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PUBLISHED DOCUMENT

Guidance on the use of BS EN 13108 Bituminous mixtures – Material specifications

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Contents

Foreword *iii*

Introduction 1

1	Scope	2
2	Terms, definitions and abbreviations	3
3	Constituent materials	4
4	Mixture composition	6
5	BS EN 13108-1 Asphalt concrete specification requirements	8
6	BS EN 13108-2 Asphalt concrete for very thin layers specification requirements	15
7	BS EN 13108-3 Soft asphalt specification requirements	15
8	BS EN 13108-4 Hot rolled asphalt specification requirements	15
9	BS EN 13108-5 Stone mastic asphalt specification requirements	20
10	BS EN 13108-6 Mastic asphalt	24
11	BS EN 13108-7 Porous asphalt	25
12	BS EN 13108-8 Reclaimed asphalt specification requirements	25
13	Evaluation of conformity	25

Annexes

Annex A (informative)	BS EN 13108 Mixture specifications	39
Annex B (informative)	BS EN 13108-1 Asphalt concrete – example specification	39
Annex C (informative)	BS EN 13108-4 Hot rolled asphalt – example specification	56
Annex D (informative)	BS EN 13108-5 Stone mastic asphalt – example specification	67

Bibliography 73

List of figures

Figure B.1 – Example specification for asphalt concrete	39
Figure C.1 – Example specification for hot rolled asphalt	56
Figure D.1 – Example specification for stone mastic asphalt	67

List of tables

Table 1 – References to protocols in BS 594987	28
Table 2 – Type testing sample preparation and testing requirements for UK asphalt concrete mixtures conforming to BS EN 13108-1	29
Table 3 – Type testing sample preparation and testing requirements for UK HRA mixtures conforming to BS EN 13108-4	29
Table 4 – Type testing sample preparation and testing requirements for UK SMA mixtures conforming to BS EN 13108-5	30
Table 5 – Permitted mean deviations from target (extracted from BS EN 13108-21:2006, Table A.1)	33
Table 6 – Determination of operating compliance level of plant for single results (extracted from BS EN 13108-21:2006, Table A.2)	33
Table 7 – Minimum frequency for analysis of finished product (tonnes/test) (extracted from BS EN 13108-21:2006, Table A.3)	34
Table 8 – Tolerances to be applied to the declared target grading and binder content (extracted from BS EN 13108-21:2006, Table A.1)	35
Table 9 – Example of a declared specification AC 32 HDM base 40/60 rec	36
Table 10 – Example of a declared specification AC 6 dense surf 160/220 PSV 60	36
Table 11 – Example of a declared specification HRA 35/14F surf 40/60 des PSV50	37
Table 12 – Next harder grades for recovered binder assessment	38
Table A.1 – Importance of mixture specifications	39

Table B.1 – Aggregate grading target limits for 32 mm designed dense/HDM/HMB base mixtures AC 32 dense/HDM/HMB base XX/YY des	44
Table B.2 – Binder grades for dense base and binder course mixtures	44
Table B.3 – Minimum target binder content for designed dense base mixtures	45
Table B.4 – Limiting wheel tracking requirements for site classifications	46
Table B.5 – Aggregate grading target limits for 32 mm designed dense/HDM/HMB binder course mixtures AC 32 dense/HDM/HMB bin XX/YY des	47
Table B.6 – Aggregate grading target limits for 20 mm designed dense/HDM/HMB binder course mixtures AC 20 dense/HDM/HMB bin XX/YY des	47
Table B.7 – Minimum target binder content for designed binder course mixtures	48
Table B.8 – Aggregate grading target limits for 20 mm, 14 mm and 10 mm EME2 mixtures AC 20/14/10 EME2 base/bin XX/YY des	49
Table B.9 – Minimum target binder content, B_{act}	49
Table B.10 – Number of gyrations	49
Table B.11 – Target limits for composition for recipe dense base and binder course mixtures AC D dense/HDM base/bin XX/YY rec	51
Table B.12 – Target limits for composition for open graded binder course mixtures AC D open bin XX/YY (grav)	52
Table B.13 – Target limits for composition for open graded surface course mixtures AC D open surf XX/YY	53
Table B.14 – Target limits for composition for close graded surface course mixtures AC D close surf XX/YY	54
Table B.15 – Guidance on selection of binder grades	55
Table B.16 – Target limits for composition for dense, medium graded and fine graded surface course mixtures AC D dense/med/fine surf XX/YY	55
Table B.17 – Maximum temperature of the mixture	56
Table C.1 – Limits for target composition for base and binder course mixtures	59
Table C.2A – Limits for target composition for surface course mixtures, Type F mixtures – Design and recipe target aggregate gradings HRA%/D F surf XX/YY des/rec	61
Table C.2B – Limits for target composition for surface course mixtures, Type F recipe mixtures – binder content HRA%/D F surf XX/YY rec	62
Table C.2C – Limits for target composition for surface course mixtures, Type C – Design mixtures HRA%/D C surf XX/YY des	63
Table C.3 – Limiting wheel tracking recommendations for site classifications	64
Table C.4 – Maximum temperature of the mixture	65
Table C.5 – Compliance grading of chippings	66
Table D.1 – Limits for target composition for SMA mixtures	70
Table D.2 – Limiting wheel tracking recommendations for site classifications	71
Table D.3 – Maximum temperature of the mixture	72

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 76, an inside back cover and a back cover.

Foreword

Publishing information

This Published Document is published by BSI and came into effect on 31 December 2010. It was prepared by BSI Subcommittee B/510/1, *Asphalt materials*. A list of organizations represented on this committee can be obtained on request to its secretary.

Information about this document

PD 6691:2010 supersedes PD 6691:2007, which is withdrawn.

This edition incorporates various minor updates, including changes to the wheel tracking information in Table B.4.

This Published Document gives guidance on the use and application of BS EN 13108.

Presentational conventions

The word “should” is used to express recommendations of this Published Document. The word “may” is used in the text to express permissibility, e.g. as an alternative to the primary recommendation of the clause. The word “can” is used to express possibility, e.g. a consequence of an action or an event.

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.

This Published Document is not to be regarded as a British Standard.

