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Bitumenske zmesi - Preskusne metode - 10. del: Zgostljivost

Bituminous mixtures - Test methods - Part 10: Compactability

Asphalt - Prüfverfahren für Heißasphalt - Teil 10: Verdichtbarkeit

Mélanges bitumineux - Méthodes d'essai pour mélange hydrocarboné à chaud - Partie 10 : Compactabilité

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English Version

Bituminous mixtures - Test methods - Part 10: Compactability

Mélanges bitumineux - Méthodes d'essai pour mélange hydrocarboné à chaud - Partie 10 : Compactabilité

Asphalt - Prüfverfahren für Heißasphalt - Teil 10: Verdichtbarkeit

This European Standard was approved by CEN on 21 August 2017.

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

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European foreword

This document (EN 12697-10:2017) 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of an identical text or by endorsement, at the latest by June 2018, and conflicting national standards shall be withdrawn at the latest by June 2018.

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 12697-10:2001.

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

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

— Terms and definitions deleted, [3.1] to [3.10];

— definition of compactability and compaction resistance have been added, [3.1]and [3.2];

— [6.2] 2nd paragraph. "At least three tests shall be carried out on each mixture"; amended to: "At least three specimens shall be compacted on each mixture";

— more detailed explanation of regression analysis for impact compaction method [7.1.2];

— change of regression procedure for impact compaction procedure by considering only thickness measurements between impact 30 and 200 in reduce effect of manual mould filling [Figure 2];

— “force” added in Clause 8, List Entry e).

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

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.

1 Scope

This European Standard describes three test methods for characterizing the compactability of a bituminous mix, by the relation between its density or void content and the compaction energy applied to it, using an impact (Marshall) compactor, gyratory compactor, or a vibratory compactor.

This European Standard applies to bituminous mixtures, both those prepared in laboratory and those resulting sampled from plant produced mixtures. The results of the test method serve to supplement the results of mixture design.

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 12697-5, *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 12697-8, *Bituminous mixtures — Test methods for hot mix asphalt — Part 8: Determination of void characteristics of bituminous specimens*

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*

3 Terms and definitions

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

3.1
compactability
K, *k*
ability of an asphalt mixture to be compacted (*K* when evaluated by gyratory compaction and *k* when evaluated by vibratory compaction)

Note 1 to entry: High values of *K* and *k* will indicate a mixture for which less compaction energy is required to obtain a given void content decrease.

3.2
compaction resistance
C, *T*
resistance of an asphalt mixture to being compacted (*C* when evaluated by impact compaction of several specimens with varied compaction energy and *T* when evaluated by impact compaction of one specimen while measuring its thickness)

Note 1 to entry: High values of *C* and *T* will indicate a mixture for which high compaction energy is required to obtain a given void content decrease.

4 Principle

The bituminous mixture is compacted at a prescribed temperature with varying compaction energies using one of three optional types of compaction methods:

a) impact compaction

b) gyratory compaction

c) vibratory compaction.

Two methods of monitoring the compactability can be applied:

— Method 1: two or more specimen are compacted with different amounts of compaction energy and their densities are measured.

— Method 2: one specimen is used and its increase in density during the compaction process is determined from its decrease in thickness.

The following Table 1 defines the compaction type to use depending of the compactness of tracking method and gives the clause of test procedure.

Table 1 — Compaction type

	Procedure clause according to compaction method		
	impact	gyratory	vibratory
Compaction of specimens with varied compaction energy	6.1.1	n. a.	6.3
Measurement of specimen thickness during compaction	6.1.2	6.2	n. a.

A graph is drawn of density (or voids content) against compaction energy. When the impact compaction is used, the compaction energy is characterized by the number of blows, when the gyratory compaction is used, by the number of gyrations and when the vibratory compactor is used, by the duration in seconds.

A mathematical formula is derived from the experimental results, the parameters of which formula characterize the compactability of the bituminous mixture.

5 Apparatus

5.1 Impact compaction

5.1.1 Marshall compactor in accordance with EN 12697-30.

5.1.2 Measuring device for automatically recording the thickness of the specimen after each blow of compaction with an accuracy of at least 0,1 mm.

