

Hot rolled asphalt for roads and other paved areas —

Part 1: Specification for constituent materials and asphalt mixtures

ICS 93.080.20

Committees responsible for this British Standard

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- County Surveyors’ Society
- Institution of Civil Engineers
- Institution of Highways and Transportation
- Mastic Asphalt Council Ltd.
- Ministry of Defence — UK Defence Standardization
- Department for Transport — Highways Agency
- Quarry Products Association
- Refined Bitumen Association
- Road Surface Dressing Association
- Scottish Office — Roads Directorate
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Contents

	Page
Committees responsible	Inside front cover
Foreword	ii
Introduction	1
1 Scope	1
2 Normative references	1
3 Terms and definitions	2
4 Constituent materials	3
5 Hot rolled asphalt mixtures	4
6 Mixing	11
7 Coated chippings for application to surface course surfaces	12
8 Sampling and testing	13
Annex A (informative) Guidance on the selection of materials and mixtures	14
Annex B (informative) Recommendations for the application of design test criteria	16
Annex C (informative) Specifying hot rolled asphalt	17
Annex D (informative) Guidance on the selection of performance related design criteria for surface course mixtures	18
Annex E (normative) Specifying performance specified hot rolled asphalt	22
Bibliography	23
Table 1 — Designation of binders and recommended storage temperatures	3
Table 2 — Composition of base (roadbase), binder course and regulating course mixtures	6
Table 3 — Composition of design type F surface course mixtures	7
Table 4 — Composition of design type C surface course mixtures	7
Table 5 — <i>Table deleted</i>	8
Table 6 — Composition of recipe type F surface course mixtures	9
Table 7 — Maximum temperatures of mixed asphalt	12
Table 8 — Grading of chippings	12
Table B.1 — Criteria for the stability of laboratory design asphalt	16
Table D.1 — Limiting wheel-tracking requirements for site classifications	20
Table D.2 — Classification of sites by traffic and stress condition	21

Foreword

This British Standard has been prepared by Subcommittee B/510/1. It supersedes BS 594-1:2002, which is withdrawn.

The previous edition of BS 594-1 introduced the following changes:

- bitumen grade references in accordance with BS EN 12591;
- terminology which will be used in future European asphalt standards to familiarize UK users with the new terms;
- reference to the in-plant blending of bitumens;
- requirements for the specification of surface course mixtures based on their resistance to deformation;
- the design type R surface course mixtures were deleted.

This edition introduces the following changes. The requirements for aggregates, the sieve sizes used for the definition of mixtures and the size designations of mixtures have been amended to align with BS EN 13043, which is being implemented in the UK on 01/01/2004. The introduction of BS EN 13043 implies the use of both different size designations and test methods. Detailed guidance and advice on the changes may be found in PD 6682-2 and PD 6682-9.

BS 594 comprises two parts:

- *Part 1: Specification for constituent materials and hot rolled asphalt mixtures;*
- *Part 2: Specification for the transport, laying and compaction of hot rolled asphalt.*

This part includes requirements for asphalt mixtures and their constituent materials and for coated chippings applied to the surface of some asphalt surface courses.

The requirements and recommendations for transporting asphalt and for site work are given in BS 594-2.

Over the years, a considerable number of hot rolled asphalt mixture compositions have evolved. During the preparation of this revision, some rationalization of the previous range has been undertaken by omitting the type R enriched mixtures. The limited range of preferred mixes introduced in the previous edition and identified in bold type in Table 2, Table 3, Table 4 and Table 6, is maintained. As mixtures suitable for most uses can be selected from this reduced range, the use of a preferred mixture is encouraged wherever possible.

Further guidance on the selection of mixtures, the application of design test criteria and recommendations for stability related to traffic conditions, and information to be provided by the purchaser and the supplier is given in Annex A, Annex B, Annex C, Annex D and Annex E.

The requirements for the composition of all asphalt mixtures are based on testing the constituents and the mixture by methods described in BS 598 and other British Standards (see Clause 2). Adjustment values for soluble binder content and material passing the 0.063 mm test sieve are given in BS 598-102. Methods of test to determine the condition of the binder on coated chippings and their rate of spread, the texture of finished surfaces, the density of cores drilled from asphalt surfacing and a method for assessing the compaction performance of other rollers by comparison with the performance of a non-vibrating 8 t roller are included in other parts of BS 598 (see Clause 2).

It has been assumed in the drafting of this part of BS 594 that the execution of its provisions is entrusted to appropriately qualified and experienced people.

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

Compliance with a British Standard does not in itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 23 and a back cover.

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Introduction

This part of BS 594 specifies the properties of materials used to make hot rolled asphalt and of the mixtures manufactured from those materials.

Base (roadbase), binder course and regulating course mixtures are specified by conventional recipe methods in 5.1.

