

Coated macadam (asphalt concrete) for roads and other paved areas —

Part 1: Specification for constituent materials and for mixtures

ICS 75.140; 93.080.20

Committees responsible for this British Standard

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- County Surveyors’ Society
- Department of the Environment, Transport and the Regions
(Highways Agency)
- Institute of Asphalt Technology
- Institution of Civil Engineers
- Institution of Highways and Transportation
- Mastic Asphalt Council Ltd.
- Quarry Products Association
- Refined Bitumen Association
- Road Surface Dressing Association
- Scottish Office (Roads Directorate)
- Society of Chemical Industry
- Transport Research Laboratory (TRL)
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Foreword

This part of BS 4987 has been prepared by Technical Committee B/510. It supersedes BS 4987-1:1993, which is withdrawn. The clause and table numbers of specific mixtures in the 1993 edition have been retained wherever possible in this edition. Clauses and tables which have been removed from this edition are marked as “*Deleted*”.

This edition introduces the following changes.

- Some terminology which will be used in future European asphalt standards is used to familiarize UK users with the new terms.
- With effect from 1.1.2002, the bitumen standard, BS 3690-1, will be replaced by BS EN 12591. This standard calls up the BS EN 12591 references only. The following table enables it to be used prior to 1.1.2002.

BS 3690-1 bitumen grade, penetration	BS EN 12591 bitumen grade, penetration	Penetration reference used in this standard
35 (± 7)	30/45	35
50 (± 10)	40/60	50
100 (± 20)	100/150	125
200 (± 30)	160/220	190
300 (± 45)	250/330	290

- With effect from 1.1.2002, DBM 50 and DBM 125 replace DBM produced with 100 pen bitumen.
- High modulus base (roadbase) and binder course macadams are included.
- A design procedure is introduced, by reference, for dense base (roadbase) and binder course mixtures incorporating 50 and 35 penetration grade bitumens and also for all 40 mm dense base (roadbase) mixtures.
- All 40 mm dense base (roadbase) recipe mixtures have been deleted.
- All 40 mm dense binder course mixtures have been deleted.
- For dense, heavy duty and high modulus mixtures which are produced with several grades of bitumen, the reference penetration value of the bitumen is included in the description of each mixture, e.g. DBM 50, HDM 50, HMB 35.
- With the introduction of designed mixtures, new bitumen grades and types of dense macadams, new dense mix descriptions have been introduced.
- The use of air voids in monitoring compaction is included. Percentage refusal density (PRD) is retained.
- Tar-bound materials have been deleted.
- Cut-back bitumen macadams have been deleted.
- Fluxed mixtures for permanent hand laid works have been included, with fluxing at the mixer.

Five varieties of dense bitumen macadam (DBM) base (roadbase) and binder course mixtures are included in this standard. With effect from 1.1.2002, the traditional mixture, previously referred to as DBM incorporating 100 pen bitumen, will be replaced by DBM 50 and DBM 125, whilst DBM 190 will replace the DBM which incorporates 200 pen bitumen. Heavy duty macadam (HDM) with a higher filler content and harder binder, previously identified as HDM, is now referred to as HDM 50. The traditional mixture with harder binder only, identified as DBM 50, remains, but high modulus mixtures produced with a harder grade of bitumen are now introduced as HMB 35. The range of HMBs may be extended by future amendments to this standard.

This standard comprises two parts:

- *Part 1: Specification for constituent materials and for mixtures;*
- *Part 2: Specification for transport, laying and compaction.*

Over the years, many coated macadam compositions have evolved. To encourage some rationalization a range of “preferred mixtures” has been included in clause 5, clause 6, clause 7 and clause 8. As mixtures suitable for most uses can be selected from this reduced range, the use of a preferred mixture is encouraged wherever possible.

Tests for certain aggregate properties are still under development and will be included in future revisions of this standard when they are fully developed and proven.

The requirements for transporting coated macadam mixtures and for site work are included in BS 4987-2.

