

ROAD PAVEMENTS – BITUMINOUS BOUND MATERIALS

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Road Pavements – Bituminous Bound Materials

901 Bituminous Roadbase and Surfacing Materials

General

- 1 Bituminous pavement courses shall be made using the materials described in Appendix 7/1.

Aggregates for Bituminous Materials

- 2 Aggregates shall be clean, hard and durable. Crushed gravel shall be derived from natural 60 mm to 200 mm cobble-sized material.

Hardness

Unless otherwise stated in Appendix 7/1, coarse aggregates for bituminous materials shall have the following properties:

- (i) a ten per cent fines value not less than 140 kN for crushed aggregate when tested in a dry condition in accordance with BS 812 : Part 111;
- (ii) an aggregate impact value not greater than 30 per cent for crushed aggregate when tested in a dry condition in accordance with BS 812 : Part 112.

Durability

Unless otherwise stated in Appendix 7/1, the aggregate source shall be tested in accordance with BS 812: Part 121 and shall have a soundness value greater than 75. In addition, the water absorption value of the coarse aggregate, determined in accordance with BS 812: Part 2, shall be less than 2 per cent.

Cleanliness

Unless otherwise stated in Appendix 7/1, the fraction of material passing 75 micron, for coarse and fine aggregates for bituminous materials, shall not exceed the limits stated in BS 594: Part 1 and BS 4987: Part 1, when tested in accordance with the washing and sieving method of BS 812: Part 103.

Transporting

- 3 Bituminous materials shall be transported in clean insulated vehicles, unless otherwise agreed by the Engineer, and shall be covered

while in transit or awaiting tipping. Dust, coated dust or water may be used on the interior of the vehicles to facilitate discharge of the mixed materials, but the amount shall be kept to a minimum by brushing.

Laying

- 4 On each day, and at each location where bituminous material is laid, at least 300 tonnes from an approved source shall be placed before material from another approved source is used. When the Contractor demonstrates, to the Engineer's approval, that the materials from different approved sources are of similar quality and that laying and compaction characteristics are similar, this requirement will be waived.
- 5 Unless hand placing is permitted, bituminous materials shall be spread, levelled and tamped by an approved self-propelled paving machine. As soon as possible after arrival at site the materials shall be supplied continuously to the paver and laid without delay. The rate of delivery of material to the paver shall be regulated to enable the paver to operate continuously.
- 6 The travel rate of the paver, and its method of operation, shall be adjusted to ensure an even and uniform flow of bituminous material across the screed free from dragging, tearing and segregation of the material.
- 7 Unless otherwise stated in Appendix 7/1, or elsewhere in this Specification, materials shall be laid in accordance with the requirements and recommendations for laying in BS 4987: Part 2 or BS 594: Part 2, as appropriate.
- 8 When laying basecourse or wearing course the paver shall be taken out of use when approaching an expansion joint of a structure. In laying the remainder of the pavement up to the joint, and the corresponding area beyond it by hand, the joint or joint cavity shall be kept clear of surfacing material.
- 9 Bituminous material, with a temperature greater than 145°C, shall not be laid or deposited on bridge deck waterproofing systems, unless precautions against heat damage have been approved by the Engineer.
- 10 Hand placing of bituminous materials shall only be permitted in the following circumstances:

- (i) For laying regulating courses of irregular shape and varying thickness.
 - (ii) In confined spaces where it is impracticable for a paver to operate.
 - (iii) For footways.
 - (iv) At the approaches to expansion joints at bridges viaducts or other structures.
 - (v) For laying mastic asphalt in accordance with BS 1447.
 - (vi) Where permitted by the Engineer.
- 11 Hand-raking of wearing course material or the addition of such material by hand-spreading to the paved area, for adjustment of level, shall only be permitted in the following circumstances:
- (i) At the edges of the layers of material and at gullies and manholes.
 - (ii) At the approaches to expansion joints at bridges, viaducts or other structures.
 - (iii) Where permitted by the Engineer.
- 12 Hand laid work shall conform with the requirements of this Clause except those relating to pavers.

Compaction

- 13 Bituminous materials shall be laid and compacted in layer thicknesses which enable surface level and regularity requirements to be met and adequate compaction to be achieved. The nominal and minimum thickness of material laid in each paver pass shall be in accordance with BS 4987 : Part 2 or BS 594 : Part 2, as appropriate, or the full course thickness where this is less than the specified minimum in BS 4987 : Part 2 or BS 594 : Part 2.
- 14 Compaction of bituminous materials shall commence as soon as the uncompacted material will bear the effects of the rollers without undue displacement or surface cracking. Compaction shall be substantially completed before the temperature falls below the minimum rolling temperatures stated in BS 594: Part 2 or BS 4987: Part 2 or Clauses 930, 932, 933, 934, as appropriate. Rolling shall continue until all roller marks have been removed from the surface.
- 15 Compaction shall be carried out using 8-10 tonnes deadweight smooth wheeled rollers having a width of roll not less than 450 mm, or by multi-wheeled pneumatic-tyred rollers of equivalent mass, or by vibratory rollers or a combination of these rollers. Wearing course

and basecourse material shall be surface finished with a smooth-wheeled roller which may be a deadweight roller or a vibratory roller in non-vibrating mode. Vibratory rollers shall not be used in vibrating mode on bridge decks.

- 16 Vibratory rollers may be used if they are capable of achieving at least the standard of compaction of an 8-tonnes deadweight roller. They shall be equipped or provided with devices, indicating the frequency at which the mechanism is operating and the travel speed, which can be read from the ground. The performance of vibratory rollers proposed for use shall be assessed as follows:
- (i) by means of site trials in accordance with BS 598: Part 109; or
 - (ii) by the Contractor producing evidence of independent trials indicating to the approval of the Engineer that, under comparable conditions, a state of compaction at least equivalent to that obtained using an 8-tonnes deadweight roller is achieved by the make and model of vibratory roller proposed for use.

