

PUBLISHED DOCUMENT

Asphalt –

Guidance on the use of BS EN 12697 “Bituminous mixtures – Test methods for hot mix asphalt”

ICS 93.080.20



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Summary of pages

This document comprises a front cover, an inside front cover,
pages i and ii, pages 1 to 65 and a back cover.

Foreword

Publishing information

This Published Document was published by BSI and came into effect on 31 October 2006. It was prepared by Subcommittee B/510/1, *Hot asphalt and coated macadam*, under the authority of Technical Committee B/510, *Road materials*. A list of organizations represented on this committee can be obtained on request to its secretary.

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. Conflicting British Standards relating to asphalt will be withdrawn at the latest by January 2008.

PD 6692 gives guidance on the use of the various parts of European Standard BS EN 12697, *Tests for bituminous materials*, prepared by CEN/TC 227/WG1/TG2, that specify test methods for asphalt.

This package includes European Standards that supersede conflicting parts of BS 598. The parts of BS 598 that are superseded by the parts in this European Standard are listed in Annex A and will be withdrawn on 1 January 2008.

NOTE Users of the different parts of BS 598 should contact BSI Customer Services for confirmation of their withdrawal.

Guidance on the various parts of European Standard BS EN 13108, *Bituminous mixtures – Material specification*, is given in PD 6691.

Presentational conventions

The provisions in this standard are presented in roman (i.e. upright) type. Its 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.

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 British Standard cannot confer immunity from legal obligations.

Introduction

This Published Document provides guidance on the use of the European Standards 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. PD 6692 gives a description of each of these European test methods along with guidance on their relevance and familiarity to UK users.

Some general features of the European Standards for asphalt are outlined in Clause 2. These features make fundamental changes to the way in which asphalts are specified and tested in the UK. Clauses 3 to 7 give guidance on each of the European test method standards for asphalt in BS EN 12697, with the scope of each European Standard reproduced in full.

For European test methods that are based on British Standards, only a brief description of the test method is given along with guidance about any changes that have been introduced and how they affect UK users. Some of the European test methods are similar, in part or in name, to existing British Standard test methods; however, the differences are significant enough to necessitate a more detailed description of the test and how its implementation affects UK users.

For European test methods that are relatively new to the UK and are likely to be widely used in the future, a detailed description of the test methods is given in an attempt to anticipate the effects of the introduction of these new test procedures. Other tests, which are also unfamiliar to UK users but are not likely to be widely used in the UK, are described only for completeness.

1 Scope

PD 6692 gives guidance on the use of each of the European test method standards for asphalt, BS EN 12697. The tests are divided up into five groups:

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

Where standards fit into more than one category, they will be described in the first and subsequently cross-referenced. The sections describing each test 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 3	Part 4	Part 5	Part 6	Part 7
	Title	Subclause	AC	BBTM	Soft A	HRA	SMA	MA	PA
1	Soluble binder content	3.1	✓	✓	✓	✓	✓	✓	✓
2	Particle size distribution	3.2	✓	✓	✓	✓	✓	✓	✓
3	Bit. recovery: rotary evap.	3.3							
4	Bit. recovery: fract. column	3.4							
5	Maximum density	4.3	✓	✓	✓	✓	✓		✓
6	Bulk density	4.4	✓	✓	✓	✓	✓	✓	✓
7	Bulk density, gamma rays	7.1							
8	Void characteristics	4.5	✓	✓	✓	✓	✓		✓
10	Compactibility	7.2							
11	Affinity, aggregate and bitumen	5.1							✓
12	Water sensitivity	4.6	✓	✓		✓	✓		✓
13	Temperature measurement	7.3							
14	Water content	7.4							
15	Segregation sensitivity	7.5							
16	Abrasion by studded tyres	4.7	✓	✓		✓	✓		
17	Particle loss of PA specimen	5.2							✓
18	Binder drainage	5.3					✓		✓
19	Permeability of specimen	5.4							✓
20	Indentation, cube or Marshall	5.5						✓	
21	Indentation using plates	5.6						✓	
22	Wheel tracking	5.7	✓			✓	✓		
23	Indirect tensile test	6.1							
24	Resistance to fatigue	5.8	✓						
25	Cyclic compression test	5.9	✓					✓	
26	Stiffness	5.10	✓			✓			
27	Sampling	6.2							
28	Preparation of samples	6.3							
29	Dimensions of a specimen	7.6							
30	Impact compactor	6.4							
31	Gyratory compactor	4.8	✓	✓		✓	✓		✓
32	Vibratory compactor	6.6							
33	Roller compactor	6.7							
34	Marshall test	5.11	✓						
35	Laboratory mixing	6.8							
36	Thickness of a pavement	7.7							
37	Hot sand test for chips	7.8							
38	C'n equipment and calibration	7.9							
39	Binder content by ignition	4.9	✓	✓	✓	✓	✓	✓	✓
40	<i>In situ</i> drainability	7.10							
41	Resistance to de-icing fluids	4.10	✓	✓		✓	✓	✓	✓
42	Foreign material	7.11							
43	Resistance to fuel	4.11	✓	✓		✓	✓	✓	✓

