



BSI Standards Publication

PUBLISHED DOCUMENT

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

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Foreword

Publishing information

This Published Document is published by BSI Standards Limited, under licence from The British Standards Institution, and came into effect on 31 March 2015. It was prepared by Subcommittee B/510/1, *Asphalt products* and 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.

Supersession

PD 6691:2015+A1:2016 supersedes PD 6691:2015, which is withdrawn.

Text introduced or altered by Amendment No. 1 is indicated in the text by tags A1 A1. Minor editorial changes are not tagged.

Relationship with other publications

This Published Document gives non-contradictory, complimentary information for use in the UK with BS EN 13108.

Use of this document

This publication is not to be regarded as a British Standard.

As a guide, this Published Document takes the form of guidance and recommendations. It should not be quoted as if it were a specification and particular care should be taken to ensure that claims of compliance are not misleading.

Any user claiming compliance with this Published Document is expected to be able to justify any course of action that deviates from its recommendations.

Presentational conventions

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

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.

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 Published Document cannot confer immunity from legal obligations.

0 Introduction

0.1 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 mixture formulation needs a declaration of the properties which are being claimed, demonstrated through a product-type testing procedure. In the simplest case it can be just grading and binder content. In more complex situations it can include performance-related properties, such as stiffness, deformation resistance and fatigue resistance. The demonstration of performance and 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 ways of describing composition, types of constituents, properties, and means of specimen preparation for product-type testing. In many cases, this choice is indicated by the words "should be as specified". For BS EN 13108 to be practicably workable in the UK there needs to be standardization from amongst these choices so that producers know what to declare through product-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 are retained in BS 594987, and conformity to BS 594987 is essential to ensure the durability of the finished work.

For recipe mixtures 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 previous British Standards (which specified asphalt mixtures). This UK guidance gives recommendations for an approach to using BS EN 13108 to arrive at mixtures similar to those which have been traditionally used over many years. 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 guidance on a means of regulating the use of reclaimed asphalt.

0.2 Assessment and verification of constancy of performance

From 1 July 2013 the Construction Products Regulation 2013 [1] was fully implemented across all EU member states. It is a requirement of BS EN 13108 product standards that an asphalt product supplied in conformity with one of the parts of BS EN 13108 is assessed for product type and for conformity utilizing Part 20 and Part 21. This process is called assessment and verification of constancy of performance (AVCP). The end result of the AVCP process is the CE marking of the product confirming that it meets the performance requirements as detailed in the declaration of performance.

BS EN 13108-20 identifies the way in which the performance of a mixture composition to the requirements of the product standards is to be determined.

BS EN 13108-21 specifies procedures to be adopted during production to ensure product constancy and conformity with declared performance.

BS EN 13108-20 calls up test methods from the BS EN 12697 series of asphalt testing standards. Separate guidance on these test methods is given in PD 6692.

0.3 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 13108-1:2006, BS EN 13108-2:2008, BS EN 13108-4:2006, BS EN 13108-5:2006, BS EN 13108-7:2006, BS EN 13108-8:2005, BS EN 13108-20:2006 and  BS EN 13108-21:2016 .

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 EN 13108 mixture specifications. Annex B contains an example specification which gives the UK choice for specifying asphalt concrete in accordance with BS EN 13108-1. Annex C contains an example specification which gives the UK choice for specifying hot rolled asphalt in accordance with BS EN 13108-4. Annex D contains an example specification which gives the UK choice for specifying stone mastic asphalt in accordance with BS EN 13108-5.

This Published Document does not give guidance on BS EN 13108-6 as this standard is either rarely used in the UK or covered by other guidance.

This Published Document is applicable to mixtures for use on roads and other paved areas, including airfields. Detailed provisions for airfields are specified elsewhere.

NOTE 1 For airfield installations on the defence estate, guidance is given in the Defence Infrastructure Organisation Practitioner's Guide 06/11 [2].

