BS 1446:1973

Specification for

Mastic asphalt (natural rock asphalt fine aggregate) for roads and footways

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Co-operating organizations

The Road Engineering Industry Standards Committee, under whose supervision this British Standard was prepared, consists of representatives of the following Government departments and scientific and industrial organizations:

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Association of Consulting Engineers
British Quarrying and Slag Federation*
British Tar Industry Association
Cement and Concrete Association
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Individual experts

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London Chamber of Commerce Incorporated
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Contents

Foreword

This British Standard was first published in 1948, under the authority of the Road Engineering Industry Standards Committee, and revised in 1962. The standard has now been revised as part of the national policy to change to the metric system.

NOTE Attention is drawn to certification facilities offered by the British Standards Institution. See the inside back cover of this standard.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 6, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

1 Scope

This British Standard gives requirements for mastic asphalt with natural rock asphalt fine aggregate for roads and footways. Appendix A and Appendix B contain, respectively, recommendations for laying and a list of information to be given in enquiries and/or orders.

NOTE 1 It is appreciated that with the publication of this metric standard it would be impractical for suppliers to be contractually obliged to supply to the metric grading limits given in Table 2 and Table 3. During the transitional period from imperial to metric units and until such time as screening equipment based on imperial sizes is replaced by new equipment conforming to metric requirements, material supplied to the grading limits given in BS 1446:1962 will be considered equally applicable with material supplied to the grading limits given in Table 2 and Table 3 of this standard. For this purpose the 1962 limits are given in Appendix C of this edition. The supplier should, however, state in his advice note to the purchaser whether he has supplied to imperial or metric grading limits.

NOTE 2 The titles of the British Standards referred to in this standard are listed on the inside back cover.

2 Definitions

For the purposes of this British Standard the following definitions, which have been extracted from BS 892, apply:

2.1
bitumen

a viscous liquid, or a solid, consisting essentially of hydrocarbons and their derivatives, which is soluble in carbon disulphide; it is substantially non-volatile and softens gradually when heated. It is black or brown in colour and possesses water proofing and adhesive properties. It is obtained by refinery processes from petroleum and is also found as a natural deposit or as a component of naturally occurring asphalt, in which it is associated with mineral matter

2.2
asphalt

a general term for certain mixtures of asphaltic cement and mineral matter

NOTE This term is normally qualified by the indication of the origin (e.g. natural rock asphalt, Trinidad Lake asphalt) or type (e.g. mastic asphalt, rolled asphalt).

2.3
natural rock asphalt

a naturally occurring calcareous rock impregnated with bitumen by a natural process

NOTE The term is here interpreted in a restricted geological sense and specifically excludes all other types of rock such as result from sporadic bitumen in any mode of occurrence in non-bituminous limestone, or in limestone of low grade impregnation, non-bituminous limestones, and artificial mixtures thereof with any bitumen of any source and description.

2.4
lake asphalt

a highly viscous natural asphalt found in well-defined surface deposits

2.5
asphaltic cement

bitumen, a mixture of lake asphalt and bitumen, or lake asphalt and flux oils or pitch or bitumen, having cementing qualities suitable for the manufacture of asphalt pavements

2.6
mastic asphalt

a type of asphalt composed of suitably graded mineral matter and asphaltic cement in such proportions as to form a coherent, voidless, impermeable mass, solid or semi-solid under normal temperature conditions, but sufficiently fluid when brought to a suitable temperature to be spread by means of a float

3 Sampling and testing

When samples, whether of the asphaltic cement, the aggregate or the mastic asphalt, are required for testing, the purchaser and the supplier shall agree on the number of samples to be taken. The samples so taken shall be identified by the supplier and one-half retained by the purchaser for the purpose of such tests as he may require.

Sampling and testing shall be carried out in accordance with the appropriate British Standards, as follows:

Asphaltic cements and their constituents:	
determination of ash content	BS 4450
determination of solubility	BS 4690
determination of penetration	BS 4691
determination of softening point (ring and ball)	BS 4692
determination of loss on heating	BS 4707
Natural rock asphalt (as specified in clause **5**)	BS 598
Coarse aggregate (as specified in clause **6**)	BS 812
Mastic asphalt	BS 598

4 Asphaltic cement

The asphaltic cement shall comply with Table 1, Column 1, 2 or 3 as specified by the purchaser.

Table 1 — Properties of asphaltic cement

Property		Asphaltic cement					
		1		2		3	
		Bitumen		Refined lake asphalt (fluxed)		Equal proportions by mass of bitumen of appropriate penetration and refined lake asphalt	
		min.	max.	min.	max.	min.	max.
Penetration at 25 °C		5	20	5	20	5	20
Softening point (ring and ball)	(°C)	65	95	65	95	65	95
Loss on heating for 5 hours at 163 °C	(%)	—	2.0	—	2.0	—	2.0
Penetration of residue after heating (percentage of original penetration)		60	—	60	—	60	—
Solubility in carbon disulphide or trichloroethylene	(%)	99	—	55	65	75	79
Mineral matter (ash)	(%)	—	0.5	29	35	17	19

5 Natural rock asphalt fine aggregate

The natural rock asphalt shall be imported in its raw state as mined, so as to be available to the Engineer for sampling and testing. The mass of the natural rock asphalt in any specific contract shall be certified, if desired, by the purchaser.