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. Therefore, there is 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 has been the case in the UK previously.

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 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 considered and, hence, are given in the relevant part of BS EN 13108-1 to -7. However, the test conditions under which those tests should be performed, when not given in the test method itself, are given in BS EN 13108-20, *Bituminous mixtures – Material specifications – Type testing*. This European Standard has normative annexes for:

- summary of properties and test methods for bituminous mixtures;
- methods of sample preparation;
- 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;
- *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 SMA and category 3 for HRA. As noted in 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 in Annex D of BS EN 13108-20 and the part of BS EN 13108 specific to the mixture type for category 2 and the Table relevant to the mixture type of Annex B to EN 13108-20 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:

- *the empirical approach*, specifying asphalt in terms of compositional recipes and requirements for constituent materials with additional requirements based on performance related tests;
- *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:

- a) performance-based requirement;
- b) requirement for a fundamental engineering property (e.g. stiffness, fatigue properties) that predicts performance and appears in primary performance prediction relationships;
- c) performance-related requirement;
- d) 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;
- e) empirical specification;
- f) combination of requirements for composition and constituent materials together with performance-related requirements;
- g) fundamental specification;
- h) combination of performance-based requirements together with 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 written including 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 Guidance on the use of BS EN 12697-1 – Soluble binder content

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 analysis of mixtures containing modified binders are outside the scope of this document.”

3.1.2 Summary of method

3.1.2.1 General

The standard 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:

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

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

The basic operations for both binder extraction and separation of the mineral matter are given, together with guidance on the choice of the alternative items of equipment in an informative annex. The test methods with the different equipment are given in a second, normative, annex with a third, informative, annex giving details of the method for determining the residual mineral matter in the binder extracted by incineration.

The methods covered for binder extraction are:

- hot extractor (paper filter) method;
- hot extractor (wire mesh filter) method;

- Soxhlet extractor method;
- bottle rotation machine method;
- centrifuge extractor method;
- cold mix dissolution of bitumen by agitation method;

The methods covered for the separation of mineral matter are:

- continuous flow centrifuge method;
- pressure filter method;
- bucket centrifuge Type 1¹⁾ method;
- bucket centrifuge Type 2 method;

The methods covered for determining the soluble binder content are:

- method by recovery from a portion using a volume calculation;
- method by recovery from a portion using a mass calculation.

All combinations of these methods permitted under the first Annex are considered to give the same result. Furthermore, other methods and equipment, including automated equipment, can be used provided that 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 that should be because of the hazards associated with all of them. In the UK, it is recommended to continue to use methylene chloride

Another, informative, annex has been added that gives guidance on determination of soluble binder content of mixtures with polymer-modified binders. This annex could be regarded as being in conflict with the scope, but the number of potential different approaches necessary to cover all possible polymers and situations together with the increase in uncertainty of the result when some polymers are used make it important that analysis of polymer-modified mixtures should not be strictly in accordance with this European Standard.

3.1.2.2 The hot extractor (paper filter) method

The hot extractor (paper filter) is the same as the British Standard hot extractor method, except that there is a modified condenser to allow for solvents with a density less than unity.