NOTE 2 There are several asphalt mixtures in general use which have not been 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 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

Standards publications

BS EN 1097-6, *Tests for mechanical and physical properties of aggregates – Determination of particle density and water absorption*

BS EN 1426 (BS 2000-49), *Bitumen and bituminous binders – Determination of needle penetration*

BS EN 12591, *Bitumen and bituminous binders – Specifications for paving grade bitumens*

BS EN 12697-3, *Bituminous mixtures – Test methods for hot mix asphalt – Part 3: Bitumen recovery: Rotary evaporator*

BS EN 12697-26, *Bituminous mixtures – Test methods for hot mix asphalt – Part 26: Stiffness*

BS EN 13043, *Aggregates for bituminous mixtures and surface treatments for roads, airfields and other trafficked areas*

BS EN 13108-1:2006, *Bituminous mixtures – Material specifications – Part 1: Asphalt Concrete*

BS EN 13108-4:2006, *Bituminous mixtures – Material specifications – Part 4: Hot Rolled Asphalt*

BS EN 13108-5:2006, *Bituminous mixtures – Material specifications – Part 5: Stone Mastic Asphalt*

BS EN 13108-7, *Bituminous mixtures – Material specifications – Part 7: Porous Asphalt*

BS EN 13108-8, *Bituminous mixtures – Material specifications – Part 8: Reclaimed asphalt*

BS EN 13108-20:2006, *Bituminous mixtures – Material specifications – Part 20: Type testing*

BS EN 13108-21:2016, *Bituminous mixtures – Material specifications – Part 21: Factory Production Control*

BS EN 13924, *Bitumen and bituminous binders – Specifications for hard paving grade bitumens*

Other publications

[N1] HIGHWAYS AGENCY. *Manual of Contract Documents for Highway Works – Volume 1: Specification for Highway Works*. 2015¹⁾

3 Terms, definitions and abbreviations

3.1 Terms and definitions

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

3.1.1 composition

3.1.1.1 mixture formulation

composition of a single mixture expressed as a target composition

NOTE 1 Two ways of declaring mixture composition are required because some countries traditionally work in terms of the theoretical percentages added in a laboratory mixture 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.

3.1.1.2 output target composition

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

NOTE This is usually the result of a production validation.

¹⁾ Available at: <http://www.standardsforhighways.co.uk/mchw/vol1/index.htm> [last viewed 24 March 2015]

3.1.2 measuring properties

COMMENTARY ON 3.1.2

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.

There is a general desire to move toward 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 (see 3.1.2.1). They include such things as triaxial tests for deformation resistance and tend to require complex and expensive test equipment.

Many of the tests used to measure mechanical properties of asphalt fall short of this fundamental ideal and are more simulative in nature. These tests are called performance-related requirements (see 3.1.2.2). These include such things as wheel tracking tests and tend to be rather more practical.

Virtually all of the tests used in the UK to measure properties of asphalt in standards and contracts are 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.

3.1.2.1 performance-based requirement

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

3.1.2.2 performance-related requirement

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

3.1.3 types of specification

COMMENTARY ON 3.1.3

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 is state-of-the-art at the time of publication, and gives recommendations only for empirical specifications.

3.1.3.1 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.

3.1.3.2 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 The working practice at time of publication in the UK 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.

3.1.3.3 bitumen paving grade

bitumen grade that provides the optimum performance for a particular type and size of asphalt mixture

NOTE An asphalt mixture manufactured using a preferred bitumen grade that has been professionally laid and compacted according to the requirements of BS 594987, will provide a layer with optimum performance characteristics. Whilst the use of softer/less viscous grades of bitumen facilitates compaction, the end result is a surface with a greater susceptibility to softening in warmer conditions with an increased risk of surface disruption caused by scouring and/or dynamic/static loading.

3.2 Abbreviations

For the purposes of this Published Document the following abbreviations apply.

AC	asphalt concrete
AVCP	verification of constancy of performance
BBA	Béton Bitumineux pour chaussées Aéronautiques
DBM	dense bituminous mixture
<i>NOTE DBM was formerly known as dense bituminous macadam.</i>	
EME2	Enrobés à module élevé
FPC	factory production control
HDM	heavy duty mixture
HRA	hot rolled asphalt
HMB	high modulus base
ITSM	indirect tensile stiffness modulus
ITSR	indirect tensile strength ratio
MCHW 1	<i>Manual of Contract Documents for Highway Works – Vol. 1 [N1]</i>
OCL	operational compliance level
PA	porous asphalt
RA	reclaimed asphalt
SMA	stone mastic asphalt
SuDS	sustainable drainage systems

4 Constituent materials

4.1 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 Assessment. 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 should be demonstrated. This evidence should be included in the product type testing documentation for the appropriate mixture formulation.

