INFRASTRUCTURE MALTA

SPECIFICATION FOR ROAD WORKS

SERIES IM/900 (IMPLEMENTATION)

ROAD PAVEMENTS - BITUMINOUS BOUND MATERIALS

This Specification Series implements the requirements in Subsidiary Legislation 499.57, Part II (New Roads and Road Works Regulations) in accordance with the Agency for Infrastructure Malta ACT XXV111, CAP. 588, Part I

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900 ROAD PAVEMENTS - BITUMINOUS BOUND MATERIALS

901 General – Regulations and Implementation

1 Whilst this Series is particularly relevant to the subject matter in its title it must be read in conjunction with the general requirements in Series IM/000 and IM/100 and with all other Infrastructure Malta (IM) Series relevant to the specification for the works to be undertaken.

Implementation of Chapter (CAP) 499.57 in accordance with Chapter (CAP) 588

2 This Infrastructure Malta (IM) Specification for Road Works (Implementation), Series IM/900 executes and implements the requirements included in the Authority for Transport (TM) **Subsidiary Legislation 499.57 – New Roads and Road Works Regulations,** Series 900 when these are incorporated in Infrastructure Malta contracts and in accordance with the constitution, functions and responsibilities of the Agency for Infrastructure Malta as enacted by **Legislation Chapter (CAP) 588**.

GPP – Green Public Procurement

3 The GPP (Malta) requires a minimum of 15% of recycled or reused content and/or by-products which shall be incorporated into the main road elements, ie base, binder and surface course. Recycled aggregate can be applied as aggregate within the scope of the EN13043 and its provisions. The recycled aggregate product (RAP) blend together with the new asphalt mix shall conform to EN13108-8.

902 Bituminous Courses General

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

Aggregates for Bituminous Materials

2 Natural, recycled unbound and manufactured (artificial) aggregates shall be clean, hard and durable and shall comply with BS EN 13043:2002 and be CE marked and have a declared performance which demonstrates that the aggregate meets the requirements of the specification.

3 Where recycled coarse aggregate or recycled concrete aggregate is used in bituminous mixtures, it shall have been tested in accordance with Clause 709 and the content of other materials (Class X) including wood, plastic and metal shall not exceed 1% by mass. Reclaimed asphalt shall comply with Clause 903.

4 The following shall apply:

a) The type of rock decay ‘Sonnenbrand’ must not be present in basalt and shall be tested in accordance with BS EN 1367-3:2001 and BS EN 1097-2:2010.

b) Aggregates extracted or sourced from outside the Maltese Islands shall be declared free of any hazardous substances or contamination by the responsible regularity Authority in Malta (or analogous EU regulator). This must include the following:

i) Release of polyaromatic hydrocarbons;

ii) Release of heavy metals;

iii) Emission of radioactivity;

iv) Release of other dangerous substances and/or contamination.

Resistance to Fragmentation (Hardness)

5 The coarse aggregates for bituminous materials shall have the following properties:

a) The resistance to fragmentation category of the coarse aggregate as defined in clause 4.2.2 of BS EN 13043:2002 shall be:

i) Los Angeles coefficient not greater than 35 per cent (LA_{35}) for aggregate used in base and binder courses;

ii) Los Angeles coefficient not greater than 20 per cent (LA_{20}) for aggregate used in surface course;

iii) Los Angeles coefficient not greater than 28 per cent (LA_{28}) for aggregate used in base-surface course;

iv) Los Angeles coefficient not greater than 28 per cent (LA_{28}) for aggregate used in asphalt concrete surface course to clause 906 in Road Construction Classes IV to VI when so instructed by the Overseeing Organisation.

b) Recovered unbound aggregates shall be natural and artificial aggregates recovered from a previous use in an unbound form and which meet the requirements of this Clause. Natural aggregates shall be approved by the Overseeing Organisation. All Properties including shape, angularity and roundness shall be declared in accordance with BS EN 13043:2002.

Durability

6 When required in IM Appendix 1/5, the aggregate source shall be tested in accordance with BS 812: Part 121 and shall have a soundness value greater than 75.

7 For routine testing, the water absorption value of the coarse aggregate shall be determined as in BS EN 1097:6. The water absorption value of the coarse aggregate shall be less than 3%.

Cleanliness

8 The proportion of coarse and fine aggregates for bituminous mixtures passing the 0.063 mm test sieve (fines content) shall not exceed the limits stated in BSI PD 6691 Annex B and Annex D, when tested in accordance with the washing and sieving method of BS EN 933-1.

9 For Asphalt Concrete (BS EN 13108-1) mixtures:

a) The fines content for coarse aggregate shall be:

i) For crushed rock: f_{NR}

b) The fines content for fine aggregate shall be:

i) For crushed rock: f_{NR}

ii) For sand: f_{10}

10 For Stone Mastic Asphalt (BS EN 13108-5) mixtures:

a) The fines content for coarse aggregate shall be f_4

b) The fines content for fine aggregate shall be f_{22}

Polishing

11 The polished stone value (PSV) according to BS EN 1097-8 is required for surface courses only. Values are set in line with the road construction classes described in Volume 7, "Directives for the Standardisation of Pavements for Traffic Areas", Transport Malta Design and Construction Standards for Road Works, Subsidiary Legislation 499.57 as follows:

a) Road Construction classes IV to VI: PSV ≥ 38 [Note 1]

b) Road Construction classes HD and I to III: PSV ≥ 57 [Note 2]

Note 1: Increased potential of skidding (eg. sharp bends, junctions, braking / slowing sectors, roundabouts and high gradients must be taken into consideration for these construction classes and the PSV_{NR} substituted by PSV ≥ 57 surface course aggregate as required.

Note 2: The PSV value refers to the mix and must be calculated as follows for blended mixtures:

$$\mathrm{PSV}_{mix} = \sum(\mathrm{PSV}_{\text{individual aggregate}} \times \text{Volume \%})$$

Flakiness Index

12 The flakiness index of surface course aggregates shall be FI_{25}

13 The flakiness index for all other courses shall be FI_{35}.

Bitumen

14 Paving grade bitumen shall comply with BS EN 12591. The paving grade to be used in this specification shall be paving grade 40/60 or 50/70 as appropriate.

15 Polymer modified bitumen shall comply with BS EN 14023 and Clause 916.

903 Reclaimed Asphalt

1 Reclaimed bituminous materials may also be used in the production of bituminous courses. The maximum amount of reclaimed bituminous material permitted shall be 10% in surface courses, 20% in base-wearing courses, 30% in binder courses and 50% in base courses. Other materials for recycling in bituminous mixtures shall only be used with the approval of the Overseeing Organisation. The mixed material shall comply with the requirements of this Series (e.g. technological properties).

2 When the amount of reclaimed bituminous material comprises 10% by mass or less, requirements to the feed stock are only those of Clause 4 of EN 13108-8 (Reclaimed asphalt).

Reclaimed Feedstock

3 All reclaimed material shall be pre-treated before use such that it is homogeneously mixed, and well-graded. The maximum particle size shall not exceed that of the bituminous mix in which it is incorporated.

Properties of Recovered Binder

4 The binder shall be recovered from the reclaimed asphalt in accordance with the requirements of BS EN 12697-3 (Bitumen Recovery: Rotary Evaporator) or BS EN 12697-4 (Bitumen Recovery: Fractionating Column) and tested in accordance with BS EN 1426 or the withdrawn BS 2000-49. The penetration value and the softening point of the binder recovered shall comply with the requirements of EN 13108-8.

5 Suitability has to be demonstrated if these requirements are not met (e.g. compaction, void content).

6 Softening point of the Bitumen recovered from the resulting mixture: ≥ 39° C and ≤ 70° C.

Compliance and Frequency of Testing

7 Compliance shall be monitored either:

a) by sampling and testing from the permanent works at a frequency approved by the Overseeing Organisation or,

b) by periodic trials at a frequency approved by the Overseeing Organisation.

8 Trial areas in which the mixed material complies with the requirements of this Series may form part of the permanent works.

904 Placing and Compaction of Bituminous Mixtures

General

1 This Clause gives general requirements for the placing and compaction of bituminous mixtures, which are complementary and additional to the requirements of BS 594987. These requirements and the requirements of BS 594987 apply to all bituminous mixtures, unless otherwise specified in the other Clauses in this Series or in contract specific IM Appendix 7/1.

2 Bituminous pavements shall be constructed using the materials specified in contract specific IM Appendix 7/1.

3 In order to exclude moisture from interfaces and ensure full interlayer bonding, the surface of all bituminous material shall be kept clean and uncontaminated. Unless agreed with the Overseeing Organisation, the only traffic permitted to run on the surface of bituminous material to be overlaid shall be that engaged in laying and compacting the next course. If any surface becomes contaminated, it shall be made good by cleaning and, if this proves impracticable, by rectification in compliance with Clause 702.

4 Prior to placing bituminous material on any new or existing bound substrate, a bond coat or tack coat shall be applied in accordance with Clauses 913, as appropriate.

5 Before work commences, the Contractor shall submit a method statement to the Overseeing Organisation that includes:

a) Laying and compaction procedures for each layer – including paving speed, paving width; size, type and number of rollers; and number of roller passes.

b) The joint formation procedures for each layer – including the location of longitudinal and transverse joints; and the method(s) of treating upstanding edges.

Transporting

6 Hot bituminous mixtures shall be transported in accordance with the requirements of BS 594987 Clause 4 and shall be covered and remain covered whilst awaiting tipping.

7 Loading of asphalt shall be carried out such that segregation is minimized, which shall be identified from visual examination.

8 Asphalt shall be transported to the laying site in sheeted vehicles to minimize temperature loss and protect against adverse weather conditions.

9 Release agents may be used subject to the approval of the Overseeing Organization. When using release agents to facilitate discharge of the asphalt, substances that are likely to cause

softening or damage to the asphalt (e.g. diesel oil or kerosene) shall not be used. Sealing grit, sand, soap solution, water or a proprietary release agent may be used on the floor and/or other surfaces of the vehicle to facilitate discharge of the asphalt. The amount used should be kept to a minimum.

Delivery to the site

10 Deliveries of asphalt to the site shall be planned to avoid the interruption of the laying process.

11 Asphalt shall be delivered at a temperature that allows it to be compacted to the specified requirements and within a reasonable time from arrival.

Laying

12 Wherever practicable, bituminous materials shall be spread, levelled and tamped by a self-propelled paving machine, which may be equipped with an averaging beam. 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 and it shall be so operated whenever practicable.

13 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, so that the material is free from dragging, tearing and segregation of the material.

14 Hot bituminous materials shall be laid in accordance with the requirements of Series 750.

15 The minimum thickness of material laid in each paver pass shall be in accordance with BS594987.

16 When laying bituminous courses, 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

17 Hand placing of bituminous materials shall only be permitted in the following circumstances:

a) For laying regulating courses of irregular shape and varying thickness.

b) In confined spaces where it is impracticable for a paver to operate.

c) For footways although laying by paver is preferred.

d) At the approaches to expansion joints at bridges, viaducts or other structures.

e) For laying mastic asphalt in accordance with the withdrawn BS 1447.

