ROAD PAVEMENTS – BITUMINOUS BOUND MATERIALS

Contents

Contents – continued on next page

ROAD PAVEMENTS – BITUMINOUS BOUND MATERIALS

Contents – continued

Road Pavements – Bituminous Bound Materials

NG 900 General

1 Advice on the design, construction and maintenance of bituminous roads is published in The Design Manual for Roads and Bridges (DMRB) Volume 7.

NG 901 Bituminous Base and Surfacing Materials

General

1 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.

The designation of products such as DBM50 refers to the penetration reference for 40/60 grade as defined in Table 1 of IS EN 12591. The penetration reference is defined in the 'Foreword' of BS 4987-1 and for most bitumen grades is a mid-point of the permitted penetration range which is regarded as a target for that grade.

Requirements included in Appendix 7/1 may include penetration reference of binder and binder modifier and aggregate properties such as polished stone value, aggregate abrasion value, Los Angeles coefficient value, magnesium sulfate soundness value and water absorption as specified in IS EN 13043.

DMRB, Volume 7, HD 36 gives guidance on aggregate properties for new bituminous surfacings. In general the minimum Polished Stone value (PSV) requirement for aggregates for surfacing materials and pre-coated chippings for application to HRA surface courses shall be $PSV60_{declared}$. In some heavily trafficked, high stress locations more onerous physical properties will apply. Reference should be made to Table 3.1 of DMRB, Volume 7, HD 36.

Aggregates for Bituminous Materials

2 With the implementation of IS EN 13043 "Aggregates for bituminous mixtures and surface treatments for roads, airfields and other trafficked areas", it will be necessary to incorporate the mechanical test values and test methods specified in this standard.

The use of natural and artificial aggregates is permitted.

There is no current test procedure for cleanness other than the requirement for aggregates to meet the specified BS 594 and BS 4987 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.

The soundness value test should initially be used for source approval of aggregates, and thereafter only in cases where their durability is suspect. 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.

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.

Transporting, Laying and Compacting

3 The purpose of Clause 901 is to place reliance on mechanisation of operations to facilitate compliance with the thickness and surface regularity requirements, particularly of surface courses, and to ensure operation of the paver is such that

hand raking and making up of surface course material is virtually eliminated, except at edges and joints. Hand-laying is also limited to places where operation of a paver is impracticable.

4 Clause 901 does not relate to laying waterproofing systems on bridge decks. The laying of hot paving materials on bridge deck waterproofing systems should be adequately supervised to ensure the waterproofing system is not damaged by excessive heat. Stockpiling of hot materials should take place off the structure or on suitably protected areas.

5 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 a requirement for site trials of vibratory rollers, proposed as an alternative to conventional deadweight rollers, is included. 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.

6 The frequency and amplitude of vibrating roll and travelling speed of the roller which have been found to be satisfactory in the trials should be used for compaction.

7 The assessment of compaction of base and binder courses shall normally be carried out by means of PRD tests or by determination of air voids content for design mixes. PRD is the ratio of the bulk density of core samples of laid material compared with the refusal density of the material when determined from the same core samples. It is therefore a direct measure of the degree of compaction of the material.

8 When reliance is placed on a method specification for the control of compaction of bituminous materials, close attention should be paid to the temperature of the material. BS 594-2, BS 4987-2 and Clauses 930, 932 to 934 lay 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. For all practical purposes where material is tested for adequacy of compaction in accordance with Clauses 929, 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.

9 BS 4987: Part 2 provides for compliance testing based on material laid in areas of 1,000 m^2 or the material laid in any one day where this is less than 1,000 m^2. At the discretion of the Employer's Representative a reduction may be made in the amount of testing by not carrying out the full PRD test method on each area of 1,000 m^2 or days work when less. On those areas which are not cored, nuclear density gauges may be used on a relative basis, having first established the gauge density reading equivalent to a level of compaction of 93% PRD for a particular source of material. Two determinations of density using a nuclear density gauge should be substituted for each core. Nuclear density gauges should only be used for control purposes. Compliance with the Specification should be judged from values determined from the coring procedure specified. Further savings in the amount of testing can be made by not carrying out the part of the test method which determines refusal density of the core material. This should only be omitted, however, once a consistent level of refusal density has been established for a particular source of material. In both cases full PRD tests should be carried out on a regular basis alongside the modified testing methods. Further information regarding the use of nuclear density gauges is given in the Transport and Road Research Laboratory Supplementary Report SR 754.

