimensions of a bituminous specimen*

EN 13108-20, *Bituminous mixtures — Material specifications — Part 20: Type Testing*

3 Terms and definitions

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

3.1
bulk density
mass per unit volume, including the air voids, of a specimen at known test temperature

3.2
maximum density
mass per unit volume, without air voids, of a bituminous mixture at known test temperature

4 Principle

The bulk density of an intact compacted bituminous specimen is determined from the mass of the specimen and its volume. The mass of the specimen is obtained by weighing the dry specimen in air.

For the first three procedures, the volume of the specimen is obtained from its mass in air and its mass in water. In the dry procedure, the mass in water is determined without pre-treatment. In the SSD-procedure, the specimen is first saturated with water, after which its surface is blotted dry with a damp Chamois. In the sealed specimen procedure, the specimen is sealed before immersion in water to prevent access of water to the voids in the specimen. In the fourth procedure, by dimensions, the volume of the specimen is obtained by measurement of the dimensions.

5 Materials

5.1 General

Calculate the density of water at the test temperature in megagram per cubic metre (Mg/m^3) to the nearest 0,000 1 Mg/m^3 as follows:

$$\rho_w = 1{,}000\ 252\ 05 + \left(\frac{7{,}59 \times t - 5{,}32 \times t^2}{10^6} \right) \quad (1)$$

where

t is the temperature of the water, in degrees Celsius (°C);

ρ_w is the density of the water at test temperature, in megagram per cubic metre (Mg/m^3).

5.2 Additional materials for the sealed specimen procedure

Material to seal the specimen, in such a way, that inclusion of voids (being no part of the specimen) between seal and specimen is prevented. The density of the sealing material at test temperature shall be known to the nearest 0,010 Mg/m^3.

NOTE The material used can be paraffin wax, shrinkage foil, latex emulsion etc. The procedure to apply such materials should be such that the specimen is not damaged. It is very important that the seal exactly covers the specimen including the voids which technologically form part of its volume: when applying the seal penetration of the internal voids belonging to the material is prevented, as well as inclusion of extra voids between seal and specimen or in seal folds.

6 Apparatus

6.1 General

6.1.1 Balance, with sufficient capacity for weighing the specimen in air and under water (e.g. via a wire basket, the mass and water displacement of which are taken into account by taring), with an accuracy of at least ± 0,1 g.

6.2 Additional apparatus for the dry, SSD and sealed specimen procedures

6.2.1 Water-bath, maintained at a uniform temperature within ± 1,0 °C in the vicinity of the test specimen(s).

It shall be provided with a grid to ensure the water circulation around the test specimen. The bath shall have a capacity of at least three times that of the volume of the specimen.

6.2.2 Thermometer.

6.3 Additional apparatus for the SSD-procedure

6.3.1 Chamois, damp, for blotting and wiping the specimen.

The Chamois shall be damp enough to ensure that the moisture at the specimen surface is removed when wiping without withdrawing moisture from the internal voids.

6.4 Additional apparatus for the dimensions procedure

6.4.1 Calliper gauge, or other suitable apparatus for measuring the dimensions of the specimen to at least ± 0,1 mm (see EN 12697-29:2002).

7 Sample sizes and sample handling

The minimum thickness of the specimen shall be 20 mm or two times the maximum nominal size of the aggregate, whichever is largest.

Care shall be taken to ensure that the specimens are not disturbed during handling. The specimens shall be stored in a cool place at a temperature not exceeding 25 °C.

8 Preparation of sample

Specimens shall be cleaned if necessary by brushing or washing, as required.

The specimens shall be dry, have a known water content, or be allowed to dry to constant mass.

NOTE Constant mass is defined as successive weighings after drying at least 1 h apart not differing more than 0,1 %.

9 Procedure

9.1 General

All masses shall be determined in gram to the nearest 0,1 g. All measurements shall be determined in millimetre to the nearest 0,1 mm.

NOTE General guidance on determining the required procedure related to the specific bituminous material is given in Annex A.

9.2 Procedure A: Bulk density — dry

Carry out the procedure as follows:

a) Determine the mass of the dry specimen (m_1). When testing damp specimens, step a) shall be carried out after steps b) to d).

b) Determine the density of the water at test temperature at the nearest 0,000 1 Mg/m^3 (ρ_w) according to 5.1.

c) Immerse the specimen in the water-bath kept at known test temperature.

d) Determine the mass of the specimen immediately the water has settled after immersion (m_2).

