



BSI Standards Publication

PUBLISHED DOCUMENT

Asphalt — Guidance on the use of BS EN 12697 “Bituminous mixtures — Test methods”

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Foreword

Publishing information

This Published Document is published by BSI Standards Limited, under licence from The British Standards Institution, and came into effect on 30 April 2018. It was prepared by Subcommittee B/510/1, *Asphalt products*, under the authority of Technical Committee B/510, *Road materials*. A list of organizations represented on these committees can be obtained on request to their secretary.

Supersession

This Published Document supersedes PD 6692:2006, which is withdrawn.

Relationship with other publications

This Published Document gives guidance on the use and application of a series of European Standards for asphalt. These European Standards were prepared by CEN/TC 227/WG1, *Bituminous Materials*, and have been adopted as British Standards.

PD 6692 also gives guidance on the use of the various parts of [BS EN 12697](#), *Bituminous mixtures – Test methods for hot mix asphalt*, prepared by CEN/TC 227/WG1/TG2, that specify test methods for asphalt.

Guidance on the various parts of [BS EN 13108](#), *Bituminous mixtures – Material specifications*, is given in PD 6691.

Use of this document

As a guide, this Published Document takes the form of guidance and recommendations. It should not be quoted as if it were a specification or a code of practice and claims of compliance cannot be made to it.

Presentational conventions

The guidance in this Published Document is presented in roman (i.e. upright) type. Any recommendations are expressed in sentences in which the principal auxiliary verb is “should”.

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

Where words have alternative spellings, the preferred spelling of the Shorter Oxford English Dictionary is used (e.g. “organization” rather than “organisation”).

Contractual and legal considerations

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

Compliance with a Published Document cannot confer immunity from legal obligations.

0 Introduction

This Published Document provides guidance on the use of the European Standards and Technical Specifications specifying test methods for asphalt. The guidance is aimed primarily at potential UK users of the test methods, but will also be of interest to all in the UK associated with the manufacture and use of asphalt throughout Europe.

Most of the European test methods for asphalt are based on national test methods from European countries, including UK test methods specified in British Standards. This Published Document gives a description of each of these test methods, together with guidance on their relevance and familiarity to UK users.

Some general features of the European Standards for asphalt are outlined in [Clause 2](#), including the requirements for CE marking and differences between empirical and fundamental tests. [Clause 3](#) is divided into subclauses, each of which gives guidance on one of the European test methods for asphalt. These subclauses follow a similar pattern, in that the testing scope and the method are summarized, followed by UK experience.

All the new test methods are included, as well as those unfamiliar to UK users and which are therefore unlikely to be widely used in the UK. Methods for testing asphalt coated with bitumen emulsion are not included, but will be incorporated into a future edition of this document.

1 Scope

This Published Document gives guidance on the use of each of the European test methods for asphalt given in [BS EN 12697](#). The tests are divided into five groups:

- a) test methods required for testing the constituent materials, as identified in BS EN 13108-20:2016, Annex A;
- b) test methods called up in at least four of the standard specifications for the different types of asphalt, BS EN 13108-1 to BS EN 13108-7, as identified in BS EN 13108-20:2016, Annex B (see [Table 1](#));
- c) test methods called up in only specific standard specifications, as identified in BS EN 13108-20:2016, Annex B;
- d) test procedures used to support the test methods in BS EN 12697-30 to BS EN 12697-33, as identified in BS EN 13108-20:2016, Annex C, plus BS EN 12697-35; and
- e) test methods and procedures not called up in the asphalt standards.

Where standards fit into more than one category, they are described in the first and subsequently cross-referenced. The subclauses describing each of the tests are listed in [Table 1](#).