The natural rock asphalt, after crushing and grinding, shall comply with the following requirements:

1) It shall contain not less than 6 % and not more than 10 % inherent bitumen. The bitumen content shall be determined by the appropriate method described in BS 598, except that:

a) Tests shall be carried out on two separate samples, each weighing not less than 50 g, dried at 100 °C to constant mass.

b) The value reported shall be the mean of the two results, provided that neither result differs from that mean by more than 0.25 %. Should the difference be greater than 0.25 % the test shall be repeated.

2) The apparent specific gravity shall be not less than 1.9 nor more than 2.5.

3) The limestone after extraction not the bitumen shall contain not less than 90 % of calcium carbonate.

6 Coarse aggregate

The coarse aggregate shall be of approved quality and free from dust. It shall consist of clean crushed igneous or calcareous rock. For use on footways it may alternatively consist of siliceous material obtained from natural deposits either directly or by screening, crushing, or other mechanical process.

The percentage and size of the coarse aggregate incorporated in the mastic asphalt will depend primarily on the thickness of the finished course, and shall lie within the applicable limits given in Table 2 (Table 4, Appendix C, for imperial gradings).

7 Manufacture and composition

The natural rock asphalt shall be ground to a powder so that it shall all pass a 2.36 mm sieve and not less than 5 % shall pass a 75 mm sieve. The rock asphalt powder shall be mixed with the requisite percentage of asphaltic cement at a temperature of from 175 °C to 215 °C and when not required for immediate use shall be cast into blocks weighing about 25 kg.

At this stage the mastic asphalt shall show on analysis a composition within the limits of Column 1 or 2 of Table 3.

When the mastic asphalt is to be transported direct from the factory to the site of work in portable mechanically driven mixers the requisite percentage of coarse aggregate shall be added after the addition of the rock asphalt as provided for above. The composition of the mix shall on analysis conform to the requirements of Table 3 (or Table 5, Appendix C, for imperial gradings) after the percentage mass of material retained on the 600 μm BS sieve has been allowed for.

Table 2 — Percentage and grading of coarse aggregate

Work	Percentage of coarse aggregate	Grading of coarse aggregate	
		Passing BS sieve	Percentage
Footways finished course thickness 20 mm – 35 mm	15–30	6.3 mm 600 µm	100 0–15
Carriageways finished course thickness 25 mm – 40 mm	30–40	20 mm 14 mm 2.36 mm	100 90–100 0–5
40 mm – 50 mm	40–50		

Table 3 — Composition by analysis of mastic asphalt

		1 (Swiss rock asphalt)		2 (All other natural rock asphalt)	
		Percentage by mass of mastic asphalt			
		min.	max.	min.	max.
Soluble bitumen		13	16	17	20
Mineral matter:					
Passing BS sieve	**Retained BS sieve**				
75 µm	—	45	65	45	65
212 µm	75 µm	5	20	5	20
600 µm	212 µm	5	20	5	20
2.36 mm	600 µm	0	5	0	5

NOTE When rock asphalts to which Column 2 is applicable are blended with rock asphalts to which Column 1 is applicable, the percentage of soluble bitumen in the resultant mastic asphalt is adjusted in accordance with the proportion of each type of rock asphalt so used, and the proportions of the rocks used and the soluble bitumen used are stated. The mastic asphalt so produced should comply in all other respects with the provisions of this specification.

8 Remelting on site

For the remelting of the mastic asphalt on site the blocks shall be broken into pieces of suitable size and loaded into a mechanically agitated mixer, conveniently placed in relation to the site. The material shall then be heated to a temperature of 175 °C to 230 °C and thoroughly incorporated with the requisite quantity of coarse aggregate (see Table 2 and Table 4) which shall be added to the mixer. After all the coarse aggregate has been incorporated, the material shall be mixed continuously for a period of not less than one hour before laying is begun and mixing shall be continued until laying operations are completed so as to maintain the coarse aggregate in suspension. At no stage during the process of mixing shall the temperature exceed 230 °C.

Appendix A Recommendations for laying

A.1 General

The surface on which the mastic is to be laid should be made good and adjusted to a contour approximating to the final contour and swept clean. The method of laying should be in accordance with the following recommendations.

A.2 Contour

The crossfall of roads with a straight crossfall should be not more than 2.5 % and not less than 2.0 % unless otherwise directed by the Engineer. With roads to be cambered the average fall of the finished surface from the crown to the channel should be not more than 3.3 % and not less than 2.2 %. These recommendations for crossfall do not apply to curves with superelevation.

A.3 Spreading

The mastic asphalt when prepared should be laid, normally in one coat, at a temperature between 175 °C and 230 °C and spread uniformly by hand with wooden floats on the prepared and regulated surface. The thickness of the mastic asphalt and percentage of added coarse aggregate should be in accordance with the provisions of Table 2 or Table 4 or as specified by the Engineer. Where necessary, battens of the requisite dimensions should be employed.