9.3 Procedure B: Bulk Density — Saturated surface dry (SSD)

Carry out the procedure as follows:

a) Determine the mass of the dry specimen (m_1). When testing damp specimens, step a) shall be carried out after steps b) to g).

b) Determine the density of the water at test temperature to the nearest 0,000 1 Mg/m^3 (ρ_w) according to 5.1.

c) Immerse the specimen in the water-bath at known test temperature. Allow the water to saturate the specimen sufficiently long enough for the mass of the specimen not to change.

NOTE In general, the required saturation period is 30 min but should not be more than 3 h.

d) Determine the mass of the saturated specimen when immersed (m_2), taking care no air bubbles adhere to the surface of the specimen or leave the specimen when weighing.

e) Remove the specimen from the water, dry the surface from adhered drops by wiping with a damp Chamois.

f) If water continues to drain from the sample, discontinue the measurement by Procedure B, saturated surface dry, and undertake the measurement by Procedure C, sealed specimen.

g) Determine the mass of the saturated, surface wiped specimen in air immediately after drying (m_3).

9.4 Procedure C: Bulk Density — Sealed specimen

Carry out the procedure as follows:

a) Determine the mass of the dry specimen (m_1).

b) Determine the density of the water at test temperature to the nearest 0,000 1 Mg/m^3 (ρ_w) according to 5.1.

c) Seal the specimen in such a way, that the internal voids in the specimen being part of the volumetric material composition are not penetrated and that no extra voids are included between seal and specimen or in seal folds. After sealing, the specimen shall be inaccessible to water when submerged.

When using paraffin wax, obtain sealing using the following procedure:

1) Bring the paraffin wax to its melting temperature + 10 °C and maintain this temperature at ± 5 °C.

2) Immerse the specimen partially in the paraffin wax for less than 5 s, agitating the specimen to make the air balls free. After cooling and solidification of the paraffin wax on this part of the specimen, repeat the same procedure on the other part. Repeat these procedures until a continuous film of paraffin wax is obtained, which totally cover the specimen.

d) Determine the mass of the dry sealed specimen (m_2).

e) Immerse the specimen in the water-bath kept at known test temperature.

f) Determine the mass of the sealed specimen under water (m_3), taking care no air bubbles adhere to the sealing when weighing.

9.5 Procedure D: Bulk density by dimensions

Carry out the procedure as follows:

a) Determine the dimensions of the specimen in millimetre in accordance with EN 12697-29.

b) Determine the mass of the dry specimen (m_1).

10 Calculation

10.1 Procedure A: Bulk density — dry

Calculate the bulk density dry of the specimen (ρ_{bdry}) to the nearest 0,001 Mg/m^3 as follows:

$$\rho_{bdry} = \frac{m_1}{m_1 - m_2} \times \rho_w \quad (2)$$

where

ρ_{bdry} is the bulk density dry, in megagram per cubic metre (Mg/m^3);

m_1 is the mass of the dry specimen, in gram (g);

m_2 is the mass of the specimen in water, in gram (g);

ρ_w is the density of the water at test temperature, in megagram per cubic metre (Mg/m^3).

10.2 Procedure B: Bulk density — SSD

Calculate the bulk density (SSD) of the specimen (ρ_{bssd}) to the nearest 0,001 Mg/m^3 as follows:

$$\rho_{bssd} = \frac{m_1}{m_3 - m_2} \times \rho_w \quad (3)$$

where

ρ_{bssd} is the bulk density (SSD), in megagram per cubic metre (Mg/m^3);

m_1 is the mass of the dry specimen, in gram (g);

m_2 is the mass of the specimen in water, in gram (g);

m_3 is the mass of the saturated surface-dried specimen, in gram (g);

ρ_w is the density of the water at test temperature, in megagram per cubic metre (Mg/m^3).

10.3 Procedure C: Bulk density — Sealed specimen

Calculate the bulk density dry sealed specimen (ρ_{bsea}) to the nearest 0,001 Mg/m^3 as follows:

$$\rho_{bsea} = \frac{m_1}{(m_2 - m_3)/\rho_w - (m_2 - m_1)/\rho_{sm}} \quad (4)$$

where

ρ_{bsea} is the bulk density sealed, in megagram per cubic metre (Mg/m^3);

m_1 is the mass of the dry specimen, in gram (g);

m_2 is the mass of the sealed specimen dry, in gram (g);

m_3 is the mass of the sealed specimen in water, in gram (g);

ρ_w is the density of the water at test temperature, in megagram per cubic metre (Mg/m^3);

ρ_{sm} is the density of the sealing material at test temperature, in megagram per cubic metre (Mg/m^3).