Table 1 — Asphalt tests in BS EN 12697 called up in asphalt specifications BS EN 13108

BS EN 12697			BS EN 13108						
Part	Description		Part 1	Part 2	Part 4	Part 5	Part 6	Part 7	Part 9
	Title	Sub-clause	AC	BBTM	HRA	SMA	MA	PA	AUTL
1	Soluble binder content	3.1	✓	✓	✓	✓	✓	✓	
2	Particle size distribution	3.2	✓	✓	✓	✓	✓	✓	
3	Bit. recovery: rotary evaporator	3.3							
4	Bit. recovery: fractionating column	3.4							
5	Maximum density	3.5	✓	✓	✓	✓		✓	
6	Bulk density	3.6	✓	✓	✓	✓	✓	✓	
7	Bulk density, gamma rays	3.7							
8	Void characteristics	3.8	✓	✓	✓	✓		✓	
9	Reference density	3.9	Withdrawn October 2011						
10	Compactibility	3.10							
11	Affinity between aggregate and bitumen	3.11						✓	
12	Water sensitivity	3.12	✓	✓	✓	✓		✓	
13	Temperature measurement	3.13							
14	Water content	3.14							
15	Segregation sensitivity	3.15							
16	Abrasion by studded tyres	3.16	✓	✓	✓	✓			
17	Particle loss of porous asphalt specimens	3.17						✓	
18	Binder drainage	3.18				✓		✓	
19	Permeability of specimen	3.19						✓	
20	Indentation: cube or cylindrical	3.20					✓		
21	Indentation using plates	3.21					✓		
22	Wheel tracking	3.22	✓		✓	✓			
23	Indirect tensile test	3.23							
24	Resistance to fatigue	3.24	✓						
25	Cyclic compression	3.25	✓				✓		
26	Stiffness	3.26	✓		✓				
27	Sampling	3.27							
28	Preparation of samples	3.28							
29	Dimensions of a specimen	3.29							
30	Spec prep: Impact compactor	3.30							
31	Spec prep: Gyratory compactor	3.31	✓	✓	✓	✓		✓	
32	Vibratory compactor	3.32							
33	Specimen prep: Roller compactor	3.33							
34	Marshall test	3.34	✓						
35	Laboratory mixing	3.35							
36	Thickness of a pavement	3.36							
37	Hot sand test for HRA chips	3.37							
38	Common equipment and calibration	3.38							
39	Binder content by ignition	3.39	✓	✓	✓	✓	✓	✓	
40	In-situ drainability	3.40							
41	Resistance to de-icing fluids	3.41	✓	✓	✓	✓	✓	✓	

Table 1 (continued)

BS EN 12697			BS EN 13108						
Part	Description		Part 1	Part 2	Part 4	Part 5	Part 6	Part 7	Part 9
	Title	Sub-clause	AC	BBTM	HRA	SMA	MA	PA	AUTL
42	Foreign material in reclaimed material	3.43							
43	Resistance to fuel	3.43	✓	✓	✓	✓	✓	✓	
44	Crack propagation by semi-circular bending	3.44	✓			✓			
45	Saturation ageing tensile stiffness conditioning (SATS)	3.45	✓						
46	Low temperature cracking and properties	3.46	✓	✓	✓	✓	✓	✓	✓
47	Ash content of natural asphalts	3.47							
48	Interlayer bonding	3.48							
49	Friction after polishing	3.49	✓	✓		✓		✓	✓
50	Resistance to scuffing	3.50							
51	Surface shear strength	3.51							
52	Oxidative ageing	3.52							

2 Overview of European Standards defining test methods for asphalts

2.1 “Back of the lorry”

Unlike previous British Standards for asphalt, the harmonized European Standards are intended to define the material arriving on site, i.e. still in the “back of the lorry” and before placement and compaction. There is therefore greater emphasis on laboratory tests to define the properties that the asphalt could achieve rather than site tests to confirm that the in-situ material has achieved the specified level of performance. As such, there is greater emphasis on laboratory-based tests and on methods to achieve repeatable preparation of the samples than was historically the case in the UK.