18 Hand-raking of surface 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:

a) At the edges of the layers of material and at gullies and manholes.

b) At the approaches to expansion joints at bridges, viaducts or other structures.

19 Unless otherwise specified in IM Appendix 7/1, the design, compaction assessment and compliance requirements for bituminous courses shall be in accordance with Clause 925. For the compaction degree determined in accordance with clause 925, a value of > 96% is required for base-wearing and single layer courses and of > 97% for all other courses.

Joints

20 Except where otherwise specified in this Series, where joints are made in any courses, the material shall be fully compacted, and the joint made flush in one of the following ways:

a) By using two or more pavers operating in echelon, where this is practicable, and in sufficient proximity for adjacent widths to be fully compacted by continuous rolling.

b) By cutting back (e.g. with roller-mounted edge wheel cutter, blade, joint cutter) 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 (200g/m per 40mm thickness), before the adjacent width is laid. A polymer modified adhesive bitumen strip with a minimum thickness of 2mm may also be used. Bitumen emulsion is not permitted.

21 All joints shall be offset at least 300mm from parallel joints in the layer beneath. Joints in the surface course shall coincide with either the lane edge or the lane marking, whichever is appropriate. No joints shall be formed between a hardshoulder / hardstrip and the edge of the carriageway, nor within a hardstrip. Longitudinal joints in shall not be situated in wheel-track zones or where subject to Percentage Impact Compactor Density (PCD) testing procedures.

Bond Coat and Tack Coat

22 The application of a bituminous bond or tack coat spray, complying with Clause 913, to the surface on which laying is to take place will be required in order to achieve sufficient layer bond.

23 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. 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 Clause 702.

24 Binder courses or base courses below surface courses should not remain uncovered by the surface course for more than three consecutive days after being laid. With prior agreement with the Overseeing Organisation this period may be extended by the minimum amount of time necessary to allow for adverse weather conditions or for other reasons.

Regulating Course

25 Regulating course materials shall be made and laid in accordance with the requirements of Clause 910.

Use of Surfaces by Traffic and Construction Plant

26 All temporary running surfaces shall be thoroughly cleaned, and a bond coat applied prior to laying the succeeding course.

27 Bond and tack coats shall be bitumen as described in Clause 913 and BS 594987. The bitumen emulsion shall not be permitted to collect in any hollows and shall be allowed to break completely before the next layer is placed.

28 Construction plant and traffic used on pavements under construction shall be suitable in relation to the material, condition and thickness of the courses it traverses so that damage is not caused to the subgrade or the pavement courses already constructed. The wheels or tracks of plant moving over the various pavement courses shall be kept free from deleterious materials.

Additional Requirements for Night-Time Works - Lighting

29 Night-time paving operations shall not be permitted without additional lighting using tower-mounted and/or "balloon" type units shall be used.

Figure 900 - 1 "Balloon" Type Lighting

30 The portable lighting shall supplement the lighting mounted on equipment to provide the following uniform lux levels on the ground:

i. ≥ 108 lux for areas on or around construction equipment; asphalt paving, milling;

ii. ≥ 215 lux for pavement or crack/pothole filling; joint repair, pavement patching/repairs.

31 The orientation angle shall be such as to reduce the glare onto oncoming traffic and the spill onto residential buildings.

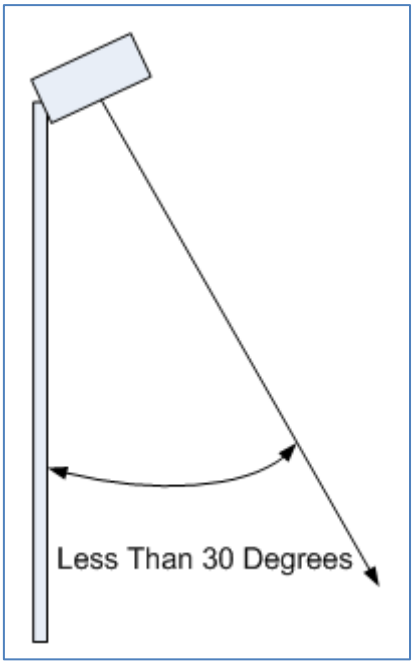

Figure 900 - 2 Lighting Orientation

905 Mix Design Specification

1 Dense Asphalt Concrete Mixtures shall be designed in accordance with the Marshall method of Mix Design according to the Asphalt Institute Manual Series No.2 (MS-2) with all associated tests complying with the relevant European Standards.

2 Stone Mastic asphalts shall be designed in accordance with Clause 908.

3 Performance Asphalt Concrete Mixtures shall be designed in accordance with Clause 909.

4 The design mixture selected by the Contractor must be approved by the Overseeing Organisation prior to its use in any Works.

Approval Process

5 The Contractor shall submit for approval a proposed Job Mix Formula (JMF) together with all applicable design data for approval by the Overseeing Organisation before beginning the work.

6 The JMF shall give a combined gradation with a single definite percentage, state the mixing and compaction temperature and a compaction density.

7 The Overseeing Organisation shall test samples of the materials proposed for use and also check the proposed mix design.

8 The asphalt producer shall report all the values obtained in the laboratory design and shall submit these together with a copy of the plotted curves resulting from the tests in an approved form to the Overseeing Organisation.

9 The asphalt mix design submission shall include a copy of the valid ISO 9001 certificate for the asphalt plant and design laboratory. Mix designs must be tested and validated by laboratories holding a valid ISO/IEC 17025 accreditation.

10 The asphalt producer shall provide the Overseeing Organisation with a complete report on the origin and composition of all aggregates, bitumen and additives if any. These shall be accompanied by the manufacturer's certification with test reports.

11 After receiving the approval for specific sources of material the asphalt producer cannot change these sources without undertaking a further mix design.

Constituent Material

12 Mix Designs have to be carried out with the constituent materials, which will be used for the mixture production. Constituent materials are fine and coarse aggregates, binder, reclaimed asphalt and additives.

Fine aggregate

13 Fine aggregate is that portion of the mineral aggregate passing the 2mm sieve.

14 Fine aggregate shall consist of crushed hard durable rock and shall be non-plastic and chemically stable.

15 The source of natural fine aggregate is considered to be the quarry at which it is produced.

16 Crushed fine aggregate shall be produced by crushing clean coarse aggregate and shall not be flaky or elongated.

17 Fine aggregate shall be clean and free from organic matter, clay, and other extraneous or detrimental materials.

18 The specifications of fine aggregates for asphalt mixtures are listed in Table 900-1.

Table 900-1: Fine Aggregate Specification

Parameter	Standard	Specification Limits	Minimum Frequency
Plasticity index	BS 1377 Part 2	4% max (stockpile) Non-Plastic (hot bins)	Each source
Sand equivalent value	BS EN 933-8	45% min.	Visible change in material
$MgSO_4$ Soundness	BS EN 1367-2	18% max.	

Acid soluble chloride content	BS 1377 Part 3	0.1% max.	1 test every 5000 tonnes
Acid soluble sulphate content	BS 1377 Part 3	0.5% max.	

Coarse Aggregate

19 Coarse aggregate is that portion of the mineral aggregate retained on the 2.36mm sieve.

20 Coarse aggregate shall consist of crushed natural stones and gravel.

21 Crushed particles shall be cubic and angular in shape and shall not be flaky or elongated.

22 The source of crushed aggregate is considered to be the quarry from which it is produced.

23 Coarse aggregate shall be clean and free from organic matter, clay, and other extraneous or detrimental material.

24 The specifications of coarse aggregates for asphalt mixtures are listed in

25 Table 900-2.

26 The polished stone value (PSV) should be determined for surface course aggregates and shall be as specified in Clause 902.

Table 900-2: Coarse Aggregate Specification

Parameter	Standard	Specification Limits			Minimum Frequency
		Base	Binder Course	Surface Course	
One or more Fractured Faces	BS EN 932-5	100% min.	100% min.	100% min.	Each source
Two or more Fractured Faces	BS EN 932-5	85% min.	85% min.	85% min.	
Flat and Elongated Particles (5:1)	BS EN 932-3 BS EN 932-4	15% max.	15% max.	10% max.	Visible change in material
Los Angeles Abrasion	BS EN 1097-2	Clause 902	Clause 902	Clause 902	
Water absorption	BS EN 1097-6	3.0% max.	3.0% max.	3.0% max.	1 test every 5000 tonnes
Polished stone value	BS EN 1097-8			Clause 902	

Mineral Filler

27 Mineral filler when separately supplied from an external source shall consist of finely ground limestone, hydrated lime or cement. When other fillers are used these shall be declared and approved by for use by the Overseeing Organisation. When using other fillers these shall be as follows:

a) When the filler contains less than 75% of the approved material and the additional filler is acidic an adhesion promoter shall be used.

b) When the filler contains more than 75% of the approved material there are no additional requirements.

28 It shall be free from organic substances and clay, shall be thoroughly dry and free from agglomerations, shall be non-plastic and shall meet the grading requirements shown in Table 900-3

Table 900-3: Filler Requirements

Sieve	% Passing
600 µm	100
300 µm	95-100
150 µm	90-100
63 µm	70-100

Asphalt Binder

29 Paving grade bitumen shall comply with BS EN 12591. The paving grade shall be paving grade 40/60 or 50/70 as appropriate.

30 Polymer-modified binder (PMB) in accordance with the requirements of BS EN 14023 and Clause 916.

31 Prior to the commencement of the mix design, the Contractor shall provide a certificate indicating conformance of binder with the specifications stated in this Series. This certificate shall be obtained from the supplier and must also include the recommended temperature ranges for mixing and compaction.

Grading of Total Aggregate

32 Aggregate size distribution has to be chosen within the limits so that the required technological properties are achieved. It must not be necessarily in the middle of the grading envelope.

Verification

33 Verification of the design proposal shall be carried out using materials obtained from the plant before manufacture of the mixes commences. Technological properties shall be determined at the proposed target binder content recommended by the Overseeing Organisation.

34 The binder content determined on verification shall be not less than the recommended bitumen content under consideration of the tolerance.

906 Dense Asphalt Concrete Mixtures

General

1 Dense asphalt concrete mixtures shall comply with BS EN 13108-1.

2 The Overseeing Organisation shall approve the mix designs of asphalt mixtures and component materials submitted by the asphalt producer.

3 The asphalt producer shall carry out a trial batch and laying trial of the designed mix design.

4 Based on the results of the trial batch and the laying trial the mix design may receive approval or may need to be amended and the trial batch and laying trial repeated.

5 The approved Job Mix Formula (JMF) may be amended as a result of experience in the execution and performance of the permanent asphalt works. Such an amendment may be submitted by the asphalt producer for the Overseeing Organisation approval.

6 Approval by the Overseeing Organisation of the JMF or amendments thereto shall in no way relieve the asphalt producer of his obligations and he shall be responsible for the soundness of the asphalt paving mixes and the satisfactory execution and performance of the asphalt paving courses.