Introduction

Overview of BS EN 13108

BS EN 13108 is based on a common format and common principles. The overall principle is to provide a way for the target composition of a mixture to be declared in a standard way and demonstrate that, at that target composition, it has certain defined properties. Each mix formulation needs a declaration of the properties which are being claimed, demonstrated through a type testing procedure. In the simplest case it can be just grading and binder content, as with BS 594 and BS 4987. In more complex situations it can include performance-related properties, such as stiffness, deformation resistance and fatigue resistance. The demonstration of conformity of the mixture on an ongoing basis requires the producer to undertake "factory production control". This is a quality management procedure involving defined inspection and test regimes and conformity criteria to prove that the mixture conforms to the declared target composition within defined tolerances.

BS EN 13108 offers a degree of choice in many aspects, such as empirical/fundamental approaches, ways of describing composition, types of constituents, properties, and means of specimen preparation for type testing. In many cases, this choice is indicated by the words, "should be as specified". For BS EN 13108 to be practically workable in the UK there needs to be standardization from amongst these choices so that producers know what to declare through type testing and purchasers know what to ask for. This Published Document gives the recommended choices for the mixtures most commonly used in the UK.

BS EN 13108 contains requirements only for the loose mixture, i.e. "in the back of the truck". The requirements for the laying of asphalts and macadams in BS 594-2 and BS 4987-2 are, therefore, not superseded generally by BS EN 13108. Consequently, laying requirements are retained in BS 594987, which superseded BS 594-2 and BS 4987-2. Conformity with BS 594987 is essential to ensure the durability of the finished work.

In many cases, BS EN 13108 adopts the principle of a declared target composition selected from a permitted range which is different from the fixed composition envelope format of BS 594 and BS 4987. This UK guidance gives recommendations for an approach to using BS EN 13108 to arrive at mixtures similar to those traditionally used, and these are included as example specifications in Annex B, Annex C and Annex D of this Published Document.

BS EN 13108 includes provisions for the use of reclaimed asphalt in asphalt mixtures. BS EN 13108-8 provides a means of defining and classifying the properties of reclaimed asphalt. This Published Document gives recommendations for a means of regulating the use of reclaimed asphalt.

BS 594 and BS 4987 were largely prescriptive standards, specifying detailed requirements for constituent materials and for composition in terms of grading and binder content with very limited requirements for any performance-related properties. BS EN 13108 is drafted more in terms of performance.

Evaluation of conformity

The determination of conformity was seen to be essentially a contractual matter and was not covered in BS 594 and BS 4987. European Standards are different in this respect and BS EN 13108-20 and BS EN 13108-21 specify requirements for “Evaluation of Conformity”. They are written in the context of demonstrating conformity for the purposes of CE marking under the Construction Products Directive [1], but are procedures to be followed to demonstrate conformity with BS EN 13108, whether or not CE marking is being undertaken.

BS EN 13108-20 specifies the way in which the conformity of a mix composition to the requirements of the specification is to be determined.

BS EN 13108-21 specifies procedures to be adopted during production to ensure consistent conformity with specification.

BS EN 13108 calls up test methods from BS EN 12697 which supersedes many of the BS 598 test methods. Separate guidance on these test methods is given in PD 6692.

Mathematical nomenclature

To accord with European nomenclature protocols, the nature of mathematical notation adopted in this Published Document is that employed in the European Standard.

When denoting a decimal fraction, European notation employs a comma (,). For example, the “six point three” millimetre sieve (6.3 mm) is denoted as 6,3 mm.

1 Scope

This Published Document gives guidance on the use of BS EN 13108-1, BS EN 13108-4, BS EN 13108-5, BS EN 13108-8, BS EN 13108-20 and BS EN 13108-21.

Clause 1 to Clause 10 of this Published Document give general guidance and background information on BS EN 13108.

Annex A gives guidance on the importance of BS 13108 mixture specifications; Annex B provides guidance, based on the requirements formerly specified in BS 4987, for producing asphalt concrete that conforms to BS EN 13108-1; Annex C gives similar guidance, based on the requirements formerly specified in BS 594-1, for producing hot rolled asphalt that conforms to BS EN 13108-4; and Annex D provides guidance for producing stone mastic asphalt that conforms to BS EN 13108-5.

This Published Document does not give guidance on BS EN 13108-2, BS EN 13108-3, BS EN 13108-6 or BS EN 13108-7 as these are either little used in the UK or are covered by other guidance.

This Published Document is applicable to mixtures for use on roads and other paved areas, but excludes airfields, detailed provisions for which are specified elsewhere [see, for example Defence Estates Functional Standards (<http://www.mod.uk/DefenceInternet/MicroSite/DE/OurPublications/FunctionalStandards/>)].

NOTE 1 Porous asphalt, which was included in BS 4987, is now covered by BS EN 13108-7. Mastic asphalt mixtures previously defined in BS 1447 are now covered by BS EN 13108-6.

NOTE 2 There are several asphalt mixtures in general use which were not historically covered by British Standards but which are now covered

in BS EN 13108. These are stone mastic asphalt, covered by BS EN 13108-5, and asphalt concrete for very thin layers (thin surfacing), covered by BS EN 13108-2.

2 Terms, definitions and abbreviations

2.1 Terms and definitions

For the purposes of this British Standard, the terms and definitions used in BS EN 13108, including the following, apply.

2.1.1 composition

2.1.1.1 mix formulation

composition of a single mixture expressed as a target composition

NOTE 1 Two ways of declaring mix composition are required because some countries traditionally work in terms of the theoretical percentages added in a laboratory mix design, whereas others work in terms of the composition found on analysis.

NOTE 2 The protocol adopted in the UK is to always work in terms of composition found on analysis, i.e. output target composition.

2.1.1.2 input target composition

expression of a mix formulation in terms of the constituent materials, the grading curve and the percentage of bitumen added to the mixture

NOTE This will usually be the result of a laboratory mix design and validation.

2.1.1.3 output target composition

expression of a mix formulation in terms of the constituent materials and the mid-point grading and soluble binder content to be found on analysis

NOTE This will usually be the result of a production validation.

2.1.2 measuring properties

NOTE 1 BS EN 13108 makes a distinction between requirements based on tests considered to be pure engineering properties, which are described as "performance-based", and those based on less rigorous and more simulative tests, which are called "performance-related".

