ROAD PAVEMENTS – BITUMINOUS BOUND MATERIALS

Contents

NG 901 Bituminous Pavement Mixtures

Introduction

1 The Manual of Contract Documents for Road Works published by the National Roads Authority in March 2000 (NRA MCDRW) last revised Series 900 in May 2005 and is now revised dated January 2010. This revision shall be used for all contracts tendered after 1st January 2010, but is being published ahead of that date to enable industry to prepare itself to be in a position to comply with the new requirements.

The revisions are due to the implementation of the new IS EN Standards for bituminous mixtures and their associated test methods. The new IS EN standards introduce new names and designations for bituminous mixtures. The new IS EN Standards for bituminous mixtures supersede the previously referenced Irish and British Standards.

These new Standards are further supported by a new BS594987 which specifies requirements for the transport, laying and compaction of bituminous mixtures.

The NRA has considered the requirements of the new Standards and chosen to rationalise them for incorporation into Series 900 of the Specification for Road Works.. The revised Series 900 includes additional requirements to those in the IS EN standards. It also includes new requirements for the sealing of cold joints to improve durability.

Some materials are included which are not covered by EN standards such as Cl 919 Surface Dressing and CL 924 High Friction Surfaces.

Background

2 The following IS EN Standards for bituminous mixtures have recently been published as part of European agreements:

IS EN 13108 Bituminous mixtures – Material specifications
IS EN 12697 Bituminous mixtures – Test methods for hot mix asphalt

BS 594987 Asphalt for roads and other paved areas – Specification for transport, laying, compaction and type testing protocols has been published by BSI. This new Standards replace BS 594, BS 598 and BS 4987.

The new IS EN standards introduce a significant change to the way bituminous mixtures are specified, namely, the Evaluation of Conformity methodology which incorporates Type Testing and Factory Production Control.

NSAI has published a guidance document SR 28 Standard recommendations for I.S.EN 13108 series that gives advice on how to specify Irish standard mixtures using the new European Standards. Elements of this advice have been made mandatory for NRA schemes by inclusion within Series 900 of the Specification for Road Works.

Following recent research looking at improvements for durability, revised clauses have been included relating to the sealing of cold joints.

General

3 Current pavement design methods may give the Contractor a choice of construction materials. The extent of this choice should be stated in Appendix 7/1 and the alternative materials identified by reference to the Specification Clause numbers. Bituminous mixture specifications are given in the Specification for Road Works and the relevant parts of IS EN 13108 with additional guidance on the specific requirements in Ireland and selection between options contained in SR28.

4 Requirements included in Appendix 7/1 may include penetration reference of binder and aggregate properties such as polished stone value, aggregate abrasion value, resistance to fragmentation, resistance to freezing and thawing, and water absorption as specified in IS EN 13043.

5 Sub-Clause 2 details the protocols which are mandatory for production and laying of bituminous mixtures. The requirement to CE mark bituminous mixtures means that documentation validating the properties of those mixtures and containing information on their composition will be available. This should be made available before the start of paving works and when any source or mix changes are made. The procedural guidelines for CE marked bituminous mixtures are outlined in Table NG 9/1.

6 Except where specifically called for in the Specification for Road Works (e.g. Clause 942), the inclusion of polymer modified bitumen in Appendices 7/1, 7/3 and/or 7/4 is subject to NRA approval in accordance with NG000.10.

7 The use of natural, recovered unbound and artificial aggregates is permitted. In this context, recovered unbound aggregates are natural aggregates recovered from a previous use in an unbound form which satisfy the requirements of Clause 901.

8 The use of IS EN 13043 in Ireland should be read in conjunction with SR17.

Resistance to Fragmentation (Hardness)

9 Regional knowledge may indicate that particular aggregates with higher levels of Los Angeles coefficient can be accepted, where these aggregates have given satisfactory service. It is expected that aggregates with a higher coefficient than that specified could be acceptable, provided the cleanness and durability criteria are satisfactory.

Resistance to Freezing and Thawing (durability)

10 The soundness value test should initially be used for source approval of aggregates, and thereafter only in cases where their durability is suspect. Where local experience indicates that an aggregate with a lower soundness value than that specified may be suitable, details of the aggregate and the appropriate soundness value should be inserted in Appendix 7/1. The soundness value test is not intended as a mandatory test for known durable aggregates. The water absorption test can be used as a routine check test of such aggregates. When required, details of the tests should be scheduled in Appendix 1/5.

11 A water absorption value of 2% or less for coarse aggregates is considered to indicate a satisfactory aggregate source. (This value may be exceeded by fine aggregates). When absorption values of coarse aggregates exceed the recommended $WA_{24}2$, magnesium sulfate soundness tests should be carried out for compliance purposes. IS EN 13043 indicates that the water absorption test is not applicable for blast furnace slag aggregates. Blast furnace slag aggregates with absorption values up to 8% have been shown to have acceptable soundness. Therefore, the durability of blast furnace slag aggregates should be determined by periodic measurement of soundness.

Cleanness

12 There is no current test procedure for cleanness other than the requirement for aggregates to meet the specified IS EN 13108 requirements for the fraction passing the 0.063 mm sieve. Provided the aggregates meet requirements for particle size distribution, based on the washing and sieving techniques of IS EN 933-1, it is considered the cleanness aspect of the aggregates will be acceptable. However, the coarse aggregates should be checked to ensure they are not coated with clay or silt after having gone through the drying plant and before being coated with bitumen.

Resistance to Polishing and Surface Abrasion

13 The Design Manual for Roads and Bridges 7.5.1 and NRA addendum to HD 36 gives guidance on aggregate properties for new bituminous surfacing.

Table NG 9/1: Procedural Guidelines for CE Marked Bituminous Mixtures to EN 13108

Step	Owner of the Action	Who Undertakes Testing	Limits and Controls	Employer's Representative's Checklist
1	The Bituminous product supplier selects constituent materials and demonstrates that the selected materials fully comply with the requirements of Clauses 901, other product clauses in this series and Appendix 7/1, where relevant.	The Bituminous product supplier is responsible for demonstrating compliance of all constituent materials. This can be carried out either by undertaking testing on receipt of materials or by purchasing from suppliers who can demonstrate full compliance under the relevant quality management regime e.g. IS EN 13043, IS EN 12591 and ISO 9001.		
2	The Bituminous product supplier determines a target composition (i.e. target grading and target binder content for the selected constituent materials) to comply with the specified binder content for recipe mixtures or the minimum binder content for other mixtures (i.e. 'design type' mixtures) and to lie within the target limits for grading, as defined in the relevant clauses for each bituminous mixture in Series 900.	The Bituminous product supplier is at liberty to declare their preferred target composition provided it meets these requirements. The composition of the manufactured bituminous mixture, relative to the declared composition, must consistently be within the tolerances given in IS EN 13108 - 21.		
3	Bituminous product supplier undertakes Initial Type Testing (including compaction tests, performance tests, etc) for a particular mix and produces a type test report in accordance with IS EN13108-20.	Type testing can be undertaken by any competent laboratory, including an in-house lab.	Type Tests relate to specific compositions. Any change in mix proportions or source material characteristics requires re-testing, except where the 'family' approach as outlined in IS EN 13108 - 20 applies.	

Table NG 9/1: Procedural Guidelines for CE Marked Bituminous Mixtures to EN 13108 (Continued)

Step	Owner of the Action	Who Undertakes Testing	Limits and Controls	Employer's Representative's Checklist
4	Bituminous product supplier produces material under a Factory Production Control System (FPC) in accordance with IS EN13108 - 21	Routine testing as required for FPC can be undertaken by any competent laboratory, including an in-house lab.	FPC is subject to independent accreditation by a Notified Body. Notified body will audit production controls right back to Initial Type Testing and constituent materials, including auditing the competence of the laboratories used for testing.	Notified Body must be listed on EU Nando website (http://ec.europa.eu/enterprise/newapproach/nando) as being registered for the relevant part of EN13108
5	When a Bituminous product supplier has his FPC system independently accredited by a Notified Body, they are then entitled to operate the CE marking system (see Annex ZA of the relevant part of IS EN 13108)			All product should be delivered under a CE marked delivery ticket in accordance with Annex ZA of the relevant part of IS EN 13108. The Notified body must be listed on the EU Nando website as being registered for the relevant parts of IS EN 13108. The Employer's Representative should ask to see the supplier's Declaration of Conformity and Certificate of FPC from the Notified Body for each individual product (see Annex ZA of the relevant part of IS EN 13108).
6	FPC certifies material up to the point of delivery. In accordance with Appendix 1/5 the specified minimum number of the FPC samples must be taken on arrival at site.			Witness the collection, splitting and dispatch of site samples.

NG 902 Reclaimed Bituminous Materials

1 Reclaimed bituminous materials include millings, planings, return loads from site and offcuts from bituminous layer joint preparation. Return loads can include bituminous materials rejected from site due to temperature problems or visual defects. Waste bituminous materials stockpiled at the plant may also be suitable.

2 To ensure homogeneity and consistency of the final product, all reclaimed materials should be granulated or crushed or similarly prepared before mixing with fresh aggregate and bitumen.

3 A check on the penetration and penetration index of the binder recovered from mixtures containing reclaimed bituminous materials must be performed on all mixtures containing reclaimed bituminous materials. Mix design procedures are not specified, these being left to the expertise of the Contractor. The requirement for trials to ensure that the materials comply with the requirements of this Clause in addition to the requirements of this Series should be sufficient to ensure the materials are suitable for use in the pavement.

4 Materials containing tar or tar-based binders should not be recycled. The environmental impact of recycling materials containing polymer-modified binder should be assessed, together with the properties of the mixture, and reported to the Employer's Representative. There is no requirement to check the quality of the aggregate in the recycled materials, it being presumed that as these come from existing pavements, or from material that was intended for new works, the aggregate quality is adequate for reuse.

NG 903 Placing and Compaction of Bituminous Mixtures

General

1 The purpose of this clause is to define the laying and compaction procedures that will maximise the durability of the finished pavement. It has been drafted to ensure compatibility with the general specifications for the transport, placing and compaction of asphalt mixtures given in BS 594987 and with other appropriate Clauses (929, 930, 942 and 945) and should always be read in conjunction with the above documents as they relate to the particular application.

2 Certain key factors are important in maximising the durability of the finished pavement and should be reviewed before work commences. These are:

i) Mechanical laying wherever practicable.
ii) Bonding of layers.
iii) Good compaction, particularly at joints.
iv) Pre-planning of compaction process.
v) Sealing of edges and joints to prevent water ingress.

3 Clause 903 applies to the surfacing overlaying bridge decks but does not relate to laying waterproofing systems. Appropriate measures should be taken to ensure that the bond system is fully activated by sufficient heat but that the waterproofing system is not damaged by excessive heat.

Laying

4 Materials should be laid by paver unless there are small or inaccessible areas where hand laying is the only practicable method. Pavers should be used with the minimum of hand raking and making up. The use of automatic levelling devices should be encouraged.