3.1.2.3 The hot extractor (mesh filter) method

The hot extractor (mesh filter) is a glass or metal extractor, fitted with a condenser and suitable extraction cup. The test portion is weighed into dried extraction thimbles made of fibrous material in the extraction cup. The extraction cup is placed in the extraction apparatus and the binder extracted by boiling the solvent until the condensed solvent becomes colourless. After extraction, the mineral aggregate with its container is removed and dried to constant mass. The solution is filtered through filter paper, or centrifuged, to remove any fine material and the mass of insoluble matter determined.

¹⁾ The bucket centrifuge Type 1 is the bucket centrifuge described in Annex E of BS 598-102:2003.

3.1.2.4 The Soxhlet extractor method

The Soxhlet extractor is a glass extractor, consisting of a flask, an extraction case with tap and vapour tube, and a condenser. The flask and dry extraction case are weighed before the test portion is added and the extraction case reweighed. The case with the test portion is placed on a gauze in the extractor, which has been filled with solvent. The extractor tap is then opened and a heater switched on. The extraction is stopped when the solvent collected in the extractor becomes colourless. The mineral aggregate with its container is then removed and dried to constant mass. The solution is filtered through filter paper, or centrifuged, to remove any fine material and the mass of insoluble matter determined.

3.1.2.5 The bottle rotation machine method

The bottle rotation machine method is the same as the British Standard extraction bottle method, with procedures for both binder determination by difference (procedure 1) and binder portion recovered (procedure 2).

3.1.2.6 The centrifuge extractor method

The centrifuge extractor consists of a bowl, an apparatus in which the bowl may be revolved, a container for collecting the solvent thrown from the bowl and a drain for removing the solvent. A weighted test portion is placed into the bowl and covered with solvent for sufficient time for the solvent to disintegrate the test portion before being placed in the extraction apparatus. The filter discs are dried to constant mass and allowed to cool in a desiccator before being weighed. The mass of a filter ring is determined and it is fitted around the edge of the bowl. The cover is clamped on the bowl tightly and a beaker is placed under the drain to collect the extract. The centrifuge is operated until solvent ceases to flow from the drain, further solvent is added and the procedure repeated until the extract is colourless.

The extract and washings are collected in a suitable container. The filter ring is removed from the bowl and dried. The contents of the bowl are removed into a metal tray and dried to constant mass. The mass of the extracted aggregate is calculated from the mass of the aggregate in the tray plus the increase in mass of the filter rings.

3.1.2.7 The cold mix with dissolution by the agitation method

For the cold mix with dissolution by the agitation method, a weighed mass of asphalt is placed in a container at a temperature of less than 90 °C to which solvent is added. The mass of the solvent is:

- 1.6 times the mass of the sample if it contains more than 5% of binder;
- 0.8 times the mass of the sample if it contains 5% or less;
- 3 to 5 times the mass of the sample if it is mastic asphalt.

The sample is shaken for at least 30 min and then left to settle.

3.1.2.8 The continuous flow centrifuge method

The continuous flow centrifuge is a high-speed continuous flow centrifuge. Two clean and dry centrifuge cups are weighed separately and one is placed in the centrifuge whilst the other is retained. The sieve that is fitted to the feed funnel is also weighed.

The feed funnel is fitted centrally above the centrifuge funnel and the binder solution obtained from the binder extraction process is fed into the feed funnel. The feed funnel tap is adjusted to give the required flow rate into the running continuous centrifuge. The filler collected in the centrifuge cup is re-washed using as small a quantity of solvent as possible until the decanted solvent becomes colourless. The centrifuged effluent is collected and the cup containing the extracted filler removed and placed in an oven for drying.

The procedure is then repeated with the second cup except at a different flow rate. After the centrifuging is completed, the cup and feed funnel sieve are placed with the first cup in the oven for drying. The filler collected is calculated from the difference in weights of the two cups and the mineral matter retained is determined from the weight of the sieve.

3.1.2.9 The pressure filter method

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. The binder solution obtained from the binder extraction process is decanted through the test sieves into the pressure filter, being forced through the filter paper using air pressure. The receptacle containing the washed aggregate is rinsed to remove as much of the mineral matter as possible; the washings are passed through the sieves and the pressure filter until the solvent is clear.