NOTE 2 There is a general desire to move towards specifying and measuring mechanical properties of asphalt in "pure" engineering terms, producing values which can be input to mechanistic analytical models to predict pavement performance. These are defined as "performance-based requirements". They include such things as triaxial tests for deformation resistance and tend to require complex and expensive test equipment.

NOTE 3 Many of the tests used to measure mechanical properties of asphalt fall short of this "fundamental" ideal and are more simulative in nature. These are called "performance-related requirements". These include such things as wheel tracking tests and tend to be rather more practical and economical.

NOTE 4 Virtually all of the tests that have been used hitherto in the UK to measure properties of asphalt in standards and contracts were performance-related. The exception to this is the indirect tensile stiffness modulus (ITSM) test which, along with all methods for measuring stiffness, is classed as performance-based. This Published Document makes recommendations based on the state-of-the-art in the UK at the time of writing, but recognizes that it might be possible to move to a more performance-based approach in the future following appropriate research and evaluation.

2.1.2.1 performance-based requirement

requirement for a fundamental engineering property that predicts performance and appears in primary performance prediction relationships

2.1.2.2 performance-related requirement

requirement for a characteristic that has been found to correlate with a fundamental engineering property that predicts performance

2.1.3 type of specification

NOTE In line with the distinction between the empirical and the fundamental approach, and performance-based and performance-related test methods, BS EN 13108-1 offers two ways of defining the composition and properties in a mixture specification, intended to facilitate a steady transition from prescriptive standards to performance standards as knowledge and confidence increases: empirical specification and fundamental specification. The other parts of BS EN 13108 use the empirical approach. This Published Document follows established UK practice and state-of-the-art at the time of writing and gives recommendations only for empirical specifications.

2.1.3.1 empirical specification

combination of requirements for composition and constituent materials together with performance-related requirements

NOTE The empirical specification involves defining within fairly close limits what the composition of the mixture should be and then adding further requirements using performance-related tests, such as wheel tracking for deformation resistance. In contrast, a fundamental specification places very little limitation on the composition in terms of aggregate type, grading, binder type and binder content, but defines asphalt properties in terms of performance-based tests such as triaxial compression.

2.1.3.2 fundamental specification

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

NOTE 1 The fundamental specification option is offered only for asphalt concrete in BS EN 13108-1.

NOTE 2 The state-of-the-art in the UK, as found in BS 594 and BS 4987, is largely prescriptive and empirically based. Performance-based tests are used to rank the performance of mixtures of standard composition using values related by experience to performance in the road. This approach is followed in this Published Document.

2.2 Abbreviations

DBM	dense bituminous macadam
HDM	high density macadam
HMB	high modulus base
ITSR	indirect tensile strength ratio

3 Constituent materials**3.1 General**

Clause 4 of each part of BS EN 13108 covers constituent materials. The general presumption is that all constituent materials conform to a European Standard or European Technical Approval. BS EN 13108

does, however, recognize that some constituents, such as fibres and pigments, might not be covered by standards and, in those cases, evidence of satisfactory use needs to be demonstrated. This evidence needs to be included in the type testing documentation for the appropriate mix formulation.

3.2 Binder

3.2.1 Paving grade bitumens are specified in accordance with BS EN 12591. This standard was implemented in the UK in 2001 and the grade selection for each material was included in BS 594-1 and BS 4987-1. These selections are included in the example specifications in Annex B, Annex C and Annex D of this Published Document.

3.2.2 Hard paving grade bitumens conforming to BS EN 13924 are used only in EME2 base and binder course mixtures.

3.2.3 Polymer modified bitumens are now covered by a framework specification in BS EN 14023. Since this is not a performance specification, type testing will demonstrate which grades are acceptable and demonstrate enhanced performance of the asphalt.

3.3 Aggregates

All aggregate requirements are specified in accordance with BS EN 13043 “as appropriate to the intended use”, which means that the detail depends on traffic, climate and the economics of local geology. Detailed recommendations for categories of all relevant properties are given in PD 6682-2.

BS EN 13043 requirements for shape, fines content, etc., were included in BS 594 and BS 4987 and these are included in the example specifications in the annexes of this Published Document. In general, the grading requirements for asphalt mixtures are determined on the finished mixture and specific requirements on constituent materials are not appropriate, with the exception of fine aggregate for hot rolled asphalt. The recommendations of PD 6682-2 are followed, where relevant, in this Published Document.

3.4 Reclaimed asphalt

3.4.1 BS EN 13108 makes specific provision for the inclusion of reclaimed asphalt in the mixture. There is no such provision in BS 594/987, but its use is permitted in and often encouraged by other relevant specifications, such as the *Specification for Highway Works* (SHW) [2].

3.4.2 There are only two definite requirements in BS EN 13108 in relation to reclaimed asphalt:

- “the upper size of the reclaimed asphalt shall not exceed the upper size of the mixture”; and
- “the aggregate in the reclaimed asphalt shall conform to the requirements for aggregate in the mixture specification.”

BS EN 13108 does, however, allow for additional requirements to be defined and specified appropriate to the intended use. BS EN 13108-8 is written as a means of classifying the properties of reclaimed asphalt in a standard way in order to facilitate such specification.

3.4.3 Annex B, Annex C and Annex D of this Published Document indicate the preferred properties of reclaimed asphalt for use in UK mixtures.

3.4.4 For the purposes of specification, it is recommended that the following criteria are adopted in the UK:

- foreign matter – category F_5 ;
- binder properties – category P_{15} .

NOTE P_{15} is a general case, but reliable and consistent feedstocks of harder reclaimed materials might make them suitable for use by agreement with the client.

3.4.5 BS EN 13108 also covers the possibility of limiting the amount of reclaimed asphalt permitted to be added to the mixture. In line with current UK practice it is recommended that the following limits normally apply:

- surface courses 10%;
- all other materials 50%.

However, it is envisaged that there will be situations where more than 10% reclaimed asphalt will be used in surface course mixtures and more than 50% in other mixtures, but these will be subject to greater levels of control.

3.4.6 In cases where more than 10% for surface course mixtures, and 20% for other mixtures, by mass of the total mixture of reclaimed asphalt is added to the mixture, it is necessary to confirm that the properties of the total binder in the mixture, calculated from the combination of the properties of the fresh binder and the properties determined on the recovered binder from the reclaimed asphalt, conform to the grade specification for the mixture. BS EN 13108 gives the option of carrying out this calculation on either penetration or softening point. In line with current UK practice it is recommended that the penetration method is adopted.