4.2 Binder

4.2.1 Paving grade bitumen

Paving grade bitumen should be specified in accordance with BS EN 12591. The selection of the grade of binders for use with mixtures are included in the example specifications in Annex B, Annex C and Annex D of this Published Document.

4.2.2 Hard paving grade bitumen

Hard paving grade bitumen conforming to BS EN 13924 should only be used in EME2 base and binder course mixtures.

4.2.3 Polymer modified bitumen

Polymer modified bitumen is covered by a framework specification in BS EN 14023. Since this is not a performance specification, product-type testing of the asphalt mixture may demonstrate which grades are acceptable.

4.3 Aggregates

All aggregate requirements should be 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.

NOTE 1 Detailed recommendations for categories of all relevant properties are given in PD 6682-2.

BS EN 13043 requirements for shape, fines content, etc., 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 HRA.

NOTE 2 The recommendations of PD 6682-2 are followed, where relevant, in this Published Document.

4.4 Reclaimed asphalt (RA)

COMMENTARY ON 4.4

For mixtures which include reclaimed asphalt, the following guidance is provided.

4.4.1 Requirements in BS EN 13108-8:2005 in relation to RA

There are only two definitive requirements in BS EN 13108-8 in relation to RA:

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

NOTE BS EN 13108-8 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 RA in a standard way in order to facilitate such specification.

4.4.2 Preferred properties of reclaimed asphalts

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

4.4.3 Criteria for adoption in the UK

For the purposes of specification, the following criteria should be adopted:

- 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.

4.4.4 Limiting the amount of reclaimed asphalt (RA)

BS EN 13108-1, BS EN 13108-4 and BS EN 13108-5 also cover the possibility of limiting the amount of RA permitted to be added to the mixture. In line with current UK practice, the following limits normally apply:

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

NOTE There are designs which meet project outcomes where more than 10% reclaimed asphalt may be used in surface course mixtures and more than 50% in other mixtures, but these are subject to greater levels of control.

4.4.5 Total binder in the mixture

In cases where more than 10% for surface course mixtures, and 20% for other mixtures, by mass of the total mixture of RA is added to the mixture, 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 RA) should conform to the grade specification for the mixture. BS EN 13108-1, BS EN 13108-4 and BS EN 13108-5 give the option of carrying out this calculation on either penetration or softening point. In line with current UK practice the penetration method should be adopted.

NOTE Additional requirements are called up in the product standards when the binder from the RA or the binder for the mixture is modified. BS EN 13108-8 requires the producer to declare the feedstock binder type, ie paving grade or modified, and the properties. The determination of recovered binder softening point in addition to penetration might assist where historical records are not available.

5 Mixture composition

5.1 General

BS EN 13108-1 to BS EN 13108-7 (inclusive) require 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%.

5.2 Grading and sieves

5.2.1 Sieve series in use in Europe

Because two different sieve series are in use in Europe (6,3 mm, 10 mm, 14 mm, 20 mm in countries such as the UK, France and Spain, and 8 mm, 11 mm (11,2 mm), 16 mm, 22 mm (22,4 mm) in countries such as Germany, Netherlands and Scandinavia) the UK choice should be indicated. The sieves used in the UK are basic sieve set "plus set 2" conforming to BS EN 13043.

NOTE Detailed guidance on this can be found in PD 6682-2.

5.2.2 Full set of coarse sieves

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, that should 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; A_1 14 mm; A_1 20 mm; 31,5 mm; and 40 mm.

NOTE 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, as shown in the example specifications in the annexes of this Published Document.

5.3 Binder content

5.3.1 Binder content categories

The binder content categories in BS EN 13108 involve a correction factor for the density of the aggregate in the mixture. 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 providing the same binder volume in all mixtures regardless of aggregate density.

5.3.2 Denser aggregates

A consideration of UK mixtures and aggregates indicated that this approach could have been detrimental for some mixtures, as some of the denser aggregates in practice needed higher binder contents to ensure adequate 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 binder content is designated as the B_{act} target value.

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 is required and this does not compromise the laying or measured characteristics of the mixture, the appropriate target binder content can be utilized when product-type testing the mixture.

5.3.3 CE marking

For the purposes of CE marking, these actual target binder contents (B_{act}) need to be corrected back to determine the B_{min} defined in BS EN 13108-1 to BS EN 13108-7 (inclusive).