5 As far as practicable, the paver should work continuously without stopping. Stops can adversely affect the ride quality of the finished pavement. Therefore, there should be sufficient mixed material on site when paving commences to ensure that lack of supply will not stop operations. However, an excess number of delivery vehicles should also be avoided as it can result in congestion on site and an extended time between mixing and laying for each load.

Compaction

6 It is important that an effective compaction plan appropriate to the site circumstances is in place and is understood by the paving crew. This is a requirement of sub-Clause 903.5.

7 There is no conclusive evidence to show all vibratory rollers provide consistently greater compaction than that achieved with conventional deadweight rollers. It is desirable that compaction should be maximised so site trials of vibratory rollers, proposed as an alternative to conventional deadweight rollers, may be beneficial. The trial should not only determine the required number of passes of the vibratory roller, but also the frequency and amplitude of the vibrating rolls and roller speed. Additional advice is included in TRRL Report LR 1102. Where evidence is provided by the Contractor to indicate a proposed vibratory roller will achieve adequate compaction, the evidence should be representative of the conditions likely to be encountered in the Works. Factors

which are relevant include types of compacted material and source of aggregate, the thickness and temperature of layers and the condition of the proposed roller compared with that previously used. Site trials are not required to prove vibrating rollers where the final density or air voids is measured as compaction is then a controlled parameter.

8 If compaction trials have been carried out, the frequency and amplitude of vibrating rollers and travelling speed of the roller which have been found to be satisfactory should be used. The contractor can use equations [1] and [2], to select the paving and rolling rates to achieve the minimum number of roller passes required before the surfacing has cooled to the minimum temperature for compaction:

Rolling length (m) = average paving speed (m/min) x T (min) … [1]
Roller passes = (Rolling rate/Paving Rate) x No of Rollers … [2]

where:

Rolling rate (m^2/min) = Roller width (m) x Roller speed (m/min)
Paver rate (m^2/min) = Paver width (m) x Paver speed (m/min))
T = time required for compaction (usually 10 min for HRA and 8 min for mixtures without pre-coated chippings)

9 When reliance is placed on a method specification for the control of compaction of bituminous mixtures, close attention should be paid to the temperature of the material. BS 594987 lays down minimum temperatures at which compaction should be substantially complete. It will, therefore, be necessary to commence rolling at temperatures exceeding the minimum, making due allowance for weather conditions, which may affect the rate of cooling of the laid material. NG 945 for cold weather working gives useful advice. For hot weather, TRL Report 494 'The Behaviour of Asphalt in Adverse Hot Weather Conditions' gives useful advice on the subject. For all practical purposes where material is tested for adequacy of compaction in accordance with Clauses 929, 930, 937 and 943, the requirements should have been achieved above the minimum rolling temperature. Any subsequent rolling at temperatures below the minimum should only be necessary to remove roller marks and regulate the surface.

Inter-layer bond

10 Inter-layer bond is essential to prevent ingress of water and resultant deterioration of the pavement. It is also important to ensure that the pavement acts as a homogenous structure. BS 594987 and Clause 920 give explicit and comprehensive requirements that should be followed. It is difficult to overestimate the importance of bond. Generally, it is good practice to lay bases in thicker lifts to minimise the number of layers and, hence, interfaces (giving due consideration to the maximum layer thicknesses given in BS 594987).

Joints

11 However a joint in a bituminous layer is constructed, it will always be the weakest part of the pavement. Therefore, it is good practice, wherever possible, to minimise the number of cold joints by, for example, using wide screeds and/or paving in echelon.

12 Joints should be located in low stressed areas of the pavement wherever practicable, as indicated in sub-Clause 903.24.

13 Compaction at joints with unsupported edges will never be as good as in the body of the mat. This is recognised in the air void content requirements in sub-Clauses 903.27, 929.27 and 930.35.

14 To guard against ingress of water at joints, Sub-Clause 903.25 requires binder to be applied to the vertical face prior to laying the adjacent mat in order to improve bond and Sub-Clause 903.28 requires overbanding to seal the surface of the joint.

15 To ensure that water does not enter the pavement from the side, sub-Clause 903.29 requires sealing the edges of the finished pavement. This is always required for the high side of the elevation. Sealing of the low side is conditional on whether it is necessary to let water out or stop water getting into the pavement. The selection is a design issue and should be specified in Appendix 7/1.

NG 906 Dense Base and Binder Course Asphalt Concrete with Paving Grade Bitumen (Recipe Mixtures)

1 The mixture designation should be chosen to suit the thickness of the layer as indicated in BS 594987 Table 6A.

Binder

2 The preferred paving grades for asphalt concrete are 40/60 and 70/100. Further guidance is given in Table NG 9/2.

Aggregates

3 For aggregates susceptible to binder stripping, the use of up to 2% of hydrated lime or cement filler may be required. This may also be achieved by the addition of adhesion agents to the bitumen or at the mixing stage.

4 Aggregates other than crushed rock and gravel may be suitable for asphalt concrete. Further guidance may be found in IS EN 13043 and S.R.17.

Declared Specifications

5 The following tables provide examples of declared specifications derived from the target composition criteria set out in the specification.

Table NG 9/2 — Selection of Binder Grades

	Binder Grade						
	Hard Paving Grade		**Paving Grade**				
Mixture type	**10/20**	**15/25**	**30/45**	**40/60**	**70/100**	**100/150**	**160/220**
AC 32 DBM Base	--	--	--	✔	✔	✓	✓
AC 32 HMB Base	--	--	✔	--	--	--	--
AC 32 HDM Base	--	--	--	✔	--	--	--
AC 32 DBM Bin	--	--	--	✔	✔	✓	✓
AC 32 HMB Bin	--	--	✔	--	--	--	--
AC 32 HDM Bin	--	--	--	✔	--	--	--
AC 20 EME2 Base or Bin	✔	✔	--	--	--	--	--
AC 14 EME2 Base or Bin	✔	✔	--	--	--	--	--
AC 10 EME2 Base or Bin	✔	✔	--	--	--	--	--
AC 20 DBM Bin	--	--	--	✔	✔	✓	✓
AC 20 HMB Bin	--	--	✔	--	--	--	--
AC 20 HDM Bin	--	--	--	✔	--	--	--
AC 20 Open Bin	--	--	--	--	✔	✓	✔
AC 14 Open Surf	--	--	--	--	✔	✓	✔
AC 10 Open Surf	--	--	--	--	✔	✓	✔
AC 14 Close Surf	--	--	--	--	✔	✓	✓
AC 10 Close Surf	--	--	--	--	✔	✓	✓
AC 6 Dense Surf	--	--	--	--	✔	✓	✓
AC 6 Med Surf	--	--	--	--	✔	✓	✔
AC 4 Fine Surf	--	--	--	--	✔	✓	✔

NOTE 1 Preferred binder grades are in bold.
NOTE 2 The use of Modified Bitumen may be considered in all mixtures for certain applications.

Table NG 9/3 — Example of a declared specification (AC 32 dense bin 70/100 rec)

Test sieve mm	Sieve Designation	Target Composition Table 4, S.R.28	Declared target grading/binder	Tolerances from Table A.1, IS EN 13108-21	Conformity specification
40	1,4D	100	100	-2 +0	98 - 100
31,5	D	99 – 100	99	-9 +5	90 – 100
20	Characteristic coarse sieve	80 – 86	83	± 9	74 – 92
6,3	Optional extra coarse sieve	52	52	± 9 a	N/A [a]
2	2 mm	27 – 33	30	± 7	23 – 37
0,250	Characteristic fine sieve	11 – 15	13	± 5	8 – 18
0,063	0,063 mm	6	6	± 3	3,0 – 9,0
Binder B_{act} (limestone)	-	4,0	4,0	± 0,6	3,4 – 4,6

[a] There is no requirement in IS EN 13108-21 to apply a conformity tolerance to an optional extra coarse or fine aggregate sieve. However, to monitor mixture consistency it may be appropriate for the producer to apply the same tolerance as that applied to the characteristic coarse or fine sieve.

NOTE 1 The example given is based on crushed rock aggregate. It should be noted that other aggregates can be used.

NOTE 2 The tolerances shown in the above table apply to the analysis of individual samples in accordance with Table A.1, IS EN 13108-21:2006.

Table NG 9/4 — Example of a declared specification (AC 20 dense bin 70/100 rec)

Test sieve mm	Sieve Designation	Target Composition Table 7, SR28	Declared target grading/binder	Tolerances from Table A.1, I.S. EN 13108-21	Conformity specification
31,5	1,4D	100	100	-2 +0	98 - 100
20	D	99 – 100	100	-9 +5	91 – 100
10	Characteristic coarse	61 – 63	63	± 9	54 – 72
6,3	Optional extra coarse sieve	47	47	± 9 a	N/A [a]
2	2 mm	27 – 33	32	± 7	25 – 39
0,250	Characteristic fine sieve	11 – 15	14	± 5	9 – 19
0,063	0,063 mm	6	6	± 3	3,0 – 9,0
Binder B_{act} (limestone)	-	4,7	4,7	± 0,6	4,1 – 5,3

[a] There is no requirement in I.S. EN 13108-21 to apply a conformity tolerance to an optional extra coarse or fine aggregate sieve. However, to monitor mixture consistency it may be appropriate for the producer to apply the same tolerance as that applied to the characteristic coarse or fine sieve.

NOTE 1 The example given is based on limestone aggregate. It should be noted that other aggregates can be used.

NOTE 2 The tolerances shown in the above table apply to the analysis of individual samples in accordance with Table A.1, IS EN 13108-21:2006.

NG 910 Hot Rolled Asphalt Surface Course (Recipe Mixture)

1 Recipe HRA mixtures should generally only be used where there is some knowledge of the performance expected from local mixtures.

2 The binder grade to be used should be stated in Appendix 7/1. The normal grade is 40/60 although 30/45 may be specified, particularly for very heavy duty use.

3 The mixture designation should be chosen to suit the thickness of the layer as indicated in BS 594987 Table 6B.

Declared Specifications

4 The following tables provide examples of declared specifications derived from the target composition criteria set out in the specification.

Table NG 9/5 — Example of a declared specification HRA 30/14F surf 40/60 Recipe mixture Schedule 1A

Test sieve mm	Sieve Designation	Target Composition Tables 25 and 27, S.R.28	Declared target grading/binder	Tolerances from Table A.1, I.S. EN 13108-21	Conformity specification
20	1,4D	100 A)	100	-2, +0	98-100
14	D	93-100	96	-8, +5	88-100
10	Characteristic coarse sieve	67-83	75	± 7	68-82
2	2mm	65	65	± 5	60-70
0,5	Optional extra fine sieve	49-68	58	± 4B)	N/A
0,250	Characteristic fine sieve	19-51	35	± 4	31-39
0,063	0,063mm	9	9	± 2	7-11
Binder B_{act}	-	7,7	7,7	± 0,6	7,1-8,3

A) Single values are recommended to ensure consistency between the original BS 4987 and BS 594 mixtures and those derived from the European Standard.

B) There is no requirement in IS EN 13108-21 to apply a conformity tolerance to an optional extra coarse or fine aggregate sieve. However, to monitor mixture consistency it may be appropriate to apply the same tolerance as that applied to the characteristic coarse or fine sieve.