NOTE Additional requirements are called up when the binder from the reclaimed asphalt or the binder for the mixture is modified.

4 Mixture composition

4.1 General

BS EN 13108 requires that:

- the grading is expressed in percentages by mass of total aggregate;
- the binder and additive content is expressed in percentages by mass of total mixture;
- the percentages passing the sieves, with the exception of the sieve 0,063 mm, are expressed to 1%; and
- the binder content, the percentage passing sieve 0,063 mm and any additive content are expressed to 0,1%.

4.2 Grading and sieves

4.2.1 Because two different sieve series are in use in Europe [6,3 mm, 10 mm, 14 mm, 20 mm in the UK, France, Spain, etc., and 8 mm, 11 mm (11,2 mm), 16 mm, 22 mm (22,4 mm) in Germany, Netherlands,

Scandinavia, etc.], it is necessary to indicate the UK choice. The sieves used in the UK are basic sieve set plus set 2, conforming to BS EN 13043. Detailed guidance on this can be found in PD 6682-2.

4.2.2 The full set of coarse sieves is as follows: 4 mm; 6,3 mm; 8 mm; 10 mm; 12,5 mm; 14 mm; 16 mm; 20 mm; 31,5 mm; and 40 mm.

However, the 8 mm and 16 mm sieves are included only as a link with set 1 and the 12,5 mm sieve is not generally used in the UK. This means that the range of sieves, both coarse and fine, to be used in asphalt specifications in the UK is: 0,063 mm; 0,125 mm; 0,250 mm; 0,500 mm; 1 mm; 2 mm; 4 mm; 6,3 mm; 10 mm; 14 mm; 20 mm; 31,5 mm; and 40 mm.

4.2.3 Whilst BS EN 933-1 suggests the need to use the full series for each grading determination on aggregates, for the purposes of determining the grading of asphalt mixtures it is not necessary to use sieves other than those used in BS EN 13108.

4.3 Binder content

4.3.1 The binder content categories in BS EN 13108 involve a correction for the density of the aggregate in the mix. The principle is that the binder content category in the standard is based on an aggregate density in the mixture of 2 650 megagrams per cubic metre (Mg/m^3). If the aggregate is denser than 2 650 Mg/m^3 the actual binder content in the true mixture is reduced proportionally, or if the aggregate is less dense it is increased with the intention of giving the same binder volume in mixtures regardless of aggregate density.

4.3.2 A consideration of UK mixtures and aggregates indicated that this approach could have been detrimental, as some of the denser aggregates in practice needed higher binder contents for durability. For this reason, the binder contents in the example specifications in this Published Document are those which are required as actual soluble binder contents on analysis of the finished mixture, with no density correction. This is the same as the way in which binder content was specified in BS 594 and BS 4987.

NOTE For empirical mixtures, if experience with a particular aggregate combination indicates that a higher or lower target binder content than that stated in the example specifications in Annex B, Annex C and Annex D of this Published Document is required and this does not compromise the laying or measured characteristics of the mixture, the appropriate target binder content can be utilized when type testing the mixture.

4.3.3 For the purposes of CE marking, these actual binder contents will need to be corrected back to determine the $B_{\min}$ defined in BS EN 13108.

4.3.4 To convert the $B_{\min}$ target values within this Published Document back to a $B_{\min}$ declared value from BS EN 13108, the following formula is used:

$$B_{\min \text{ declared}} = \frac{\rho_b \times B_{\min \text{ target}}}{2\,650} \quad (1)$$

where:

ρ_b is the mean particle density of the aggregate mixture, in megagrams per cubic metre (Mg/m^3), determined in accordance with BS EN 1097-6.

The $B_{\min}$ declared value calculated from this formula can only be in divisions of 0,2. A $B_{\min}$ declared value of 0,1 division, such as 5,3%, is rounded down to the nearest 0,2 value, 5,2%.

NOTE 1 It is this back-corrected binder content which should be declared for CE marking purposes.

NOTE 2 Type test reports should clearly include both values.

5 BS EN 13108-1 Asphalt concrete specification requirements

5.1 General

BS EN 13108-1 is essentially a menu of specification requirements from which individual mixture specifications can be selected. Thus, choices have to be made, and not all requirements are relevant to UK applications. Clause 5 of this Published Document discusses these requirements and indicates those which are recommended as appropriate for use in the UK. In Annex B of this Published Document, these recommended choices are presented in the form of an example specification.

5.2 Empirical or fundamental requirements

The state-of-the-art in the UK for asphalt concrete is generally for an empirical form of specification with a relatively prescriptive requirement on composition, sometimes with additional requirements for performance-related properties. The example specification in Annex B of this Published Document follows this empirical approach.

5.3 General, empirical and fundamental requirements

5.3.1 Introduction

BS EN 13108-1:2006 specifies:

- general requirements in 5.2, which apply to all mixtures;
- empirical requirements in 5.3, which apply only to empirically specified mixtures; and
- fundamental requirements in 5.4, which apply only to fundamentally specified mixtures.

5.3.2 General requirements

5.3.2.1 Composition

BS EN 13108-1:2006, 5.2.1.1, requires that:

- the grading is expressed in percentages by mass of total aggregate;
- the binder and additive content is expressed in percentages by mass of total mixture;
- the percentages passing the sieves, with the exception of the sieve 0,063 mm, are expressed to 1%; and
- the binder content, the percentage passing sieve 0,063 mm and any additive content is expressed to 0,1%.

5.3.2.2 Grading

BS EN 13108-1:2006, Table 2, specifies very general grading requirements, in terms only of oversize, passing 2 mm and filler content applicable to all mixtures. These, on their own, are relevant only to fundamentally specified mixtures as they offer a very high degree of design freedom. Additional characteristic and optional sieves, which are of particular importance in characterizing the material and for factory production control, are included in the example specification in Annex B of this Published Document.

5.3.2.3 Void content

Maximum and minimum void content categories can be selected from BS EN 13108-1:2006, Table 3 and Table 4. These void contents apply during type testing, and the method of mixing and specimen compaction/manufacture needs to be defined within the type testing document.