The requirements for the composition of all mixtures are based on the testing of the constituents and of the mixture by methods described in BS 598.

Provision is made to measure the compaction of macadam on the road in terms of either air voids or the percentage refusal density (PRD) as described in BS 598-104.

It has been assumed in the drafting of this part of BS 4987 that the execution of its provisions is entrusted to appropriately qualified and experienced people.

Annex A and Annex C are normative. Annex B and Annex D are informative.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

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

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 25 and a back cover.

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1 Scope

This part of BS 4987 specifies the requirements for all types of coated macadam (asphalt concrete) to be laid as base (roadbase) (group one), binder course (group two), surface course (group three) or porous asphalt surface course (group four) for roads and other paved areas excluding heavy duty airfield pavements. This standard does not include requirements for macadams incorporating bitumen emulsions as binders which are specified in BS 434-1.

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 63 (all parts), *Road aggregates*.

BS 410-2, *Test sieves — Technical requirements and testing — Test sieves of perforated metal plate* (ISO 3310-2).

BS 598 (all parts), *Sampling and examination of bituminous mixtures for roads and other paved areas*.

BS 812 (all parts), *Testing aggregates*.

BS 812-103.1, *Testing aggregates — Part 103: Method for determination of particle size distribution — Section 103.1: Sieve tests*.

BS 1047, *Specification for air-cooled blast furnace slag aggregate for use in construction*.

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

BS 3690-1, *Bitumens for building and civil engineering — Part 1: Specification for bitumens for roads and other paved areas*.

BS 4987-2:2001, *Coated macadam for roads and other paved areas — Part 2: Specification for transport, laying and compaction*.

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

BS 7392, *Method for determination of distillation characteristics of petroleum products* (ISO 3405).

BS EN 12591:2000, *Bitumen and bituminous binders — Specifications for paving grade bitumens*.

Department of Transport *Specification for Highway Works*, 2001 edition¹⁾. Department of the Environment, Transport, and the Regions, London: The Stationery Office.

3 Terms and definitions

For the purposes of this part of BS 4987, the terms and definitions given in BS 6100 and the following apply.

3.1

test sieve

sieve conforming to BS 410-2

3.2

traffic categories

3.2.1

traffic category

volume of commercial vehicles travelling in one direction counted over a 16 h period and expressed in commercial vehicles per day (c.v.d.)

¹⁾ In preparation.

3.2.2

traffic category A

volume of more than 250 c.v. per lane per day

NOTE These categories refer to existing traffic levels, not projected levels.

3.2.3

traffic category B

volume of up to 250 c.v. per lane per day

NOTE These categories refer to existing traffic levels, not projected levels.

3.3

commercial vehicle

vehicle with an unladen mass exceeding 1.5 t

4 Constituent materials

4.1 Binder

4.1.1 With effect from 1.1.2002, the binder shall be one of the following types:

- a) petroleum bitumen conforming to BS EN 12591:2000, Table 1 sampled and tested in accordance with BS 3195-3 (EN 58);
- b) petroleum bitumen conforming to BS EN 12591:2000, Table 1, Grade 190 or 290 pen, to which a flux oil, conforming to the requirements shown in Annex A (see A.2), has been added;
- c) for porous asphalt the binder shall be as described in clause 8.

4.1.2 Until 31.12.2001, the binder shall be of the following type:

— petroleum bitumen conforming to BS 3690-1, sampled and tested in accordance with BS 3195-3 (EN 58).

The grade of binder shall be as given in clause 5, clause 6, clause 7 and clause 8 for the individual mixtures.

NOTE 1 The recommended storage temperatures for binders are given in Annex B.

NOTE 2 The grades of binders specified in clause 5, clause 6, clause 7 and clause 8 are suitable for machine laid macadam. See B.5.7 for guidance on grades of binders for hand laid mixtures and A.6 for deferred set and depot stock mixes.

NOTE 3 See B.5.5 for guidance on binders for use in porous asphalts, including modified binders.