The clean aggregate is transferred from sieves to a tray and the solvent evaporated from the aggregate, the sieves and the receptacle. Any mineral matter in the receptacle is transferred to the tray with the remainder of the aggregate. The mass of the aggregate in the tray is weighed and the filter paper, complete with any mineral matter, is removed from the pressure filter and dried to constant mass. A filtering aid is permitted.

3.1.2.10 The bucket centrifuge type 1 method

The bucket centrifuge type 1 (for use with samples from the bottle rotation machine) is as described in Annex E of the British Standard for the extraction bottle method: binder directly determined.

3.1.2.11 The bucket centrifuge type 2 method

The bucket centrifuge type 2 (for use with agitated samples) uses higher speeds of not less than 40 000 m/s² for at least 30 min for mastic asphalt and for at least 15 min for other types of mixture.

3.1.2.12 Binder content of mixtures containing modified binders

With regard to the binder recovery methods, the following is recommended.

- For the hot extractor (paper filter and wire mesh filter) and Soxhlet extractor methods, extraction should not be stopped when the solvent collected becomes colourless but to continue for a period of approximately 10% of the time taken for the solvent to become colourless. The hot extractor should have a transparent inspection window in order to determine the completion of extraction.
- 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.
- For the centrifuge extractor method, extraction should be continued for an extra 200 ml addition of solvent after the extract has become colourless.
- For cold mix dissolution of modified binder by agitation, the container should be shaken for at least 45 min instead of 30 min. However, this method cannot be applied if the solubility of the modified binder is insufficient.

With regard to the separation of mineral matter methods, the following is recommended.

- For the continuous flow centrifuge, re-washing of the filler collected in the centrifuge cup should be repeated once more, after the decanted solvent has become colourless.
- The use of the pressure filter is not recommended for polymer modified binder because of risks of clogging.
- For the methods for bucket centrifuges type 1 and type 2, no changes are needed.

3.1.3 Equivalent British Standard

BS 598-102:2003.

3.1.4 Principal differences

All the methods in BS 598-102 are included, with the extraction bottle method being combined into the bottle rotation machine, and the hot extractor method becoming the hot extractor (paper filter). No adjustment factors for the binder or filler contents are applied in the European Standard for the proportion of fine aggregate found relative to the design quantity.

3.1.5 Implications for UK

The loss of the adjustment factors on the binder and filler contents for the deviation from the design quantity of fine aggregate will either produce tighter tolerances on gradings for recipe aspects of any specification or will require revision of the tolerances applied. Nevertheless, the European Standard does permit the procedures currently being used whilst allowing additional ones that have been proven elsewhere. Therefore, the implementation should allow greater flexibility without having any detrimental effects on the current or developing UK approaches to asphalt specification, providing due allowance is made for the loss of the correction factors.

With regard to polymer-modified binders, the use of which is increasing, there is a need to have defined procedures for assessing the binder contents of such mixtures. However, there is limited detail in the Annex to the European Standard, in particular with respect to recommendations about suitable solvents and/or additional procedures for each type of polymer currently used.

3.2 Guidance on the use of 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 EN 12697-1. NOTE Fibres, solid (non-soluble during extraction) additives and (some) binder modifiers influence the test result.”

3.2.2 Summary of method

The standard references BS EN 933-1 for extracting the binder by solvent to obtain the aggregate with a rider that, if there is insufficient material available, all the material shall be used. The particle size distribution is then obtained by sieving. If the material has been thoroughly washed during extraction so that it has a limited fines content, dry sieving can be used but it has to be verified against wet sieving for each specific mixture.

3.2.3 Equivalent British Standard

BS 598-102:2003, **5.1.5**, **5.2.6** and **5.3.6**.

3.2.4 Principal differences

Both standards refer to the aggregate analysis standard. BS 598-102 requires sieving of all the coarse aggregate but only a sample of the fine aggregate, whereas BS EN 12697-2 leaves that aspect to the aggregate standard, BS EN 933-1.

3.2.5 Implications for UK

There are no significant implications for the United Kingdom in having this aspect in a separate standard, other than with regard to the requirement for wet sieving, or verification that dry sieving gives equivalent results to wet sieving for each mixture. These implications will be resolved in the next revision of BS EN 12697-2.