Where compaction is to be determined in accordance with sub-Clause 19 of this Clause, the requirements to prove the performance of rollers shall not apply. In such case the Contractor may use any plant to achieve the specified level of compaction and finish at temperatures above the minimum specified rolling temperature.

- 17 Bituminous materials shall be rolled in a longitudinal direction, with the driven rolls nearest the paver. The roller shall first compact material adjacent to joints and then work from the lower to the upper side of the layer, overlapping on successive passes by at least half the width of the rear roll or, in the case of a pneumatic-tyred roller, at least the nominal width of one tyre.
- 18 Rollers shall not be permitted to park or stand on warm compacted materials.
- 19 Unless stated otherwise in Appendix 7/1, the compaction level of dense roadbase and basecourse macadams shall be determined by the Percentage Refusal Density Test in accordance with Clause 927 and as follows:
- (i) At least 3 days before material from each source of dense macadam is first laid in the Works, the Contractor shall carry out a trial to demonstrate compaction plant and rolling procedures. The trial area

shall be not less than 30 m nor more than 60 m long and of a width and thickness approved by the Engineer. If the trial area complies with the Contract it may form part of the Permanent Works.

- (ii) The materials, mixing and laying plant proposed for the Works shall be used for the trial.
- (iii) At three locations selected by the Engineer, two nominal 150 mm diameter cores shall be taken by the Contractor using an approved coring machine, in accordance with BS 598: Part 100. At least two of the locations shall be from the wheel track zones of the completed carriageway. For the purposes of this Clause the wheel track zone shall be taken to be between 0.5 m and 1.1 m and between 2.55 m and 3.15 m from the centre of the nearside lane markings for each traffic lane.
- (iv) The material in the trial area shall be deemed acceptable if the average Percentage Refusal Density of the three locations is not less than 93%, when determined in accordance with Clause 927. Should the material not be deemed acceptable the trial area shall be removed and the trial repeated.
- (v) Further material shall not be laid in the Works until the Engineer has approved the material laid in the trial area.
- (vi) The compaction level of dense roadbase and basecourse macadam forming the Permanent Works shall be tested to the frequency stated in BS 4987: Part 2, at locations as stated above.
- (vii) The material in the Permanent Works shall be deemed acceptable if the average Percentage Refusal Density of the three locations is not less than 93% when determined in accordance with Clause 927. Should the material not be deemed acceptable it shall be removed and replaced with complying material.
- (viii) The walls and bases of holes from which core samples have been cut shall be dried, painted with hot bituminous binder, and filled to the underside of the wearing course with dense macadam in accordance with BS 4987: Part 1, and be well rammed in layers not exceeding 50 mm. Where cores have been cut through the wearing course, the last layer of fill material shall comply with the specification for the wearing course.

Chippings

- 20 The application of coated chippings to areas of wearing course shall be by an approved mechanical spreader capable of distributing chippings to an even rate of spread. Addition of chippings by hand operation shall only be permitted in the following circumstances:
 - (i) In confined spaces, where it is impracticable for a chipping spreader to operate.
 - (ii) As a temporary expedient, when adjustments have to be made to the spreader distribution mechanism.
 - (iii) When hand laying of the wearing course is permitted.
 - (iv) To correct uneven distribution of chippings.
- 21 Chippings shall be applied uniformly and rolled into the wearing course surface so they are effectively held and provide the specified texture depth.

Joints

- 22 Where longitudinal joints are made in wearing courses, the material shall be fully compacted and the joint made flush in one of the following ways; only method (ii) shall be used for transverse joints:
 - (i) By using two or more pavers operating in echelon, where this is practicable. The pavers shall be in sufficient proximity for adjacent widths to be fully compacted by continuous rolling and the longitudinal edges effectively rolled together whilst hot.
 - (ii) By cutting back the exposed joint, for a distance equal to the specified layer thickness, to a vertical face, discarding all loosened material and coating the vertical face completely with a suitable hot bitumen, or cold-applied thixotropic bitumen, or polymer modified adhesive bitumen tape with a minimum thickness of 2 mm, before the adjacent width is laid.
- 23 All joints shall be offset at least 300 mm from parallel joints in the layer beneath wherever possible, and in a layout approved by the Engineer. Joints in wearing courses shall coincide with either the lane edge or the lane marking, whichever is appropriate. Longitudinal joints in materials subject to Percentage Refusal Density testing shall not be situated in wheel track zones.

General

- 24 The Engineer may direct the application of a bituminous tack coat spray, complying with Clause 920, to the surface on which laying is to take place.
- 25 Bituminous material shall be kept clean and uncontaminated. The only traffic permitted to run on bituminous material to be overlaid shall be that engaged in laying and compacting the next course or, where a basecourse is to be blinded or surface dressed, that engaged on such surface treatment. Should any bituminous material become contaminated the Contractor shall make it good by cleaning it and, if this proves impracticable, by rectification in compliance with the 700 Series.
- 26 Basecourse material shall not remain uncovered by either the wearing course or surface treatment, whichever is specified in the Contract, for more than three consecutive days after being laid. The Engineer may extend this period by the minimum amount of time necessary because of weather conditions or for any other reason; in this case the Contractor shall apply a bituminous tack coat spray complying with Clause 920 to the surface immediately prior to laying the next layer.

Regulating Course

- 27 Regulating course material shall be made and laid in accordance with the requirements of Clause 907.

902 Not Used

903 Dense Bitumen Macadam Roadbase

- 1 Dense bitumen macadam roadbase shall be 28mm nominal size aggregate dense roadbase complying with BS 4987 : Part 1, and with sub-Clauses 2, 3 and 4 of this Clause and the requirements of Appendix 7/1. The nominal layer thickness shall be within the range of 70mm to 100mm.

Aggregate

- 2 The coarse aggregate shall consist of crushed rock or crushed gravel complying with the requirements of BS 4987: Part 1. The fine

aggregate may be crushed rock or sand or mixtures thereof, but the type shall be subject to the approval of the Engineer. The quality of the fine aggregate shall comply with the requirements of BS 4987: Part 1. The aggregate shall be in a surface dry condition prior to mixing unless the macadam is manufactured in a drum mixing plant in compliance with Clause 923.