5.3.4 Target values

To convert a B_{act} target value within this Published Document back to a B_{min} declared value from BS EN 13108-1 to BS EN 13108-7 (inclusive), the following formula is used:

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

where:

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

The $B_{\text{min declared}}$ 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%. Product type test reports should clearly include both values.

It is this back-corrected binder content B_{min} which is declared for CE marking purposes.

NOTE For the convenience of the recipients of CE marking, B_{act} can also be declared in a delineated area of the CE marking information sheet identified as "additional information".

6 BS EN 13108-1 asphalt concrete specification requirements

6.1 General

BS EN 13108-1 is a menu of specification requirements from which individual mixture specifications can be selected. Thus, choices should be made, and not all requirements are relevant to UK applications. Clause 5 discusses these requirements and indicates those that should be followed in the UK.

NOTE In Annex B, these recommended choices are presented in the form of an example specification. The current working practice in the UK for asphalt concrete is for an empirical 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.

6.2 General, empirical and fundamental requirements

6.2.1 General

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.

6.2.2 General requirements

6.2.2.1 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%.

6.2.2.2 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 FPC, are included in the example specification in Annex B.

6.2.2.3 Void content

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

In the UK, experience with void content specifications for asphalt concrete mixtures used on roads is generally limited to dense base and binder courses produced under MCHW 1 [N1]. 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 dense type materials, but the criteria should be defined. In such cases these should be quoted as “no requirement” categories $V_{\max\text{NR}}$ and $V_{\min\text{NR}}$.

6.2.2.4 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 without any evidence of balling of fine aggregate.

6.2.2.5 Water sensitivity

There may be specific applications where water sensitivity is appropriate. However, it is generally recommended that the “no requirement” category $ITSR_{\text{NR}}$ is adopted. The categories are given in BS EN 13108-1:2006, 5.2.4 in terms of the indirect tensile strength ratio that is determined from cylinder splitting testing of soaked and unsoaked specimens.

6.2.2.6 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.

The “no requirement” category Abr_{ANR} should be adopted in the UK.

6.2.2.7 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 previously defined in BS 598-110, but the test procedure and reporting differ.

In the UK, such requirements for asphalt concrete have hitherto applied only to dense asphalt concrete binder course mixtures under MCHW 1 [N1]. Categories for this application using cores from trial strips, are included in the example specification in Annex B. The “large device” is called up in the specification for EME2 and BBA using slab compacted specimens, and appropriate categories are included in the example EME2 and BBA specification in Annex B. Other than for these specific applications, the “no requirement” categories P_{NR} , WTS_{AIRNR} and PRD_{AIRNR} should be adopted in the UK.

6.2.2.8 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.

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

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

6.2.2.10 Temperature of the mixture

Temperature limit requirements are given in BS EN 13108-1:2006, Table 11 (see B.3.6 of this Published Document). Guidance on suitable minimum temperatures at delivery and for compaction is given in BS 594987:2015, Table A1.

6.2.3 Empirical requirements

6.2.3.1 General

BS EN 13108-1:2006, 5.3 specifies the more specific and prescriptive detailed requirements which apply to empirically specified mixtures.

NOTE 1 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).

NOTE 2 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.

6.2.3.2 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. There are requirements in BS EN 13108-1:2006, Table 1 and 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, 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 give a single point or a very narrow envelope from which to select for the target values for each of the sieves.

This, in combination with the tolerances from BS EN 13108-21, results in overall grading specification envelopes utilised for assessing the conformity of the mixture as defined in BS EN 13108-21 for factory production control.

6.2.3.3 Binder content

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

The binder content requirement in BS EN 13108-1 contains a 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 mixture 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; and
- 31,5 mm to 40 mm.

Some care should be taken in the application of this correction factor as the effect might not be consistent with the mineralogical nature of aggregates used in the UK. To ensure that the performance and durability of mixtures sensitive to these

mineralogical differences are not compromised, the recommended binder content designated as B_{act} is presented in Annex B against the coarse aggregate type, in line with the methodology previously used.

NOTE The selection of the appropriate target binder content for the particular mixture takes account of a number of important factors. These particularly include the handling and laying characteristics of the mixture and the anticipated performance in the pavement. As already stated, two of the factors which 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.

6.2.3.4 Additives

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

6.2.3.5 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_{minNR} , S_{maxNR} , F_{NR} and Q_{minNR} are adopted in the UK.