NOTE 1 The tolerances shown in the above table apply to the analysis of individual samples in accordance with Table A.1, IS EN 13108-21:2006.

NOTE 2 For additional grading requirements, for maximum percentage of aggregate passing 2 mm and retained on 0,5 mm sieves in surface course mixtures, refer to Table 5, IS EN 13108-4:2006.

NOTE 3 In practice, the maximum passing the 0,5 mm sieve will be restricted by the value passing the 2 mm sieve.

NG 911 Hot Rolled Asphalt Surface Course (Design Mixture)

1 The special requirements included in Appendix 7/1 may include specific mix designations, binder grade and for 30% and 35% stone content mixtures, the required properties of coated chippings in accordance with Clause 915.

2 The method for determining the design binder content for surface course is described in BS 594987 Annex H. The target binder content in the mixture will normally be the higher of the design binder content and the minimum binder content.

3 The contractor may usually be permitted to use either type C or type F mixtures.

4 In the past, Marshall properties, such as stability and flow, were used as indicators of resistance to permanent deformation, but this is no longer included as an option in the IS EN 13108 standards. In very heavily trafficked situations, where resistance to permanent deformation is of high importance, it is recommended that performance related Hot Rolled Asphalt to Clause 943 is used.

Declared Specifications

5 The following table provides an example of a declared specification derived from the target composition criteria set out in the specification.

Table NG 9/6 — Example of a declared specification HRA 35/14F surf 40/60 Design mixture Schedule 1A

Test sieve mm	**Sieve Designation**	**Target Composition Table 26**	**Declared target grading/binder**	**Tolerances from Table A.1, I.S. EN 13108-21**	**Conformity specification**
20	1,4D	100 [A)]	100	-2, +0	98-100
14	D	95-100	97	-8, +5	89-100
10	Characteristic coarse sieve	62-81	70	± 7	63-77
2	2mm	61	61	± 5	56-66
0,5	Optional extra fine sieve	44-63	50	± 4	N/A [B)]
0,250	Characteristic fine sieve	16-46	40	± 4	36-44
0,063	0,063mm	8,0	8,0	± 2	6,0-10,0
Binder B_{act}	-	6,4	6,4	-	-

A) Single values are recommended to ensure consistency between the original BS 4987 and BS 594 mixtures and those derived from the European Standard.

B) There is no requirement in IS EN 13108-21 to apply a conformity tolerance to an optional extra coarse or fine aggregate sieve. However, to monitor mixture consistency it may be appropriate to apply the same tolerance as that applied to the characteristic coarse or fine sieve.

NOTE 1 The tolerances shown in the above table apply to the analysis of individual samples in accordance with Table A.1, IS EN 13108-21:2006.

NOTE 2 For additional grading requirements, for maximum percentage of aggregate passing 2 mm and retained on 0,5 mm sieves in surface course mixtures, refer to Table 5, IS EN 13108-4:2006.

NOTE 3 In practice, the maximum passing the 0,5 mm sieve will be restricted by the value passing the 2 mm sieve.

NG 912 Close Graded Asphalt Concrete Surface Course

1 Table 2.2.I from NRA addendum to DMRB Vol. 7 standard HD 36 does not allow the use of Coated Macadams on roads where the 85th percentile traffic speed is above 50km/hr. Accordingly, it is for use on roads with a mandatory speed of traffic less than or equal to 50km/hr.

2 The nominal size of aggregate for close graded surface course will depend upon the required layer thickness for the compacted surface course and should be selected from BS 594987 and stated in Appendix 7/1.

3 The traffic category should be specified in Appendix 7/1.

4 Special requirements included in Appendix 7/1 may include grade of binder and type of aggregate.

Declared Specifications

5 The following table provides an example of a declared specification derived from the target composition criteria set out in the specification.

Table NG 9/7 — Example of a declared specification (AC 14 close surf 70/100)

Test sieve mm	Sieve Designation	Target Composition Table 12, S.R.28	Declared target grading/binder	Tolerances from Table A.1, I.S. EN 13108-21	Conformity specification
20	1,4D	100	100	-2 +0	98 – 100
14	D	100	100	-8 +5	92 – 100
10	Optional extra coarse sieve	77 – 83	81	± 9	N/A [a]
6,3	characteristic coarse sieve	52 – 58	56	± 7	49 – 53
2	2 mm	25 – 31	29	± 6	23 – 35
1	Characteristic fine sieve	14 – 26	24	± 4	20 – 28
0,063	0,063 mm	6	6	± 2	4,0 – 8,0
Binder B_{act} (other crushed rock)	-	5,1	5,1	± 0,5	4,6 – 5,6

[a] There is no requirement in IS EN 13108-21 to apply a conformity tolerance to an optional extra coarse or fine aggregate sieve. However, to monitor mixture consistency it may be appropriate for the producer to apply the same tolerance as that applied to the characteristic coarse or fine sieve.

NOTE 1 The example given is based on other crushed rock aggregate. It should be noted that other aggregates can be used.

NOTE 2 The tolerances shown in the above table apply to the analysis of individual samples in accordance with Table A.1, IS EN 13108-21:2006.

NG 915 Coated Chippings for Application to Hot Rolled Asphalt Surfaces

1 It has been suggested that the use of cold pre-coated chippings from site stockpiles can cause rapid cooling of the surface of Hot Rolled Asphalt surface courses, potentially contributing to premature chipping loss. During periods of low ambient air temperature, it may be prudent for Contractors to consider the use of covered stockpiles.

2 Design mix rolled asphalt surface course materials are often stiffer than recipe mix compositions. They are less workable and, to obtain effective compaction and retention of chippings rolled into the surfacing, constraints on laying conditions may have to be considered.

3 Coking of chippings can occur during prolonged storage at high temperature. This can be mitigated by cooling of the chippings and limiting the height of stacking to reduce the possibility of coking occurring.

4 The hot sand test described in BS 598: Part 108 provides a means of identifying and rejecting chippings which are unlikely to be retained in the surfacing under traffic due to coking or contamination.

NG 916 Open Graded Asphalt Concrete Surface Course

1 The size of the mixture should be chosen to suit the thickness of the layer as indicated in BS 594987 Table 6A.

NG 917 Cold Milling (Planing) of Bituminous Bound Flexible Pavement

1 Clause 917 relates to the milling of pavements on existing road carriageways. It is not relevant to the rectification of bituminous layers in new construction.

2 Rectification of new construction should be carried out in accordance with sub clause 702.10

NG 918 Slurry Sealing

1 These notes include and extend in some respects the main points of advice on slurry sealing given in IS EN 13808, RC380, IS EN 12273 and BS 434 : Part 2.

2 For works of magnitude the full control testing programme should be undertaken, but for a small area of work the Employer's Representative may prefer to judge the material on the basis of the required field trials.

3 Gradings of blended aggregate for 1.5 mm and 3 mm thick finished surface are given. In the event of a greater thickness being required the grading should be revised in consultation with the manufacturer of the particular process.

4 The usual additives used to control consistency, mix segregation, and setting rate are CEM1 Portland cement to IS EN 197 : Part 1 or hydrated lime to IS EN 459-1. However, it is advisable to consult the emulsion manufacturer for advice on this point.

5 Techniques for mixing and laying vary according to the type of emulsion used and in some cases the use of a cationic tack-coat Class Kl-40 is recommended before laying the slurry. The machines should be equipped to give a light spray of water onto the tack-coat film just before the slurry is spread. After the slurry has set sufficiently it may sometimes be necessary to roll it with a multiwheeled smooth tread rubber-tyred roller. The manufacturer of the emulsion should be consulted on the desirability of rolling and also tack coating.

6 Variation in colour of the slurry seal which can sometimes occur should normally be self-rectifying within 24 hours, but this period may be extended depending on weather conditions and traffic. With some processes using hydrated lime as the additive a degree of efflorescence can become apparent during the first 24 hours and persist for a while afterwards. This is not an indication of uneven mixing or segregation and it should disappear after 2-3 weeks.

7 Slurry seal made with emulsions specially formulated for the slurry seal process is sufficiently stable to form a free flowing slurry and is capable of sustaining this condition throughout the laying procedure adopted. Setting time of the mix may be within a few minutes or extended as desired. For less rapid setting slurry the emulsion should be Class A4 slow setting. This can be used where the rate of set is not important, i.e. when work is being carried out on areas where the slurry can be expected to dry out naturally before being subjected to traffic or rain.

NG 919 Surface Dressing: Recipe Specification

1 This specification is of the conventional Recipe/ Method type.

2 The surface dressing should be designed in accordance with the requirements of the Institute of Asphalt Technology (IAT) guidelines for Surface Dressing in Ireland, second edition.

3 The Contractor should state the source and type of binder he proposes to use together with the data required by Appendix 7/21.

4 The Contractor's attention should be drawn to the need for best practice as set out in Section 5 of the IAT guidelines.

5 Product Identification Test: Penetration, softening point, Fraass Brittle point, toughness, tenacity, and other viscosity measurements are not in themselves sufficient as product identification tests, although they can be useful as quick or low cost Quality Assurance tests to check consistency from load to load of the binder. The Contractor should provide a Binder Data Sheet giving at least the information specified.

6 The binder sprayer should be checked for accuracy of transverse distribution using the test method stated. This assesses the ability of the spray bar in real working conditions and may be carried out quickly using the correct binder. The Depot Tray test to BS 1707 averages the rate of spray over 60 seconds in a static condition and therefore does not simulate site conditions such as the influence of varying spraybar height above the road, or any tendency to pump or pressure surging. The performance of the binder sprayer is classified in accordance with the value of the coefficient of variation (cv) for the regularity of transverse distribution. The class required for the sprayer, to be specified in Appendix 7/21, should be selected from Table NG 9/8.

7 The compiler should specify the minimum PSV required for a particular site together with the maximum AAV.

Table NG 9/8 Accuracy of Binder Sprayer

Site	Coefficient of Variation (Cv)	Class
Single Carriageways	< 12%	2
Lightly Trafficked Single Carriageways	<15%	1

8 The chipping spreader should be checked for accuracy of transverse distribution using the stated method. With multi-layered surface dressings it is very important to obtain the correct rate of spread of the larger chipping as under or over chipping will reduce the quality of the dressing and may result in it failing to perform as a multi-layered system. Particular attention should be paid to the rate of spread in the vicinity of the overlaps in the chipping spreader mechanism as the performance, particularly of worn spreaders, can be significantly different in these areas from the rest of the spreader.

9 Remedial work to the existing road, for example, patching, should be carried out prior to surface dressing. It should be carried out in such a manner that the hardness and macrotexture of the remedial work is sufficiently similar to the rest of the road to avoid problems of variable appearance and behaviour in the completed dressing for at least the duration of the defect period; for example, patching using close textured bitumen macadam should be carried out in the previous summer otherwise it will absorb bitumen into the voids and chip loss may ensue. If the existing surface is Hot Rolled Asphalt then the patches will have to be laid with Hot Rolled Asphalt and preferably sufficiently far in advance of the Works for the binder to wear off the surface otherwise there will be excess binder in that area. Patches should not have a horizontal sealing strip applied as this will show through the dressing very rapidly and has been known to initiate fatting failure. The use of binder rich materials should not be used to pre-seal areas especially longitudinally in the wheel tracks as the dressing will fat up and macrotexture will be lost.