3.3 Guidance on the use of BS EN 12697-3 – Binder 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 pavement materials in a form suitable for further testing. The procedure is only suitable for the recovery of paving grade bitumens, for which this European Standard is the reference method. The fractionating column procedure (see 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. 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 Equivalent British Standard

BS 2000-397:1995.

3.3.4 Principal differences

BS EN 12697-3 is based on BS 2000-397 and, therefore, there are no significant differences. The main difference is that the sample is agitated and left to stand prior to centrifuging/filtering out the insoluble matter rather than being rotated gently.

3.3.5 Implications for UK

None.

3.4 Guidance on the use of BS EN 12697-4 – Binder recovery: fractionating column

3.4.1 Scope of BS EN 12697-4

BS EN 12697-4 “describes a test method for the recovery of soluble bitumen from bituminous mixtures from pavements in a form suitable for further testing. The procedure is suitable for the recovery of penetration grade bitumen and is also suitable for mixtures containing volatile matter such as cutback bitumen but the results may be less precise. NOTE There is limited experience of recovery when polymer-modified bitumen is used.”

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 Equivalent British Standard

BS 2000-105:1991

3.4.4 Principal differences

BS EN 12697-4 is based on BS 2000-105 and, therefore, there are no significant differences. The only omission is the advice on preparation of the binder solution, but this was only advice in BS 2000-105.

3.4.5 Implications for UK

The inclusion of this test method in the suite of tests will reinstate the situation in the United Kingdom because the fractionating column method, which is required for mixtures containing volatile matter such as cutback bitumen, was withdrawn when the rotary evaporator method, BS 2000-397, became a full British Standard.

4 Guidance on test methods called up in several standard specifications for asphalt

4.1 Guidance on the use of BS EN 12697-1 – Soluble binder content

See 3.1.

4.2 Guidance on the use of BS EN 12697-2 – Determination of particle size distribution

See 3.2.

4.3 Guidance on the use of BS EN 12697-5 – Determination of the maximum density

4.3.1 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 mixtures. NOTE 1 Samples can be supplied as loose material or as compacted material. NOTE 2 General guidelines on selection of a test procedure to determine the maximum density of a bituminous mixture is given in [an] Annex”.

4.3.2 Summary of methods

4.3.2.1 Volumetric method

The volumetric method is the reference method for 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.

4.3.2.2 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.

4.3.2.3 Mathematical method

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

4.3.3 Equivalent British Standard

DD 228:1996 (incorporating Amendment 1) and BS 598-104: 2005, Annex E.

4.3.4 Principal differences

In the British Standards, the mathematical method is included in part of the Annex to BS 598-104 rather than DD 228. Relative to these standards, BS EN 12697-5:

- does not limit the maximum size of sample;
- allows heating to only 110 °C rather than 120 °C in order to break up samples;
- allows the test to be carried out at any temperature, with correction by using the density of water at that temperature, rather than standardizing on 25 °C;
- calibration of the pycnometer is not required for the hydrostatic test; and
- in the hydrostatic test, the application of a vacuum is not mandatory.

4.3.5 Implications for UK

The differences are not significant in terms of the overall applicability of the test other than, possibly, the dropping of the vacuum conditions for the hydrostatic test. Therefore, there should not be any adverse implications in adopting BS EN 12697-5.

4.3.6 Other comments

Comparison tests have been carried out in France, with several laboratories using each of the different procedures in BS EN 12697-5. Their conclusions were that the hydrostatic method should be dropped on the basis of the wider spread of results (possibly due to there not being a mandatory requirement to use a vacuum) so that the method with the solvent was the most reliable. However, the methods with water did not produce totally unacceptable results and, for CE marking purposes, the volumetric procedure with water has been selected.

4.4 Guidance on the use of BS EN 12697-6 – Determination of bulk density of bituminous specimens

4.4.1 Scope of BS EN 12697-6

BS EN 12697-6 “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 cores cut from the pavement after placement and compacting. 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 specimen with a closed surface);
- c) bulk density – sealed specimen (for specimen with an open or coarse surface);
- d) bulk density by dimensions (for specimen with a regular surface and with geometric shapes, i.e. squares, rectangles, cylinders etc.)