Dense Asphalt Concrete Mixtures - Marshall Design Criteria

7 The Asphalt Institute MS-2 “Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types” shall be used in designing the bituminous mixtures using Marshall design method with all associated tests complying with the relevant European Standards.

a) The “output target composition” shall be used from EN 13108-1, so the binder content is the soluble binder content found on analysis. This shall be corrected to the 2.650 Mg/m^3 aggregate density equivalence for CE-marking purposes.

a) When tested according to BS EN 932-1:2012, the combined mineral aggregate grading shall conform to the following criteria:

Table 900-4: Marshall Asphalt Grading Envelopes

Sieve Size	Percentage Passing (By Weight)			
	Base Course	Binder Course	Base-Wearing Course	Surface Course
40mm	100	-	-	-
31.5mm	90 – 100	-	-	-
28mm	-	100	100	-
20mm	70 – 100	90 – 100	78 – 100	-
14mm	53 – 85	70 – 90	63 – 85	100
10mm	40 – 73	55 – 80	50 – 75	75 – 100
6.3mm	30 – 60	40 – 65	40 – 65	40 – 75
2mm	19 – 45	25 – 45	20 – 45	20 – 45
0.5mm	8 – 25	8 – 22	8 – 22	8 – 22
0.125mm	5 – 15	5 - 15	5 – 15	5 – 15
0.063mm	5 – 9	5 - 9	5 - 9	5 - 9
Binder Content (% of total mix), B_{act}	3.2 – 5.4	3.4 – 5.6	3.4 – 5.6	4.0 – 6.0

Table 900-5: Marshall Asphalt Design Criteria

Parameter	Base Course	Binder Course	Base-Wearing	Surface Course
Number of Compaction blows at each end of specimen	75	75	75	75
Stability minimum (kN) (min)	9.5	9.5	10.0	11.0
Flow (mm)	2 - 4	2 - 4	2 - 5	2 - 4
Voids in Mix (Air Voids) (%)	3 - 7	3 - 7	3 - 7	3 - 7
Percentage Refusal Density (%) (250 gyrations, BS EN 12697-31)	≥ 3			
Void in Mineral Aggregate VMA (%)	Table 900-6: Minimum Voids in Mineral Aggregate			

Recommended Voids filled with bitumen VFB (%)	65 - 78	65 - 78	65 - 85	65 - 78
Retained Stability (%) (Marshall 60ºC, 24 hours)	75 min.	75 min.	75 min.	75 min.
Void content of laid materials after compaction (%)	7 max.	7 max.	7 max.	7 max.

Table 900-6: Minimum Voids in Mineral Aggregate

Nominal Maximum Particle Size (mm)	Minimum VMA, Percentage Bitumen			
	3.0%	4.0%	5.0%	5.5%
2	19.0	20.0	21.0	22.0
6.3	16.0	17.0	18.0	19.0
10	14.0	15.0	16.0	17.0
14	13.0	14.0	15.0	16.0
20.0	12.0	13.0	14.0	15.0
31.5	10.0	11.0	12.0	13.0

8 After the Job Mix Formula has been established and approved, all mixes furnished shall conform thereto within the following tolerances shown in Table 900-7 as specified in EN13018-21 for mean of four results. Absolute values are as per EN13108-21 Table A.1. This may mean that the grading curve for the job mix formula is outside of the limits shown in Table 900-4 which is acceptable.

Table 900-7: Dense Asphalt Concrete Quality Control Tolerances

Percentage [a] Passing	Base Course	Binder Course	Base-Wearing Course	Surface Course
D	- 9 / + 5 %	- 8 / + 5 %	- 8 / + 5 %	- 8 / + 5 %
Any Characteristic sieve(s) < D and > 2 mm	± 9 %	± 7 %	± 7 %	± 7 %
2 mm	± 7 %	± 6 %	± 6 %	± 6 %

Any Characteristic sieves < 2 mm and > 0,063 mm	± 5 %	± 4 %	± 4 %	± 4 %
0,063 mm	± 3 %	± 2 %	± 2 %	± 2 %
Soluble binder content	± 0.6 %	± 0.5 %	± 0.5 %	± 0.5 %
[a] A tolerance of −2 % shall apply to the requirement of 100 % passing 1,4 D.				

907 Plastomer Modification and Additivation – Non-Elastomeric

1 Non-elastomeric plastomer (eg. EVA, LDPE, PP) modification or additivation may be used with Asphalt Concretes specified in Clause 906 and 909. These may be either added directly as “dispersion” content (in the wet) in the bitumen or added “in the dry” (i.e dosed in the pugmill mixer before dosing of bitumen).

Note – When added in the dry the plastomers do not modify the “base” binder and are designed to improve the performance of the asphalt mix; they must not be used in substitution of the SBS Polymer Modified Bitumen to BS EN 14023 as specified in clause 916.

2 The Contractor shall declare the polymeric base of the additives (Eg. Plastomeric PP / LDPE / EVA and similar). The PMA additives and their properties must be declared in the mix design submitted to the Overseeing Organisation for approval. The Contractor must also declare the proportion of additive by weight in the bitumen mixture (or an alternative approved proportioning ratio).

3 The asphalt mix with additives shall conform to the requirements of clause 909.

4 Additionally the residual bitumen from the mix following extraction shall “pass” the homogeneity examination under a fluorescent microscope.

5 The asphalt concrete mix shall comply with the requirements of clause 909.

908 Stone Mastic Asphalt Mixtures

General

1 Stone Mastic asphalts shall comply with BS EN 13108-5.

2 The Overseeing Organisation shall approve the mix designs of asphalt mixtures and component materials submitted by the asphalt producer.

3 The asphalt producer shall carry out a trial batch and laying trial of the designed mix design.

4 The binder for shall be an elastomeric polymer (SBS- Styrene-Butadine-Styrene) modified bitumen, PmB, conforming to Clause 916.

5 Cellulose fibres, at a minimum addition rate of 0.3%, shall be used.

6 Based on the results of the trial batch and the laying trial the mix design may receive approval or may need to be amended and the trial batch and laying trial repeated.

7 The approved JMF may be amended as a result of experience in the execution and performance of the permanent asphalt works. Such an amendment may be submitted by the asphalt producer for the Overseeing Organisation approval.

8 Approval by the Overseeing Organisation of the JMF or amendments thereto shall in no way relieve the asphalt producer of his obligations and he shall be responsible for the soundness of the asphalt paving mixes and the satisfactory execution and performance of the asphalt paving courses.

Stone Mastic Asphalt Design Criteria

9 These materials shall be designed using the gyratory compactor and tested for wheel tracking and indirect tensile stiffness.

a) The "output target composition" shall be used from EN 13108-5, so the binder content is the soluble binder content found on analysis. This shall be corrected to the 2.650 Mg/m^3 aggregate density equivalence for CE-marking purposes.

b) The grading shall comply with the requirements of Table 900-8.

c) The binder drainage shall not exceed 0.3% when tested in accordance with BS EN 12697-18.

Table 900-8: Target Stone Mastic Asphalt composition

Sieve Size	Percentage Passing (By Weight)		
	Single Course	Binder Course	Surface Course
28 mm	100	100	
20 mm	94 - 100	94 - 100	100
14 mm	70 - 95	65 - 90	90 - 100
10 mm	25 - 40	25 - 40	35 - 60
6.3 mm	20 - 35	20 - 35	22 - 36
2 mm	15 - 30	15 - 30	16 - 30
0.250 mm	7 - 20	7 - 20	7 - 20
0.063 mm	7 - 11	7 - 11	6 - 12
Bitumen Content (%), B_{act}	5.0 – 6.5	5.0 – 6.5	5.0 – 7.0

Gyratory compaction

10 Gyratory compaction shall be undertaken in accordance with BS EN 12697-31 with readings taken up to 250 gyrations. The criteria for the gyratory compaction test shall be as Table 900-9.

Table 900-9: Gyratory test criteria

Characteristic	Unit	Value	Comments
Vertical pressure	kPa	600±3	
Rotation angle	Degrees	1.25° ±0.02	
Rotation speed	RPM	30	
Specimen diameter	mm	150	Base Course
		100	Binder and Surface Course

Table 900-10: Gyratory compaction criteria

Revolutions	% Air voids	Comment
10	11 - 15	
120	3 - 6	Site air voids
205	≥ 3	Refusal density
250	≥ 2.5	Refusal density confirmation

11 The readings should be automatically recorded throughout the duration of the test which will be complete at 250 gyrations. The critical number of gyrations are 10, 120 and 205 gyrations.

12 The 120 gyrations figure is the reference air voids for site compaction control.

13 The 205 gyrations figure is the refusal density air voids.

14 The sample should have received full compaction after 205 gyrations, but the test is continued up to 250 gyrations to confirm this.

15 The specification criteria are given in

16 Table 900-10: Gyratory compaction criteria. The air voids content of the samples shall be tested in accordance with BS EN 12697-8.

17 When a proposed JMF is approved, it will be subject to the Indirect Tensile Stiffness test.

Indirect Tensile Stiffness

18 The JMF compacted to 120 gyrations shall be tested for the indirect tensile stiffness modulus, ITSM, in accordance with BS EN 12697-26. The specification criteria for this are shown in Table 900-11.

Table 900-11: ITSM criteria

Property	Value
Test Temperature	20°C
Stiffness on 120 gyrations specimen	≥ 4000 MPa

Resistance to Permanent Deformation

19 Once the proposed JMF has successfully completed the ITSM testing criteria the mix will be subjected to the wheel tracking test.

a) Slab samples will be prepared in accordance with BS EN 12697-33.

b) The wheel track test will be accordance with BS EN 12697-22 small size model B testing air.

c) The mean wheel tracking slope and the mean proportional rut depth will be ascertained, and the test temperature shall be 60°C.

20 The specification criteria are shown in Table 900-12.

Table 900-12: Resistance to Permanent Deformation test criteria

Test Temperature	Category WTS_{air}	Category PRD_{air}
°C	Wheel track slope mm/1000cycles	Maximum proportional rut depth %
60	1.00	9.00

Quality Control

9 After the JMF has been established and approved, all mixes furnished shall conform thereto within the following tolerances shown in Table 900-13 as specified in EN13018-21 for mean of four results. Absolute values are as per EN13108-21 Table A.1. This may mean that the grading curve for the job mix formula is outside of the limits shown in Table 900-8 which is acceptable.

Table 900-13: Tolerances for Quality Control

Percentage [a] Passing	Binder Course	Single Layer Course	Surface Course
D	- 8 / + 5 %	- 8 / + 5 %	- 8 / + 5 %
Any Characteristic sieve(s) < D and > 2 mm	± 7 %	± 7 %	± 7 %
2 mm	± 6 %	± 6 %	± 6 %
Any Characteristic sieves < 2 mm and > 0,063 mm	± 4 %	± 4 %	± 4 %
0,063 mm	± 2 %	± 2 %	± 2 %
Soluble binder content, B_{act}	± 0.5 %	± 0.5 %	± 0.5 %
[a] A tolerance of − 2 % shall apply to the requirement of 100 % passing 1.4 D			

909 Performance Asphalt Concrete Mixtures

General

2 Performance asphalt concrete mixtures shall comply with BS EN 13108-1 and incorporating either binder modification or mix additivation in the dry.