In the UK, experience with void content specifications for asphalt concrete materials used on roads is generally limited to dense macadam base and binder courses produced under SHW, Clause 929 [2]. The example specification in Annex B of this Published Document translates these requirements in terms of BS EN 13108-1, using specimens taken from full-scale trial strips.

There might be scope for developing requirements for voids-related design of other “macadam” type materials, but work is required to define the criteria. In such cases these should be quoted as “no requirement” categories $V_{\max\text{NR}}$ and $V_{\min\text{NR}}$.

5.3.2.4 Coating and homogeneity

BS EN 13108-1:2006, 5.2.3, requires that the material when discharged from the mixer is homogenous in appearance, with the aggregate completely coated with binder and no evidence of balling of fine aggregate. This requirement is virtually identical to that from BS 4987.

5.3.2.5 Water sensitivity

Water sensitivity is specified in BS EN 13108-1:2006, 5.2.4, in terms of the indirect tensile strength ratio determined from cylinder splitting testing of soaked and unsoaked specimens. This has tended to be regulated by mix type and selection of constituents and there is no UK experience of requirements based on this test. This is not the test specified by BBA HAPAS *Guidelines for the Assessment of Thin Surfacing Systems* [3] with which producers and specifiers might be familiar. There might be scope for developing requirements for “macadam” type materials, but work is required to define the criteria.

It is therefore recommended that the “no requirement” category ITSR_{NR} is adopted in the UK.

5.3.2.6 Resistance to abrasion by studded tyres

The requirement in BS EN 13108-1:2006, 5.2.5, is relevant only to those Scandinavian countries where studded tyres are used in winter. Since these are illegal in the UK, the requirement is not relevant.

It is therefore recommended that the “no requirement” category Abr_{ANR} is adopted in the UK.

5.3.2.7 Resistance to permanent deformation

BS EN 13108-1:2006, 5.2.6, specifies resistance to permanent deformation in terms of either the large (French) wheel tracking test or the small wheel tracking test. The small device is very similar to that defined in BS 598-110, but the test procedure and reporting differ.

In the UK, for macadams, such requirements have hitherto applied only to dense macadam binder courses under SHW, Clause 952 [1]. Categories for this application using cores from trial strips, are included in the example specification in Annex B of this Published Document. The large device is called up in the specification for EME using slab compacted specimens, and appropriate categories are included in the example EME specification in Annex B.

It is recommended that, other than for these specific applications, the “no requirement” categories P_{NR} , WTS_{AIRNR} and PRD_{AIRNR} are adopted in the UK.

5.3.2.8 Reaction to fire

There is a regulatory requirement in some countries for a Euroclass for reaction to fire if asphalt is to be laid in certain types of tunnel. This is not a regulatory requirement in the UK, so the “no requirement” category should be adopted.

5.3.2.9 Resistance to fuel and de-icing fluid for application on airfields

The BS EN 13108-1:2006, 5.2.8 and 5.2.9, requirements apply only to airfields, so for use in other applications the “no requirement” category should be adopted.

5.3.2.10 Temperature of the mixture

Temperature requirements are given in BS EN 13108-1:2006, Table 11 (see B.3.6 of this Published Document). The maximum temperatures at any stage are similar to those from BS 4987. Guidance on suitable minimum temperatures at delivery and for compaction is given in BS 594987.

5.3.3 Empirical requirements

5.3.3.1 Introduction

BS EN 13108-1:2006, 5.3, specifies the more specific and prescriptive detailed requirements which apply to empirically specified mixtures. It should be noted that these requirements refer only to the target composition. Tolerances are applied during factory production control and are specified in BS EN 13108-21 (see also 13.3 of this Published Document).

The requirement for producers is to declare a target composition within the specified constraints on constituents, grading, binder content, etc., which meets all other specified requirements, such as voids and deformation resistance.

5.3.3.2 Grading

BS EN 13108-1:2006, 5.3.1.2, requires the grading of the target composition to fall within the limits of a grading envelope. In the UK, this approach is used by SHW, Clause 929 [1]. There are requirements

in BS EN 13108-1:2006, Table 2, for which sieves are to be used, related to the upper size “D” of the mixture. There are also limitations on the number of additional sieves which can be called up, to limit the complexity of grading specifications. In the example specification given in Annex B of this Published Document, sieve selections have been made in accordance with these requirements.

BS EN 13108-1:2006, Table 12, imposes a minimum range or width on this specification envelope for designed mixtures. For recipe mixtures, the grading specifications in Annex B of this Published Document give single point or very narrow envelope gradings, which, in combination with the tolerances from BS EN 13108-21, result in overall grading envelopes similar to those in BS 4987.

5.3.3.3 Binder content

An empirical specification will include requirements for minimum and/or maximum binder contents, selected from tables with 0,2% increments (see BS EN 13108-1:2006, 5.3.1.3). In the UK, “output target composition” is used, so the binder content is the soluble binder content found on analysis.

Importantly, the binder content requirement contains a compensation formula to correct binder content for density variations of aggregate. The main requirement is based on an aggregate particle density of 2 650 Mg/m³. For lower density aggregates the binder addition is increased and for higher density aggregates it is reduced using the following formula.

$$\alpha = \frac{2\,650}{\rho_b} \quad (2)$$

where:

ρ_b is the mean particle density of the aggregate mixture, in Mg/m³, determined in accordance with BS EN 1097-6;

α is the compensation factor.

The mean particle density of the aggregate mixture should be calculated as the weighted mean of the apparent particle densities of the coarse and fine aggregate particle size fractions comprising the mix formulation: 0,063 mm to 2 mm, 2 mm to 4 mm, 4 mm to 6,3 mm, 6,3 mm to 10 mm, 10 mm to 14 mm, 14 mm to 20 mm, 20 mm to 31,5 mm, 31,5 mm to 40 mm.

Some care is necessary in the application of this correction factor as the effect might not be consistent with the mineralogical nature of aggregates used in the UK. In order to ensure that the performance and durability of mixtures sensitive to these mineralogical differences are not compromised, the recommended binder content is presented in Annex B of this Published Document against the coarse aggregate type, in line with the methodology previously used in BS 4987.