Filler

- 3 When the coarse aggregate is crushed gravel, 2% by mass of total aggregate of Portland cement or hydrated lime shall be added. The percentage of fine aggregate shall be reduced accordingly. Cement or hydrated lime is not required when the crushed gravel is limestone.

Binder

- 4 The binder shall be petroleum bitumen of 100 pen grade complying with the specification issued by the National Roads Authority/ Department of Environment as appropriate.

904 Not Used

905 Rolled Asphalt Basecourse

- 1 Rolled asphalt basecourse shall comply with BS 594 : Part 1 for basecourse mixtures, and with sub-Clauses 2 and 3 of this Clause, and the requirements of Appendix 7/1. Unless otherwise specified in Appendix 7/1, it shall contain 60 per cent of crushed rock or crushed gravel coarse aggregate of 28 mm nominal size.

Filler

- 2 When the coarse aggregate is crushed gravel, 2% by mass of total aggregate of Portland cement or hydrated lime shall be added. The percentage of fine aggregate shall be reduced accordingly. Cement or hydrated lime is not required when the crushed gravel is limestone.

Binder

- 3 The binder shall be petroleum bitumen of 50 pen grade complying with the specification issued by the National Roads Authority/ Department of Environment as appropriate.

906 Dense Bitumen Macadam Basecourse

- 1 Dense bitumen macadam basecourse shall comply with BS 4987 : Part 1 for dense basecourse, and with sub-Clauses 2, 3 and 4 of this Clause, and the requirements of Appendix 7/1. Unless otherwise specified in Appendix 7/1, it shall be of 28 mm or 20 mm size. The nominal layer thickness of material containing aggregate of 28mm size shall be within the range of 60 to 100mm. The nominal layer thickness of material containing aggregate of 20mm size shall be within the range of 50 to 80mm.

Aggregate

- 2 The coarse aggregate shall consist of crushed rock or crushed gravel complying with the requirements of BS 4987: Part 1. The fine aggregate may be crushed rock or sand or mixtures thereof, but the type shall be subject to the approval of the Engineer. The quality of the fine aggregate shall comply with the requirements of BS 4987: Part 1. The aggregate shall be in a surface dry condition prior to mixing unless the macadam is manufactured in a drum mixing plant in compliance with Clause 923.

Filler

- 3 When the coarse aggregate is crushed gravel, 2% by mass of total aggregate of Portland cement or hydrated lime shall be added. The percentage of fine aggregate shall be reduced accordingly. Cement or hydrated lime is not required when the crushed gravel is limestone.

Binder

- 4 The binder shall be petroleum bitumen of 100 pen grade complying with the specification issued by the National Roads Authority/ Department of Environment as appropriate.

907 Regulating Course

- 1 Regulating courses shall be in accordance with sub-Clauses 2, 3 and 4 of this Clause. Bituminous materials for regulating courses shall meet the requirements for the appropriate material, as specified in BS 594 or BS 4987 as relevant.

- 2 Regulating courses, which may consist of one or more layers of a bituminous material, shall have their finished surfaces laid to achieve the appropriate tolerances for horizontal alignments, surface levels and surface regularity, for pavement layers, in accordance with Clause 702.
- 3 Rolled asphalt shall be used for regulating courses where rolled asphalt is specified for the next pavement layer.
- 4 Where the total depth of a regulating course exceeds 100 mm then the course shall be laid so that each regulating layer has a compacted thickness of between 50 mm and 100 mm.

908 Not Used

909 Not Used

910 Rolled Asphalt Wearing Course (Recipe Mix)

- 1 Rolled asphalt wearing course shall comply with BS 594 : Part 1 for wearing course recipe mixtures, and with sub-Clauses 2, 3, 4 and 5 of this Clause, and the requirements of Appendix 7/1. It shall have a nominal coarse aggregate content of 30% by mass of the total mix and the nominal size of the coarse aggregate shall be 14 mm. It shall comply with the requirements for the recipe mixture approved by the Engineer.

Binder

- 2 The binder shall be petroleum bitumen of 50 pen grade complying with the specification issued by the National Roads Authority/ Department of Environment as appropriate. The binder content, expressed as percentage by mass of the total mix, shall be $7.8 \pm 0.6\%$ where the coarse aggregate is crushed rock, and $7.5 \pm 0.6\%$ where the coarse aggregate is crushed gravel.

Coarse Aggregate

- 3 The coarse aggregate shall consist of crushed rock or crushed gravel complying with the quality and grading requirements of BS 594, and shall have a polished stone value, when determined in accordance with BS 812: Part 114, not less than 45.

Fine Aggregate

- 4 The fine aggregate may be crushed rock or sand or mixtures thereof. The fine aggregate shall be obtained from a source which has proven by experience to give continuously satisfactory performance in recipe mixtures. The source shall be subject to the approval of the Engineer.

Coated Chippings

- 5 Coated chippings shall be 20 mm nominal size unless otherwise described in Appendix 7/1 and shall comply with Clause 915.

911 Rolled Asphalt Wearing Course (Design Mix)

- 1 Rolled asphalt wearing course shall be designed in accordance with the procedures of BS 598 : Part 107 and shall comply with BS 594 : Part 1 for wearing course design mixtures, and with sub-Clauses 2 to 7 of this Clause, and the requirements of Appendix 7/1. The design mix shall be Type F or R having a nominal coarse aggregate content of 30% by mass of the total mix and the nominal size of the coarse aggregate shall be 14 mm. It shall comply with the requirements for the design mixture approved by the Engineer.

Binder

- 2 The binder shall be petroleum bitumen of 50 pen grade complying with Specification issued by the National Roads Authority/Department of Environment as appropriate.

Coarse Aggregate

- 3 Coarse aggregate shall be crushed rock with a polished stone value not less than 45 when determined in accordance with BS 812 : Part 114.