3 The Overseeing Organisation shall approve the mix designs of asphalt mixtures and component materials submitted by the asphalt producer.

4 The asphalt producer shall carry out a trial batch and laying trial of the designed mix design.

Binder Modification or Additivation

5 The penetration grade bitumen conforming to clause 905 may be modified with elastomer (SBS) polymers in accordance with Clause 916 or with plastomer (EVA, PP, PE) in accordance with Clause 907.

Mix Additivation (In the Dry)

6 The additives shall conform to clause 907 and are incorporated in the heated aggregate in the mixing pugmill in the dry (i.e before bitumen dosing).

Binder Drainage

7 The binder drainage shall not exceed 0.3% when tested in accordance with BS EN 12697-18 (Schennberg method). In this regard, Performance Asphalt Concrete may thus need to contain cellulose fibre absorbers.

8 Based on the results of the trial batch and the laying trial the mix design may receive approval or may need to be amended and the trial batch and laying trial repeated.

9 The approved JMF may be amended as a result of experience in the execution and performance of the permanent asphalt works. Such an amendment may be submitted by the asphalt producer for the Overseeing Organisation approval.

10 Approval by the Overseeing Organisation of the JMF or amendments thereto shall in no way relieve the asphalt producer of his obligations and he shall be responsible for the soundness of the asphalt paving mixes and the satisfactory execution and performance of the asphalt paving courses.

Performance Asphalt Concrete - Performance Mixtures Design Criteria

11 These materials shall be designed using the gyratory compactor and tested for wheel tracking and indirect tensile stiffness.

a) The "output target composition" shall be used from EN 13108-1, so the binder content is the soluble binder content found on analysis. This will need to be corrected to the 2.650 Mg/m^3 aggregate density equivalence for CE-marking purposes.

b) The grading shall comply with the requirements of Table 900-14.

Table 900-14: Target Performance Asphalt Concrete composition

Sieve Size	Percentage Passing (By Weight)			
	Perf AC 32 Base Course	Perf AC 20 Binder Course	Perf AC 14 Surface Course	Perf AC 10 Surface Course
40mm	100	-	-	-
31.5mm	90 - 100	100	-	-
20 mm	70 - 100	90 - 100	100	-
14 mm	53 - 85	66 - 84	90 - 100	100
10 mm	40 - 73	53 - 71	66 - 84	90 - 100
6.3 mm	30 - 60	39 - 57	50 - 64	66 - 84
2 mm	19 - 45	21 - 35	28 - 42	30 - 49
0.063 mm	5 - 9	5 - 9	6 - 10	7 - 11
Bitumen Content (%), B_{act}	3.6 – 5.1	4.0 - 5.3	4.5 - 5.8	5.0 - 6.1

Gyratory compaction

12 Gyratory compaction shall be undertaken in accordance with BS EN 12697-31 with readings taken up to 250 gyrations. The criteria for the gyratory compaction test shall be as Table 900-15.

Table 900-15: Gyratory test criteria

Characteristic	Unit	Value	Comments
Vertical pressure	kPa	600±3	
Rotation angle	Degrees	1.25° ±0.02	
Rotation speed	RPM	30	
Specimen diameter	mm	150	Base Course
		100	Binder and Surface Courses

Table 900-16: Gyratory compaction criteria

Revolutions	% Air voids	Comment
10	9 - 13	
120	4 - 6	Site air voids
205	≥ 3	Refusal density
250	≥ 2.5	Refusal density confirmation

13 The readings should be automatically recorded throughout the duration of the test which be complete at 250 gyrations. The critical number of gyrations are 10, 120 and 205 gyrations.

14 The 120 gyrations figure is the reference air voids for site compaction control.

15 The 205 gyrations figure is the refusal density air voids.

16 The sample should have received full compaction after 205 gyrations, but the test is continued up to 250 gyrations to confirm this.

17 The specification criteria are given in Table 900-16: Gyratory compaction criteria. The air voids content of the samples shall be tested in accordance with BS EN 12697-8.

18 When a proposed JMF is approved, it will be subject to the Indirect Tensile Stiffness test.

Indirect Tensile Stiffness

19 The JMF compacted to 120 gyrations shall be tested for the indirect tensile stiffness modulus, ITSM, in accordance with BS EN 12697- 26. The specification criteria for this are shown in Table 900-17.

Table 900-17: ITSM criteria

Property	Value	
Test Temperature	20°C	40°C
Stiffness on 120 gyrations specimen	≥ 5500 MPa and <8500 MPa	≥ 600 MPa and <2500 MPa

Resistance to Permanent Deformation

20 Once the proposed JMF has successfully completed the ITSM testing criteria the mx will be subjected to the wheel tracking test.

a) Slab samples will be prepared in accordance with BS EN 12697-33.

b) The wheel track test will be accordance with BS EN 12697-22 small size model B testing air.

c) The mean wheel tracking slope and the mean proportional rut depth will be ascertained, and the test temperature shall be 60°C.

21 The specification criteria are shown in Table 900-18.

Table 900-18: Resistance to Permanent Deformation test criteria

Test Temperature	Category WTS_{air}	Category PRD_{air}
°C	Wheel track slope mm/1000cycles	Maximum proportional rut depth %
60	0.80	6.00

Quality Control

10 After the JMF has been established and approved, all mixes furnished shall conform thereto within the following tolerances shown in Table 900-19 as specified in EN13018-21 for mean of four results. Absolute values are as per EN13108-21 Table A.1. This may mean that the grading curve for the job mix formula is outside of the limits shown in Table 900-15 which is acceptable.

Table 900-19: Tolerances for Quality Control

Percentage [a] Passing	Perf AC 32 Base Course	Perf AC 20 Binder Course	Perf AC 14 Surface Course	Perf AC 10 Surface Course
D	- 9 / + 5 %	- 8 / + 5 %	- 8 / + 5 %	- 8 / + 5 %
Any Characteristic sieve(s) < D and > 2 mm	± 9 %	± 7 %	± 7 %	± 7 %
2 mm	± 7 %	± 6 %	± 6 %	± 6 %
Any Characteristic sieves < 2 mm and > 0,063 mm	± 5 %	± 4 %	± 4 %	± 4 %
0,063 mm	± 3 %	± 2 %	± 2 %	± 2 %
Soluble binder content, B_{act}	± 0.6 %	± 0.5 %	± 0.5 %	± 0.5 %
[a] A tolerance of −2 % shall apply to the requirement of 100 % passing 1,4 D.				

910 Dense Asphalt Concrete Regulating Courses

1 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.

2 Minimum layer thickness for regulating courses has to be at least 2.5 x maximum aggregate size. If the minimum thickness cannot be achieved, scarifying will be necessary.

3 Compaction degree of ≥ 96% is accepted for regulating courses.

911 Water Sensitivity of Surface Course

1 The water sensitivity of mixtures conforming with BS EN 13108 Parts 1 and 5 shall conform to, at least, category $ITSR_{min}$ 80.

912 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 (scarified) shall be removed to the specified depth by a milling machine approved by the Overseeing Organisation. Damping with water sprays or mist jets shall be used to control and minimise dust. 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 produce a clean and regular running

surface with a groove depth not greater than 10mm, with a uniform texture, to the satisfaction of the Overseeing Organisation.

3 Carriageways shall be milled to the tolerance of surface levels specified in clause 702.

In spaces with difficult access (e.g. projecting kerbline and manholes) tolerances <10mm will be. If the tolerance is 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 910.

4 Existing ironwork shall not be disturbed by the milling action. When 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 may be permitted subject to the approval of the Overseeing Organisation as follows:

a) all temporary ramping materials and/or other measures must be removed prior to placing the new permanent surfacing;

b) ramps must measure a maximum 1% grade (slope) on the approaching / leading side and relative to the existing surrounding pavement grades;

c) longitudinal ramps must be a minimum of 300 mm wide under traffic, and must be visually monitored at all times for the period the ramps are in use;

d) the above shall be incorporated in the scope of IM Appendix 1/17 – Traffic Safety and Management at no additional cost.

6 If the milled surface profile varies by more than the permissible tolerance 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 6 or 10mm, 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-length widths. If this is impracticable, the proposed programme of milling shall be submitted to the Overseeing Organisation 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 lose debris.

9 No stockpiling shall be allowed on site unless permitted by the Overseeing Organisation.

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

11 48 hours prior to cold-milling the Contractor shall carry out a sweep of the area(s) by electronic detection equipment to locate any buried metalwork within the layer to be cold-milled.

913 Bituminous Prime Coats, Tack Coats and Bond Coats

Prime Coats

1 Prime coats shall be bitumen emulsions complying with BS EN 13808, C 55 B 10 as shown in Table 900-20: Bituminous Prime Coat or an approved equivalent that has the same fitness for purpose.

2 The prime coat shall be slow setting.

Table 900-20: Bituminous Prime Coat

Requirement	Test Standard	Value	EN 13808 Class
Polarity	EN 1430	+ve	
Water Content (%)	EN 1428	45 ± 2	5 (100% less water content %)
Binder content (%) – Including oil distillate	EN 1431	≥ 53 (55 ± 2)	5 (C 55)
Residue on sieving (0.5mm sieve); Homogeneity (%)	EN 1429	≤ 0.2	3
Oil distillate (%) – where used	EN 1431	≤ 3.0	3
Setting - 7 days (%)	EN 12847	≤ 10	3
pH (Acidity)	EN 12850	To be declared	
Mixing with Cement (g)	EN 12848	< 2	10
Penetration at 25ºC (0.1mm)	EN 1426	50 to 100	3
Softening Point (ºC)	EN 1427	35 to 56	8

Tack Coats

3 Tack coats shall be bitumen emulsions complying with BS EN 13808, C 60 B 3 as shown in Table 900-21 or an approved equivalent that has the same fitness for purpose.

4 Tack coats shall be rapid setting.

Table 900-21: Bituminous Tack Coat

Requirement	Test Standard	Value	EN 13808 Class
Polarity	EN 1430	+ve	
Water Content (%)	EN 1428	40 ± 2	6 (100% less water content %)
Binder content (%) – Including oil distillate	EN 1431	≥ 58 (60 ± 2)	6 (C 60)
Residue on sieving (0.5mm sieve); Homogeneity (%)	EN 1429	≤ 0.2	3
Oil distillate (%) – where used	EN 1431	≤ 2.0	2
Setting - 7 days (%)	EN 12847	≤ 10	3
pH (Acidity)	EN 12850	To be declared	
Breaking (Forshammer filler)	EN 13075-1	70 to 155	3
Penetration at 25ºC (0.1mm)	EN 1426	≤ 100 (50 to 100)	3
Softening Point (ºC)	EN 1427	≥ 35 35 to 56	8

5 Modified tack coats shall be bitumen emulsions complying with BS EN 13808, C 69 BP 3 as shown in Table 900-22 or an approved equivalent that has the same fitness for purpose.