NOTE The selection of the appropriate target binder content for the particular mixture takes account of a number of important factors. These include particularly the handling and laying characteristics of the mixture and the anticipated performance in the pavement. As already stated, two of the factors which will significantly affect the target binder content selected for empirically specified mixtures are the relative density of the combined aggregates and the surface characteristics and the mineralogical nature of the particular type(s) of aggregate used.

The correction factor is not applicable to slag aggregates, and provision is made for these in the annexes of this Published Document in terms of compacted bulk density.

5.3.3.4 Additives

If the specifier has requirements for additives these need to be included in the specification, in accordance with BS EN 13108-1:2006, 5.3.1.4.

5.3.3.5 Marshall values for application on airfields

Marshall test properties specified in BS EN 13108-1:2006, 5.3.2, are only for use on airfields. Thus, for use in other applications the “no requirement” categories $S_{\min\text{NR}}$, $S_{\max\text{NR}}$, F_{NR} and $Q_{\min\text{NR}}$ are adopted in the UK.

5.3.3.6 Voids filled with bitumen

The BS EN 13108-1:2006, 5.3.3, requirement is not generally adopted in the UK, other than for some asphalt concrete on airfield applications. It is therefore recommended that for use in other applications the “no requirement” category VFB_{NR} is adopted in the UK.

5.3.3.7 Voids in mineral aggregate

The BS EN 13108-1:2006, 5.3.4, requirement is not generally adopted in the UK other than for some asphalt concrete on airfield applications. It is therefore recommended that for use in other applications the “no requirement” category VMA_{NR} is adopted in the UK.

5.3.3.8 Void content at 10 gyrations

The BS EN 13108-1:2006, 5.3.5, requirement is a measure of mix workability and compactability. In the UK it is included only in specifications for EME2 and appropriate requirements are included in the example specification in B.3.4 of this Published Document. For other mixtures it is recommended that the “no requirement” category $V10G_{\min\text{NR}}$ is adopted in the UK.

5.3.3.9 Over-specification

BS EN 13108-1:2006, 5.3.6, contains limitations on specifiers to prevent over-specification by the combination of unnecessarily onerous combinations of requirements.

5.3.4 Fundamental requirements

5.3.4.1 Introduction

BS EN 13108-1:2006, 5.4, offers a less prescriptive approach to composition, linked with measurement of stiffness, deformation resistance and fatigue properties by performance-based test methods.

5.3.4.2 Composition – grading and binder content

Grading is limited only by the general requirements of BS EN 13108-1:2006, Table 2. BS EN 13108-1:2006, 5.4.1.2, requires that binder content is greater than 3,0%.

5.3.4.3 Stiffness

For the purposes of BS EN 13108-1:2006, 5.4.2, all stiffness test methods are considered equivalent. In the UK it is anticipated that stiffness of base and binder course mixtures will be determined, where required, on cored cylindrical specimens from trial strips using the indirect tensile stiffness modulus test conforming to BS EN 12697-26:2004, Annex C.

It is recommended that, other than for these specific applications, the “no requirement” categories $S_{\min\text{NR}}$ and $S_{\max\text{NR}}$ are adopted in the UK.

NOTE In the UK it is anticipated that stiffness will be specified in conjunction with an otherwise empirical specification. It is believed that there is provision for this within the standard and associated CE marking requirements.

5.3.4.4 Resistance to permanent deformation in triaxial compression test

It is not intended that triaxial testing for deformation resistance will be used in specifications in the UK.

It is therefore recommended that the “no requirement” category f_{cmaxNR} is adopted in the UK.

5.3.4.5 Resistance to fatigue

It is not intended that fatigue testing will be used in specifications in the UK.

It is therefore recommended that the “no requirement” category $\varepsilon_{6\text{-NR}}$ is adopted in the UK.

5.3.4.6 Over-specification

BS EN 13108-1:2006, 5.4.5, contains limitations on specifiers to prevent over-specification by the combination of unnecessarily onerous combinations of requirements.

5.3.4.7 Durability

Asphalt concrete produced in accordance with BS EN 13108-1 and laid in accordance with BS 594987 may be considered durable for a reasonable working life (the period of time during which the performance of the works will be maintained at a level compatible with the declared performance of the characteristics).

5.4 Identification

5.4.1 Introduction

BS EN 13108-1:2006, Clause 7, requires that the delivery ticket contains at least the following information relating to identification:

- the manufacturer and mixing plant;
- mix identification code;
- designation of the mixture;
- how to obtain the full details demonstrating conformity with the European Standard;

- details of any additives (see 5.3.3.4 of this Published Document);
- details of compliance with any clauses, where requested, for specific use on airfields specifications.

NOTE Information concerning regulatory marking accompanies the product (for CE marking and labelling see BS EN 13108-1:2006, ZA.3), but characteristics which are not necessarily part of regulatory marking, for example, special requirements for airfields, could be made available by alternative means, i.e. retained by the dispatching depot if agreed with the client.

5.4.2 Mix designation

The BS EN13108-1 mix designation consists of the minimum four sections as below.

AC	<i>D</i>	base/bin/surf	binder
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where:

- AC is asphalt concrete;
- D* is the upper sieve size of the mix, in mm;
- base is base course;
- bin is binder course;
- surf is surface course;
- binder is the designation of the binder used.

However, BS 4987 previously included other descriptors in order to differentiate certain types of materials, e.g. dense bitumen macadam, open graded macadam, dense surface course and close graded surface course. It is recommended that these descriptors are partially retained in material designations on delivery tickets.

5.4.3 Examples

Dense asphalt concrete with maximum aggregate size 20 mm for binder course with paving grade bitumen, grade 100/150, designed target grading is designated as AC 20 dense bin 100/150 des.

NOTE 1 This would previously have been designated from BS 4987-1:2005, 6.5, Table 15 (and Table C.2), as 0/20 mm DBM 125 design binder course or 0/20 DBM 125 des, or similar.

Open graded asphalt concrete with maximum aggregate size 10 mm for surface course with paving grade bitumen, grade 160/220 (empirically specified mixture) is designated as AC 10 open surf 160/220.

NOTE 2 This would previously have been designated from BS 4987-1:2005, 7.2, Table 20 and Table 21, as 0/10 mm size open graded surface course 160/220 or 0/10 OGSC 190, or similar.

In some instances it might be appropriate to add and identify extra information, such as aggregate PSV, to this core description, e.g. AC 10 open surf 160/220 PSV 60.