Marshall Stability and Flow

- 4 The Marshall stability and flow for the complete mixture at the target binder content, determined in accordance with the procedures of BS 598: Part 107, shall be as described in Appendix 7/1.

Verification

- 5 Verification of the design proposal shall be carried out using materials obtained from the plant before manufacture of the wearing course commences. Stability and flow values shall be determined at the proposed target binder content.
- 6 The results of design verification for stability shall fall within 2 kN of the design proposal. Additionally, the stability shall be not more than 0.5 kN below the lower range value described in Appendix 7/1. The flow value obtained shall not exceed that stated in BS 594: Part 1. The target binder content determined on verification shall be not less than the specified minimum value given in BS 594: Part 1.

Composition

- 7 When determined in accordance with the procedures of BS 598 : Part 102, the composition of the plant mixture shall comply with the requirements for the wearing course design mixture approved by the Engineer. The nature and source of the constituent materials may be changed only with the approval of the Engineer which may require the mix to be redesigned.

Coated Chippings

- 8 Coated chippings shall be 20 mm nominal size unless otherwise described in Appendix 7/1 and shall comply with Clause 915.

912 Close Graded Bitumen Macadam Wearing Course

- 1 Close graded bitumen macadam wearing course shall comply with BS 4987 : Part 1, and with sub-Clauses 2, 3, 4 and 5 of this Clause, and the requirements of Appendix 7/1.

Aggregate

- 2 The coarse aggregate shall consist of crushed rock complying with the quality requirements of BS 4987. The fine aggregate may be crushed rock or sand or mixtures thereof, but the type shall be subject to the approval of the Engineer. The quality of the fine aggregate shall comply with the requirements of BS 4987.

- 3 The aggregate shall be in a surface dry condition prior to mixing unless the material is manufactured in a drum mixing plant in compliance with Clause 923.
- 4 The coarse aggregate retained on the 6.3 mm BS sieve shall have the polished stone value, when determined in accordance with BS 812: Part 114, described in Appendix 7/1. The aggregate passing the 6.3 mm BS sieve shall have a polished stone value of not less than 45. The coarse aggregate retained on the 6.3 mm BS sieve shall have an aggregate abrasion value, determined in accordance with BS 812: Part 113, not greater than 12.

Binder

- 5 The binder shall be petroleum bitumen of 100 pen or 200 pen grade complying with the specification issued by the National Roads Authority/Department of Environment as appropriate, as described in Appendix 7/1.

913 Not Used

914 Not Used

915 Coated Chippings for Application to Rolled Asphalt Wearing Course

- 1 The chippings and the manner of coating, when used for rolling into the surface of rolled asphalt, shall be in accordance with BS 594 : Part 1 and with sub-Clauses 2 and 3 of this Clause.
- 2 The minimum polished stone value of the chippings shall be 60. The maximum aggregate abrasion value of the chippings shall be 12. The maximum flakiness index of the chippings shall be 20.
- 3 The polished stone value shall be determined in accordance with BS 812 : Part 114. The aggregate shall be deemed to comply if the 2 most recent consecutive results, from tests relating to the material to be supplied, and carried out within the previous 6 months by a testing laboratory approved by the Engineer, are equal to or greater than 60.

- 4 The aggregate abrasion value shall be determined in accordance with BS 812: Part 113. The flakiness index shall be determined in accordance with BS 812: Part 105, Section 105.2.

916 Open Graded Bitumen Macadam Wearing Course

- 1 Open graded bitumen macadam wearing course shall comply with BS 4987: Part 1, and with sub-Clause 2, 3, 4 and 5 of this Clause for open graded wearing course and the requirements of Appendix 7/1.
- 2 The coarse aggregate shall consist of crushed rock complying with the quality requirements of BS 4987. The fine aggregate may be crushed rock or sand or mixtures thereof, but the type shall be subject to the approval of the Engineer. The quality of the fine aggregate shall comply with the requirements of BS 4987.
- 3 The aggregate shall be in a surface dry condition prior to mixing unless the material is manufactured in a drum mixing plant in compliance with Clause 923.
- 4 The coarse aggregate retained on 6.3 mm BS sieve shall have the polished stone value, when determined in accordance with BS 812: Part 114, described in Appendix 7/1. The aggregate passing the 6.3 mm BS sieve shall have a polished stone value of not less than 45. The coarse aggregate retained on the 6.3 mm BS sieve shall have the aggregate abrasion value, determined in accordance with BS 812: Part 113, not greater than 12.
- 5 The binder shall be petroleum bitumen of 200 pen grade complying with the specification issued by the National Roads Authority/Department of Environment as appropriate.

917 Cold-milling (Planing) of Bituminous Bound Flexible Pavement

- 1 Where milling of bituminous bound flexible pavement is required, the area of carriageway to be milled shall be removed to the specified depth by a milling machine approved by the Engineer. The process shall be carried out so as not to produce excessive quantities of either

- fumes or smoke. Dust shall be minimised by damping with water sprays. The use of machines which employ direct flame heating shall not be permitted.
- 2 The cut edges shall be left neat, vertical and in straight lines. The Contractor shall brush and sweep the milled surface by mechanical means, to the satisfaction of the Engineer, to produce a clean and regular running surface with a groove depth not greater than 10 mm, and with a uniform texture.
 - 3 Carriageways shall be milled to the tolerance for surface levels specified in Clause 702 for basecourse. If the tolerances in this Clause are exceeded, the full extent of the area which does not comply shall be rectified by further milling or by regulating with materials in accordance with Clause 907.
 - 4 Existing ironwork shall not be disturbed by the milling action. Where necessary, surfacing in the vicinity of ironwork shall be removed by pneumatic tools or other suitable methods.
 - 5 Where milling is carried out on a carriageway open to traffic, temporary ramping to ensure the safe passage of vehicles shall be provided to the approval of the Engineer.
 - 6 If the milled surface profile varies by more than 10 mm, when measured transversely or longitudinally by a 3 metre straight edge, adjustments or replacements shall be made to the cutting teeth on the milling drum before work continues. Any discontinuity between adjacent milling passes exceeding 10 mm, when measured transversely by a 3 metre straight edge, shall be rectified by further milling or regulating before placing bituminous materials.
 - 7 Where milling is required over extensive areas, the Contractor shall programme the work to allow removal of full lane widths. If this is impracticable, the proposed programme of milling shall be submitted to the Engineer for approval.
 - 8 Immediately after milling, surplus material shall be removed by a machine of suitable and efficient design and the milled surface swept to remove all dust and loose debris.
 - 9 The material removed from the carriageway shall be run to spoil in tips provided by the Contractor, unless otherwise described in Appendix 2/3. No stockpiling shall be allowed on Site unless permitted by the Engineer.