4.1.3 When the addition of adhesion agents is made to bitumen, the mixtures shall have the relevant penetration required for bitumen given in clause 5, clause 6, clause 7 and clause 8.

NOTE The addition of adhesion agents to the bitumen or at the mixing stage (see also B.2) can reduce the risk of water stripping the binder from some aggregates.

4.2 Coarse aggregate

4.2.1 Type of coarse aggregate

The coarse aggregate shall be material substantially retained on a 3.35 mm test sieve and shall consist of one of the following.

- a) Crushed rock of one or more of the following groups: basalt, gabbro, granite, gritstone, hornfels, limestone, porphyry or quartzite.
- b) Gravel of one or more of the groups in a) or flint, crushed or uncrushed, or combinations of both types.
When gravel other than limestone gravel is used, 2 % by mass of the total aggregate of either hydrated lime or Portland cement shall be used as a filler.
- c) Blast furnace slag conforming to BS 1047.
- d) Steel slag, either electric arc furnace slag or basic oxygen slag, which shall be weathered until it is no longer susceptible to falling and the compacted bulk density of which shall be between 1 700 kg/m³ and 1 900 kg/m³ when tested as for blast furnace slag.

NOTE 1 The use of 2 % by mass of the total aggregate of hydrated lime or Portland cement filler reduces the risk of water stripping the binder from some aggregates. This may also be achieved by the addition of adhesion agents to the bitumen or at the mixing stage.

NOTE 2 Aggregates other than those referred to in a) to d) may be suitable for coated macadams but are outside the scope of this standard.

4.2.2 Particle shape

With the exception of the porous asphalts specified in clause 8, for which lower values are specified, the overall flakiness index of the coarse aggregate shall not exceed 45 % for crushed rock and crushed gravels and 50 % for uncrushed gravels, when tested in accordance with BS 812.

4.2.3 Fraction passing 75 μm sieve

When gravel is used, the material passing the 75 μm sieve shall not exceed 1 % by mass of the coarse aggregate when determined in accordance with the washing and sieving method described in BS 812-103.1.

NOTE 1 Although there is no acceptable method for determining clay content of coarse aggregate, an indication of quantity is given by using the sedimentation test described in BS 812-103.2.

NOTE 2 This standard does not include requirements for all the properties of aggregates such as the polished-stone value or the aggregate abrasion value that may be required to control skidding resistance or the 10 % fines value which indicates aggregate strength (see B.5.2).

4.3 Fine aggregate

4.3.1 Type of fine aggregate

The fine aggregate shall substantially pass a 3.35 mm test sieve and be of one of the following types:

- a) fines produced by crushing material from one of the groups specified in 4.2.1; or
- b) sand; or
- c) a mixture of a) and b).

4.3.2 Fraction passing 75 μm sieve

When sand is used, the material finer than 75 μm shall not exceed 8 % by mass of the fine aggregate when determined in accordance with the washing and sieving method described in BS 812-103.1.

NOTE Although there is no acceptable method for determining clay content of fine aggregate, an indication of quantity is given by using the sedimentation test described in BS 812-103.2.

4.4 Added filler

If added filler is used in the macadam it shall consist of crushed rock, crushed slag, hydrated lime, Portland cement or other material approved by the specifier, and at least 75 % of it shall pass a 75 μm test sieve (see also note 1 in 4.2.1).

4.5 Composition of designed and recipe mixtures

4.5.1 The binder content and aggregate grading of the freshly-mixed coated material made to a recipe specification, when sampled and tested in accordance with BS 598, shall conform to the relevant requirements for groups one, two, three and four as specified in clause 5, clause 6, clause 7 and clause 8 respectively of this standard. Freshly mixed designed material shall additionally conform to the requirements of 4.7. All high modulus mixtures shall be designed

NOTE 1 The binder contents for recipe mixtures given in tables in clause 5, clause 6, clause 7 and clause 8 are appropriate for most aggregates but it is not possible to cover the requirements of all aggregates in this way. Where the characteristics of the aggregates require a binder content other than those given, a new target binder content should be agreed between the manufacturer and the owner of the road or paved area based on trials and or evidence of satisfactory performance. The tolerance as specified in the relevant table in clause 5, clause 6, clause 7 and clause 8 should apply.