2.2 CE marking

The European Standard specifications for asphalt define the means of assessing a material against the essential requirements set out in the mandate for those documents. Generally, the assessment is defined in terms of the tests required to be undertaken and the classes that materials can be allocated to depending on the results of those tests. The set of classes that a material meets for each of the essential requirements defines its CE mark. Because the system is intended to apply across Europe without the need for retesting in each country, the tests have to be uniquely defined for each situation.

The tests required for CE marking and the available classes that can be claimed are dependent on the asphalt type being assessed and, hence, are given in the relevant part of BS EN 13108-1 to BS EN 13108-9. However, the test conditions under which those tests are performed, when not given in the test method itself, are given in BS EN 13108-20, which has normative annexes for:

- properties and test methods for bituminous mixtures;
- methods of sample preparation; and
- test procedures and conditions.

2.3 Status of tests

Tests can be categorized by their status within the system, although not formally defined in any part of [BS EN 12697](#). The options are:

- *Category 0*: test method not covered by a European Standard test method;
- *Category 1*: test method covered by a European Standard test method, but not called up by a European Standard material specification;
- *Category 2*: test method covered by a European Standard test method that is called up by a European Standard material specification, but is not applied for CE marking of the material; and
- *Category 3*: test method covered by a European Standard test method that is called up by a European Standard material specification and is applied for CE marking of the material.

In these definitions, “test method” includes the test parameters used. For example, with the wheel tracking test, the small size device with [BS 598-110](#) frequency and load is category 0, the extra-large device is category 1 and the small-scale device to Procedure A is category 2 for stone mastic asphalt (SMA) and category 3 for hot rolled asphalt (HRA). As demonstrated by this example, the categories can change depending on the material being assessed.

For the purposes of distinguishing whether a test, including test parameters, covered by [BS EN 12697](#) is categorized as 1, 2 or 3, the test parameters have to be as given in BS EN 13108-20:2016, Annex D; the part of [BS EN 13108](#) specific to the mixture type for category 2; and the table relevant to the mixture type of BS EN 13108-20:2016, Annex B, for category 3.

2.4 Empirical and fundamental tests

The ultimate aim of the European Standard specifications for asphalt was to specify the material in terms of fundamental, performance-based properties. However, given the differences in knowledge and experience with fundamental specifications for asphalt mixtures in Europe, it was not possible to restrict the specifications to the fundamental approach. Therefore, it was planned to provide two ways of specifying asphalt:

- a) the *empirical approach*, specifying asphalt in terms of compositional recipes and requirements for constituent materials, with additional requirements based on performance-related tests; and
- b) the *fundamental approach*, specifying asphalt in terms of performance-based requirements linked to limited prescription of composition and constituent materials, offering a greater degree of freedom.

It was envisaged that, as users gain experience with performance-based testing, there would be a shift towards greater use of the fundamental approach to specification.

The definitions underpinning this dual approach are:

- 1) performance-based requirement:
requirement for a fundamental engineering property (e.g. stiffness, fatigue properties) that predicts performance and appears in primary performance prediction relationships;
- 2) performance-related requirement:
requirement for a characteristic (e.g. wheel tracking properties, Marshall properties) that has been found to correlate with a fundamental engineering property that predicts performance;
- 3) empirical specification:
combination of requirements for composition and constituent materials, together with performance-related requirements;

4) fundamental specification:

combination of performance-based requirements and limited requirements for composition and constituent materials, with more degrees of freedom than for an empirical specification.

However, only the European Standard for asphalt concrete, BS EN 13108-1, has been drafted to include the fundamental specification approach, the other standards being restricted to the empirical specification approach. Furthermore, there is often some confusion as to whether some tests provide performance-based requirements or performance-related requirements, particularly the simulative tests.

3 Guidance on test methods required for testing the constituent materials

3.1 BS EN 12697-1 — Soluble binder content

NOTE The references in this subclause to specific annexes of BS EN 12697-1 are to the 2012 edition.