- 10 Carriageways which are closed to traffic shall be resurfaced after milling prior to reopening the carriageway to traffic, unless otherwise agreed by the Engineer.

918 Slurry Sealing

- 1 Slurry sealing shall comply with BS 434 : Part 1 and Part 2, and with sub-Clauses 2 to 19 of this Clause.

Aggregate

- 2 Occurring sand free from silt, clay or other fine material. The aggregate, whether a mixture or not, shall have a smooth grading within the limits of Table 9/1.

Table 9/1: Aggregate Grading

BS Sieve Size	Percentage by mass of total aggregate and additive passing	
	3 mm Finished thickness	1.5 mm Finished thickness
5 mm	100	100
3.35 mm	80-100	100
2.36 mm	75-100	95-100
1.18 mm	55-90	70-95
600 micron	35-70	55-75
300 micron	20-45	30-50
150 micron	10-25	10-30
75 micron	5-15	5-15

Additive

- 3 The additive shall be Portland cement complying with IS 1 or hydrated lime complying with BS 890. At least 75% shall pass the 75 micron BS sieve.

Bitumen Emulsion

- 4 The slurry seal bitumen emulsion shall comply with BS 434 : Part 1 and shall be either:
 - (i) Class A4 Rapid Setting or Class K3 capable of producing a slurry which on laying develops early resistance to traffic and rain and is sufficiently stable to permit mixing with the specified aggregate, without breaking during the mixing and laying processes, or
 - (ii) Class A4 Slow Setting.

Tack Coat

- 5 Where required, or described in Appendix 7/3, tack coat shall be cationic bitumen emulsion complying with BS 434 : Part 1.

Composition of Mixed Material

- 6 The mixed material shall comprise aggregate, bitumen emulsion and, where necessary, additive complying with sub-Clause 3 of this Clause. The amount of emulsion used shall be between 180 litres/tonne and 250 litres/tonne of dry aggregate; the precise proportions of each constituent being selected after laboratory tests and trials using the same plant intended to be used in the Works. When additive complying with sub-Clause 3 of this Clause is used, the proportion shall not normally exceed 2% by mass of aggregate.

Mixing

- 7 The materials shall be measured into a mechanical mixer and mixed such that the aggregate is completely and uniformly coated with bitumen emulsion and a slurry is produced of consistency that can be satisfactorily laid as described in sub-Clauses 12 to 14 of this Clause. When required, an additive complying with sub-Clause 3 of this Clause, shall be used to control consistency, mix, segregation and setting rate.

Preparation of Site

- 8 Before applying tack coat or spreading slurry, any necessary patching of the road surface shall be completed. Immediately before application of bituminous materials, loose material, dust and vegetation shall be cleaned from the existing surface by sweeping, supplemented if necessary by air jet, and removed from the site. All ironwork, road studs and where directed by the Engineer, road markings, shall be masked. At junctions with surfaces not to be treated, clean lines shall be defined by masking, or other suitable means.

Laying

- 9 If required, a tack coat shall be applied in accordance with BS 434 : Part 2 before spreading the slurry seal.
- 10 The rate of spread of tack coat shall depend on the surface to be treated. For bituminous surfaces the rate shall be 0.15-0.30 l/m² and for concrete surfaces it shall be 0.4-0.6 l/m².

- 11 Slurry shall be evenly spread by mechanical means such that the aggregate cover (dry mass equivalent) is 4-6 kg/m² for 3 mm finished thickness and 2-4 kg/m² for 1.5 mm finished thickness.

- 12 All voids, cracks and surface irregularities shall be completely filled. Spreading shall not be undertaken when the ground temperature falls below 4°C or when standing water is present on the surface. In warm dry weather the surfacing, immediately ahead of the spreading, shall be slightly damped by mist water spray applied mechanically, unless the Engineer agrees otherwise.

- 13 The slurry shall be rolled by a self-propelled or towed multi-wheeled smooth tread rubber-tyred roller, having an individual wheel load between 0.75 and 1.5 tonnes, making at least six passes, unless the Contractor demonstrates to the satisfaction of the Engineer that rolling is unnecessary or that a smaller number of passes is satisfactory for a particular process. Rolling shall commence as soon as the slurry has set sufficiently to ensure rutting or excessive movement will not occur.

- 14 The finished slurry shall have uniform surface texture and colour throughout the work, without variations of texture within the lane width, or from lane to lane, due to segregation of aggregates or colour, due to variations in the emulsion/water content of the mixture.

- 15 The finished surface shall be free from blow holes and surface irregularities due to scraping, scabbing, dragging, droppings, excess overlapping or badly aligned longitudinal or transverse joints, damage by rain or frost, or other defects. Slurry sealing which does not comply with this Clause or is non-uniform in surface texture or colour 24 hours after laying shall be rectified by removal and replacement with fresh material rolled in compliance with the Specification or, if this is impractical, by having fresh material superimposed and rolled in compliance with the Specification. Areas so treated shall be not less than 5 m long and not less than one lane wide. All areas being worked on shall be kept free of traffic until permitted by the Engineer.