NOTE 2 The binder content of recipe dense binder course may be reduced by up to 0.5 % if the compaction is controlled by either air voids or the PRD test as described in BS 598-104 if agreed between the manufacturer and the specifier; this would normally apply to roads carrying category A traffic.

NOTE 3 Where a base (roadbase) is to be open to traffic before the binder course is laid, the upper layer of base (roadbase) should conform to a dense binder course specification. On all but lightly trafficked sites, the dense binder course should be a designed mixture. See 4.7.

4.5.2 Where the bulk density of the blast furnace slag used is between those densities specified for groups one, two, three and four, a proportional change shall be made to the binder content.

4.6 Terminology of dense, heavy duty and high modulus base (roadbase) and binder course mixtures

References to any designed dense mixtures in groups one and two, base (roadbase) and binder course mixtures, shall include the nominal aggregate size, the pavement layer in which it is to be laid, the mid-range penetration grade of the bitumen to be used in its production and the word “designed”. Mix descriptions for the complete ranges of both designed and recipe groups one and two mixtures shall be in accordance with Annex C (Table C.1). Additionally, recipe dense mixtures shall be described as shown in Table C.2.

NOTE Guidance on the use of designed dense mixtures and recipe dense mixtures is given in Annex B.

4.7 Design of dense (DBM 50), heavy duty (HDM 50) and high modulus base (HMB 35) base (roadbase) and binder course mixtures conforming to groups 1 and 2

4.7.1 The mixtures shall be designed in accordance with clause **929** of the *Specification for Highway Works:2001*, except as amended in **4.7.2**.

4.7.2 The target aggregate grading and target binder content shall be within the limits stated in Table 1, Table 2, Table 3, or Table 4, for mixtures within group one (see clause **5**) or Table 13, Table 14, Table 15 and Table 16 for dense recipe mixtures within group two (see clause **6**). Additionally, for heavy duty macadam (HDM 50) mixtures, the target percentage of aggregate grading passing the 75 µm sieve shall not be less than 7.0 %. In high modulus (HMB 35) base (roadbase) and binder course mixtures, grade 35 pen bitumen shall be used. For compliance purposes the binder content and aggregate grading limits shall be those obtained by applying the tolerances stated in Table C.3 to the target binder content and target aggregate grading. The aggregate grading curve shall be smooth and continuous and shall not vary from the low limit on one size of sieve to the high limit on the adjacent sieve size or vice-versa.

The average binder volume shall not be less than 7.0 % of the total volume of the mixture for 40 mm size macadams, 8.0 % for 28 mm and 9.4 % for 20 mm macadams.

5 Group one: dense base (roadbase) mixtures

NOTE 1 See **4.6** for the terminology used to refer to designed and recipe dense macadams.

NOTE 2 Guidance on the selection of designed or recipe mixtures is given in Annex B.

5.1 40 mm size dense base (roadbase), including HMB 35, DBM 50, DBM 125, DBM 190 and HDM 50

These are all designed mixtures and the aggregate grading, bitumen content and grade of binder shall be determined in accordance with **4.7**. The target aggregate grading and binder content shall fall within the limits given in Table 1 and Table 2. For HDM 50 the percentage by mass of aggregate passing the 75 µm sieve shall be 7 % to 11 %.

Table 1 — Target aggregate grading limits for 40 mm size dense base (roadbase) designed mixtures

Test sieve aperture size	Aggregate: crushed rock, slag or gravel % by mass passing
50 mm	100
37.5 mm	95 to 100
28 mm	70 to 94
14 mm	56 to 76
6.3 mm	44 to 60
3.35 mm	32 to 46
300 µm	7 to 21
75 µm (DBM and HMB)	2 to 9
75 µm (HDM)	7 to 11