The use of the descriptor “rec” (for “recipe”) may be considered appropriate to identify an empirical recipe based mixture. Alternatively, “des” (for design) may be used to identify a mixture which has

undergone type testing to determine an appropriate target grading and binder content to achieve voids content and/or performance-related testing to validate mixture stiffness or deformation resistance.

6 BS EN 13108-2 Asphalt concrete for very thin layers specification requirements

These materials have traditionally been procured in the UK as proprietary laid systems certified under the BBA HAPAS approval scheme. It is envisaged that the use of BS EN 13108-2 will be as a means of declaring and classifying the material element within BB/HAPAS approvals for laid systems. Therefore, additional guidance on formulation and performance should be sought from suppliers approved under that scheme for these materials.

BS EN 13108-2 is essentially a menu of specification requirements from which individual mixture specifications can be selected. For UK application the selection of levels and classes will be made within the BBA HAPAS Guidelines [3].

BS EN 13108-2 applies to surface courses to be laid at a thickness of 20 mm to 30 mm. The aggregate is generally gap-graded to form a stone-to-stone contact and to provide an open surface texture. The thickness requirement limits the size of aggregate used to 6,3 mm; 8 mm or 10 mm (although the 8 mm size is not generally used in the UK), but with a selection of grading classes within the nominal aggregate size definition.

7 BS EN 13108-3 Soft asphalt specification requirements

Soft asphalt is traditionally used in the cold northern regions of Europe where roads heave significantly during the winter under conditions of prolonged deep frost and are then reshaped and rerolled in spring after the thaw. As there is no such application in the UK, no use of BS EN 13108-3 is foreseen and specific guidance on its use is not considered necessary in this Published Document.

8 BS EN 13108-4 Hot rolled asphalt specification requirements

8.1 General

BS EN 13108-4 is essentially a menu of specification requirements from which individual mixture specifications can be selected. Thus, choices have to be made and not all requirements are relevant to all UK applications. This subclause discusses these requirements and indicates those which are recommended as appropriate for use in the UK. The requirements are presented in Annex C of this Published Document in the format of an example specification.

8.2 Composition

8.2.1 General

BS EN 13108-4:2006, 5.1, requires that:

- the mix formulation is declared and documented;
- at the target composition the mixture conforms to the selected requirements;
- the grading is expressed in percentages by mass of total aggregate;
- the binder and additive content is expressed in percentages by mass of total mixture;
- the percentages passing the sieves, with the exception of the sieve 0,063 mm, is expressed to 1%; and
- the binder content, the percentage passing sieve 0,063 mm and any additive content is expressed to 0,1%.

8.2.2 Grading

BS EN 13108-4:2006, 5.2.2, requires specifications to be presented as a grading envelope, and specifies that the target composition of the mix falls within the grading envelope. In the UK, we are familiar with this approach from the use of SHW, Clause 929 [2]. There are requirements in BS EN 13108-4:2006, Table 2 and Table 4, for which sieves are to be used, related to the upper size “*D*” of the mixture. There are also limitations on the number of additional sieves which can be called up, to limit the complexity of grading specifications. In the example specification given in Annex C of this Published Document, sieve selections have been made in accordance with these requirements. The example specifications are grouped as base and binder course and surface course mixtures. Additional guidance on recipe, design and performance-related surface course mixtures is included in Annex C.

8.2.3 Binder content

For base and binder course, recipe and design surface course mixtures, the target and/or minimum binder content is defined in Table C.1, Table C.2A, Table C.2B and Table C.2C of this Published Document (see BS EN 13108-4:2006, 5.2.3).

In the UK, “output target composition” is used, so the binder content is the soluble binder content found on analysis.

Importantly, the binder content requirement contains a compensation formula to correct binder content for density variations of aggregate. The main requirement is based on an aggregate particle density of 2650 Mg/m³. For lower density aggregates the binder addition is increased and for higher density aggregates it is reduced using the following formula:

$$\alpha = \frac{2\,650}{\rho_b} \quad (3)$$

where:

- ρ_b is the mean particle density of the aggregate mixture, in Mg/m³, determined in accordance with BS EN 1097-6;
- α is the compensation factor.

NOTE The mean particle density of the aggregate mixture should be calculated as the weighted mean of the apparent particle densities of the coarse and fine aggregate particle size fractions comprising the mix formulation: 0,063 mm to 2 mm, 2 mm to 4 mm, 4 mm to 6,3 mm, 6,3 mm to 10 mm, 10 mm to 14 mm, 14 mm to 20 mm, 20 mm to 31,5 mm, 31,5 mm to 40 mm.

Some care is necessary in the application of this correction factor as the effect might not be consistent with the mineralogical nature of aggregates used in the UK. In order to ensure that the performance and durability of mixtures sensitive to these mineralogical differences are not compromised, the recommended binder content is presented against the coarse aggregate type, in line with the methodology previously specified in BS 594.

8.2.4 Binder volume

Only performance-related surface course mixtures use the method of determining the quantity of binder in the mixture required by BS EN 13108-4:2006, 5.2.4 (see C.2.5.1.4.2 of this Published Document).

8.2.5 Additives

If the specifier has requirements for additives these need to be included in the specification, in accordance with BS EN 13108-4:2006, 5.2.5.

8.3 Coating and homogeneity

BS EN 13108-4:2006, 5.3, requires that the material when discharged from the mixer is homogenous in appearance, with the aggregate completely coated with binder and no evidence of balling of fine aggregate.

8.4 Void content

BS EN 13108-4:2006, 5.4, requirements are only specified for performance-related surface course mixtures (see C.2.5.1.4 of this Published Document).

8.5 Water sensitivity

BS EN 13108-4:2006, 5.5, specifies water sensitivity in terms of the indirect tensile strength ratio (ITSR) determined from cylinder splitting testing of soaked and unsoaked specimens. This has tended to be regulated by mix type and selection of constituents and there is no UK experience of requirements based on this test. This is not the test specified by BBA HAPAS *Guidelines for the Assessment of Thin Surfacing Systems* [3] with which producers and specifiers might be familiar. There might be scope for developing requirements for HRA type materials, but work is required to define the criteria.

It is therefore recommended that the “no requirement” category $ITSR_{NR}$ is adopted in the UK.