Preliminary Slurry Mixture Design and Trial Areas

- 16 Using the same plant proposed for the Works, the Contractor shall make trial mixes of the slurry, varying the bitumen emulsion/aggregate

ratio to produce a slurry of creamy consistency which, whilst the screed box is travelling at the laying speed, will flow ahead of the screeding blade across the whole width of the spreader at all times. At least three trial mixes shall be made, each sufficient to spread a trial area of 40 square metres, to the specified finished thickness. The preparation of the existing surface for the trials, the tack coat spreading and the rolling methods shall comply in all respects with this Clause. Trial areas which achieve the required spreading consistency will be examined after 24 hours, for surface texture and adhesion, and if satisfactory the test specified in sub-Clause 17 of this Clause shall be carried out on samples of the same composition.

- 17 For each of the satisfactory trial mixes, at least two circular specimens shall be prepared, as described in BS 434 : Part 2, for a wet track abrasion test. The approved mix proportions for the main work shall be selected following laboratory tests using a combination of bitumen emulsion, aggregate blended where necessary with additive and water, having a wet track abrasion test result of less than 500 g/m².
- 18 When a proposed mix has been approved variations shall not be made in mixing time, mix proportions or in the type, size, grading or source of any of the constituents without the agreement of the Engineer who may require further tests to be made.

Site Control Tests

- 19 The mix proportions shall be controlled and the mass of all materials incorporated shall be checked and recorded at least four times daily. The quantity of emulsion used, and the rate of spread of mixed material, in kilogrammes of aggregate per square metre, shall be recorded for each load of aggregate and, if required, for each separate run within a load of aggregate.
- 20 The Contractor shall provide all necessary testing equipment and whenever spreading is taking place shall, in the presence of the Engineer, carry out the tests specified in Table 9/2 at the frequency stated therein. A copy of the results of each of the tests and of each recorded mass and check for rate of spread shall be passed to the Engineer.

Table 9/2: Site Control Test Requirements

Test	Frequency	
	Batch mixing	Continuous mixing
Wet Track Abrasion Test (BS 434 : Part 2)	4 times daily	Every second run
Grading of each separate stockpile of sand and crusher run fine aggregate	Every 20 tonnes	Every 20 tonnes
Grading of samples of the blended aggregate	4 times daily	4 times daily
Percentage of bitumen in the cured seal	4 times daily	4 times daily
Slurry stability test (Clause 928 for cationic emulsions only)	Daily or for each load of emulsion delivered	Daily or for each load of emulsion delivered

919 Surface Dressing

- 1 Surface dressing shall be carried out in accordance with the recommendations of the Department of the Environment Publication "Surface Dressing".

920 Bituminous Sprays

- 1 When it is necessary to prepare a surface for the application of a bituminous spray and to undertake the spraying and any specified blinding, this shall be done in accordance with the specification for surface dressing issued by the Department of the Environment in so far as it applies to the work to be undertaken in accordance with the undermentioned general requirements and any specified requirements as described in Appendix 7/4.
- 2 The binder shall be spraying grade cationic bitumen emulsion complying with the specification issued by the National Roads Authority/ Department of Environment as appropriate.
- 3 The Engineer may require the Contractor to provide a test certificate showing that a particular binder distributor has been tested since the previous surface dressing season and that the test indicates conformity of the

distributor with the requirements of BS 3136 for emulsion distributors.

- 4 Before spraying is commenced, the surface shall be free of all loose material, the surface as a whole shall be dry and any damp areas shall be completely free of standing water.
- 5 Blinding material, where required by the Contract, shall consist of a commercial grade of hard clean crushed rock, fine aggregate or sand: it shall contain not more than 15 per cent retained on a 6.3 mm BS sieve. It shall be applied to the binder and left unrolled. The rate of application shall be 5.5-7.0 kg/m².
- 6 Unless the Engineer permits otherwise, all loose material on the sprayed surface, including any blinding material, shall be removed before any further layer of the pavement is laid.

921 Surface Texture of Rolled Asphalt Wearing Courses

- 1 The texture depth of the surface of rolled asphalt wearing courses shall be measured by the sand patch method described in BS 598 : Part 105.
- 2 The average texture depth of each 1000 m section of carriageway lane or the complete carriageway lane where this is less than 1000 m, shall be not less than 1.5 mm. The average of each set of 10 individual measurements shall be not less than 1.2 mm.

922 Not Used

923 Bituminous Material Manufactured by Drum Mixing Plants

- 1 Where materials are manufactured by drum mixing plants they shall additionally comply with the following:
 - (i) The heating and drying of aggregates prior to mixing shall not be required.
 - (ii) The aggregate and any added filler shall be proportioned and transferred to the mixing drum where the required volume

of binder shall be added. The materials shall be processed so that on discharge from the drum the mixed material shall be of uniform composition and all particles of aggregate shall be completely coated.

- (iii) The moisture content of the mixed material shall be less than 1.0% by mass of the aggregate and binder.
- (iv) The temperature of the mixed material on discharge from the drum shall be within the appropriate range given in Table 9/3.

Table 9/3: Temperature of Material and Discharge from the Drum

Penetration of Bitumen	Temperature Range °C
50	150-190
100	120-175
200	110-150

924 Resin Based High Skid Resistant Surface Treatment

Surface Treatment

- 1 High skid resistant surface treatments, made with aggregate of high polishing resistance and resin-based binders, shall consist of a film of binder sprayed on to a sound substrate and covered with aggregate to provide a textured, durable matrix of high skid resistance.

Binder

- 2 The binder shall contain an epoxy or other approved resin component. When cured the binder shall comply with sub-Clause 14 of this Clause.

Aggregate

- 3 The aggregate shall be calcined bauxite which has, when determined in accordance with BS 812 : Part 114, a minimum polished stone value of 72, unless otherwise described in Appendix 7/1. The grading of the aggregate shall be such that not more than 5% is retained on a 3.35 mm BS sieve and not more than 5% passes a 1.18 mm BS sieve. The aggregate shall be clean and free from foreign matter.