5.1.3 Slide calliper rule with accuracy 0,1 mm.

5.2 Gyratory compaction

5.2.1 Gyratory compactor in accordance with EN 12697-31.

5.3 Vibratory compaction

5.3.1 Vibratory compactor in accordance with EN 12697-32.

6 Test procedure

6.1 Impact compaction

6.1.1 Different specimens for each level of compaction energy, recording increases in density

For the determination of a single value of the compactability, prepare and compact Marshall specimen in accordance with EN 12697-30 for each number of blows of compaction. The numbers of blows shall be 5, 15, 25, 35, 50 and 100 to each side of the specimen.

If required, determine the mass of bituminous mixture to be used in the specimen in order to achieve the specimen thickness in accordance with EN 12697-30 by a preliminary compaction test.

Determine the bulk density of the compacted specimens in accordance with EN 12697-6.

6.1.2 One specimen for all levels of compaction energy, recording decreases in thickness

For the determination of a single value of compactability prepare and compact a Marshall specimen in accordance with EN 12697-30 using 100 blows of compaction to each side.

If required, determine the mass of bituminous mixture to be used in the specimen in order to achieve the specimen thickness in accordance with EN 12697-30 by a preliminary compaction test after 100 blows to each side by a preliminary compaction test.

Measure the change in thickness of the specimen after each blow using the specified device according to 5.1.2.

Once the specimen has cooled to room temperature, take four measurements of its final thickness from evenly spaced around the perimeter of the specimen by using the calliper as specified in 5.1.3. The position of these measurements shall be clearly marked along each specimen. All measurements shall have a limit deviation of ± 0,1 mm. Calculate the mean final thickness of the specimen from these four singles measurements.

Calculate the thickness of the specimen for each number of blows from the specimen thicknesses measured during the compaction process and the mean final thickness measured on the cooled specimen .

6.2 Gyratory compaction

Determine the variation of the density of the bituminous mixture with the number of gyrations in accordance with EN 12697-31. The number of gyrations shall be at least 200.

At least three specimens shall be compacted on each mixture. Use the arithmetic mean of the three or more densities for the calculation of the compactability.

Determine the maximum density of the mixture in accordance with EN 12697-5 and calculate the void content of the specimens for the various numbers of gyrations in accordance with EN 12697-8.

6.3 Vibratory compaction

Prepare the compacted specimens of bituminous mixture in accordance with EN 12697-32, except that initial compaction shall be achieved for a few seconds of vibration, use the large 146 mm diameter tamping foot.

Prepare duplicate specimens at different levels of compaction with a total compaction time for each side of the specimens of 10 s, 15 s, 20 s, 30 s, 60 s and 120 s. If no density increase occurs after 60 s, limit the total compaction time to 60 s but the number of compacted specimens remain as six.

Determine the bulk density of each specimen in accordance with EN 12697-6 and record the test result as the average of two determinations for each condition.

Determine the maximum density of mixture in accordance with EN 12697-5 and the air void content of each compaction levels in accordance with EN 12697-8.

7 Calculation and expression of results

7.1 Impact compaction

7.1.1 Different specimens for each level of compaction energy, recording increases in density

The variation of the bulk density of the compacted specimens as a function of the compaction energy can be expressed by Formula (1) using the regression parameters ρ_∞, ρ_0 and C. The regression parameters shall be evaluated by using optimization strategies in order to minimize the sum over the squared difference between measured and modelled values of $\rho(E_1)$. An example for test results is shown in Figure 1.

$$\rho\left(E_1\right) = \rho_\infty - \left(\rho_\infty - \rho_0\right) exp\left(\frac{-E_1}{C}\right) \quad (1)$$

where

$\rho(E_1)$ is the bulk density of specimens compacted at compaction energy, E_1, using an impact compactor, expressed in megagrams per cubic metre (Mg/m³);

ρ_∞ is the regression parameter; theoretical maximum achievable bulk density (impact compaction), expressed in megagrams per cubic metre (Mg/m³);

ρ_0 is the regression parameter; theoretical initial specimen bulk density (impact compaction), expressed in megagrams per cubic metre (Mg/m³);

E_1 is the compaction energy (impact compactor), expressed with 42 Nm as unit, its numerical value is equal to the number of blows to each side of the specimen;

C is the regression parameter; compaction resistance (impact compaction, method with different specimens for each level of compaction energy), expressed with 42 Nm as unit.