8.6 Reaction to fire

There is a regulatory requirement in some countries for a Euroclass for reaction to fire if asphalt is to be laid in certain types of tunnel. This is not a regulatory requirement in UK, so the “no requirement” category should be adopted.

8.7 Resistance to permanent deformation

BE EN 13108-4:2006, 5.7, requirements for resistance to permanent deformation are only specified for performance-related surface course mixtures (see C.2.5.1.4.4 of this Published Document).

8.8 Stiffness

For the purposes of BS EN 13108-4:2006, 5.8, all stiffness test methods are considered equivalent. In the UK it is not anticipated that stiffness of HRA mixtures will be determined. It is therefore recommended that the “no requirement” categories $S_{\min NR}$ and $S_{\max NR}$ are adopted in the UK.

8.9 Resistance to fuel for application to airfields

The BS EN 13108-4:2006, 5.9, requirement applies only to airfields, so for use in other applications the “no requirement” category is adopted.

8.10 Resistance to de-icing fluid for application to airfields

The BS EN 13108-4:2006, 5.10, requirement applies only to airfields, so for use in other applications the “no requirement” category β_{NR} is adopted.

8.11 Temperature of the mixture

BS EN 13108-4:2006, Table 16, specifies temperature requirements (see C.2.6 of this Published Document). The maximum temperatures at any stage are similar to those from BS 594. See BS 594987 for guidance on suitable minimum temperatures at delivery and for compaction.

8.12 Over-specification

BS EN 13108-4:2006, 5.12, contains limitations on specifiers to prevent over-specification by the combination of unnecessarily onerous combinations of requirements, in particular the means for specifying the quantity of binder or air voids in a mixture.

8.13 Durability

HRA produced in accordance with BS EN 13108-4 and laid in accordance with BS 594987 may be considered durable for a reasonable working life (the period of time during which the performance of the works will be maintained at a level compatible with the declared performance of the characteristics).

8.14 Identification

8.14.1 General

BS EN 13108-4:2006, Clause 7, requires that the delivery ticket contains at least the following information relating to identification:

- the manufacturer and mixing plant;
- mix identification code;
- designation of the mixture;

- how to obtain the full details demonstrating conformity with BS EN 13108-4;
- details of compliance with any clauses where requested for specific use on airfields specifications; and
- details of any additives (see 8.2.5 of this Published Document).

NOTE Information concerning regulatory marking accompanies the product (for CE marking and labelling see BS EN 13108-4:2006, ZA.3), but characteristics which are not necessarily part of regulatory marking, for example, special requirements for airfields, could be made available by alternative means, i.e. retained by the dispatching depot if agreed with the client.

8.14.2 Mix designation

In BS EN 13108-4:2006, Clause 7, mixture designations follow the model below.

HRA	grading designation	base/bin/surf/reg	binder
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where:

HRA	is hot rolled asphalt;
grading designation	is taken from BS EN 13108-4:2006, Table 2 and Table 4 (Table C.1 and Table C.2A, Table C.2B and Table C.2C of this Published Document);
base	is base course;
bin	is binder course;
surf	is surface course;
reg	is regulating course;
binder	is the designation of the binder used.

BS 594 did not specify a specific method of designating hot rolled asphalts, or the mixture grading designations where slightly different. Comparative examples are shown in 8.14.3 of this Published Document.

8.14.3 Examples

HRA containing 50% of a coarse aggregate with maximum aggregate size 20 mm for binder course with paving grade bitumen, grade 100/150 is designated as HRA 50/20 bin 100/150.

NOTE 1 This would previously have been designated from BS 594-1:2005, 5.1, Table 2, Column 3, as 50% 0/20 mm HRA B/C 125 pen, or similar.

HRA containing 35% of a coarse aggregate with maximum aggregate size 14 mm and a Type F fine aggregate for surface course with paving grade bitumen, grade 40/60, and designed aggregate grading, is designated as HRA 35/14F surf 40/60 des.

NOTE 2 Previously from BS 594-1:2005, 5.2, Table 3, Column 3, as 35% 0/14 mm HRA S/C 50 pen, or similar.

In some instances it might be appropriate to add and identify extra information, such as aggregate PSV, to this core description, e.g. HRA 35/14F surf 40/60 des PSV 65.

The use of the descriptor “rec” (for “recipe”) may be considered appropriate to identify an empirical recipe-based mixture. Alternatively, “des” (for design) being used to identify a mixture which has undergone type testing to determine its optimum target binder content and, where required, performance-related testing to validate its deformation resistance.

9 BS EN 13108-5 Stone mastic asphalt specification requirements

9.1 General

NOTE A high proportion of SMA type material has traditionally been procured in the UK as proprietary laid systems certified under the BBA HAPAS approval scheme. It is envisaged that a significant application of BS EN 13108-5 in the UK will be as a means of declaring and classifying the material element within BBA HAPAS approvals for laid systems. Therefore, additional guidance on formulation and performance should be sought from suppliers approved under that Scheme.

Where SMA is procured as a generically specified material (i.e. non-BBA HAPAS), the material specification will need to use the levels and classes from BS EN 13108-5, with conformity established in accordance with BS EN 13108-20 and BS EN 13108-21.

BS EN 13108-5 is essentially a menu of empirical specification requirements from which individual mixture specifications can be selected. Thus, choices have to be made and not all requirements are relevant to all UK applications. Clause 9 of this Published Document discusses these requirements and indicates those which are recommended as appropriate for use in the UK. The requirements are presented in Annex D of this Published Document in the format of an example specification.

BS EN 13108-5 applies to materials in which aggregate particles are generally gap-graded to form a stone-to-stone contact within a mastic of fine aggregate and binder, and will generally provide a relatively open surface texture. The size of aggregate used is limited to 6,3 mm, 10 mm, 14 mm or 20 mm.

9.2 Composition

9.2.1 General

BS EN 13108-5 requires that:

- the mix formulation is declared and documented;
- at the target composition the mixture conforms to the selected requirements;
- the grading is expressed in percentages by mass of total aggregate;
- the binder and additive content are expressed in percentages by mass of total mixture; and
- the percentages passing the sieves (with the exception of the sieve 0,063 mm) are expressed to 1%, the binder content, the percentage passing sieve 0,063 mm and any additive content to 0,1%.