NOTE [An] Annex ... (informative) gives general guidance on selecting the appropriate procedure.”

4.4.2 Summary of method

The thickness of specimens has to be not less than both 20 mm and twice the nominal aggregate size. General guidance on which of the four methods to select is given in an Annex although the relevant methods to be used for CE Marking for different materials are set out in BS EN 13108-20.

The “dry” procedure is for specimens with a very dense surface. The specimen is weighed in air when dry (either at the start of the test or after drying at the end) and in water. The density is calculated from the two masses together with the density of the water at the test temperature.

The “saturated surface-dry” (“SSD”) procedure is for specimens with a dense surface. The specimen is weighed in air when dry (either at the start of the test or after drying at the end), in water after being allowed to soak until at constant weight and after removal from the water and being wiped so as to be surface dry. The density is calculated from the three masses together with the density of the water at the test temperature.

The “sealed specimen” procedure is for specimens with an open or coarse surface. The specimen is weighed in air when dry, sealed with paraffin wax, shrinkage foil or latex emulsion (taking care not to enclose any air bubbles between the specimen and the seal folds) before being re-weighed dry and then in water. No distinction is made between sealing materials that fill at least the larger of the surface voids, such as paraffin wax, and those that span across those voids, such as shrinkage foil. The density is calculated from the three masses together with the density of the water at the test temperature.

The “by dimensions” procedure is for specimens with regular geometric shapes (cuboids or cylinders). The specimen is weighed in air when dry and its dimension measured. The density is calculated from the mass and the dimensions.

4.4.3 Equivalent British Standards

Clause 4 of BS 598-104:2003 and Clause 8 of BS 598-107:2004.

4.4.4 Principal differences

BS 598-104 contains both the “dry” and “sealed specimen” methods for cores while BS 598-107 contains the “dry” procedure for laboratory compacted specimens. The requirement to remove pre-coated chippings before testing cores, given in BS 598-104, is not in BS EN 12697-6.

4.4.5 Implications for UK

The test procedures in BS EN 12697-6 are more comprehensive than those in BS 598-104 and BS 598-107 and will allow the various densities to be measured in a standardized form. However, the loss of the requirement to remove pre-coated chippings before testing will need to be allowed for in future specifications.

4.4.6 Other comments

Comparison tests have been carried out in France, with several laboratories using each of the procedures in BS EN 12697-6 other than by dimensions. Their conclusions were that the three methods are equivalent, based on the inter-laboratory spread. For low voids contents, they gave the same results whilst for “intermediate” voids contents (6% to 12%), the method using paraffin wax gave result midway between those with the other two methods. The maximum divergences were of the order of 0.03 Mg/m³, which equates to approximately 1% of air voids.

4.5 Guidance on the use of BS EN 12697-8 — Determination of voids characteristics of bituminous specimen

4.5.1 Scope of BS EN 12697-8

BS EN 12697-8 “describes a procedure for calculating two volumetric characteristics of a compacted bituminous specimen: the air voids content (V_m) and the voids content in the mineral aggregate filled with binder (VFB). The method is suitable for specimens which are laboratory compacted or specimens from cores cut from the pavement after placement and compacting. These volumetric characteristics can be used as a mix design criteria or as parameters for evaluating the mixture after placing and compacting in the road.”

4.5.2 Summary of method

The procedures are simple calculations. The air voids content is calculated from the difference between the maximum density and bulk density measurements, as a proportion of the maximum density. The voids in the mineral aggregate filled with binder is calculated from the binder content, the voids in the mineral aggregate, the bulk density of the specimen and the density of the binder. For this calculation, the voids in the mineral aggregate is calculated from the air voids content, the binder content of the specimen and the bulk densities of the specimen and the binder.

4.5.3 Equivalent British Standard

None, but the procedure for air voids content is given in a sub-clause repeated in Clauses 929 and 937 of the *Specification for Highway Works* [1].

4.5.4 Principal differences

None.

4.5.5 Implications for UK

The method for air voids content is needed because more specifications are incorporating limits for air voids contents whilst there is less need for the voids in the mineral aggregate filled with binder. However, the standardization of both is useful.