10.4 Procedure D: Bulk density by dimensions

10.4.1 Cylindrical specimen

Calculate the bulk density by dimensions of a cylindrical specimen (ρ_{bdim}) to the nearest 0,001 Mg/m^3 as follows:

$$\rho_{bdim} = \frac{m_1}{\frac{\pi}{4} \times h \times d^2} \times 10^3 \quad (5)$$

where

ρ_{bdim} is the bulk density of the specimen — procedure “by dimensions”, in megagram per cubic metre (Mg/m^3);

m_1 is the mass of the dry specimen, in gram (g);

h is the height of the specimen, in millimetre (mm);

d is the diameter of the specimen, in millimetre (mm).

10.4.2 Rectangular specimen

Calculate the bulk density by dimensions of a rectangular specimen (ρ_{bdim}) to the nearest 0,001 Mg/m^3 as follows:

$$\rho_{bdim} = \frac{m_1}{h \times l \times w} \times 10^3 \quad (6)$$

where

ρ_{bdim} is the bulk density of the specimen procedure “by dimensions”, in megagram per cubic metre (Mg/m^3);

m_1 is the mass of the dry specimen, in gram (g);

h is the height of the specimen, in millimetre (mm);

l is the length of the specimen, in millimetre (mm);

w is the width of the specimen, in millimetre (mm).

11 Precision

11.1 General

The precision data for this method are informative and have been obtained from DIN 1996-7:1992-12 [1] which is similar to procedure B: SSD. The procedure implements values depending on mix type for σ_R = $(8 - 28) \times 10^{-3}$ Mg/m^3 and $R = (22 - 82) \times 10^{-3}$ Mg/m^3. The exact values for the other procedures are not available.

11.2 Repeatability (same observer — same apparatus)

Standard deviation: $\sigma_r = (6 + 0{,}1 \times A) \times 10^{-3}$ Mg/m^3

Repeatability: $r = 2{,}77 \times \sigma_r = (17 + 0{,}3 \times A) \times 10^{-3}$ Mg/m^3

where

A is the percentage by mass of mineral aggregate larger than 11,2 mm in the bituminous mixture.

11.3 Reproducibility (different observers — different apparatus)

Standard deviation: $\sigma_R = (8 + 0{,}2 \times A) \times 10^{-3}$ Mg/m^3

Reproducibility: $R = 2{,}77 \times \sigma_R = (22 + 0{,}6 \times A) \times 10^{-3}$ Mg/m^3

where

A is the percentage by mass of mineral aggregate larger than 11,2 mm in the bituminous mixture.

12 Test report

With reference to this European Standard, the test report shall include the following information:

a) origin of the specimen;

b) thickness of the specimen, in millimetre, if it is cut from the road;

c) other dimensions of the specimens if required;

d) mass of the dry specimen, in gram;

e) test procedure that has been followed;

f) if appropriate, the sealing material used;

g) bulk density, in megagram per cubic metre to the nearest 0,001 Mg/m^3.

Annex A
(informative)

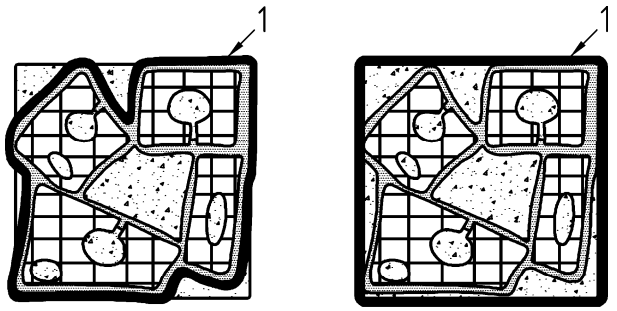
General guidance on selection of a test procedure to determine the bulk density of compacted bituminous materials

A.1 General

The main issue in selecting a procedure for the determination of the bulk density of bituminous materials is, whether the voids in the specimen surface are taken into account as a part of the specimen volume sufficiently precisely. The ideal procedure takes into account exactly those voids that are part of the volumetric material composition, but neglects those voids that occur as specimen irregularities due to the specimen preparation method.

The specific requirements for the particular method to be used for CE marking are given in EN 13108-20.