Mixing of Binder and Accuracy of Spraying

- 4 The binder shall be sprayed by a metered machine that accurately and continuously batches together the components of the binder; intimately mixing them before spraying. A control mechanism shall maintain each component within 5% by mass of the normal proportion specified by the resin manufacturer and a calibrated flow meter (or other approved means) shall be provided for each component. If the components of the binder are heated to facilitate spraying, the temperature shall not exceed the maximum recommended by the resin manufacturer. A temperature gauge accurate to $\pm 2^{\circ}\text{C}$ shall be used with all binders that require heating.
- 5 The vessels containing the components shall each be provided with an approved method of measuring the volume of material used.
- 6 The machine shall spray the binder, such that the amount collected on any longitudinal stretch of the surface 50 mm wide within the width of the spray shall not be less than 90% of the overall minimum requirement for the surface being treated (see sub-Clause 8 of this Clause). The mean amount of binder collected on any four adjacent 50 mm wide strips shall be not less than 95% of the overall minimum requirement. Before work commences, and thereafter at intervals not exceeding one month or as otherwise required by the Engineer, the Contractor shall provide evidence that the sprayer and all metering gauges complies with the requirements of the Specification. If required, the test to measure the spray pattern shall be made in the presence of the Engineer.

Preparation

- 7 The surface shall be vigorously brushed to remove dust, laitance and other loose matter. Any oil visible on the surface shall be removed by washing and scrubbing with a detergent solution followed by flushing with clean water or by another approved method. The surface shall be allowed to dry before application of the binder. Unless otherwise directed by the Engineer, existing road markings, ironwork and road studs shall be suitably masked.

Application

- 8 The binder shall be sprayed on to a dry surface at a rate which will vary according to the texture and porosity of the surface. On a smooth close textured surface the amount of

binder shall be not less than 1.35 kg/m^2 or such rate specified by the resin manufacturer; on a more rugous surface a greater rate of spread may be required. Heated binders shall be allowed to cool before application of the aggregate. A mechanically-metered plant shall be used to cover the binder uniformly with an excess of aggregate. Rolling of the aggregate is not permitted.

- 9 Hand application of the binder, to areas not accessible to the mechanical sprayer, will be permitted if the Engineer approves the proposed methods of batching, mixing and application of binder to the road surface. Similarly, in areas not accessible to the mechanical aggregate spreader, hand application of the aggregate will be permitted with the approval of the Engineer.

Aftercare

- 10 The material used as masking shall be removed together with the binder sprayed upon it and the remainder of the binder allowed to cure. During the curing period no disturbance or trafficking of the treated surface will be permitted. Before opening to traffic at the end of the curing period the excess aggregate shall be removed by vacuum sweeper or other approved means.
- 11 The Contractor shall have regard to the increase in cure time of the resin binder with decrease in temperature in order to allow sufficient time for the resin binder to cure between the end of the spray operation and the time when the road is to be opened to traffic. Details of cure time variation of the resin with respect to temperature shall be supplied by the resin manufacturer.

Checking and Testing

- 12 A check shall be made by the Contractor at the end of each working shift to determine the quantities used of each binder component. The check shall be made by means of dip-sticks or other approved devices. The measured volumetric quantities of the components shall be converted to mass units to estimate the average rate of spread of binder upon the surface, by dividing the total mass of the components by the measured area of the surface treated. The net aggregate coverage rate shall also be recorded, and all details given to the Engineer.

- 13 The average accuracy of batching shall be determined from the known used masses of the components. The relative proportions of components so determined shall fall within the limits specified in sub-Clause 4 of this Clause.
- 14 The Contractor shall provide the Engineer with samples of the binder, from the spraybar of the sprayer, at a rate of not less than two samples for each shift worked or each 1,000 square metres completed, whichever is the lesser. Each sample shall be poured to a depth of $3.2 \text{ mm} \pm 0.4 \text{ mm}$, into a shallow tray of at least $150 \text{ mm} \times 150 \text{ mm}$ which shall be supplied by the Contractor. The binder shall be cured, with no further mixing, at $23^\circ\text{C} \pm 5^\circ\text{C}$ and after 7 days tested as described in BS 2782 : Part 3, Method 320A : 1976 (1986) except that the rate of grip separation shall be 5 mm per minute with a tolerance of 20%. Although the test piece shall be cut to the dimensions shown in Figure 1, Method 320A, the requirement that the narrow parallel portion shall nowhere deviate by more than 2% from the mean shall be deleted. The conditioning period at $23^\circ\text{C} \pm 1^\circ\text{C}$ shall be at least 2 hours immediately before testing takes place. The tensile strength of the specimens shall be not less than 10.5 N/mm^2 and the elongation at break not less than 30%.

925 Testing of Bituminous Mixtures and Their Component Materials

- 1 The sampling, testing and analysis of bituminous mixtures shall comply with BS 598 : Parts 100 to 103.
- 2 A bulk sample of coated chippings shall be obtained as described in BS 598 : Part 100. Hot sand testing shall be carried out in accordance with BS 598 : Part 108.

926 Not Used

927 The Percentage Refusal Density Test

- 1 The compaction level of bituminous roadbase and basecourse macadam shall be determined in accordance with the Percentage Refusal Density Test, as specified in BS 598 : Part 104.

928 Testing of Slurry Sealing Material (Cationic Emulsions)

Slurry Stability Test

- 1 75 gm of the blended aggregate shall be weighed in a glass beaker or similar container and the corresponding quantities of water and cationic emulsion in the slurry mix added. The slurry shall be stirred with a slow deliberate action (about 60 rpm) for 15 to 30 seconds, after which a specimen of about half the mixture shall be cast upon an impervious surface.
- 2 The cast specimen shall exhibit cohesive properties in not more than 10 minutes and when set and drenched in water shall be waterfast as demonstrated by the absence of brown colour in the wash water.

929 Not Used

930 Heavy Duty Bitumen Macadam Roadbase

- 1 Heavy duty bitumen macadam roadbase shall comply with BS 4987 : Part 1 for dense roadbase, and with sub-Clauses 2 to 7 of this Clause, and the requirements of Appendix 7/1.