Table 900-22: Bituminous Tack Coat (Modified)

Requirement	Test Standard	Value	EN 13808 Class
Polarity	EN 1430	+ve	
Water Content (%)	EN 1428	40 ± 2	6 (100% less water content %)
Binder content (%) – Including oil distillate	EN 1431	≥ 60 (60 ± 2)	6 (C 60)
Oil distillate (%)	EN 1431	≤ 2	2
Setting - 7 days (%)	EN 12847	≤ 10	3
pH (Acidity)	EN 12850	To be declared	
Breaking (Forshammer filler)	EN 13075-1	70 to 155	3
Cohesion energy force ductility 50mm/min, 5ºC, (J/cm^2)	EN 13598	≥ 3	2
Residual Penetration at 25ºC (0.1mm)	EN 1426	≤ 100	3
Residual Softening Point (ºC)	EN 1427	≥ 60 35 to 56	2
Residual Elastic recovery at 25ºC (%)	EN 13398	≥ 50	5

Bond Coats

6 Bond coats shall conform to the requirements in BS 594987 or approved equivalent.

7 For application to planed or milled asphalt, the minimum target rate of spread for bond coats shall provide no less than 0.35kg/m^2 of residual binder.

8 For application to newly laid asphalt or overlaying existing (un-planed or un-milled) asphalt, the minimum target rate of spread for bond coats shall provide not less than 0.2kg/m^2 of residual binder.

9 Bond coats shall be machine-applied at a uniform rate by calibrated metered mechanical spraying equipment, spray tanker or spraying device integral with the paving machine.

10 The tolerance on the specified rate of spread shall not exceed ±20% and the accuracy of the spread shall not exceed 15%.

Table 900-23: Bituminous Bond Coat (Polymer Modified)

Requirement	Test Standard	Value	EN 13808 Class
Polarity	EN 1430	+ve	
Water Content (%)	EN 1428	30 ± 2	9 (100% less water content %)
Binder content (%) – Including oil distillate	EN 1431	≥ 69 (69 ± 2)	9 (C 69)
Residue on sieving (0.5mm sieve); Homogeneity (%)	EN 1429	≤ 0.2	3
Oil distillate (%)	EN 1431	0 (Not Permitted)	
Setting - 7 days (%)	EN 12847	≤ 10	3
pH (Acidity)	EN 12850	To be declared	
Breaking (Forshammer filler)	EN13075-1	70 to 155	3
Residual Penetration at 25ºC (0.1mm)	EN 1426	≤ 100 (50 to 70)	3
Residual Softening Point (ºC)	EN 1427	≥ 65 35 to 56	2
Residual Elastic recovery at 25ºC (%)	EN 13398	≥ 75	4

Manufacture and Product Data

11 Bond coats and tack coats shall be manufactured in plants operating under a system conforming to the requirements of BS EN ISO 9002: 1994. The Contractor shall complete the binder data sheet specified in IM Appendix 7/4 and supply a copy to the Overseeing Organisation prior to the application of the product.

Preparation

12 Any limitations on area availability and timing or other constraints relating to the execution of works shall be as specified in IM Appendix 1/13. Before spraying is commenced, the surface shall be free of all loose material and standing water. Surface preparation shall be carried out in accordance with BS 594987and shall comply with any requirements specified in IM Appendix 7/4. When specified in IM Appendix 7/4, street furniture, ironwork and drop-kerbs shall be masked using self-adhesive masking material before application starts and removed prior to the completion of the works.

Application

13 Application shall be by metered mechanical spraying equipment, spray tanker or spraying device integral with the paving machine. The spraying equipment used shall not cause permanent deformation to the surface. Tack coats and Bond Coats shall be sprayed onto an existing surface prior to overlay in accordance with Clause 901. For small or inaccessible areas, application may be by hand-held sprayer with the agreement of the Overseeing Organisation.

Rate of Spread

14 The rate of spread shall be in accordance with BS 594987.

Accuracy of Application

15 Spray application shall be uniform. Before spraying begins, the Contractor shall provide the Overseeing Organisation with a test certificate showing the results for rate of spread and accuracy of spread. The certificate shall demonstrate that the spraying device has been tested, using the product to be used in the Contract, not more than six weeks before commencement of the work. These tests shall be carried out in accordance with prEN 12272-1 either by a laboratory, or by the Contractor. Not more than six weeks prior commencement of work, the certificate showing that the spraying device has been tested, using the product to be used in the Contract, must be presented. The tolerance on the specified rate of spread shall not exceed ±20% and the coefficient of variation of the transverse distribution shall not exceed 15%. During the works the Contractor shall repeat the tests for rate of spread and accuracy of application. The results shall be reported verbally to the Overseeing Organisation within 24 hours of carrying out a test and in writing within 7 days.

16 Where application is by hand-held sprayer lance, the rate of spread shall be measured by calculating the volume applied per square meter and evenness shall be visually assessed.

Hot on Hot Laying

17 The Overseeing Organisation may permit the exclusion of a bond coat between bituminous layers in hot over hot applications when evidence of equivalent bonding performance is provided by the Contractor.

Overlaying Concrete Surfaces

18 The Contractor shall submit evidence of the suitability of bond coat he intends to use when overlaying concrete surfaces to the Overseeing Organisation prior to the commencement of the work.

Blinding Material

19 When specified in IM Appendix 7/4, blinding material shall consist of hard clean crushed rock or sand containing not more than 15% retained on a 6.3mm sieve. It shall be spread over the sprayed area and left unrolled. The rate of application shall ensure that the coverage is essentially complete. When blinding material is used on cementitious materials it shall be light in colour to minimize solar gain. All loose material on a sprayed surface including non-adhered blinding material shall be removed prior to the application of an overlay.

Bond Testing

20 Application rate and quality of tack coats and bond coats have to be chosen in such a way that upon core testing on 15cm diameter cores, by the shear apparatus according to the Leutner, the following results are achieved:

Tack Coat

a) Surface course to binder course or base course:

   i) minimum load ≥ 14KN,

   ii) shear way: 2 - 5mm;

b) Binder course to base course:

   i) minimum load: ≥ 10N,

   ii) shear way: 1 - 4.5mm.

Bond Coat

c) Surface course to binder course or base course:

   i) minimum load ≥ 14KN,

   ii) shear way: 2 - 5mm;

d) Binder course to base course:

   i) minimum load: ≥ 10KN,

   ii) shear way: 1 - 4.5mm.

Prime Coats

21 Where required prime coating of unbound granular surfaces shall comply to EN 13808 or approved equivalent. The performance classes to EN 13808 shall be as follows:

a) Binder content (EN 1431): Class 4

b) Efflux time (EN 12846): Class 6

c) Residual on Sieving: 0.5mm, Class 2; 0.160mm, Class 2

d) pH: Cationic

e) % coating (EN 13614): Class 3

f) Breaking (EN 13075-1): Class 2

g) Retained Penetration (EN 1426): Class 6

h) Retained softening point (EN 1427): Class 6

22 The rate of application shall be in the range from 600 to 800 g/m^2.

914 Surface Macrotexture of Bituminous Surface Courses

1 Surface macrotexture of bituminous surface courses shall be in accordance with this Clause. Initial surface macrotexture for bituminous surface courses shall be measured using the volumetric patch method described in BS EN 13036-1.

2 Texture depth shall be measured by 10 individual measurements taken at approximately 5m spacing along a diagonal line across the lane width. At least one set of 10 measurements shall be made for each 500m section of carriageway lane. The average texture depth for each set of 10 individual measurements and the average texture depth of each 1000m section (or complete carriageway lane where this is less than 1000m) shall not be less than the appropriate values shown in Table 900-24. Average minimum texture depth shall be 1.0mm or less where High Friction Surfacing to Clause 915 is to be laid immediately on new bituminous surface course.

Table 900-24: Requirements for Initial Texture Depth for Materials

Road Type	Surfacing Type	Average per 1000 m section, mm		Average for a set of 10 Measurements, mm	Single Result
		Min.	Max.	Min.	Min.
All	Asphalt Concrete	0.7	-	0.7	0.5
	Stone Mastic Asphalt	1.0	1.3	0.9	0.7
As stated in IM Appendix 7/1	IM Appendix 7/1				

915 High Friction Surfaces

1 High friction surfacing systems shall have current International or British Board of Agreement HAPAS Roads and Bridges Certificates. If the supplier of the system is not from Great Britain a certificate of a comparable Board or a governmental approved Testing Institute is required.

2 A high friction surfacing system with a current International or British Board of Agreement HAPAS Roads and Bridges Certificate shall only be installed by a Contractor who is familiar with the system.

3 The high friction surfacing system HAPAS or equivalent product acceptance scheme certification shall have a Type 1 classification

4 The high friction surfacing system shall be cold applied and shall achieve a minimum tensile adhesion of 0.8MPa as specified in IM Appendix 7/1 when tested in accordance with TRL Report 176 Laboratory Tests on High-Friction Surfaces for Highways IM Appendix J.

5 The high friction surfacing system required for each location shall be as specified in IM Appendix 7/1.

6 The colour pigment of the product shall be any one of the following:

a) Black

b) Red (RAL 3001);

c) Green (RAL 6010);

Aggregate

7 Aggregate used in high friction surfacing systems shall have the minimum polished stone value of 70 and a maximum aggregate abrasion value of 1.0.

Installation and Quality Control Procedures

8 The installation and quality control procedures shall be in accordance with the International or British Board of Agreement Roads and Bridges Certificate for each system and the current method statement agreed by the BBA or by a comparable board. The results of all quality control checks carried out on site by the Contractor and quality assurance information compiled in accordance with the requirements of the Certificate, shall be made available to the Overseeing Organisation on request.

System Coverage

9 For each location where high friction surfacing is applied, the total quantities of each system component used, the measured area of the surface treated and the calculated coverage rate in kg/m^2 shall be reported to the Overseeing Organisation within three days of completion at that location. For systems in which aggregate is broadcast over a film of binder applied to the

surface, the calculated coverage rate shall be that of the binder film and shall not include the mass of the aggregate.

After care

10 During the specified curing period no disturbance or trafficking of the treated surface will be permitted.

Guarantee

11 The Contractor shall guarantee the high friction surfacing materials and workmanship for a period of two years from the date of opening the surfacing to traffic. This guarantee shall exclude defects arising from damage caused by settlement, subsidence or failure of the carriageway on which the surfacing has been applied, but shall cover failure to meet the minimum requirements set out in Table 4 of the BBA/HAPAS 'Guidelines Document for the Assessment and Certification of High Friction Surfaces for Highways', or a comparable international document.