Surface course mixtures are specified in three ways. In 5.2 design mixtures are specified, based on the mechanical testing of the asphalt mixture to determine a design binder content. This binder content is of particular value when dealing with aggregates of previously unknown performance. Design mixtures are recommended for use on heavily trafficked roads.

Since the previous revision of this standard, mixtures have been developed which are suitable for use on very heavily trafficked sites. These are now specified in 5.4 (performance specified mixtures). No mix design method is specified. Instead, the as-laid asphalt mixtures are specified in terms of their resistance to deformation under varying degrees of traffic stress, from moderate to the most severe.

The recipe type of surface course mixture specified in 5.3 is the conventional mixture which has proved satisfactory, except under heavy traffic, for most applications for many years.

Where hot rolled asphalt surface course mixtures, of nominal 35 % coarse aggregate content or less, are used in trafficked areas it is usual to apply coated chippings to provide a suitable level of skidding resistance to the finished road. The properties of such chippings and the requirements for their manufacture are specified in Clause 7.

1 Scope

This part of BS 594 specifies requirements for mixtures of hot rolled asphalt to be laid as surface course, regulating course, binder course or base (roadbase) on roads and other paved areas, excluding heavy duty airfield pavements.

It also specifies requirements for coated chippings, but excludes requirements for site-specific properties such as polished stone values and abrasion values of aggregates.

NOTE The terms “base (roadbase)”, “binder course” and “surface course” are used throughout this standard in place of the traditional terms “roadbase”, “basecourse” and “wearing course” respectively to encourage use of the new terminology which will be used in European asphalt standards to be introduced in the near future.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this British Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. For undated references, the latest edition of the publication referred to applies.

BS 410-1:2000 (ISO 3310-1:2000), *Specification for test sieves — Technical requirements and testing — Part 1: Test sieves of metal wire cloth.*

BS 410-2:2000 (ISO 3310-2:2000), *Specification for test sieves — Technical requirements and testing — Part 2: Test sieves of perforated metal plate.*

BS 594-2:2003, *Hot rolled asphalt for roads and other paved areas — Part 2: Specification for transport, laying and compaction of hot asphalt.*

BS 598-100:1987, *Sampling and examination of bituminous mixtures for roads and other paved areas — Part 100: Methods for sampling for analysis.*

BS 598-101, *Sampling and examination of bituminous mixtures for roads and other paved areas — Part 101: Methods for preparatory treatments of samples for analysis.*

BS 598-102:1996, *Sampling and examination of bituminous mixtures for roads and other paved areas — Part 102: Analytical test methods.*

BS 598-107:1990, *Sampling and examination of bituminous mixtures for roads and other paved areas — Part 107: Method of test for the determination of the composition of design wearing course rolled asphalt.*

BS 598-108:1990, *Sampling and examination of bituminous mixtures for roads and other paved areas — Part 108: Methods for determination of the condition of the binder on coated chippings and for measurement of the rate of spread of coated chippings.*

BS 598-109, *Sampling and examination of bituminous mixtures for roads and other paved areas — Part 109: Methods for the assessment of the compaction performance of a roller and recommended procedures for the measurement of the temperature of bituminous mixtures.*

BS 598-110, *Sampling and examination of bituminous mixtures for roads and other paved areas — Part 110: Methods of test for the determination of wheel-tracking rate and depth.*

BS 812-2, *Testing aggregates — Part 2: Methods for determination of physical properties.*

BS 3195-3 (EN 58), *Methods for sampling petroleum products — Part 3: Method for sampling bituminous binders.*

BS 3690-3, *Bitumens for building and civil engineering — Part 3: Specification for mixtures of bitumen with pitch, tar and Trinidad lake asphalt.*

BS 6100, *Glossary of building and civil engineering terms.*

BS EN 197-1, *Cement — Part 1: Composition, specifications and conformity criteria for common cements.*

BS EN 932 (all parts), *Tests for general properties of aggregates.*

BS EN 933 (all parts), *Tests for geometrical properties of aggregates.*

BS EN 1097 (all parts), *Tests for mechanical and physical properties of aggregates.*

BS EN 1367 (all parts), *Tests for thermal and weathering properties of aggregates.*

BS EN 1744 (all parts), *Tests for chemical properties of aggregates.*

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

BS EN 13043:2002, *Aggregates for bituminous mixtures and surface treatments for roads, airfields and other trafficked areas.*

HIGHWAYS AGENCY, *Specification for Highway Works (SHW)*. London: The Stationery Office.

3 Terms and definitions

For the purposes of this part of BS 594 the terms and definitions given in BS 6100 and the following apply.