3.1.1 Scope of BS EN 12697-1

BS EN 12697-1 describes test methods for the determination of the soluble binder content of samples of bituminous mixtures. The test methods described are suitable for quality control purposes during the production of plant mix and for checking compliance with a product specification. The guidance given in Annex D for the analysis of mixtures containing modified binders should be followed.

3.1.2 Summary of method

BS EN 12697-1 provides a unified approach to the examination of asphalt mixtures that allows some divergence in the detail of procedures followed by individual laboratories. The determination of binder content comprises:

- a) binder extraction by dissolving the sample in a hot or cold solvent;
- b) separation of the mineral matter from the binder solution;
- c) determination of the binder content by difference or by binder recovery;
- d) calculation of the soluble binder content; and
- e) if required, correction for any insoluble portion of the binder.

The standard includes a definition of binder content that allows for there being an insoluble portion.

The basic operations for both binder extraction and separation of the mineral matter are given, together with requirements for equipment in a normative annex. Another normative annex sets out the method for determining the residual mineral matter in the binder extracted by incineration, which may be followed as part of the sequence of operations to obtain a test result, but is otherwise used to prove the effectiveness of the separation of mineral matter.

The methods covered for binder extraction are:

- 1) hot extractor (paper filter);
- 2) hot extractor (wire mesh filter);
- 3) Soxhlet extractor;
- 4) bottle rotation machine;
- 5) centrifuge extractor; and
- 6) cold mix dissolution of bitumen by agitation.

The methods covered for the separation of mineral matter are:

- i) continuous flow centrifuge;
- ii) pressure filter;
- iii) bucket centrifuge Type 1; and
- iv) bucket centrifuge Type 2.

The methods covered for determining the soluble binder content are:

- recovery from a portion using a volume calculation; and
- recovery from a portion using a mass calculation.

All permitted combinations of these methods are considered to give the same result. Other methods and equipment, including automated equipment, can be used provided it can be demonstrated that they provide the same results as one of the given methods within the limits of the precision given in the standard. This assumption is generally correct provided the same solvent is used, but no agreement could be reached across Europe as to which solvent to use because of the hazards associated with all of them. In the UK, the continued use of methylene chloride (dichloromethane) is recommended.

Another, informative, annex (Annex D) gives guidance on the determination of soluble binder content of mixtures with polymer-modified binders.

3.1.3 Test equipment

3.1.3.1 The hot extractor (paper filter)

The hot extractor (paper filter) is a cylindrical container made from non-corrodible or brass gauze of approximately 1 mm to 2 mm aperture size or, alternatively, a spun copper tube, with a ledge at the bottom on which a removable gauze disc rests.

3.1.3.2 The hot extractor (mesh filter)

The hot extractor (mesh filter) is a glass or metal extractor, fitted with a condenser and suitable extraction cup.

3.1.3.3 The Soxhlet extractor

The Soxhlet extractor is a glass extractor consisting of a flask, an extraction case with tap and vapour tube, and a condenser.

3.1.3.4 The bottle rotation machine

The bottle rotation machine method involves rolling the test portion with solvent in a metal bottle with a capacity appropriate to the size of sample being analysed, with procedures for both binder determination by difference (procedure 1) and binder portion recovered (procedure 2, also known as the binder direct method).

3.1.3.5 The centrifuge extractor

The centrifuge extractor consists of a bowl, an apparatus in which the bowl can be revolved, a container for collecting the solvent thrown from the bowl, and a drain for removing the solvent.

3.1.3.6 Sealed container for the cold mix dissolution of bitumen by agitation

For the cold mix dissolution of bitumen by agitation, a weighed mass of asphalt is placed in the sealed container

3.1.3.7 The continuous flow centrifuge

The continuous flow centrifuge is a high-speed continuous flow centrifuge.

3.1.3.8 The pressure filter

The pressure filter has a dry, pre-weighed filter paper fitted into it. A nest of test sieves is supported above a funnel mounted above the pressure filter.