6.2.3.6 Voids filled with bitumen

The requirements specified in BS EN 13108-1:2006, 5.3.3 are not generally adopted in the UK, other than for some asphalt concrete on airfield applications. For use in other applications the “no requirement” category VFB_{NR} should be adopted.

6.2.3.7 Voids in mineral aggregate

The requirements specified in BS EN 13108-1:2006, 5.3.4 are 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} should be adopted.

6.2.3.8 Void content at ten gyrations

The requirements specified in BS EN 13108-1:2006, 5.3.5 are a measure of mixture workability and compactability. The “no requirement” category $V10G_{minNR}$ should be adopted.

6.2.4 Fundamental requirements

COMMENTARY ON 6.2.4.

BS EN 13108-1:2006, 5.4 offers a less prescriptive approach to composition than previously specified in BS 4987, but also links with measurement of stiffness, deformation resistance and fatigue properties by performance-based test methods.

6.2.4.1 Composition – grading and binder content

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

6.2.4.2 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 might be determined, where required, on cored cylindrical specimens from trial strips using the indirect tensile stiffness modulus test in accordance with BS EN 12697-26:2012, Annex C.

Other than for these specific applications, the “no requirement” categories $S_{\min\text{NR}}$ and $S_{\max\text{NR}}$ should be adopted.

NOTE It is anticipated that stiffness might be specified in conjunction with an otherwise empirical specification. There is provision for this within the standard and associated CE marking requirements.

6.2.4.3 Resistance to permanent deformation in triaxial compression test

It is not intended that triaxial testing for deformation resistance should be used in specifications in the UK. Therefore the “no requirement” category f_{cmaxNR} should be adopted.

6.2.4.4 Resistance to fatigue

Fatigue testing should not be used in specifications. Therefore the “no requirement” category $\varepsilon_{6\text{-NR}}$ should be adopted.

6.2.4.5 Over-specification

The requirements specified in BS EN 13108-1:2006, 5.4.5 contain limitations on specifiers to prevent over-specification by the combination of inappropriate and unnecessarily onerous combinations of requirements.

6.2.4.6 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 should be maintained at a level compatible with the declared performance of the characteristics).

6.3 Identification

6.3.1 General

The product-type test report contains all the relevant detailed information and the information on the delivery ticket, as required by this Published Document, is that required to enable identification of the product and provide traceability to CE marking. If additional information is required on the delivery ticket, this should be specified in documents relating to the application of the product.

The delivery ticket should contain at least the following information relating to identification (as required by BS EN 13108-1:2006, Clause 7):

- the manufacturer and mixing plant;
- mixture identification code;
- designation of the mixture;
- how to obtain the full details to ensure conformity with the European Standard;
- details of any additives (see 6.2.3.4); and
- details of compliance with any clauses, where requested, for specific use on airfields specifications.

NOTE Information concerning regulatory marking is made available by the manufacturer (for CE marking and labelling see BS EN 13108-1:2006, ZA.3). Characteristics that are not necessarily part of regulatory marking, for example, special requirements for airfields, may also be made available as agreed with the client.

6.3.2 Mixture designation

6.3.2.1 General

The BS EN 13108-1 mixture 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;
<i>D</i>	is the upper sieve size of the mixture, in mm;
base	is the base course;
bin	is the binder course;
surf	is the surface course; and
binder	is the designation of the binder used.

NOTE UK common practice previously included other descriptors for differentiating certain types of materials, e.g. dense bitumen macadam, open graded macadam, dense surface course and close graded surface course.

The descriptors in Annex B should be used in material designations on delivery tickets.

6.3.2.2 Examples of dense asphalt concrete and open graded asphalt concrete

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

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

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

All mixtures are recipe unless they are designed. The descriptor "des" (for design) should be used to identify a mixture which has undergone type-testing for the determination of an appropriate target grading and binder content to achieve voids content and/or performance-related testing to validate mixture stiffness or deformation resistance. The descriptor "rec" (for "recipe") can be used to identify an empirical recipe based mixture.

7 BS EN 13108-2 asphalt concrete for very thin layers specification requirements

BS EN 13108-2 is a list of specification requirements from which individual mixture specifications can be selected. For UK application the selection of levels and classes should be made from within MCHW 1 [N1].

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 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.

8 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 BS EN 13108-3 should not be used in this context and specific guidance on its use is not considered necessary in this Published Document.