A.4 Surface finish of carriageways

Unless otherwise specified by the Engineer the asphalt for carriageways, while still warm and in a plastic condition, should be covered with a layer of approved coated, hard 14 mm or 20 mm chippings. The chippings, prior to application, should comply with BS 63 and be clean; the coating should be 1.5 % to 2.5 % of asphaltic cement of medium penetration (e.g. 40–80 penetration at 25 °C). To enable the chippings to carry the specified proportion of asphaltic cement 2 % to 3 % of filler should be added either before or after the addition of the asphaltic cement.

The chippings should be evenly distributed at the rate of 7.5 kg/m^2 to 10.0 kg/m^2 for 14 mm chippings and 10.0 kg/m to 13.0 kg/m^2 for 20 mm chippings. The chippings should then be rolled or otherwise pressed into the surface of the asphalt.

When the chippings are being spread, the channels against the kerbs should be covered by battens, not less than 150 mm wide, so as to ensure that a smooth channel is maintained to facilitate the flow of surface water to the gullies.

In particular situations skid resistance is highly important and in such cases, in order to aid skid resistance in wet weather, a stone of relatively high resistance to the polishing effect of traffic should be used.

A.5 Surface finish of footpaths and lightly trafficked roads

Unless otherwise specified by the Engineer, the asphalt for footpaths and lightly trafficked roads should be finished in one of the two following ways:

1) A sanded finish should be obtained by applying sand to the mastic asphalt while it is still plastic and rubbing it well by means of wooden floats.

2) An indented finish should be obtained by rolling with an indenting or crimping roller while the mastic asphalt is still plastic enough to take the impressions of the roller.

A.6 Joints

Care should be taken to ensure that all joints are properly and truly made.

The joints between sections of work should be made by warming the existing asphalt by the application of an excess of hot mastic which is subsequently trimmed off to form an accurately level joint.

A.7 Projections

Before laying mastic asphalt the edges of all manholes, gulley frames, boxes etc. against which it is to abut should be cleaned and painted with a thin coating of bitumen. The finished surface should be kept flush with, or not exceeding 3 mm above, such projections. Where the surface is to abut kerbs, the edges of these should be similarly cleaned and painted.

A.8 Channels

Channels should be formed to provide a fall sufficient to avoid retention of surface water.
See also **A.4** paragraph 3.

A.9 Accuracy of finish on carriageways

The surface of the mastic asphalt, tested with a straight edge 3 m long placed parallel to the centre line of the carriageway, should have no depression greater than 7 mm.

A.10 Traffic control

Newly laid sections should not be opened to traffic until the asphalt has cooled to the prevailing atmospheric temperature.

Appendix B Information to be given with enquiry and/or order

The following information shall be given by the purchaser with his enquiry and/or order:

1) The asphaltic cement to be used (Clause **4**).

2) Whether it is desired to sample the natural rock asphalt, as mined, for testing (Clause **5**).

3) The thickness of the finished course (Clause **6**).

4) Whether samples of the mastic asphalt will be taken for testing, and whether such samples of the mastic asphalt will be taken before or after laying. If the latter, at what period (Clause **3**).

5) Any special instructions relating to contours (see **A.2**).

6) Type of surface finish required (see **A.4** and **A.5**). If coated chippings are required then size (according to BS 63) and type (according to BS 812) of chippings.

Appendix C Grading of coarse and fine aggregate using imperial screening equipment (Extracted from BS 1446:1962)

Table 4 — Percentage and grading of coarse aggregate (imperial sieves)

Work	Percentage	Grading	
		Passing BS sieve	Percentage
Footways finished course thickness ¾ in–1¼ in	15–30	¼ in No. 25	100 0–15
Carriageways finished course thickness 1 in–1½ in	30–40	¾ in ½ in No. 7	100 90–100 0–5
1½ in–2 in	40–50		

Table 5 — Composition by analysis of mastic asphalt (imperial sieves)

		1 (Swiss rock asphalt)		2 (All other natural rock asphalt)	
		Percentage by mass of mastic asphalt			
		min.	max.	min.	max.
Soluble bitumen		13	16	17	20
Mineral matter:					
Passing BS sieve	**Retained BS sieve**				
No. 200	—	45	65	45	65
No. 72	No. 200	5	20	5	20
No. 25	No. 72	5	20	5	20
No. 7	No. 25	0	5	0	5

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Publications referred to

This standard makes reference to the following British Standards:

BS 63, *Single-sized roadstone and chippings.*

BS 598, *Sampling and examination of bituminous mixtures for roads and buildings.*

BS 812, *Methods for sampling and testing of mineral aggregates, sand and fillers.*

BS 892, *Glossary of highway engineering terms.*

BS 4450, *Method for determination of ash from petroleum products.*

BS 4690, *Method for determination of solubility of bitumen.*

BS 4691, *Method for determination of penetration of bitumen.*

BS 4692, *Method for determination of softening point of bitumen (ring and ball).*

BS 4707, *Method for determination of loss on heating of bitumen and flux oil.*

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London
W4 4AL