916 Polymer Modified Bitumen

1 The base unmodified bitumen shall be modified using a styrene butadiene styrene (SBS) elastomer.

2 The polymer modified bitumen shall comply with the following classes (values) BS EN 14023

i. <u>General Testing</u>

a)	Penetration 25 °C (EN 1426):	Class 4 (45/80)
b)	Softening point: R&B (EN1427):	Class 4 (≥ 70ºC)
c)	Fraass breaking point (EN 12593):	Class 5 (≤ -10ºC)
d)	Elastic recovery at 25°C (EN13398):	Class 4 (≥ 70%)
e)	Ageing (RTFOT, R & B, EN 12607-1):	Class 2 (≤ 8ºC)
f)	Ageing (RTFOT, Penetration, EN 12607-1):	Class 7 (≥ 60%)
g)	No segregation in the dispersion of polymers – This shall be confirmed using fluorescence microscopy.	

ii. <u>Performance Characterization Tests</u>

3 The polymer modified bitumen shall also comply with the following:

a)	DSR, G*/sinδ, min. 1.00kPa@ 10 rad/s [1]	70ºC test temperature
b)	MSCR, $J_{nr\ 3.2}$, max 2.0 kPa^{-1} (RTFOT) [2]	70ºC test temperature
c)	MSCR, $J_{nr\ diff}$, max 75% (RTFOT) [2]	70ºC test temperature

Notes

1. EN 14770; 2. EN 16659

917 Cold Lay Surfacing Materials

1 This specification is applicable to the reinstatement of bituminous pavements using Cold-Lay Surfacing Materials (CSM) in the following road categories and for the layer depths indicated:

a) For minor permanent reinstatements only of bituminous surface layers for Construction Class I, II, III, IV, V and VI roads up to a depth of up to 100mm.

Performance Guarantee

2 Where used as a permanent reinstatement the performance and durability guarantee of the Cold-lay Surfacing Material (CSM) shall be for a minimum period of 5 years.

Material Requirements

3 The CSM shall be either:

a) A “proprietary” mix complying with the requirements of the UK “Guidelines Document for the Assessment and Certification of Permanent Cold-lay Surfacing Material” issued by the British Board of Agrèment - BBA or equivalent.

b) A hot or cold mix complying with the requirements of this Specification. All emulsions used in CSM shall be medium to rapid setting emulsions.

4 The testing parameters of the “proprietary” mixes used in achieving the UK BBA certification or equivalent shall not be construed as sufficient unless they comprise those parameters that indicate acceptable performance in local climatic conditions (e.g. performance and durability under prolonged high pavement temperatures from June to September) to the satisfaction of the Overseeing Organisation.

5 Deferred set mixtures are permitted.

Aggregates and Binder Requirements

6 Aggregates must comply with the requirements for Class I roads specified in this series.

7 Bituminous binders shall be compatible with local climatic conditions.

8 The use of a polymer-modified bitumen is permitted.

Additives

9 Hydraulic binders are permitted but must demonstrate that:

a) No shrinkage compensation is required.

b) The material remains flexible.

Substrate Preparation

10 The surface preparation shall follow the guidance in the UK ADEPT Code of Practice for Innovative Patching Products.

11 The substrate shall be compacted to the specified requirements whenever these are stated. In all other situations the substrate shall be compacted to refusal.

12 All materials and surfaces shall be free of contamination.

13 All reinstatement shall be of the "inset" type having edges saw-cut or trimmed so as to achieve a straight, smooth and vertical profile.

14 The shape, profile and outline regularity shall be such that will assist proper compaction.

15 A bituminous tack coat as specified by the producer of the CSM shall be applied at a rate that ensures a minimum residual binder content at the surface of 0.15 kg/m2.

16 For repairs that extend into the binder course and/or base an offset stepped detail (min. 75mm) for the binder and base layers shall be used to ensure that vertical joints do not pass through more than one layer at the same location.

17 All exposed vertical edges must be cleaned and coated using hot-applied penetration 50/70 grade bitumen. Other proprietary bituminous products recommended by the producer of the CSM will be permitted.

Layer / Lift thickness

18 The minimum compacted layer (or lift) thickness shall be equivalent to that existing before the intervention but limitations shall be applied based on the lift/aggregate size ratio.

19 The mix aggregate size shall provide for a minimum of two (2) nominal sizes - Base and Surface.

Presence of Water and Moisture

20 The surfacing material must invariably permit application in the presence of high moisture and water-saturated road pavements and pavement substrates.

Surface Reinstatement

21 The opening shall be reinstated in accordance with the specified requirements and applying the producer's recommended methodology (including compacted layer over layer where required)

22 The material must be compacted to the specified density and to the level of the surrounding enclosing area avoiding marks, ridges, material shoving and edge overbanding. The finishing compaction shall always be by plate compactor.

23 All surface joints must be cleaned and coated using hot-applied 50/70 penetration grade bitumen. Proprietary products recommended by the producer of the CSM will be permitted.

Compaction Requirements

24 The material must be laid and formed to reflect the existing surface camber or crossfall following compaction.

25 The compacted material shall be level (0mm / + 3mm) with the adjoining pavement surface.

26 The material shall be capable of being wet-flush cored “in-situ” after 24 hours.

27 The material shall be compacted to have air voids of between 2% and 10%.

28 The maximum density of the mix shall be determined in accordance with EN 12697-5, Procedure A, in water.

29 The bulk density shall be determined in accordance with EN 12697-6, Procedure C, sealed specimen.

30 The maximum density and the core bulk density shall be used to determine the air void content in accordance with EN 12697-8.

Testing

31 Testing shall be in accordance with Table 900-25.

Table 900-25: Tests and Use of CSM

Material	Test	Frequency	Remarks
PCSM	Cores: 150mm min. diameter.	When instructed	a) Overseeing Organisation may request replicate / split samples; b) Core sockets to be reinstated using equivalent material by the Contractor.
Use limitations			12m^2 maximum, daily (or as agreed).

Workability

32 The producer shall declare a test method for determining the workability of the mix.

Soluble binder content and Residual binder content (After recovery)

33 The soluble binder content shall be determined in accordance with BS EN 12697-1, Bituminous mixtures. - Test methods for hot mix asphalt. The producer of the mix shall indicate the solvent and the method to be used so as to ensure an accurate determination of the binder content.

34 The bitumen recovery from the soluble portion of the binder shall be determined in accordance with BS EN 12697-3, Bituminous mixtures, Test methods for hot mix asphalt, Bitumen recovery: Rotary evaporator.

35 The producer shall submit the target content for the bitumen content. The tolerance range for the residual binder content shall be ± 0.5%.

Grading of Aggregate

36 The producer shall submit the grading curve of the product. The maximum nominal aggregate size shall be 10.0mm (± 2.0mm).

37 When determined in accordance with BS EN 12697-2, Test methods for hot mix asphalt, Determination of particle size distribution, the grading of the mix shall comply with the manufacturer's grading curve.

38 The tolerance on the percentage passing each sieve shall be as indicated in EN 13108-7 for the individual sieve/s.

Curing Time (Complete)

39 The producer shall declare the curing time curve of the mix. This shall be validated by the "no trafficking" time of the mix.

Trafficking Time

40 The “no trafficking” time for the compacted material before opening to traffic (including HGV traffic) shall not be longer than 1 hour comprising wet pavements and inclement weather.

Sensitivity to Water

41 When tested for Marshall Stability and Flow after conditioning in accordance with MSA EN 12697-12 – Method of Test for Sensitivity to Water of Cold Bituminous Mixes (Plant Mixed) - the mix shall comply with the following:

a) Dry Group

i) Marshall stability (kN): ≥ 8

ii) Marshall flow (mm): 2mm to 5mm

b) Wet Group

i) Marshall stability (kN): ≥ 35% of tested dry value but ≥ 3 kN

ii) Marshall flow (mm): 2mm to 5mm

Particle Loss (Cantabro)

42 When determined in accordance with MSA EN 12697-17 – Method of Test for Particle Loss of Cold Bituminous Mixes (Plant Mixed) - the particle loss shall be < 15%.

43 When determined in accordance with MSA EN 12697-17 – Method of Test for Long-Term Aging Resistance of Cold Bituminous Mixes (Plant Mixed) - the particle loss shall be < 30%.

Stripping Resistance (Rolling Bottle)

44 When determined in accordance with EN 12697-11 – Method of Test for affinity between aggregate and bitumen - the mix shall comply with the following:

Table 900-26: Stripping Resistance

Rolling time (hours)	% Covered (minimum)
6	65
24	40
48	20

918 Temporary Filling of Surface Depressions

1 Temporary filling to depressions shall be carried out using a proprietary material specifically formulated to treat such depressions. The depression shall be cleaned out and the surface thoroughly dried. The area to be filled shall be masked to provide straight edges and the filling material laid in accordance with the manufacturer's instructions.

2 The minimum skid resistance value of the proprietary material when laid shall be 60 measured by the Skid Resistance Pendulum Method in accordance with BS EN 13036-4 and the surface shall have a texture at least equal to that of the existing adjacent surfacing.

3 The Contractor shall obtain the Overseeing Organisation's approval to the use of any proprietary material for filling depressions.

4 Permanent filling to depressions shall be carried out using material complying with Series 900.

919 Patching (Inset)

1 Patching (Inset) is defined as replacement of surface course, binder course and base course where the materials are laid in small areas.

2 The existing defective surfacing and/or temporary filling of trenches and depressions shall be broken out so as to provide a cavity with straight vertical edges.

3 The surface preparation, filling, compaction and sealing shall comply with Series 900.

920 Composite Geosynthetic (Geogrid) for Asphalt Overlay

Geogrid

1 The geogrid shall be a composite reinforced geosynthetic having bi-axial glass fibre strands (knitted or glue bonded) with a weight not less than 350g.

2 It shall comply to the requirements of MSA EN 15381. The tensile strength in both directions must be of at least 100kN.

Geogrid and Moisture Barrier

3 The geogrid and moisture barrier shall be a composite reinforced geosynthetic having bi-axial glass fibre strands (knitted or glue bonded) and non-woven geotextile with a weight not less than 450g.

4 It shall comply to the requirements of MSA EN 15381. The tensile strength in both directions must be of at least 100kN.

921 Bond Coat

5 The minimum requirement for the bond coat used to secure the composite geosynthetic in place is a bitumen emulsion or penetration grade bitumen as specified by the manufacturer.

All bond coats for geosynthetic must be applied by a calibrated binder distributor tested annually for conformity to BS1707. The evenness and overall rate of bond coat should be regularly checked on site by carpet tile testing in accordance with BS EN 12272-1.

Surface Preparation

6 The surface on which the binder is laid shall be flat and free of loose parts. If sprayed to a milled surface, striations must be no more than ± 5mm from peak to trough. If necessary, holes and other irregularities on the underlying surface shall be repaired beforehand.

Site Testing and Records

7 The installation Contractor of the geosynthetic system must have a quality management system that is BSI 9001 accredited and be registered with a certification body for the installation of geosynthetics. The geosynthetic installer must trained in equivalence to the UK National Highway Sector Scheme 13.