3.1.3.9 The bucket centrifuge type 1

The bucket centrifuge type 1 (for use with samples from the bottle rotation machine) has four buckets fitted and centrifuge tubes of at least $(50 \times 10^3) \text{ mm}^3$ capacity and an acceleration of between $(1.5 \times 10^4) \text{ m/s}^2$ and $(3.0 \times 10^4) \text{ m/s}^2$.

3.1.3.10 The bucket centrifuge type 2

The bucket centrifuge type 2 (for use with agitated samples) uses higher speeds, producing a minimum acceleration of not less than $40\,000 \text{ m/s}^2$ for at least 30 min for mastic asphalt (MA) and for at least 15 min for other types of mixture.

3.1.3.11 Binder content of mixtures containing modified binders

With regard to the binder recovery methods, for the bottle rotation machine method the minimum rolling times should be increased, although the rotation speed of the bottles should not exceed 20 rev/min because of the risk of crushing the aggregate.

3.1.4 UK experience

The procedures followed using the test equipment described in [3.1.3.2](#) to [3.1.3.7](#) and in [3.1.3.10](#) have not been widely adopted in the UK.

UK experience of BS EN 12697-1 is almost exclusively with the bottle rotation method of binder extraction, followed by mineral separation using either the pressure filter method, often referred to as “binder by difference” or the bucket centrifuge type 1 method, often referred to as “binder direct”.

UK experience has demonstrated that following the standard requirements for the bucket centrifuge type 1 method (“binder direct”) does effectively separate the mineral filler from the binder solution. Therefore it is not necessary to demonstrate this by use of the method in BS EN 12697-1, Annex C. It is also not known to be used in the UK to prove the effectiveness of the separation of the mineral matter in other methods.

Polymer-modified binders, the use of which continues to increase, need to have defined procedures for assessing the binder contents of such mixtures. However, there is limited detail in Annex D, in particular with respect to recommendations about suitable solvents and/or additional procedures for each type of polymer used.

Much of the laboratory determination of asphalt binder content for factory production control purposes has moved to the ignition method covered by BS EN 12697-39 on environmental and health and safety grounds.

3.2 BS EN 12697-2 — Determination of particle size distribution

3.2.1 Scope of BS EN 12697-2

BS EN 12697-2 specifies a procedure for the determination of the particle size distribution of the aggregate of bituminous mixtures by sieving. The test is applicable to aggregates recovered after binder extraction in accordance with BS EN 12697-1 or BS EN 12697-39.

3.2.2 Summary of method

BS EN 12697-2 references BS EN 12697-1 for extracting the binder by solvent to obtain the aggregate provided that, if there is insufficient material available, all the material is to be used. However the minimum amount of material is the lesser of 50 *D* g and 1 000 g. The particle size distribution is then obtained by sieving in accordance with BS EN 933-1. If the material has been thoroughly washed during extraction so that it has a limited fines content, dry sieving can be used, but further washing might be necessary if more than 1% of the aggregate passes 0.063 mm sieve.

3.2.3 UK experience

The standard is well established and widely used in the UK.

3.3 BS EN 12697-3 — Bitumen recovery: rotary evaporator

3.3.1 Scope of BS EN 12697-3

BS EN 12697-3 describes a test method for the recovery of soluble bitumen from bituminous mixtures used in road, airfield or similar pavements in a form suitable for further testing. The test can be undertaken on either loose or compacted asphalt materials. The procedure is only suitable for the recovery of paving grade bitumens, for which materials this is the reference method. For recovery of polymer-modified bitumens, the rotary evaporator is recommended. The fractionating column procedure (see BS EN 12697-4) is the reference method for mixtures containing volatile matter such as cut-back bitumen.

3.3.2 Summary of method

The bitumen is separated from the sample by dissolving in dichloromethane (or other suitable solvent). After removal of undissolved solids from the bitumen solution, the bitumen is recovered from it by vacuum distillation using a rotary evaporator. The bitumen is in solution for less than 24 h.