10 Cleanliness of the existing road surface is extremely important. The binder will adhere only to the top layer of the material on which it is sprayed and if there is mud or dust then the surface dressing will fail rapidly, through the lack of bond with the underlying structure. It may be necessary in some circumstances to use high pressure washing to remove strongly adherent material. The

masking of street furniture should be carried out with care as the interface between the furniture and the surrounding surface should be sprayed in order to exclude water from the road structure, but any cover must not be rendered immovable.

11 The mode of operation of surface dressing contracts can necessitate the adoption of techniques requiring equipment for traffic management and safety over and above that normally required by static works. For example, where traffic lights are required as part of the traffic management scheme, in order to facilitate the relocation of the lights, some sites may require the provision of additional sets over and above the minimum necessary, so that the work progresses with a minimum of interruption and disruption to road users.

12 In order to ensure that only the binder is overlapped on transverse joints the chipping application should stop short of the end of the binder film wherever possible. When spraying from a completed section some hand canning and masking of the end is necessary in order to abut the joint without forming a ridge.

13 Longitudinal joints should have slightly overlapped binder films obtained by leaving a wet edge approximately 100 mm wide. Care should be taken to ensure that double chipping does not take place as this will form a ridge. As the binder overlap is generally in a lightly trafficked location the additional thickness of binder film is unlikely to be a problem. Quartering (spraying of a part bar) should be avoided wherever possible, but may be necessary at tapers and other similar locations. An overlap (up to 300 mm) should be provided to ensure full rate of spread of binder at all points.

14 The frequency of testing for rates and accuracy of spread of binder and chippings should be stated in Appendix 1/5. The rate of testing should be reduced once the Contractor has demonstrated his ability to consistently meet the requirements. The more consistent a Contractor is in his work the lower the rate of testing that can be employed, a minimum rate of 1 test per day could be reached if the Contract is large enough. The Employer's Representative may carry out testing at audit frequency, typically at about 10% of the specified frequency for the Contractor. If the results from this audit testing are significantly different from those of the Contractor, for example, by more than the reproducibility of the test, then the Employer's Representative and the Contractor should work together to determine the source of difference. With this type of specification it is important that all the required testing is carried out, preferably under supervision, as it is not possible to assess the rate of spread of either binder or aggregate subsequent to the spreading of those materials.

15 Traffic control immediately after surface dressing is most crucial in the production of good quality surface dressing. On high speed roads the best way of doing this is to introduce convoy vehicles into the traffic stream in order to keep speeds low. The deployment of 20 kph signs, when permitted, is an extremely useful method of inducing caution in the road user. If possible cones should be used to vary the lane position so that as much of the dressing as possible is subjected to slow speed traffic. The lane should be suction swept prior to removal of the convoying vehicles from the traffic stream, care being taken not to remove chippings, which would otherwise become part of the mosaic. With multi-layered surface dressing it may not be necessary to sweep, unless there are windrows which should be removed. If the work has been carried out correctly there will be no loose large chippings. Provided there are no loose large sized chippings it may be useful to gradually increase the speed of the convoying vehicles to disperse excess small chippings to the side of the lane for subsequent removal.

NG 920 Bond Coats, Tack Coats and Other Bituminous Surface Courses

Bond Coats and Tack Coats

1 This Clause specifies tack coats and bond coats for Asphalt concrete, Hot Rolled Asphalt, porous asphalt, and regulating courses. Bond coats and tack coats are applied prior to overlay to promote the development of a homogenous pavement structure. Bond is particularly important in highly stressed areas. Useful advice is provided in the Design Manual for Roads and Bridges (DMRB), Volume 7, HD37 and NRA addendum to HD37.

2 Bond coats and tack coats promote adhesion between layers of material. The choice of tack coat or bond coat depends on the condition of the substrate, the stiffness and binder content of the layers and the type of site. Tack or bond coat should be used between all bituminous layers. A bond coat may be more appropriate where materials are to be laid less than 30 mm thick, or where a particular site has a binder lean substrate and permeability is considered a problem. Advice on the choice of tack coat or bond coat, together with recommended target application rates, is provided in BS 594987 and sub-Clause 3 for Hot Rolled Asphalts and Asphalt Concrete, respectively. Bond coats generally have a

higher binder content containing modifiers and are usually used at a higher rate of spread thus promoting improved adhesion with some waterproofing capability, important to prevent water ingress below porous or permeable materials. Additional information is provided in HD37 (DMRB 7.5.2).

3 Rates of spread of binder should follow the recommendations of Series 900, BS594987 and RC380. Rates of spread may need to be altered for varying macrotexture and porosity of the existing road and an increased rate at the kerb or road edge is beneficial to minimise water ingress where compaction by traffic is least.

Bituminous Sprays

4 Bituminous sprays may be used to seal and protect earthworks, drainage media, recycled material and cementitious materials including cement-stabilised soil. The primary purpose is not necessarily to promote bond with an overlay, but to limit the evaporation or ingress of water and in cementitious materials, to facilitate proper curing.

NG 921 Surface Macrotexture of Bituminous Surface Courses

1 Surface course layers are the interface between the vehicle tyre and the road pavement. A consideration of their long term contribution to skidding resistance performance, over the design life, must include both the microtexture and the macrotexture of the laid material.

2 In general the depth of initial surface macrotexture is the determining factor in the ability of the surface course to assist in the dispersal of surface water from the tyre road contact area in the wet at higher speed. It for this reason that differing target levels are set for speeds above and below 60km/hr. This speed limit is generally applied to urban areas where free-flowing high speed traffic is inappropriate regardless of the geometric configuration.

3 The criteria set in the specification is based on long established empirical observations For Hot Rolled Asphalt surface course this is achieved by the application of coated chippings, as described in Clause 915 and BS 594987. For surfacings in accordance with cl 942, it is a function of their mix design, and the properties of the constituent materials, in particular the flakiness index of the coarse aggregates.

4 Very high surface texture on high stress areas, particularly roundabouts, compromises toughness and durability and renders the surface prone to fretting, chipping loss and deterioration. In achieving a balance between long term skidding resistance through aggregate retention and the speed constraint offered by the geometric layout it is good practice to adopt lower texture requirements in such situations and a value of 1.2mm is considered appropriate for the national road network.

NG 923 Binder Reclaimed using the Rapid Recovery Test (RRT) and Accelerated Ageing using the Modified Ageing Rolling Thin Film Oven Test (RTFOT)

1 The RRT is able to drive off water from polymer modified emulsions rapidly at a comparatively low temperature of 85ºC because the stainless steel screws continually disturb the binder and there is a controlled gas flow over the binder surface encouraging a homogenous break without skinning. This is important as higher temperatures would drive off the volatile oils and/or destroy or change the microstructure of the binder, which would not, therefore, simulate the residual binder on the road. Some polymer microstructures are more sensitive to temperature than others and this should be considered when heating samples for subsequent testing.

2 Nitrogen gas is used, rather than air, to minimise ageing of the binder and to increase safety especially with cutback binders.

3 This recovery method simulates the state of a binder film soon after application using conventional surface dressing and bond coat sprayers or slurry surfacing mixing equipment; the method is not intended to drive off all the volatile components nor to remove every molecule of water. However, the microwave procedure has been found to provide consistent results and eliminate the remaining moisture that may be damaging to other test methods, such as a rheometer water bath. The RRT is also used for conventional unmodified emulsions and cutbacks although the methods described in IS EN 13074 may be preferred for unmodified bitumen emulsions, as it does not require RTFOT apparatus, however it takes a much longer time.

4 Two bottles are used to set the cycle time for the microwave oven. The total weight of binder is needed to check against binder content of the emulsion. 'Recovered Binder' from these two bottles may be used for further testing. When the cycle time has been established together with the number of cycles

(normally one or two) the test may be carried out without repeating this check for the same emulsion sample. The other bottles will not need any microwave treatment if only one cycle demonstrates that constant weight has been achieved, although when the 'Recovered Binder' is to be used in a rheometer water bath, one cycle in a microwave might be prudent to minimise leaching.

5 The 'Recovered Binder' from the bottles may be conveniently scraped onto a non-adhesive sheet or dish (eg. PTFE or silicone) in order to collect enough material for a test. Care should be taken to minimise volatile oil loss and opportunity for oxidation by ensuring a quick transfer to the storage penetration test pot or other test apparatus.

6 The percentage loss of weight should be recorded as an indicator of water and/or volatile oil losses and compared to the binder content of an emulsion or the percentage volatile flux oil of a cutback if known.

7 It has been found to be possible to leave the metal screws in the bottles in the microwave for some materials, however, the risk should be assessed bearing in mind the concentration of volatile oil and the effect of any arcing in the bottle.

8 The period required for the RTFOT oven temperature to stabilise may be much shorter than that prescribed in ASTM D2872-88, as modern ovens with micro-processor controls stabilise very quickly, normally within 1 hour.

9 Recording sample history is important as the method of sampling, whether from spraybar or storage tank or just after manufacture, may affect the properties of the binder. The sample size and its subsequent treatment in terms of re-heating, exposure to frost, regular stirring etc. may make considerable difference to the result for water or volatile oil loss.

10 The stainless steel screws are manufactured from high quality surgical steel so that they are resistant to corrosion, which is particularly a problem with emulsions.

11 'Stabilising' using nitrogen gas at 135ºC for one hour removes most of the volatile oil left within the 'Recovered' sample after the RRT. Some binders with large quantities of volatile flux will need conditioning at 135ºC for more than one hour before the nitrogen gas supply is switched to air to begin the ageing process. If two hours are required for this conditioning the total time of test will be extended by one hour. The binder sample after loss of the majority of its volatile oil by this process results in a so-called 'Stabilised Binder' and may be used for test although the properties after the first period of ageing at 3 hours may be more consistent and represent a few years on the road.

12 The weight loss during 'stabilising' may be used to evaluate the proportion of volatile oil present and the length of time necessary to drive it off may indicate the volatility. Tests on the samples before and after 'stabilising' may reveal properties of solvating ability and fluxing power. The quality of nitrogen (oxygen impurity) and air in the sample may result in some ageing. It is possible to use purer nitrogen and lower temperature to investigate volatile oil loss.

13 The procedure for RTFOT ('Short Term Ageing') for binders for Hot Mix Asphalt is faster than normal, only 45 mins. as opposed to 75 mins (both at 163ºC using air) and is due to the use of screws, which accelerate the test. The problems experienced with polymer modified binders not turning and continually exposing new surfaces as efficiently as unmodified binders in the conventional test is overcome by the use of screws which minimise phase separation and skinning. The sample is always removed by scraper, whereas the method of removal in IS EN 12607-1 was designed for unmodified binders and when the binder does not flow easily from the glass bottles (sometimes the case with heavily modified binders) the option to scrape rather than pour may introduce sample heterogeneity and reproducibility problems.