8 On-site, it will be necessary to demonstrate that the installed composite or self-adhesive geosynthetic is bonded to the substrate by means of an adhesion to base layer test, specified in sub-Clause 6 which will achieve 6kg/m^2. The frequency of the test should be one per every installed 1000m^2 and the result should be recorded and supplied to the Employer.

9 The test involves the insertion of a hook off a spring balance under the centre of the pavement composite grid. The spring balance shall be pulled up until the sample just starts to pull loose and a record of the gauge reading shall be noted. In the event that 6kg or more of force is required to pull the sample up from the road surface, sufficient adhesion has taken place and the paving operation may begin.

Self-Adhesive Geosynthetic for Trench Repair or Widening

10 The self-adhesive geosynthetic shall be knitted self-adhesive glass fibre strands coated with an elastomeric polymer coating which coats all filaments within the strand. The tensile strength of the system must be 100kN and it must have been manufactured to the requirements of MSA EN 15381 and carry a CE mark and a declaration of performance. The self-adhesive reinforcement system must always be installed to a fresh bituminous layer and never to milled or concrete surfaces.

11 Bond coats are not required to secure the self-adhesive reinforcement to the regulated surface. Bond coats may be specified to achieve bond between surfacing layers reinforced with a self-adhesive geosynthetic and if an emulsion bond coat is specified between surfacing layers it must have fully ‘broken’ before overlaying commences.

922 Stress Alleviating Asphalt Interlayer (SAMI)

1 The mix shall comply with the requirements in IM Appendix 7/1.

923 Bituminous Micro-Surfacing

General

1 Micro-surfacing mixes shall be designed by the Contractor and must conform to the requirements oof EN 12273 and the provisions of this IM Appendix.

2 The Contractor shall provide the Overseeing Organization with a detailed mix design proposal as part of the TAIT (see below for details). This must be based on the TAIT (Type Approval Installation Trial) and shall comprise the following for the approval of the Contracting Authority:

a) The technical physical and mechanical testing characteristics of the mixture components including any admixtures and additives (eg. Cement, fibres)

b) The performance characteristics for macrotexture, rutting resistance, deformation, displacement, high temperature susceptibility, ageing, ravelling, chipping loss and cracking

c) The product mixing and placement method statements

d) The “ph” and particle charge of the emulsion

e) The final layer thickness

f) The durability performance criteria

g) Details on the incorporation of reinforcement membranes or grids

Road Performance

3 The Contractor shall provide detailed technical and performance evidence of measurable satisfactory in situ performance covering a minimum period of 3 years on road sites where:

a) The pavement temperature is proven and equal to or higher than that of Malta. This must include at least 2 full summer cycles. The equivalence to the Malta road pavement temperatures shall be established using appropriate measurements as approved by the Contracting Authority.

b) The road comprises at least one tight curve with a radius ≤ 85m;

c) The road comprises at least one decelaration / braking area;

d) The road is exposed to a traffic AADT of at least 40,000 with an HGV intensity of at least 6%.

Constituents

4 Aggregates - The aggregates shall comply with EN 13043. The following requirements shall apply:

a) Resistance to fragmentation ≤ LA20

b) Resistance to polishing PSV ≥ 53

c) Water absorption ≤ 2.0%

5 Binder - The Contractor shall submit a detailed Binder Data Sheet for the approval of the Contracting Authority.

TAIT (Type Approval Installation Trial)

6 The TAIT shall comply with the requirements of EN 12273, Annex C.

Trial Runs

7 A trial test shall be performed consisting of a minimum 60m section covering the full width of a two-lane road. A set of 6 pairs of samples shall be taken and tested for the following:

a) Abrasion in accordance with IM Appendix A of EN 12274-5;

b) Analysis to establish the binder content in accordance with EN 12274-7

c) Shaking abrasion in accordance with EN 12274-7

Bond Coat

8 A bond coat shall be used and sprayed so as to provide a binder film of not less than 0.2kg/m2 or as otherwise approved. The bond coat shall provide a minimum cohesion value of 1.2 J/m2.

9 The bond coat shall be uniformly applied by mechanical tank-sprayers and be free of streaks and blobs in accordance with BS 594987 or approved equivalent.

Performance Requirements

10 The essential characteristics shall be as indicated in EN 12273, Table ZA.1.

11 The following shall apply:

Table 900-27: Performance Characteristics

Characteristic	Standard / Specification	Compliance
Shear Bond Strength	UK Ministry of Defence Specification 045, Slurry Surfacing for Airfields	To comply with Table 4.2 when tested as per IM Appendix E of same;

Macrotexture	UK Ministry of Defence Specification 045, Slurry Surfacing for Airfields	To comply with Table 4.3 (when tested as per EN 13036-1) for microsurfacing.
Visual assessment	UK Ministry of Defence Specification 045, Slurry Surfacing for Airfields	To comply with clause 4.5 and Table 4.4;
Durability of the binder	UK Ministry of Defence Specification 045, Slurry Surfacing for Airfields	To comply with clause 4.5 and Table 4.6 (IM Appendix C, ageing profile test and EN 12274-5, abrasion mass loss.
Thickness of layer and finished levels	As per TAIT	

Mixing

12 The mixing of the microsurfacing mixture shall be in approved mobile combined mixing and spreading unit.

13 The unit shall permit the precise proportioning, dosage, dispensing and calibration of the mixture components. The design must allow for the feeding and mixing together in a continuous process of the aggregate, emulsion, filler, water, additives and any other approved components. Gauges shall control the dosage and feeding rates.

14 On completion of the mixing all particles of the aggregates shall be completely and uniformly coated and the mix shall achieve a uniform and creamy consistency to achieve a slow, easy and consistent flow.

Application

NB: Direct Application on concrete surfaces shall not be permitted.

15 The Contractor shall ensure that the surfaces to be treated with microsurfacing shall be preapred so as to mensure the the finished product film is uniform and fully bonded with the pavement.

16 The rate of application shall be controlled by a calibrated spreader-box attached to the mixing unit. This shall be assisted by a squeegee or neoprene rubber that is attached to the screeding blade.

17 Distribution of the mixture shall be by mechanical augers acting against the spreader blade and across the full width of the blade.

18 Spreading by hand shall be limited to those areas that preclude the use of the mobile unit's spreader.

19 Longitudinal lane joints shall be straight. Transverse joints shall be straight across the lane and at right angles to the longitudinal joints. Agglomerations standing above the general level shall be removed by wire brushing and excessive overlapping shall be minimized by the "wiping off" technique.

20 The thickness of the surfacing shall be verified every 150 linear metre of carriageway. 16 in number measurements shall be made

Rolling (If required by the producer)

21 If required by the producer (and the TAIT) the rolling shall be as defined in the method statement. Only multi-wheeled smooth tread pneumatic rollers shall be permitted.

Layer Thickness

22 The layer thickness shall not exceed 15mm unless oterwise approved by the Ovewrseeing Organisation.

23 The mixture nominal size shall be in the range of 10mm to 5mm.

24 Single or multi-layered applications shall be site-dpendent and in strict complainace with the producer's method statement.

Testing Requirements

25 The requirements of EN 12273 shall apply including the requirements in respect of factory production control (FPC). Additionally, the following routine tests shall be performed:

Table 900-28: Performance Characteristics

Characteristic	Standard / Specification	Compliance
Abrasion test	UK Ministry of Defence Specification 045, Slurry Surfacing for Airfields	Clause 7.3.1 and 7.3.2
Analysis	UK Ministry of Defence Specification 045, Slurry Surfacing for Airfields	Clause 7.3.3 and 7.3.4
Shear Bond Strength	UK Ministry of Defence Specification 045, Slurry Surfacing for Airfields	Clause 7.3.5 and 7.3.6
Macrotexture	UK Ministry of Defence Specification 045, Slurry Surfacing for Airfields	Clause 7.3.7 to 7.3.9

FPC frequencies	UK Ministry of Defence Specification 045, Slurry Surfacing for Airfields	Tables 7.3, 7.4, 7.5, 7.6, 7.7 and 7.8.

Calibration

26 The equipment calibration requirements shall be as indicated in the UK Ministry of Defence Specification 045, Slurry Surfacing for Airfields, Table 7.2.

Reinforcement

27 The use of reinforcement geotextiles or geogrids shall be permitted. These shall be included in the TAIT.

Table 900-29: Durability of Performance

Characteristic	Standard / Specification	At Start	After 2 Years
Macrotexture	EN 13036-1	1.0	0.9
Visual assessment	UK Ministry of Defence Specification 045, Slurry Surfacing for Airfields	To comply with clause 4.5 and Table 4.4;	To comply with clause 4.5 and Table 4.4;
Wheel Tracking Rut Depth	EN 12697-22 (60 degrees C)	(mm of rut/mm of thickness) 0.233 mean; 0.35 max.	NA

924 Warm Mix Asphalt

1 Warm Mix Asphalt (WMA) is the generic term used to describe the reduction in production, paving and compaction temperatures achieved through the application of one of several WMA technologies. The producer shall submit a mix design for WMA production showing compliance with all other clauses of Series 900 and associated appendices.

2 WMA may be produced by organic chemicals that allow the reduction of asphalt laying temperatures by 30^{o}C or more.

3 All requirements for bituminous bound mixtures set in this specification apply to WMA.

4 The Contractor shall identify the technology to be used and shall comply with the manufacturer's recommendations for incorporating additives and WMA technology into the mix.

5 The Contractor shall comply with the manufacturer's recommendations regarding receiving, storage, and delivery of chemical additives if this is the technology chosen.

6 WMA using Organic Chemical Additive: For WMA using additives, the design shall be performed using the additive. Each WMA design shall specify the production temperatures recommended by WMA manufacturer to be used in the production of WMA.

7 The Contractor shall submit a declaration of performance of the WMA to the Overseeing Organisation prior to commencing any work.

925 Surfacing Integrity for all Surface Courses

1 Unless specified differently elsewhere, a guarantee shall be provided for the integrity of all surface courses and the workmanship for a period of five years from the date of opening to traffic.

2 The guarantee shall include for defects such as fretting, ravelling, stripping and loss of chippings. Replacement of the surfacing or other remedial measures agreed with the Employer shall be executed if the surfacing is in a "Suspect", "Poor" or "Bad" condition as defined in IM Appendix A of TRL Report TRL674 – "Durability of thin surfacing systems, Part 4, Final report after nine years monitoring, TRL report 674 which shall be used for all surface courses.

926 Grouted Macadam Surface Course for Bus Stations and Bus Areas

1 Grouted Macadam surface courses, for the purpose of this specification, are defined as asphalts. They are manufactured using a 2-part process comprising an open-graded asphalt that is flooded with a high strength cementitious mortar.