Aggregate

- 2 The coarse aggregate shall consist of crushed rock or crushed gravel complying with the requirements of BS 4987: Part 1. The fine aggregate may be crushed rock or sand or mixtures thereof, but the type shall be subject to the approval of the Engineer. The quality of the fine aggregate shall comply with the requirements of BS 4987: Part 1. The aggregate shall be in a surface dry condition prior to mixing unless the macadam is manufactured in a drum mixing plant in compliance with Clause 923.
- 3 Aggregate grading shall comply with BS 4987 : Part 1 for dense roadbase, except the percentage by mass of total aggregate passing the 75 micron sieve shall be 7% to 11%.

Filler

- 4 When the coarse aggregate is crushed gravel, 2% by mass of total aggregate of Portland cement or hydrated lime shall be added. The

percentage of fine aggregate shall be reduced accordingly. Cement or hydrated lime is not required when the gravel is limestone.

Binder

- 5 The binder shall be petroleum bitumen of 50 pen grade complying with the specification issued by the National Roads Authority/ Department of Environment as appropriate.

Mixing

- 6 The material shall be mixed in a plant which has a facility to incorporate added filler during the mixing process. The maximum temperature of mixed macadam at any stage shall not exceed 185°C.

Laying

- 7 Compaction shall be substantially completed while the temperature of the mixed macadam is greater than 105°C.

931 Not Used

932 Dense Bitumen Macadam Roadbase With Grade 50 Penetration Binder

- 1 Dense bitumen macadam roadbase with 50 penetration binder shall comply with BS 4987 : Part 1 for dense roadbase, and with sub-Clauses 2 to 6 of this Clause, and the requirements of Appendix 7/1.

Aggregate

- 2 The coarse aggregate shall consist of crushed rock or crushed gravel complying with the requirements of BS 4987: Part 1. The fine aggregate may be crushed rock or sand or mixtures thereof, but the type shall be subject to the approval of the Engineer. The quality of the fine aggregate shall comply with the requirements of BS 4987 : Part 1. The aggregate shall be in a surface dry condition prior to mixing unless the macadam is manufactured in a drum mixing plant in compliance with Clause 923.

Filler

- 3 When the coarse aggregate is crushed gravel, 2% by mass of total aggregate of Portland cement or hydrated lime shall be added. The percentage of fine aggregate shall be reduced accordingly. Cement or hydrated lime is not required when the gravel is limestone.

Binder

- 4 The binder shall be petroleum bitumen of 50 pen grade complying with the specification issued by the National Roads Authority/ Department of Environment as appropriate.

Mixing

- 5 The maximum temperature of mixed macadam at any stage shall not exceed 185°C.

Laying

- 6 Compaction shall be substantially completed while the temperature of the mixed macadam is greater than 105°C.

933 Heavy Duty Bitumen Macadam Basecourse

- 1 Heavy duty bitumen macadam basecourse shall comply with BS 4987 : Part 1 for dense basecourse, and with sub-Clauses 2 to 7 of this Clause, and the requirements of Appendix 7/1.

Aggregate

- 2 The coarse aggregate shall consist of crushed rock or crushed gravel complying with the requirements of BS 4987: Part 1. The fine aggregate may be crushed rock or sand or mixtures thereof, but the type shall be subject to the approval of the Engineer. The quality of the fine aggregate shall comply with the requirements of BS 4987: Part 1. The aggregate shall be in a surface dry condition prior to mixing unless the macadam is manufactured in a drum mixing plant in compliance with Clause 923.
- 3 Aggregate grading shall comply with BS 4987 : Part 1 for dense basecourse, except the percentage by mass of total aggregate passing the 75 micron sieve shall be 7% to 11%.

Filler

- 4 When the coarse aggregate is crushed gravel, 2% by mass of total aggregate of Portland cement or hydrated lime shall be added. The percentage of fine aggregate shall be reduced accordingly. Cement or hydrated lime is not required when the gravel is limestone.

Binder

- 5 The binder shall be petroleum bitumen of 50 pen grade complying with the specification issued by the National Roads Authority/ Department of Environment as appropriate.

Mixing

- 6 The material shall be mixed in a plant which has a facility to incorporate added filler during the mixing process. The maximum temperature of mixed macadam at any stage shall not exceed 185°C.

Laying

- 7 Compaction shall be substantially completed while the temperature of the mixed macadam is greater than 105°C.

934 Dense Bitumen Macadam Basecourse With Grade 50 Penetration Binder

- 1 Dense bitumen macadam basecourse with 50 penetration binder shall comply with BS 4987 : Part 1 for dense basecourse, and with sub-Clauses 2 to 6 of this Clause, and the requirements of Appendix 7/1.

Aggregate

- 2 The coarse aggregate shall consist of crushed rock or crushed gravel complying with the requirements of BS 4987: Part 1. The fine aggregate may be crushed rock or sand or mixtures thereof, but the type shall be subject to the approval of the Engineer. The quality of the fine aggregate shall comply with the requirements of BS 4987: Part 1. The aggregate shall be in a surface dry condition prior to mixing unless the macadam is manufactured in a drum mixing plant in compliance with Clause 923.

Filler

- 3 When the coarse aggregate is crushed gravel, 2% by mass of total aggregate of Portland cement or hydrated lime shall be added. The percentage of fine aggregate shall be reduced accordingly. Cement or hydrated lime is not required when the gravel is limestone.

Binder

- 4 The binder shall be petroleum bitumen of 50 pen grade complying with the specification issued by the National Roads Authority/ Department of Environment as appropriate.

Mixing

- 5 The maximum temperature of mixed macadam at any stage shall not exceed 185°C.

Laying

- 6 Compaction shall be substantially completed while the temperature of the mixed macadam is greater than 105°C.

935 Not Used

936 Not Used

937 Not Used

938 Not Used

939 Not Used

940 Not Used

941 Not Used