14 If only 'Aged Binder' samples are required for Emulsions then except for two bottles to provide 'Recovered Binder' the test may be run continuously and the microwave procedure ignored as the 'Stabilising' period at 135ºC will drive off any remaining water from the samples.

15 The Modified Ageing Rolling Thin Film Oven Test (Modified Aging RTFOT) is an alternative to the high pressure ageing test (HiPAT). To evaluate 'ageing' or 'stabilising' of the binder on the road and does not require a SHRP PAV apparatus, which is considered to be a greater safety hazard when using emulsions or cutbacks containing highly volatile oil. In static tests such as the trays in the HiPAT or PAV the presence of polymer in the binder leads to skinning and heterogeneous ageing of the samples and depends how they are scraped. The combination of the screw continually mobilising the binder film and the rotation of the specimen in the air stream in the Modified Ageing RTFOT reduces the test time whilst maintaining a homogeneous sample. This is particularly relevant for heavily polymer-modified binders and is one reason why 135ºC was selected (otherwise the binder is not continuously disturbed). The test temperature for viscosity is at this temperature. The

protocol minimises the possible phase separation of the polymer from the base binder.

16 The binder may lose volatile oil, but may increase in weight due to the products of oxidation so care should be exercised in evaluating weight changes.

17 Binder samples for test from other apparatus may be loaded into the bottles without carrying out the RTFOT at 163ºC. Binders that have been tested in accordance with IS EN 12607-1 in a separate RTFOT apparatus do not necessarily result in identical 'Aged Binder' after the Modified Ageing RTFOT, this especially the case when the binder is heavily modified (skinning is likely to occur).

18 The 'Recovered Binder' provides the first sample for test for bituminous emulsions, cutbacks and fluxed binders. With the Modified Ageing RTFOT a further three samples at different ages are provided. The 'Aged Binder' is deemed to be the sample after 8 hours although the HiPAT work (simulative of PAV) would indicate that equivalent samples in terms of stiffness are achieved at 22 hours. The ageing of emulsions and cutbacks on the road is likely to be less than for Hot Mixed Asphalt binders where the temperature of mixing is high. The samples may be used to provide graphical data such as complex stiffness modulus G* (see Clause 928) or Vialit Pendulum Cohesion (see Clause 939). The RTFOT used for Hot Mix binders does 'Age' the binder considerably and so the equivalent to HiPAT or PAV is approximately 8 hours in the Modified Ageing RTFOT (see schematic diagrams below).

19 The test method produces around 10 g of material per bottle. This is sufficient for testing using rheology (see Clause 928) or Vialit Pendulum Cohesion (see Clause 939). For other tests sufficient bottles should be used and the binder combined prior to testing.

20 Polymer modified binders may need to be heated and stirred prior to testing in other apparatus to ensure that internal stresses are not present in the test specimens.

Figure NG 9/1: Bituminous Emulsion, Cutback and Fluxed Binder - Polymer Modified and Unmodified

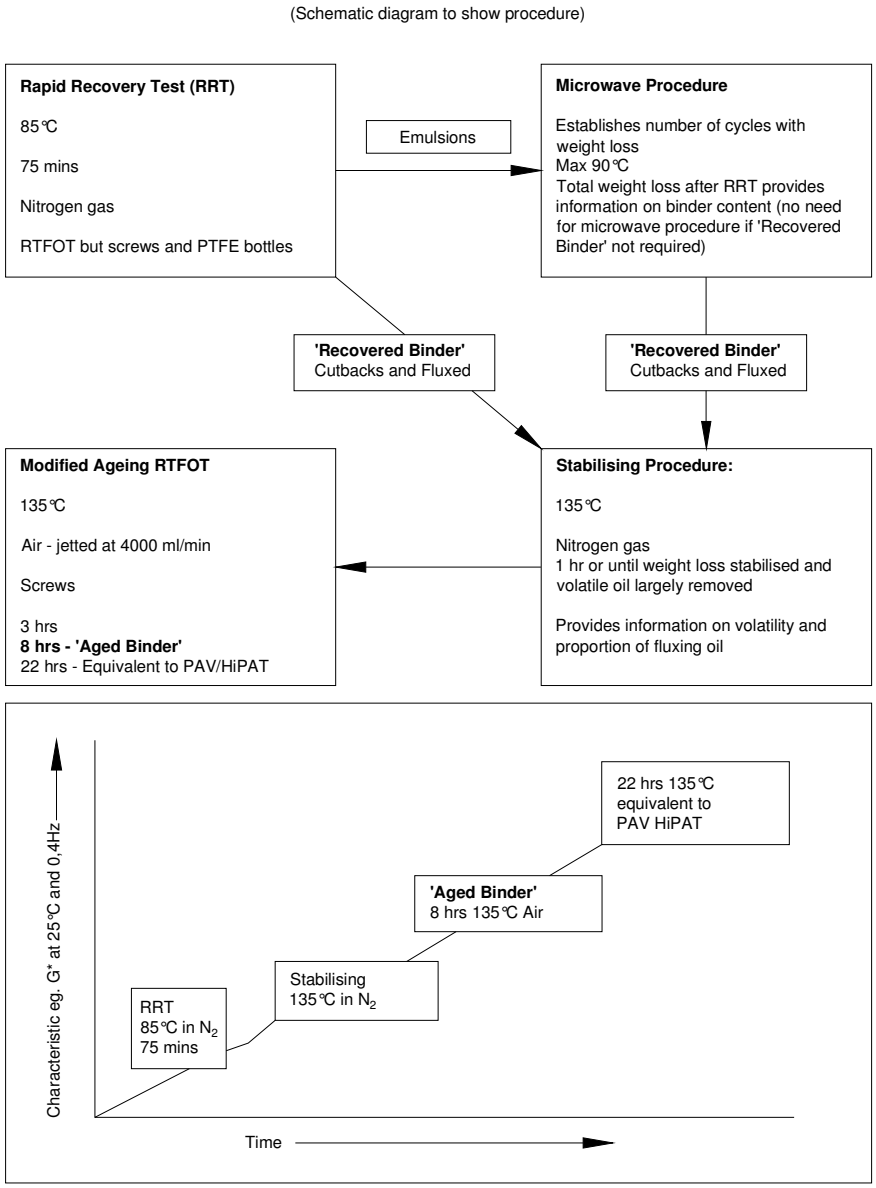
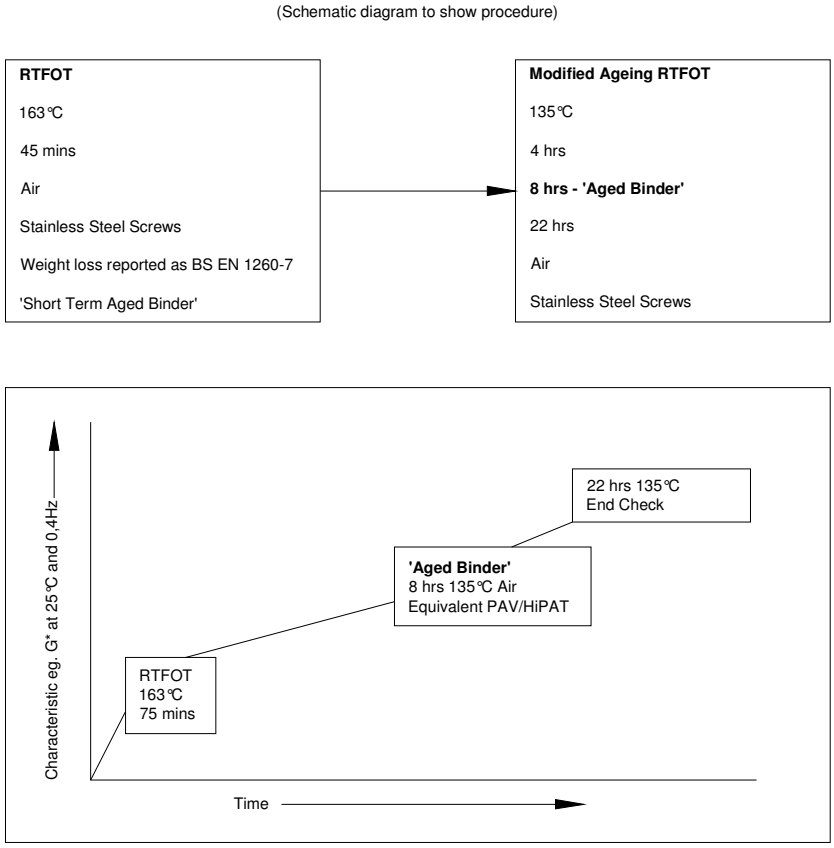


Figure NG 9/2: Bituminous Binders for Hot Mix Asphalt - Polymer Modified and Unmodified



NG 924 High Friction Surfaces

1 High skid resistant durable surface treatments are now available which consist of a thin film of resin based binder sprayed on to a sound surface and covered with small size calcined bauxite aggregate of high PSV. Surface treatments comprising high PSV aggregates mixed with resin before spreading on the surface do not comply with the requirements of Clause 924.

2 Experience has shown these surfacings can be effective in reducing traffic accidents on sites where rapid deacceleration can occur especially if this is coincident with high traffic density. Typical sites are the approaches to signal controlled junctions, roundabouts and pedestrian crossings subject to a heavy flow of vehicles and high approach speeds.

3 These surfacings require good adhesion to the underlying strata, and their application can be weather depedent. In comparison to other surfacing materials their effective life can be quite short. They should only be used after consideration has been given to the use of cheaper alternative measures such as surface dressing with a high PSV natural aggregate, improved road signs and markings, improved street lighting, etc.

4 The Specification is based on high skid resistant surface treatments which have been proven over a number of years and are known to give very good skid resistance and a relatively high level of durability. The treatment should only be used on surfaces which are dry, clean, hard and sound. Surfaces not suitable for treatment include slurry seals, fatted and multilayer surface dressings and surface dressings over soft or unsound bases. Performance on concrete may not be as good as on bituminous surfacings.

5 Attention is required to ensure the surface is properly prepared. The surface to which resin is applied shall be dry and free from dust, oil, excess bitumen and other contaminant that may cause lack of adhesion.

6 The level of relative humidity and temperature affects production rates so levels should be stated in Appendix 7/1. The manufacturer's recommendations should be sought for the particular system in use.

7 The polished stone value test cannot be carried out on material supplied to site. The

supplier has to provide a suitably graded sample.

NG 925 Testing of Bituminous Mixtures

General

1 The demonstration of the conformity of asphalt mixtures is covered by two parts of IS EN 13108:

-IS EN 13108-20 Type testing; and
-IS EN 13108-21 Factory production control.

2 These two parts have been drafted in the context of a process of "Evaluation of Conformity" relating to IS EN 13108. They can be used in the "Attestation of Conformity" for the purposes of CE marking under the Construction Products Directive. Importantly, the requirements apply and are identical whether or not CE Marking is to be applied.