3.1

stability

maximum resistance to deformation, in kilonewtons, of a moulded asphalt specimen made and tested in accordance with BS 598-107

3.2

flow

deformation of moulded asphalt specimen, in millimetres, at the point of maximum resistance, when made and tested in accordance with the requirements of BS 598-107

3.3

design binder content

binder content of a surface course design mixture determined in accordance with the procedure described in BS 598-107

3.4

target binder content

nominal soluble binder content of a surface course design mixture specified in 5.2 and which is equal to or greater than the design binder content and the specific requirements given in Table 3 and Table 4

3.5

added filler

material, a substantial proportion of which passes a 0.063 mm test sieve, added to the mixture in excess of that present in the coarse and fine aggregates

3.6

test sieve

sieve conforming to BS 410-1 (ISO 3310-1) or BS 410-2 (ISO 3310-2)

3.7

commercial vehicle

vehicle with an unladen weight exceeding 1.5 t

4 Constituent materials

4.1 Binder

The binder used in hot rolled asphalt mixtures shall be one of the binders designated in Table 1. Paving grade bitumen shall conform to BS EN 12591. Lake asphalt-bitumen mixtures shall conform to BS 3690-3.

NOTE 1 Guidance on the selection and use of different grades of binder is given in Annex A. Improved performance characteristics may be achieved by the use of modified bitumens but these are outside the scope of this standard. Guidance is available in the *Design Manual for Road and Bridgework, Volume 7* (HD 37/99) [1].

70/100 and 100/150 pen grade bitumen may be produced by blending in the mixer at the asphalt plant. The grades used for blending shall be no harder than 30/45 pen nor softer than 160/220 pen and shall conform to BS EN 12591. The producer shall be able to demonstrate that the plant is capable of adequately blending the bitumens. Measures for ensuring consistency of proportioning of the blend shall be included in plant quality management systems. These shall include evidence of type tests carried out on a laboratory blend of the bitumens to demonstrate conformity to BS EN 12591. The quality assurance/management systems shall also include the steps to be taken to demonstrate the continuing adequacy of the process following significant changes being made to those parts of the plant involved in the process of bitumen blending.

No grades of bitumen harder than 70/100 pen shall be blended in the mixer.

NOTE 2 Other grades may be in-plant blended provided that the resulting bitumen can be sampled and tested before it is added to the aggregate and to ensure it conforms to BS EN 12591.

Table 1 — Designation of binders and recommended storage temperatures

Binder number	Type	Grade	Recommended storage temperature °C
1	Bitumen	30/45 pen	170
2	Lake asphalt-bitumen	35 pen	175
3	Bitumen	40/60 pen	165
4	Lake asphalt-bitumen	50 pen	170
5	Bitumen	70/100	160
6	Lake asphalt-bitumen	70 pen	165
7	Bitumen	100/150	150

NOTE Prolonged storage of binders at elevated temperatures may result in hardening. To reduce this risk, binders should be delivered to coating plants at temperatures below 200°C and prolonged subsequent storage above the temperatures given in this table should be avoided. (It should be recognized that binder deliveries may result in short-term storage temperatures above those recommended in this table.)

4.2 Coarse aggregate

4.2.1 Type of coarse aggregate

Coarse aggregate shall be material substantially retained on a 2.36 mm test sieve and shall conform to all appropriate requirements of BS EN 13043 and consist of one of the following.

- Crushed rock of one or more of the following groups: basalt, gabbro, granite, gritstone, hornfels, limestone, porphyry or quartzite.
- Gravel of one or more of the groups in a) or flint.
- Blastfurnace slag conforming to BS 1047.
- Steel slag, either electric-arc furnace or basic oxygen slag, with a compacted bulk density between 1.60 Mg/m³ and 1.80 Mg/m³ when tested in accordance with BS 812-2.

NOTE 1 Some aggregates other than those referred to in a) to d) have been found to be suitable for hot rolled asphalt. Guidance is available on the use of secondary and recycled aggregates, e.g. *Specification for Highway Works* (SHW).

NOTE 2 This British Standard does not include requirements for site-specific properties of aggregates, such as the polished stone value or the aggregate abrasion value, that may be required to assist skid-resistance, or the 10 % fines value which indicates aggregate strength.

4.2.2 Particle shape

The coarse aggregate shall conform to flakiness category FI₃₅.

4.2.3 Fines content

The coarse aggregate shall conform to fines category f₄.

NOTE 1 Some aggregates other than those referred to in 4.2.1a) to d) have been found to be suitable for hot rolled asphalt. Guidance is available on the use of secondary and recycled aggregates, e.g. *Specification for Highway Works* (SHW).

NOTE 2 This standard does not include requirements for all the properties of aggregates, for example polishing resistance, abrasion resistance and resistance to fragmentation. Guidance on the specification of such requirements in accordance with BS EN 13043 and the relationship between the new European aggregate test methods and those previously used in the UK can be found in PD 6682-2. Specification should be in terms of the categories recommended in PD 6682-2. Further guidance is given in B.5.2.