3.3.3 UK experience

For clarity, the bitumen solution is poured through a 0,063 mm sieve to remove the insoluble material retained on this sieve, prior to removal of insoluble material passing a 0,063 mm sieve by centrifuging or filtration. For use of dichloromethane as solvent, the temperature of the first phase of distillation is changed from 115 °C to 85 °C. However, as this can prolong the extraction significantly, experience indicates that this temperature can be increased to 100 °C, where it is assumed that identical binder properties would be obtained. It should also be noted that if the pressure rises above atmospheric in the evaporator, it could lead to breakage. When residuum other than binder appears at the inner side of the evaporating flask, this fact and the colour of the residuum should be reported. In the case of modifiers added to the binder, e.g. waxes, these modifiers might not be thoroughly dissolved/diluted in the recovered binder. This limitation could influence the binder properties.

3.4 BS EN 12697-4 — Bitumen recovery: fractionating column

3.4.1 Scope of BS EN 12697-4

BS EN 12697-4 specifies a test method for the recovery of soluble bitumen from bituminous mixtures from pavements in a form suitable for further testing. The procedure is the reference method for mixtures containing volatile matter, such as cutback bitumen, but is also suitable for the recovery of penetration grade bitumen.

3.4.2 Summary of method

The binder is separated from the sample by dissolving in dichloromethane. After removal of undissolved solids, the binder solution is concentrated by atmospheric distillation in a fractionating column. The last traces of solvent are removed from the concentrate by distillation at an elevated

temperature and reduced pressure with a stream of carbon dioxide gas. When cutback bitumens containing very volatile fluxes are being recovered, the carbon dioxide gas is omitted.

3.4.3 UK experience

The standard is used in the UK for recovering bitumen from mixtures containing volatile matter, such as cutback bitumens. The accuracy of the results of subsequent tests on these recovered binders might be less precise than those obtained from testing paving-grade binders.

3.5 BS EN 12697-5 — Determination of the maximum density

3.5.1 Scope of BS EN 12697-5

BS EN 12697-5 specifies test methods for determining the maximum density of a bituminous material (voidless mass). It specifies a volumetric procedure, a hydrostatic procedure and a mathematical procedure. The test methods are intended for use with loose bituminous mixtures containing paving grade bitumens, modified binders or other bituminous binders used for hot mix asphalt. The tests are suitable for either fresh or aged bituminous materials. Samples can be supplied as loose material or as compacted material, but the latter should first be loosened and separated (see [3.5.2.1](#) and [3.5.2.2](#)).

3.5.2 Summary of methods

3.5.2.1 Volumetric method

The volumetric method is the reference method for determining maximum density. The sample is broken up into coarse aggregate and agglomerations of not more than 6 mm diameter in order to expose any occluded voids. The volume of the material is measured as the de-aired water displaced in a pycnometer, after evacuating any air by the application of a partial vacuum. Boiled water or a suitable organic solvent can be used instead of de-aired water. The maximum density is then calculated from that volume and the dry mass of the sample.

3.5.2.2 Hydrostatic method

The sample is broken up into coarse aggregate and agglomerations of not more than 6 mm diameter in order to expose any occluded voids. The material is then weighed in air and water. If required, a partial vacuum can be applied or the water used can have been boiled. The maximum density is calculated from the dry and wet masses.

3.5.2.3 Mathematical method

The maximum density is calculated from the densities of the constituent components and their relative proportions in the mixture.

3.5.3 UK experience

The method most widely used in the UK for CE marking purposes is the volumetric procedure with water.

The maximum density of airfield materials is generally determined by the mathematical procedure.

The mathematical method is also a useful check on the volumetric procedure for all bituminous mixtures.

3.6 BS EN 12697-6 — Determination of bulk density of bituminous specimens

NOTE The references in this subclause to specific annexes of BS EN 12697-6 are to the 2012 edition.