3 They spell out, in some detail, the obligations of a producer of asphalt, so as to be able to make a declaration that the material conforms to a particular specification drawn from the relevant part of IS EN 13108.

Initial Type Testing

4 Initial type testing is a procedure in which a given mix formulation (target composition and set of constituents) is put through a series of tests to prove that it complies with the detailed specification requirements, in particular any performance-related properties, with which conformity is being claimed. The required properties for each mix type are contained in SR28 Tables 41 to 45. This is similar to a combination of a technical file, a mix design report and/or a job standard mix trial report. The result of a type testing procedure is a type test report. This is a formal document which relates only to the formulation which has been tested and which provides proof that the formulation complies with the relevant specification detail.

5 For further guidance on type testing reference should be made to SR28 section 10.2. Additionally, protocols for the initial type testing of asphalt materials in accordance with BS EN 13108-20 *Type testing* are included in Annex C, Annex D, Annex E, Annex F and Annex G of BS594987.

Factory Production Control

6 Factory production control is, in essence, a schedule for a quality system to ensure that, at the asphalt plant, a mix formulation which has already been type tested is manufactured consistently in conformity with requirements such as temperature and that the composition of the mixed material is within certain tolerances of the target. It does not include requirements for measuring performance-related properties of the asphalt other than a requirement that the validation carried out under initial type testing should be repeated at least at five yearly intervals, or when material sources are altered.

7 IS EN 13108-21 is based on certain requirements of ISO 9001 but stands alone and does not require reference to ISO 9001 for its application.

8 So, in summary, a mixture is in conformity with the European Standard if there is a valid type test for the particular mix composition covering all of the specified requirements and if it is produced at a plant conforming fully to the requirements of factory production control.

9 IS EN 13108 does not deal with the subject of "acceptance testing" as this is a contractual issue.

10 For further guidance on factory production control reference should be made to SR28 section 10.3.

NG 928 Determination of the Complex Shear (Stiffness) Modulus (G*) and Phase angle (Δ) of Bituminous Binders Using a Dynamic Shear Rheometer (DSR)

1 The IP equilibrated temperature test method provides a fundamental set of data for type testing purposes. However, as this test is time consuming the temperature sweep test method has been found to be more convenient to check the properties of a binder against the former test and is accepted for this purpose. Where there are differences and/or there is doubt the determining test is the IP test method. It has been found that although the values of G* at any particular combination of frequency and temperature may be different for the two methods the slopes of the graphs of G* against frequency are in very good agreement and in particular values of T2kPa - T2MPa are virtually identical in the two methods.

2 The method of sample preparation for bituminous emulsions limits the maximum temperature for the sample to 100°C to prevent changes to the microstructure of the material that would not be experienced in practice and for cutback binders to minimise

loss of volatile oils, which would only take place after many months on the road. The results for these samples may be more variable as homogeneity is not ensured, but this may be more representative of the condition immediately after application.

3 Fine mineral or organic matter in modified binders containing more than 20% by weight and/or where particles or fibres exceed dimensions greater than 40% of the plate gap may not provide true values. However, repeatable results have been achieved for Lake Asphalt (36% fine filler) and polymer modified binder/filler mixtures used in the manufacture of asphalt of up to 50% by weight of filler. The behaviour of binder/filler mixtures is critical in predicting the performance of asphalt.

4 Most rheometers operate using an air bearing; to avoid damage, the air supply to the bearing should be switched on before the instrument is switched on. When not in use the spindle should be secured. Such instruments should not be operated without air.

5 A rheometer should be used that is capable of controlling the temperature of both the top and bottom of the sample to prevent temperature gradients within the sample for the equilibrated temperature test method and minimise any temperature gradients for the temperature sweep method.

6 When the rheometer uses water or other liquid as the temperature control mechanism, it is advisable to use glycol or a mixture of glycol and water for low temperature work (below 5°C).

7 Caution needs to be exercised in the selection of the plate geometry in order to be assured of achieving accurate results. If not known, the operational limits of stiffness should be determined for each plate geometry in each DSR (either by the manufacturer or the operator). Measurements carried out beyond the limits will give increasingly inaccurate results. Software correction to the stiffness may be acceptable providing appropriate validation is available.

8 Gap settings within the range 0.5 mm to 2 mm and strain settings within the range 0.005 and 0.02, have been found to be suitable for typical proprietary bituminous binders over the temperature range -5°C to +60°C at 0.4 Hz for parallel plate geometries (up to 80°C for some elastomeric modified binders). The gap set will change with temperature and appropriate steps will need to be taken to account for these changes. If the DSR has automatic gap compensation feature then the gap may be set at any temperature within the range to be covered. If the DSR has no gap compensation feature, the gap should be set at the mid temperature of the range to be covered. A suitable means of correcting for gap changes should be used; one way is to gap at each temperature, another is to apply software corrections.

9 Depending on the rheometer used and the sample being tested, it may be possible to measure all the results using a single plate geometry (diameter and gap). The amplitude of the oscillation of the moving plate of the DSR should be such that the sample deformation is within the linear region of the material being tested. The rheometer operator should know the limitations of the instrument and use more than one plate and/or gap if necessary to cover the range for G* at 0.4 Hz of at least 20 MPa to 2 kPa.

10 The check that the test is being carried out within the linear range is most conveniently made by carrying out a strain sweep at both the highest and lowest temperature to be used for the rheological characterisation.

11 It has been found convenient to test at (approximately) the following temperatures as the minimum number needed to generate curves required: -5°C, 5°C, 15°C, 25°C, 35°C, 45°C and 60°C. In order to provide the temperature value within the range of results for the High Equi-stiffness Temperature some binders may require testing at temperatures above 60°C so a further frequency sweep at 70°C or higher may be necessary. The accuracy of ± 0.5°C is a maximum, the target temperature range should be nearer ± 0.1 C. Eleven equally spaced logarithmic frequencies including 0.1, 0.4, 1.6 and 10 Hz have been found to be acceptable. Where the DSR used has pre-set frequencies as close an approximation to even logarithmic spacing should be used as is possible.

12 Errors may be introduced by machine limitations, which should be checked with the rheometer manufacturer, for example:

i) At low sample stiffness, the minimum torque that the instrument can generate and measure accurately may be too high to keep the sample in its linear region.
ii) At 25°C and at a frequency of 0.4 Hz the strain should be typically maintained in the range 0.005 to 0.02.
iii) At high sample stiffness, the maximum torque that the instrument can generate may be insufficient to deform the sample by the minimum amount that can be measured accurately.
iv) At high sample stiffness, the spindle of the moving plate may deform due to spindle compliance, causing an error in the measurement of strain.

v) At short loading times the rotational inertia of the spindle may cause errors in measurement of torque. This type of error is most obvious when the sample stiffness is low.

Values of G* above 107 Pa tend to be less reliable and the difference in values between different bituminous binders becomes less, so effort to improve precision at low temperatures is of little benefit. Also at this limiting stiffness non-linear effects begin and machine compliance becomes a problem.

13 For most binders, over the range 5°C to 60°C it has been found that an 8 mm diameter plate will give sufficiently precise results (although this may be limited at the high temperature end by the precision with which torque can be measured). It may be more convenient to test over the whole range with one test geometry and then to review the results to determine whether a second or even a third geometry may be necessary.

14 Some polymer modified binders exhibit unusual structuring or crystallisation that result in different curves for the temperature sweep when heating and cooling. It is therefore important to record the direction of sweep, cooling is difficult to control so heating is the normal procedure.

15 The data at frequencies other than 0.4 Hz are recorded for future analysis if required. The production of a Master Curve referenced to 25°C would be a useful addition, but is optional. Zero-Shear-Viscosity is required as it may prove to be useful as a performance-related parameter for deformation in asphalt or binder flow in surface treatments. Temperatures of 45°C and 60°C have been chosen to relate to the wheel-tracking test. There are several analysis packages available to carry out this calculation.

16 The notes and guidance supplied in the IP Test Method IP PM CM/02 should be studied, for completeness some of the notes are duplicated or amplified in this clause.

NG 929 Dense Base and Binder Course Asphalt Concrete (Design Mixtures)

1 The requirements in Clause 929 are now based on the European Asphalt Standard IS EN 13108-1 and as detailed in SR28 and BS 594987. This has implications for the verification and validation of mixtures as described below.

2 Clause 929 requires that designed dense base and binder course asphalt concrete mixtures meet the stated detailed requirements. It is the responsibility of the asphalt producer to provide verification of these properties for each mixture in the form of a Type Test Report, in accordance with IS EN 13108-20. This verification will have been carried out in accordance with a protocol given in BS 594987 Annex C. The protocol, based on the job mixture approval trial procedure specified previously in earlier editions of the UK Specification for Highway Works Clause 929, is technically equivalent and provides the same information.

3 For most contracts, the information from the Type Test Report, supported by CE Marking, should be sufficient to demonstrate that the mixture complies with the requirements of Clause 929. Under these circumstances, there is no need for an additional job mixture approval trial. On particularly large or critical projects, there may be a benefit in undertaking validation trials as part of the contract. Where required, these should be carried out in accordance with BS 594987 Annex C and the requirement clearly indicated in Appendix 7/1. It should be noted that this additional testing should only be specified where there is reasonable justification to do so.

4 If required, mix volumetrics can be monitored in the Permanent Works by determining void contents of cores compacted to refusal. This can provide an indication of deformation resistance. It should be noted however, that resistance to permanent deformation assessed by wheeltracking forms part of the Type Test Report. Monitoring void content at refusal will generally only be practicable only on larger contracts. If void content at refusal is to be monitored in the permanent works, this should be clearly indicated in Appendix 7/1.

5 Verification of wheel tracking properties for each mixture will be provided in the form of a Type Test Report in accordance with IS EN 13108-20. This verification will have been carried out in accordance with a protocol given in BS 594987 Annex D. Requirements appropriate to traffic and stress condition should be selected from Table NG 9/9.

6 On particularly large or critical projects it may be appropriate to monitor resistance to permanent deformation in the permanent works. If required, this should be clearly indicated in Appendix 7/1 along with the site classification.

7 When specifying resistance to permanent deformation, it will be necessary to take into account the transitional problems brought about by the change in the wheel tracking test

method from BS 598 part 110 to IS EN 12697-22, which uses similar equipment but different duration and loading. Further information is given in the note to SR28 Table 4 and Table NG 9/9. Work is in hand to establish criteria for the new method, but in the interim, requirements should be based on the BS 598 test but with data provided to show the values for the same mix tested to the IS EN 12697 method.

8 Sub-clause 18 requires a minimum stiffness category of 1800 MPa for mixtures containing 40/60 grade binder. This is a minimum default value for these mixtures and should not be confused with the design stiffness. Further information on design stiffness can be found in HD 26 (DMRB 7.2.3). There is no protocol covering stiffness determination for dense base and binder asphalt concrete mixtures in BS 594987. Therefore, the following Type Testing protocol should be adopted:

'Following the general protocol in BS 594987 Annex C, take an additional, three adjacent core pairs as described in C.3.2. Cut test specimens from these cores and determine stiffness in accordance with IS EN 12697-26 (ITSM method 20°C). The mean of the set of six values shall not be less than 1800 MPa for mixtures containing 40/60 grade binder.'