9 BS EN 13108-4 hot rolled asphalt specification requirements

9.1 General

BS EN 13108-4 is a menu of specification requirements from which individual mixture specifications can be selected. Thus, specific choices should be made as not all requirements are relevant to all UK applications. This Clause discusses these requirements and indicates those that should be applied.

NOTE The requirements are presented in Annex C in the format of an example specification.

9.2 Composition

9.2.1 General

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

- the mixture 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%.

9.2.2 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 mixture falls within the grading envelope. There are requirements in BS EN 13108-4:2006, Table 2 and Table 4, for which sieves should 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, 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.

9.2.3 Binder content for base and binder course

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 (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.

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:

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

where:

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

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 mixture 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; and
- 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. 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.

9.2.4 Binder volume

Only performance-related surface course mixtures should be made using 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).

9.2.5 Additives

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

9.3 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.

9.4 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).

9.5 Water sensitivity

There may be specific applications where water sensitivity is appropriate. However, it is generally recommended that the “no requirement” category $ITSR_{NR}$ is adopted.

BS EN 13108 4:2006, 5.5 specifies water sensitivity in terms of the $ITSR$ determined from cylinder splitting testing of soaked and unsoaked specimens.

9.6 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.

9.7 Resistance to permanent deformation

BS 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).

9.8 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 shall be determined, so “no requirement” categories S_{minNR} and S_{maxNR} should be adopted in the UK.

9.9 Resistance to fuel for application on airfields

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

9.10 Resistance to de-icing fluid for application on airfields

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

9.11 Temperature of the mixture and suitable minimum temperatures at delivery and compaction

BS EN 13108-4:2006, Table 16, specifies temperature requirements (see C.2.6).

BS 594987 gives requirements on suitable minimum temperatures at delivery and for compaction.

9.12 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.

9.13 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 are maintained at a level compatible with the declared performance of the characteristics).

9.14 Identification

9.14.1 General

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

- the manufacturer and mixing plant;
- mixture 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).

NOTE Information concerning regulatory marking accompanies the product (for CE marking and labelling see BS EN 13108-4:2006, ZA.3), but characteristics that 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.

9.14.2 Mixture designation

As 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.

9.14.3 Examples of mixture designation

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

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 40/60, and designed in accordance with BS EN 13108-4:2006, Annex H, is designated as HRA 35/14F surf 40/60 des.

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.

All mixtures are recipe unless they are designed. The descriptor "des" (for design) should be used to identify a mixture which has undergone product-type testing for the determination of an appropriate target grading and binder content. The descriptor "rec" (for "recipe") can be used to identify an empirical recipe based mixture. The descriptor "perf" (for "performance-related") can be used to identify mixtures which have undergone performance-related testing for resistance to permanent deformation.

10 BS EN 13108-5 stone mastic asphalt specification requirements

10.1 General

BS EN 13108-5 is a menu of empirical specification requirements from which individual mixture specifications can be selected. Thus, choices should be made and not all requirements are relevant to all UK applications. Clause 9 discusses these requirements and indicates those which are recommended as appropriate for use in the UK. The requirements are presented in Annex D 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. The size of aggregate used is limited to 6,3 mm, 10 mm, 14 mm or 20 mm.

10.2 Composition

10.2.1 General

BS EN 13108-5 requires that:

- the mixture 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;
- 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%.

10.2.2 Grading

BS EN 13108-5:2006, 5.2.2 requires specifications to be presented as a grading envelope, and specifies that the target composition of the mixture falls within the grading envelope. BS EN 13108-5:2006, Table 2 specifies requirements for which sieves are to be used, related to the upper size of the mixture. There are also limitations on the number of additional sieves which should be called up, to limit the complexity of grading specifications.

In the example specification given in Annex D, sieve selections have been made in accordance with these requirements, as have the requirements of BS EN 13108-5:2006, Table 3, which limit the range of the selected grading envelope.

10.2.3 Target and minimum binder content

The target and/or minimum binder content is defined in Table D.1 (see BS EN 13108-5:2006, 5.2.3).

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

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 and for higher density aggregates it is reduced using the following formula:

$$\alpha = \frac{2,650}{\rho_b} \quad (4)$$

where:

ρ_b is the mean particle density of the aggregate mixture, in megagrams per cubic metre (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 mixture 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; and
- 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.

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 its anticipated performance in the pavement.