A.2 Background (see Figure A.1)



Key

1 ——— boarders of measured volume

Figure A.1 — Voids in the specimen

Figure A.1 a) shows the effect of procedures A and B: As the water penetrates the surface voids, they are not seen as a part of the volume of the specimen. In this case, a relatively low volume a relatively high bulk density will be calculated. This is correct if the surface voids do occur e.g. due to the specimen preparation method or due to sampling defects. However, this is not correct in the case of a coarse bituminous mixture with high voids content: The voids that are an intrinsic part of the mixture are not validated. In that case, the obtained mixture density is not representative for the produced material.

NOTE When the pores are wide, the water will leave the specimen after taking it out of the water bath. The negative effect will be less severe; however, in that case the accuracy of the procedure will be reduced as the handling of the specimen because the test operator activities will have an increased influence on the test result.

Figure A.1 b) shows the effect of procedure D: The volume is obtained via measuring the dimensions of the specimen which means that all surface voids are incorporated in the specimen volume. This thus leads to a relatively high specimen volume or a relatively low bulk density. This procedure will be correct if the surface voids are an intrinsic part of the bituminous material.

An intermediate result is obtained when the specimens are sealed (procedure C): Part of the surface voids will be measured as belonging to the specimen volume, part of the voids will be excluded from the specimen volume. This procedure theoretically will provide the most realistic results; however due to practical operational problems, the increased complexity of this procedure (which is not relevant to all materials) and costs, this procedure is not applied in all cases.

A.3 Guidance

To select a procedure for a specific situation the following guidance is given:

a) Procedure A: Bulk density — Dry

Procedure A is suitable for measuring the bulk density of very dense, practically non-absorptive bituminous specimens. It is a quick, easy method and is, for example, particularly convenient for many dense laboratory prepared specimens.

The applicability of the procedure is related to the specimen surface texture and the accessibility of internal voids of the specimen: the specimen should be smooth, the internal voids should be difficult to access. This procedure is suitable e.g. for hot rolled asphalt (smooth specimen, relatively very fine pores) and for mastic asphalt (almost no accessible pores).

b) Procedure B: Bulk density — SSD

Procedure B is suitable for measuring the bulk density of dense-graded bituminous specimens having a low water absorption level or a slow drainage of absorbed water.

Extreme care should be taken in achieving the saturated, surface dried state of the specimen. An excess film of moisture on the surface will lead to an under-estimation of the bulk density and thus to an over-estimation of the voids level in the specimen or an under-estimation of the level of voids filled with binder. Excessive drainage of water will lead to an over-estimation of the bulk density and thus to an under-estimation of the voids level of the specimen.

The applicability of this procedure is related to the voids level and the diameter of the pores: for continuously graded materials such as asphalt concrete (with relatively small pores) with voids contents up to approximately 5 %, for materials which give rise to large diameter voids in the specimen (e g. stone mastic asphalt) up to approximately 4 %.

c) Procedure C: Bulk density — sealed specimen

Procedure C is suitable for measuring the bulk density of bituminous specimens with air voids levels up to 15 %. The method however is less convenient to conduct than either procedure A or B and is therefore rarely used.

In the case of testing laboratory prepared specimens with a rough surface texture, certain sealing materials (e.g. foils) cause observation of texture voids as internal specimen voids, which may cause an under-estimating of the specimen density or an over-estimating of the air voids level of the specimen. Other sealing materials (e.g. paraffin wax) might penetrate into the internal voids of the specimen, leading to an over-estimation of the bulk density and thus to an under-estimation of the air voids level of the specimen.

This procedure is not suitable for reclaimed asphalt because it cannot be excluded that it contains water.

d) Procedure D: Bulk density by dimensions

Procedure D is suitable for measuring the bulk density of bituminous specimens whatever the voids content may be. Specimens should have a regular surface and a geometric shape to facilitate the measurement of their dimensions. Procedure D described in this European Standard is suitable for void contents greater than 15 %.

Also in this procedure the surface texture voids are considered as part of the internal specimen voids, which may cause an under-estimating of the specimen density or an over-estimating of the air voids level of the specimen. This is especially significant when laboratory prepared specimens (not sawn or cored) are being tested.

Procedure D is particularly applicable to porous asphalt.

Bibliography

[1] DIN 1996-7:1992-12, *Testing of asphalt; Determination of bulk density, compacted density, void content and degree of compaction* [1)]

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

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

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

1) Document withdrawn.

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