9 Indirect density gauges, including nuclear density gauges, are specified for compaction control. It is important that these are calibrated across an appropriate range of densities as required by BS 594987. Such gauges have a penetration depth of approximately 80 mm and where layer thicknesses exceed this it is especially important that cores are visually inspected to ensure that they are uniformly compacted.

10 A new requirement for density control close to joints has been introduced. Experience has shown that in-situ void content requirements in the wheeltracks are generally achieved. Therefore, the frequency of testing in this position has been reduced. Compaction at joints is considered to be a primary factor in affecting the durability of asphalt pavements and testing at this location has therefore been introduced. Contractors may need to adopt special measures of joint compaction in order to comply with this requirement.

11 Where dense asphalt concrete base and binder course mixtures are to run on directly by normal highway traffic (due to traffic management requirements) it is recommended that they be surface dressed to prevent water ingress and to provide adequate skid resistance.

Declared Specifications

12 The following tables provide examples of declared specifications derived from the target composition criteria set out in the specification.

TABLE NG 9/9: Classification of Sites by Traffic and Stress Condition for Resistance to Permanent Deformation of Base and Binder course asphaltic concrete to Clause 929

<table>
<tr><td rowspan="3"></td><td rowspan="3">Site Category</td><td rowspan="3">Site Definition</td><td colspan="5">Traffic at Design Life (Commercial vehicles per lane per day)</td></tr>
<tr><td colspan="4">CLASS 1</td><td>CLASS 2</td></tr>
<tr><td>Up to 250</td><td>251 – 500</td><td>501 – 1000</td><td>1001 – 1500</td><td>>1500</td></tr>
<tr><td rowspan="5">I & II</td><td>A</td><td>Motorway (main line)</td><td colspan="3" rowspan="5">Table 9/16, Classification 1</td><td colspan="2" rowspan="5"></td></tr>
<tr><td>B</td><td>Dual carriageway (all purpose) non-event sections</td></tr>
<tr><td>C</td><td>Dual carriageway (all purpose) minor junctions</td></tr>
<tr><td>D</td><td>Single carriageway non-event sections</td></tr>
<tr><td>E</td><td>Single carriageway minor junctions</td></tr>
<tr><td>IA & IIA</td><td colspan="2">As I and II above but with contraflow anticipated during summer months</td><td colspan="2" rowspan="9"></td><td colspan="3" rowspan="9">Table 9/16, Classification 2</td></tr>
<tr><td rowspan="3">III</td><td>F</td><td>Approaches to and across major junctions (all limbs)</td></tr>
<tr><td>G1</td><td>Gradient 3% to 10%, longer than 50m</td></tr>
<tr><td>L</td><td>Roundabout</td></tr>
<tr><td>IIIA</td><td colspan="2">As III above, but with contraflow anticipated ruing summer months or in a south-facing cutting uphill</td></tr>
<tr><td>IV</td><td>G2</td><td>Gradient steeper than 10%, longer than 50m</td></tr>
<tr><td>IVA</td><td colspan="2">As IV above, but with contraflow anticipated during summer months or in a south-facing cutting uphill</td></tr>
<tr><td></td><td>J/K</td><td>Approach to roundabout, traffic signals, pedestrian crossings, railway level crossings and similar</td></tr>
</table>

Table NG 9/10 — Example of a declared specification (AC 32 HDM Base 40/60 des)

Test sieve mm	**Sieve Designation**	**Target Composition Table 4, S.R.28**	**Declared target grading/binder**	**Tolerances from Table A.1, IS EN 13108-21**	**Conformity specification**
40	1,4D	100	100	-2 +0	98 - 100
31,5	D	90 – 100	93	-9 +5	84 – 98
20	Characteristic coarse sieve	71 – 95	81	± 9	72 – 90
6,3	Optional extra coarse sieve	44 – 60	50	± 9 a	N/A [a]
2	2 mm	20 – 40	28	± 7	21 – 35
0,250	Characteristic fine sieve	6 – 20	11	± 5	6 – 16
0,063	0,063 mm	7 – 11	9	± 3	6,0 – 12,0
Binder B_{act} (other crushed rock)	-	Min. 3,7	3,9	± 0,6	3,3 – 4,5

[a] There is no requirement in IS EN 13108-21 to apply a conformity tolerance to an optional extra coarse or fine aggregate sieve. However, to monitor mixture consistency it may be appropriate for the producer to apply the same tolerance as that applied to the characteristic coarse or fine sieve.

NOTE 1 The example given is based on crushed rock aggregate. It should be noted that other aggregates can be used.

NOTE 2 The tolerances shown in the above table apply to the analysis of individual samples in accordance with Table A.1, IS EN 13108-21:2006.

NG 930 EME2 Base and Binder Course Asphalt Concrete (Design Mixtures)

1 EME2 is a durable, deformation resistant, high performance base and binder course mixture, based on established French technology. The designation EME is from the French name Enrobé à Module Élevé ("High Modulus Coated"), and this acronym is being retained to differentiate these mixtures from the traditional High Modulus Base (HMB) materials which have significantly lower binder contents. Further information on the background to the material and the reasons for its introduction are explained in TRL report TRL 636.

2 Two IS EN 13924 binder grades are permitted for use in EME2.

3 The requirements in Clause 930 are as stipulated in IS EN 13108-1 with further guidance given in SR 28 and BS 594987. This has implications for the verification and validation of mixtures as described below.

4 Clause 930 requires that EME 2 base and binder course mixtures meet the stated detailed requirements in terms of constituents, composition, void content, water sensitivity, deformation resistance, stiffness modulus and fatigue properties. It is the responsibility of the asphalt producer to provide verification of these properties for each mixture in the form of a Type Test Report, in accordance with IS EN 13108-20. This verification will have been carried out by laboratory testing of some properties and validation of others by means of a site trial in accordance with a protocol given in BS 594987 Annex E.

5 Generally, the information from the Type Test Report should be sufficient to demonstrate mixture compliance. As EME2 mixtures are new in Ireland, it is considered appropriate to have site validation trials of volumetrics and stiffness carried out on each contract. These should be carried out in accordance with BS 594987 Annex E and the requirement to do so clearly indicated in Appendix 7/1. On particularly large or critical projects, there may be a benefit in undertaking full validation trials as part of the contract. It should be noted that this additional testing should only be specified where there is reasonable justification to do so.

6 Binder content is a critical feature of EME2 mixtures. Therefore, a separate assessment of soluble binder content is included as a safeguard to ensure that binder contents are targeted close to the intended value and do not fall. In order to conform to this requirement, producers will need to maintain production close to mid point.

7 EME2 is a binder rich material and should be more readily compacted to a low void content than traditional DBM, HDM and HMB materials. It is recommended that the trial strips constructed for the Type Test Report are used to evaluate and develop the contractor's method statement for compaction required by Clause 903.5.

8 A new requirement for density control close to joints has been introduced. Contractors may need to adopt special measures of joint compaction in order to comply.

9 EME2 is designed to be laid in thick lifts with small nominal size aggregate. Generally, it is good practice to lay bases in thicker lifts to minimise the number of layers and, hence, interfaces (giving due consideration to the maximum layer thicknesses given in BS 594987)

NG 937 Stone Mastic Asphalt (SMA) Regulating Course

1 The requirements in Clause 937 are stipulated in IS EN 13108-5 with further guidance given in SR28 and BS 594987. This has implications for the verification and validation of mixtures as described below.

2 Clause 937 requires for the volumetric properties of SMA regulating mixtures. It is the responsibility of the asphalt producer to provide verification of these properties for each mixture in the form of a Type Test Report, in accordance with IS EN 13108-20. This verification will have been carried out in accordance with a protocol given in BS 594987 Annex G. The protocol is based on the job mixture approval trial procedure specified previously in earlier editions of the UK Specification for Highway Works, is technically equivalent and provides the same information.

3 The means to specify resistance to permanent deformation for SMA regulating mixtures are contained within this Clause. Requirements appropriate to traffic and stress condition should be selected from Table 9/25. Verification of wheel tracking properties for each mixture will be provided in the form of a Type Test Report in accordance with IS EN 13108-20. This verification will have been carried out in accordance with a protocol given in BS 594987 Annex G.

4 On particularly large or critical projects it may be appropriate to monitor resistance to permanent deformation in the permanent works. If required, this should be clearly indicated in Appendix 7/1 along with the site classification.

5 When specifying resistance to permanent deformation, it will be necessary to take into account the transitional problems brought about by the change in the wheel tracking test method from BS 598 part 110 to IS EN 12697-22, which uses similar equipment but different duration and loading. Further information is given in the note to SR28 Table 4. Work is in hand to establish criteria for the new method, but in the interim, requirements should be based on the BS 598 test but with data provided to show the values for the same mix tested to the IS EN 12697 method.

Declared Specifications

6 The following table provides an example of a declared specification derived from the target composition criteria set out in the specification.

NG 938 Porous Asphalt Surface Course

1 Porous asphalt is not intended for use without prior design approval by the National Roads Authority Standards Section. Guidance to the requirements specified in Clause 938 is contained in HD 27 (DMRB 7.2.4). The use of Porous Asphalt is restricted in accordance with HD36.

2 Clause 938 contains requirements for porous asphalt. The binder shall be preblended polymer modified bitumen.

3 The type of binder permitted, requirements for the physical and geometrical properties of the coarse aggregate and the traffic category should be stated in Appendix 7/1. The specification of specific proprietary modifiers in Appendix 7/1 is not permitted.

4 Before use of a modifier or modified binder the Contractor should provide all necessary information to enable evaluation of the modifier to be carried out and suitable specification clauses for its use to be prepared.

5 Landscaping operations should preferably be completed before laying porous asphalt surface course, to avoid contamination of the surface.

6 Porous asphalt shall be designed to finish on a level grade or on an up-grade and shall not finish or commence at a junction.

Table NG 9/11 — Example of a declared specification SMA 10 reg 70/100

Test sieve (mm)	Sieve designation	Target composition (Table 34, S.R.28)	Declared target grading/binder	Tolerances from Table A.1 of I.S. EN 13108-21	Conformity Specification
14	1,4D	100	100	-2+0	98 – 100
10	D	90 - 100	100	-8 +5	92 - 100
6,3	Characteristic coarse sieve	30 – 55	45 [a]	± 6	39 - 51
2	2 mm	20 - 35	20	± 6	14 - 26
0,063	0,063 mm	6 - 12	12	± 2	10 -14
Binder B_{act}	-	5,7	5,7	± 0,5	5,2 – 6,2

[a] There is no requirement in IS EN 13108-21 to apply a conformity tolerance to an optional extra coarse or fine aggregate sieve. However, to monitor mixture consistency it may be appropriate for the producer to apply the same tolerance as that applied to the characteristic coarse or fine sieve.

NOTE The tolerances shown in the above table apply to the analysis of individual samples in accordance with Table A.1, IS EN13108-21:2006.