2 Grouted macadam surfacing shall meet the following requirements:

a) Compressive strength > 60N/mm^2

b) Flexural strength at 28 days > 5N/mm^2

c) Resistant to aviation fuel, diesel and petrol (BS EN 12697-43)

d) Wheel Tracking rate <= 0.5µm/cycle (BS EN 12697-22)

e) Skid Resistance (pendulum test) > 60 (BS EN 13036-4)

f) Must be able to be open to Traffic after 24 hours

927 Testing of Bituminous Mixtures and their Component Materials

1 The sampling, testing and analysis of bituminous mixtures shall comply with BS EN 12697-27 except where specified otherwise in this Series. The following test levels shall apply:

a) Factory production control (FPC) shall be carried out by the Contractor to ensure that the completed construction works are according to the requirements of the contract. The frequency shown in Table 900-30 is only a minimum requirement. The test results have to be presented to the Overseeing Organisation. Deviations from the contractual requirements have to be reported to the Overseeing Organisation and any shortcomings are to be rectified without delay.

Table 900-30: Type and Frequency of Testing

Test Type / Construction Materials	Specification	Test Requirements
1. Aggregate	Clause 902	When required
2. Mixture		
2.1 Grain size distribution	EN 12697-2	All Mixtures per design
2.2 Bitumen content	EN 12697-1	All Mixtures per design
2.3 Softening point of recovered bitumen	EN 1427	All Mixtures per design
2.4 Density and void content of specimen	EN 12697-5 EN 12697-6 EN 12697-8	All Mixtures per design
2.5 Stability and flow (Marshall)	EN 12697-34	All Mixtures per design
3. Layer properties		
3.1 Compaction degree	EN 12697-30 EN 12697-5 EN 12697-6 EN 12697-8	All layers
3.2 Layer bond	ALP A-StB: Part 4	All layers
3.3 Levels (longitudinal / transversal slope)	String method	When required
3.4 Regularity	3m straight edge	All surface course base-wearing course and other single layer courses per site Other courses as required
3.5 Thickness respectively	BS EN 12697-36	All layers
3.6 Void content	BS 594987 Clause 9	All layers

b) Control testing shall be carried out by the Overseeing Organization as required. The type of testing is described in Table 900-30. The results of the control testing shall be the basis for the acceptance of the construction works. Control sampling and testing

in situ will be in the presence of the Contractor - they may also be carried out in the absence of the Contractor if he has been informed in good time.

2 The Contractor may require additional control testing if evidence is provided that the outcome of control testing is not representative of the area under examination. Sampling places and their assigned partial areas are determined in the presence of the Contractor. The partial area assigned to the initial test result shall not be less than 20% of the initial area.

3 The Overseeing Organisation may also carry out additional control testing at its own discretion. The results of the initial and the additional control tests assigned to the partial areas are decisive for the acceptance of the construction works. The Contractor must meet the costs of the additional control tests.

4 Arbitration testing may be carried out if one any one of the Parties contends that the control testing was not carried out correctly. It will be carried out by a laboratory independent of the parties and which did not perform the control testing and will be chosen by the Overseeing Organisation and the Contractor. Both parties may be present during testing.

5 Arbitration may only be invoked where a party provides valid evidence that a test is unreliable or inaccurate.

6 The result of the arbitrary test replaces the initial test result. Testing costs are to be covered by the party to which the result is not in favour.

7 Interpretation of the test results is based on the tolerances of this specification and the reproducibility and repeatability of the specification in question.

8 Aggregates and bitumen may be incorporated within the framework of control testing or arbitration.

Recovered Bitumen

9 The softening point (ring and ball) of the recovered bitumen must not exceed the upper limit of the bitumen used by more than 8°C i.e. for grade 50/70 bitumen the softening point must not exceed 62°C.

Mixing and Combination of Samples

10 The mixing and/or combination of test samples (either in loose or cored samples) without the approval of the Overseeing Organization shall not be permitted.

928 In-Situ Void Content Measurements by Electronic (Non-Nuclear) Density Gauge

1 Compaction shall be controlled and monitored in accordance with the general requirements of BS 594987 9.5.1, the specific requirements of this Clause and Clause 930 (compaction degree K).

2 Compaction shall be continuously assessed using an indirect density gauge in accordance with BS 594987 9.4.2 with readings taken at 20m intervals in alternate wheel-tracks. Gauge readings shall also be taken at the core location used for correlation [Note 1] (for each and every specific mix as approved by the Overseeing Organization or approved equivalent) specified in sub-Clauses 11 and 12. Each gauge shall be individually calibrated on each mixture from each mixing plant and the calibrations shall be continually checked and updated based on correlations between gauge readings and core densities at the same locations.

Note 1: Correlation is defined as the "in-situ cores to gauge readings offsets". The depth of influence of the gauge shall also be considered.

3 For each location, the in-situ void content shall be determined in accordance with BS EN 12697-8 using the bulk density from the gauge reading and the maximum density taken from the mixture type testing data and updated with values from testing in accordance with sub-Clause 11.

4 The average in situ void content calculated from any six consecutive indirect gauge readings shall not exceed 7% for EN13108-1 mixtures and 6% for EN 13108-5 mixtures.

5 In the event of a failure to meet the requirements in sub-Clause 4, cores shall be taken at each location and void contents determined as described in sub-Clause 11 and the evaluation of the extent of any non-conformity shall be based on these. If it is necessary to remove and replace any material to restore conformity this shall be in lengths not less than 15m unless otherwise agreed by the Overseeing Organisation.

6 For the material from each mixing plant, a pair of cores shall be taken from every 200 linear metres laid and the void content shall be determined in accordance with BS 594987, clause 9.5.1.3.

7 The average in situ air voids for each core pair shall not exceed 7%.

8 For the material from each mixing plant a pair of cores shall be taken every 200 linear metres laid, centred 100mm from the final joint position at any unsupported edge and the air void shall be determined in accordance with BS 594987, clause 9.5.1.3.

9 The average in situ void content for each of these pairs shall not exceed 9%.

10 In the event of non-conformity with sub-Clauses 7 or 9 then density readings with indirect gauges and, if necessary, further cores shall be taken to establish the extent. If it is necessary to remove and replace any material to restore conformity, this shall be in lengths not less than 15m unless otherwise agreed by the Overseeing Organisation.

11 Each core extracted shall be examined for evidence of excessive voids below the depth to which the indirect density gauge penetrates. If excessive voids are observed, further cores shall be taken to determine its extent.

12 Two copies of the final indirect density test results obtained and their correlation with in-situ air void contents shall be passed to the Overseeing Organisation within 72 hours.

929 CE Marking

Declaration of Performance / Conformity

1 The Contractor shall submit to the Overseeing Organisation the producer's CE Marking and Declaration of Performance (DoP).

2 For the purposes the DoP the B_{act} (actual bitumen) target bitumen value will need to be corrected back to B_{min} (defined in BS EN 13108-1 and 5 (SMA) as "output composition") using the formulae described therein for the asphalt concrete and stone mastic asphalt. Guidance is available in the UK BS PD 6691.

930 The Percentage Impact Compactor Density Test (PCD-Test)

1 The compaction degree K of asphalt is the quotient of the sample density of the compacted material δ_A and the density δ'_A of the specimen as per the approved Mix Design.

$$\mathrm{K} = \frac{\partial \mathrm{A}}{\partial' A} \text{ x } 100(\%)$$

2 The provisions of Clause 928 shall also apply.

931 Price Reductions

1 The Overseeing Organisation may carry out price reductions for non-conforming mixes and for the following characteristics in lieu of remedial work:

a) compacted thickness

b) bitumen content (soluble)

c) compaction degree (in situ)

Unless otherwise indicated these shall be in accordance to the formulae in Series IM/150. If the defects are for more than a single characteristic the price reductions are added unless stated otherwise.

2 The Overseeing Organisation shall not be under any contractual obligation to apply price reductions for non-conforming and/or defective works.

932 Further Test Requirements

1 The Overseeing Organisation may require further testing to that included in the previous clauses:

i. to demonstrate product conformity before final acceptance (and the release of retention or guarantee monies).

ii. in cases where tests executed by accredited laboratories result are indecisive.

2 The following are classified as “further” tests and are non-exhaustive:

i. Particle Loss, Fretting, Scuffing and Ravelling – Cantabro Test; Scuffing Test;

ii. Deformation and Rutting - Wheel-tracking

933 Road Works Sector Schemes

1 The Contractor shall comply with the requirements of the approved Road Works Sector Schemes listed in Series 100, IM Appendix A.

934 Asphalt Paving Performance Indicators

1 The performance indicators listed in the Table 900-31 shall apply.

2 They shall be measured as follows:

a) At the start of the service (Target Value)

b) After a service period of five (5) calendar years (Limit Values).

3 The provisions in the UK DMRB CS Series for Pavement Condition assessment shall be used (Eg. CS 227, 228, 229, 230) for guidance and acceptance in cases of disputes.

Table 900-31: Asphalt Paving Performance Indicators (Appendix VIII)

Ref	Indicator	Unit	Target value	Limit value	Reference
1	Longitudinal Regularity	mm	≤ 4 / ≤ 20 locations / 300m	≤ 8 / ≤ 20 locations / 300m	Series IM/700
2	Transverse Regularity	mm	≤ 4 / 3m	≤ 8 / 3m	Series IM/700
3	Rutting depth	mm	4	10	This Table
4	Deformations, Humping, Tearing, Bump Corrugations, Crazing, Pumping, Depressions, Faulting, Subsidence, Settlement		None	None	This Table
5	Dry Mix - Chipping loss, Particle Adhesion Loss, Fretting, Ravelling,	NA	None	None	This Table

Ref	Indicator	Unit	Target value	Limit value	Reference
	Pitting, Tearing, Scuffing				
6	Potholes	NA	None	None	This Table
7	Deformation, Shoving, Waveboarding	NA	None	None	This Table
8	Tearing, Interlayer Slipping, Delamination	NA	None	None	This Table
9	Bituminous Joints Sealing – Deterioration, Flushing, Delamination, Fretting (including with Chambers, Kerbs and Gutters, etc)	NA	None	None	This Table
10	Rich Mix - Bleeding / Fatting / Flushing, Rich patches, Binder surface migration from lower courses, Tackiness, Streaking	NA	None	None	This Table
11	Not Used				
	Surface Macrotexture				
12	Asphalt Concrete				Series IM/900
13	Performance Asphalt Concrete		0.7	0.4	Series IM/900
14	Stone Mastic Asphalt		1.0	0.8	Series IM/900
15	High Friction Surfacing (HFS)		As in UK BBA Certificate		Series IM/900
	Surface Microtexture (Skidding / Polishing)				
16	Arterial / Distributor / Designated High Traffic Roads	BPN No.	65	60	Series IM/900
17	Others	BPN No.	55	50	Series IM/900
18	Cracks, Crocodiling,	NA	None	None	This Table

Ref	Indicator	Unit	Target value	Limit value	Reference
	Micro-cracks (Hairline)				
	Layer Bonding				
19	Bituminous Wearing Course	kN @ 2mm – 5mm	14	14	Series IM/900
20	Bituminous Binder Course and Bituminous Base Course	kN @ 1 – 4.5mm	10	10	Series IM/900