4.3 Fine aggregate

4.3.1 Type of fine aggregate

Fine aggregate shall substantially pass a 2 mm test sieve and shall be one of the following types:

- a) sand;
- b) fines produced by crushing coarse aggregate conforming to 4.2.1;
- c) a blend of a) and b).

NOTE Advice on the selection of asphalt mixtures containing various types of fine aggregate is given in Annex A.

4.3.2 Fines content

The fines content shall conform to the appropriate fines category specified in 5.1.1.2, 5.2.2.2 or 5.3.2.2.

NOTE For guidance on fines quality see PD 6682-2.

4.4 Added filler

Added filler shall be Portland cement conforming to BS EN 197-1 or limestone.

The grading of added filler shall be in accordance with BS EN 13043:2002, 5.2.1.

The loose bulk density in kerosene of added filler shall be in accordance with BS EN 13043:2002, 5.5.5.

NOTE For all other properties specified in BS EN 13043:2002, Clause 5 it is recommended that the “No Requirement” category is used.

5 Hot rolled asphalt mixtures

5.1 Group 1: base (roadbase), binder course and regulating course mixtures

NOTE 1 Adherence to the requirements of this clause will generally give mixtures of satisfactory performance. However, it is impossible in a general specification to cover all suitable aggregates a few of which might necessitate binder contents other than those in Table 2.

NOTE 2 The requirements for composition are based on testing the constituent materials and the mixture in accordance with methods referred to in Clause 4, Clause 5 and Clause 8. The values of binder content are those for the soluble binder content on analysis.

5.1.1 Aggregate

5.1.1.1 Coarse aggregate

Coarse aggregate shall conform to 4.2.

5.1.1.2 Fine aggregate

Fine aggregate shall conform to 4.3 and fines category f₂₂ of BS EN 13043.

5.1.1.3 *Added filler*

When added filler is required to achieve the composition given in Table 2, it shall conform to 4.4.

5.1.2 *Binder*

The grade and type of binder shall conform to 4.1.

5.1.3 *Composition of the mixture*

The results of a mixture analysis shall be adjusted in accordance with BS 598-102:1996, Clause 6. The adjusted results shall conform to Table 2, appropriate to the particular mixture designation and coarse aggregate, and within a tolerance of $\pm 0.6\%$ (m/m) of the total mixture on the values for binder content.

5.2 Group 2: surface course design mixtures

5.2.1 *General*

Design mixtures shall either be type F or type C conforming to Table 3 or Table 4.

NOTE Type F is characterized by a gap grading typical of traditional hot rolled asphalt surface course mixtures usually associated with the use of a fine sand, although other fine aggregates conforming to the grading limits may also be used.

Type C is characterized by a coarser grading usually associated with the use of crushed rock or slag fine aggregates. However, natural sand may be used in part or in total.

The designation F reflects a finer grading of the fine aggregate used in this type of mix. A coarser grading of the fine aggregate is used in type C mixes. The distinction between types F and C mixtures is in grading only; no restriction should be placed on the source and type of fine aggregate.

5.2.2 *Aggregate*

5.2.2.1 *Coarse aggregate*

Coarse aggregate shall conform to 4.2.

5.2.2.2 *Fine aggregate*

Fine aggregate shall conform to 4.3.

For type F mixtures, fine aggregate shall be 0/2 mm conforming to grading category $G_A 90$ and fines category f_{10} .

For type C mixtures, fine aggregate shall be 0/4 mm conforming to grading category $G_A 85$ and fines category f_{16} .

5.2.2.3 *Added filler*

When added filler is required to achieve the composition given in Table 3 or Table 4 it shall conform to 4.4.

5.2.3 *Binder*

The grade and type of binder shall conform to 4.1.

NOTE Guidance on the selection and use of different grades of binder is given in Annex A.

5.2.4 *Target binder content*

The target binder content shall be determined by adjusting the design binder content, determined in accordance with the procedure in BS 598-107 (see 3.3), where required, to allow for such properties as workability and durability.

The target binder content shall be not less than either the design binder content or the appropriate minimum value in Table 3 or Table 4 and shall be such that the values for stability and flow, tested in accordance with BS 598-107, at the target binder content are within the specified range selected from Table B.1.

NOTE 1 Design proposals should be verified in accordance with Annex B.

NOTE 2 The factors incorporated in the design method of BS 598-107 are such that for most type F mixtures, the design binder content is satisfactory as the target binder content. Addition of extra binder improves workability and durability and is acceptable as long as the resultant mixture properties conform to Table B.1. As there is less knowledge of the design of type C mixtures using this method, greater care is needed to ensure the specified binder content is adequate as regards workability and durability.