NG 942 Polymer Modified Stone Mastic Asphalt Surface Course

1 This Specification for PMSMA surface course systems is not intended to be an exhaustive specification for the use of proprietary-type mixtures, but rather to form a set of minimum requirements for Contractors to tender for work.

Quality Control for Manufacture

2 The initial assessment as to the suitability of PMSMA surface course systems relies on the systems, at a minimum, complying with the quality control requirements detailed in Clause 942 and IS EN 13108-21. Because of the diversity of both systems and roads on which they may be applied, compliance with the minimum requirements in Clause 942 does not automatically mean that the particular system is suitable for every situation where a PMSMA surface course system is required. The appropriate properties need to be checked against the properties of the system as recorded in the quality control for manufacture and Factory Production Control documentation.

3 Although compliance with Clause 942 is a mandatory requirement manufacturers may also specify additional testing and quality control procedures to ensure satisfactory performance of the PMSMA surfacing.

4 The minimum polished stone value of the coarse aggregate and the maximum aggregate abrasion value should be selected from table 9/32.

Performance Levels

5 The deformation resistance of PMSMA surface course systems can be set in terms of wheel tracking level. In deciding on the level, and hence the limiting wheeltracking rate, the limiting wheel-tracking rut depth and the temperature of the test are specified in table 9/36.

6 Specified road/tyre noise levels are only necessary in noise-sensitive areas. The Levels of noise, in terms of reduction relative to hot rolled asphalt, where applicable should be stated.

Surface Macrotexture

7 With reference also to Clause 921, the surface macrotexture obtained with a PMSMA surfacing cannot necessarily be compared to that of a conventional single surface dressing or Hot Rolled Asphalt. With PMSMA surfacings, the choice of target aggregate grading is the Contractor's provided that the

limits specified in table 9/35 are satisfied and the specified minimum surface macrotexture is achieved. To ensure that a macrotexture is provided and maintained on all roads with a mandatory speed of traffic greater than 60km/h, an initial macrotexture depth of 1.5 mm is specified and a minimum requirement of 1.3 mm after three years has been included as part of the Contractor's guarantee.

8 The performance levels of macrotexture depth, i.e. 1.5 mm initial and 1.3 mm after 3 years of trafficking, should be used as the basis for setting the macrotexture depth requirements with a mandatory speed of traffic greater than 60km/h. For PMSMA surface course materials with "negative" macrotexture, the noise tends to decrease with higher macrotexture because there are more paths for the trapped air to escape from, which is contrary to the experience with conventional surfacings having "positive" macrotexture. For urban roads with speed restrictions of 60 km/h or less the initial texture depth may be reduced to 1.2 mm initially and 1.0 mm after three years of trafficking.

9 Whilst measurement of macrotexture depth for compliance purposes is to be by the volumetric patch technique specified in IS EN 13036-1 only, the TRL Mini Texture Meter (Sensor Measured Texture Depth (SMTD)), may be used as a screening procedure, as recommended by BS 598: Part 105.

10 Calibration trials and checks should be undertaken at the start and during the course of work to derive and confirm a relationship between the sand patch method and the SMTD.

11 In the event of a dispute, or discrepancy between the two methods, only results obtained using the volumetric patch technique will be considered for compliance purposes.

12 Calibrations carried out on site are only applicable to that site and that surfacing.

13 SMTD is numerically different from macrotexture measured by the volumteric patch technique. The volumetric macrotexture depth is a measurement of the average depth of hollows in the surface below general level of peaks. SMTD is the standard deviation of the sample height measurements.

14 In a similar way to measuring macrotexture prior to opening to traffic, assessment of macrotexture in the wheel tracks at the end of the guarantee period can be carried out by SMTD methods or mini texture meter, subject to them being calibrated against the volumetric patch technique prior to carrying out a survey.

Surface Preparation, Transportation, Placement and Compaction

15 The design and manufacture of the materials is the Contractor's responsibility, within the constraints of the Quality Control for Manufacture and the Factory Production Control documentation for the system. This transfer of responsibility provides scope for the Contractor to design and place the materials to suit the Contractor's system.

Road Markings

16 Contraflow and maintenance operations often require the application of temporary retro reflecting road studs. There are many proprietary types of stud available. Trials have indicated that many types of stud leave a sticky deposit of bituminous adhesive which clogs the surface voids and some studs also cause pluck-out of surface aggregate. Therefore, trials may need to be performed, at the outer edge of the hard shoulder, to ensure that the studs proposed for use can be removed from the surface without plucking-out surface aggregate or leaving an excessive deposit.

17 Problems have also been reported with preformed marking tapes on negatively macrotextured surfaces coming unstuck in wet weather. Trials should be performed to select the best material.

Guarantee Period

18 The guarantee period should be clearly stated as relating only to the surface course. An appropriate Special Requirement should be included in the Contract Conditions or the Works Requirements, which draws particular attention to sub-Clause 942.17.

NG 943 Hot Rolled Asphalt Surface Course and Binder Course (Performance-Related Design Mixtures)

1 This clause is for the specification of Hot Rolled Asphalt mixtures that have been designed to achieve controlled levels of resistance to permanent deformation (rutting) measured by the wheel tracking test. These mixtures are used as both surface course and binder course. They are particularly suitable as a binder course over bridge deck waterproofing. When used as surface course they must be chipped to provide a skid resistant surface.

2 Using Hot Rolled Asphalt surface course to this clause will ensure a good level of resistance to permanent deformation within the surface course itself. Designers should be aware that significant rutting often occurs in the lower layers of the pavement and use of a performance designed surface course on an inadequate substrate will not protect against this. To provide adequate resistance to deformation, binder course and base designed in accordance with Clauses 929, 930 or 937 should be used, particularly in the top 100 mm of the pavement.

3 In almost all cases, the use of a modified binder or binder modifier will be required in order to achieve the more onerous (Site Classification 2) performance level. Since these are generally proprietary products, sub-Clause 5 requires the submission of information to the Employer's Representative for approval. If there is evidence of successful use of a modified binder/modifier in similar conditions, the presumption should be of approval.

4 Verification of wheel tracking properties for each mixture will be provided in the form of a Type Test Report in accordance with IS EN 13108-20. This verification will have been carried out in accordance with a protocol given in BS 594987 Annex F. This protocol is based on the job mixture approval trial procedure specified previously in earlier editions of Clause 943, is technically equivalent and provides the same information. Requirements appropriate to traffic and stress condition should be selected from Table 9/38 and included in Appendix 7/1.

5 On particularly large or critical projects it may be appropriate to monitor resistance to permanent deformation in the permanent works. If required, this should be clearly indicated in Appendix 7/1 along with the site classification.

6 When specifying resistance to permanent deformation, it will be necessary to take into account the transitional problems brought about by the change in the wheel tracking test method from BS 598 Part 110 to IS EN 12697-22, which uses similar equipment but different duration and loading. Further information is given in SR28 and Table NG 9/12. Work is in hand to establish criteria for the new method, but in the interim, requirements should be based on the BS 598 test but with data provided to show the values for the same mix tested to the IS EN 12697 method.

NG 945 Weather Conditions for Laying Bituminous Mixtures

1 This Clause considers the laying conditions for bituminous mixtures in four separate categories:

i) General, applying to all bituminous mixtures.
ii) Hot bituminous materials laid less than 50 mm thick.
iii) Porous Asphalt and PMSMA surface courses.
iv) Hot Rolled Asphalt with pre-coated chippings.

2 The layer thickness has a major effect on the time available for compaction before the temperature drops below that at which the compaction is effective. Materials laid 50 mm or more thick, other than Hot Rolled Asphalt with chippings, are likely to be tolerant of all but the most extreme conditions encountered in Ireland.

3 For materials at nominal thicknesses below 50 mm, air temperatures and, more particularly, wind speeds have a significant effect. For this situation, Sub-Clause 945.2 calls up Figure 9/4 which gives limiting conditions based on a minimum available compaction time of 8 min. Contractors will need to take account of this requirement in their compaction plans drawn up under sub-Clause 903.5.

4 The weather conditions for the laying of PMSMA surface course systems are covered by Clause 942.

5 Experience with Hot Rolled Asphalt with pre-coated chippings led to the conclusion that the most appropriate combination for laying in Irish weather conditions was a 35 % stone content mixture laid at a nominal 50 mm thickness. Sub-Clause 945.4 gives specific limiting delivery, air temperature and wind speeds for this mixture and thickness only. These requirements for Hot Rolled Asphalt with pre-coated chippings are based on a minimum available compaction time of 10 min from the time the material emerges from the paver. The use of modified binders in the Hot Rolled Asphalt can change the relevant conditions.

6 The additional constraints that can apply in during winter and/or night-time laying that can affect the suitability of the weather conditions include:

i) The temperature of bituminous mixtures drops rapidly during winter and night time laying operations. Extra care needs to be taken to ensure bituminous mixtures are adequately protected

during transportation, off loading, laying and rolling.

ii) Cooling of bituminous layers, factors affecting cooling (wind chill, temperature) and time available for compaction (particularly during short night time lane possessions) needs to be borne in mind whilst planning for laying operations.

iii) Human factors and health, welfare and safety implications should be given extra consideration for winter and night time working.

7 The requirements of BS 594987 and Clause 903 still apply, unless specifically amended by this Clause.

TABLE NG 9/12: Classification of Sites by Traffic and Stress Condition for Resistance to Permanent Deformation of Performance Related HRA Surface Course and Binder Course (performance related design mixtures) to Clause 943

<table>
<tr><td rowspan="3"></td><td rowspan="3">Site Category</td><td rowspan="3">Site Definition</td><td colspan="5">Traffic at Design Life (Commercial vehicles per lane per day)</td></tr>
<tr><td colspan="4">CLASS 1</td><td>CLASS 2</td></tr>
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<tr><td>B</td><td>Dual carriageway (all purpose) non-event sections</td></tr>
<tr><td>C</td><td>Dual carriageway (all purpose) minor junctions</td></tr>
<tr><td>D</td><td>Single carriageway non-event sections</td></tr>
<tr><td>E</td><td>Single carriageway minor junctions</td></tr>
<tr><td>IA & IIA</td><td colspan="2">As I and II above but with contraflow anticipated during summer months</td><td colspan="3" rowspan="8"></td><td colspan="2" rowspan="8">Table 9/38, Classification 2</td></tr>
<tr><td rowspan="3">III</td><td>F</td><td>Approaches to and across major junctions (all limbs)</td></tr>
<tr><td>G1</td><td>Gradient 3% to 10%, longer than 50m</td></tr>
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<tr><td>IIIA</td><td colspan="2">As III above, but with contraflow anticipated ruing summer months or in a south-facing cutting uphill</td></tr>
<tr><td>IV</td><td>G2</td><td>Gradient steeper than 10%, longer than 50m</td></tr>
<tr><td>IVA</td><td colspan="2">As IV above, but with contraflow anticipated during summer months or in a south-facing cutting uphill</td></tr>
<tr><td></td><td>J/K</td><td>Approach to roundabout, traffic signals, pedestrian crossings, railway level crossings and similar</td></tr>
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