10 The objective of the PRD specification is to obtain uniform compaction of 95% Refusal Density in the dense macadam. The Specification limit of 93% has been chosen following precision trials which have indicated a standard deviation for the test used on macadam base of about 1.5% on single core pairs (TRL Reports SR 717 and CR1 refer). Using this data it can be shown that for a mean density of 95% Refusal Density not more than one in one hundred results of the average of three core pairs should fall below 93%. For compliance with the Specification this can be taken as no result falling below 93%.

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 when the amount of reclaimed bituminous materials to be added to the mix exceeds 10%. 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 Employers 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, and that the aggregate quality is adequate for reuse.

NG 904 Not Used

NG 905 Not Used

NG 908 Not Used

NG 910 Rolled Asphalt Surface Course (Recipe Mix)

1 The composition of the permitted mixture shall be in accordance with BS 594-1 and is listed in Table 9/2.

NG 911 Rolled Asphalt Surface Course (Design Mix)

1 The special requirements included in Appendix 7/1 may include the appropriate table and column numbers of permitted mixtures from BS 594-1. Additionally the required Marshall stability and flow and the required properties for coated chippings, such as PSV and AAV, should be included.

2 The method of determining the design binder content for surface course mixtures is described in BS 598: Part 107. Determination of the target binder content, by adjustment of the design binder content, is described in BS 594-1 for surface course design mixtures. The target binder content is always at or above the design binder content. The design binder content is the quantity of bitumen required for the mix in order to achieve the required stability. There are occasions when this design binder content would be too low for long term durability. Therefore, a minimum target binder content is required by the British Standard and this may be above the design binder content.

3 The required Marshall stability and flow values, when tested on laboratory specimens made in accordance with BS 598: Part 107, should comply with the

requirements of BS 594-1, Annex B. Verification of the design should be carried out in accordance with that Annex. Samples prepared from plant-produced material, and tested in accordance with the procedures of BS 598: Part 107, are not directly comparable with those obtained on laboratory prepared specimens. The range of values of Marshall stability given in BS 594-1, Annex B permit a number of mixtures using locally available materials; however the specified stability should be the mid-point of the range.

4 Checks on production material should normally be by analysis, in accordance with BS 598: Part 102 and comparison with the composition of the design, together with checks on the properties of the constituent materials. Advice on the possible use of Marshall tests on specimens produced from production material is given above.

NG 912 Close Graded Macadam 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 High Speed roads. Accordingly, it is for use on low speed roads where the 85th percentile traffic speed is 50 km/h or less.

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 Table 9/2 and stated in Appendix 7/1.

3 The traffic category in relation to the tables of BS 4987-1 should be specified in Appendix 7/1. BS 4987-1 Category A traffic may be taken as being equivalent to 2.5 million standard axles (msa), or more, for a 20 year design life.

4 Special requirements included in Appendix 7/1 may include grade of binder and type of aggregate. Advice is given in BS 4987.

NG 913 Not Used

NG 914 Not Used

NG 915 Coated Chippings for Application to Pre-mixed Surfacings

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. BS 594-1 covers action to be taken, including 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 Macadam Surface Course

1 The nominal size of aggregate for open textured macadam surface course will be 0/10 mm as stated in Table 9/2.

2 Special requirements included in Appendix 7/1 may include grade of binder and type of aggregate. Advice is given in BS 4987.

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.

Rectification of new construction should be carried out in accordance with sub-Clause 702.10.

NG 918 Slurry Sealing

These notes include and extend in some respects the main points of advice on slurry sealing given in BS 434: Part 2.

1 For works of magnitude the full control testing programme should be undertaken, but for a small area of work it may be preferred to judge the material on the basis of the required field trials.

2 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.

3 The usual additives used to control consistency, mix segregation, and setting rate are Portland cement (CEM I) to IS EN 197 : Part 1 or hydrated lime to BS 890. However, it is advisable to consult the emulsion manufacturer for advice on this point.

4 Techniques for mixing and laying vary according to the type of emulsion used and in some cases the use of a cationic tackcoat Class K1-40 is recommended before laying the slurry. The machines should be equipped to give a light spray of water onto the tackcoat film just before the slurry is spread. After the slurry has set sufficiently it may sometimes be necessary to roll it with a multi-wheeled smooth tread rubber-tyred roller. The manufacturer of the emulsion should be consulted on the desirability of rolling and also tack coating.

5 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.

6 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 2003.

3 The Contractor should state with his tender submission the source of his aggregates and provide accredited results of the physical and geometrical properties for each source.

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

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

6 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.

7 The binder sprayer should be checked for accuracy of transverse distribution using the test method stated. This assesses the ability of the spraybar 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 9/9.

TABLE NG 9/9: Accuracy of Binder Sprayer

Site	Coefficient of Variation (Cv)	Class
Motorways and Dual Carriageways	< 10%	3
Single Carriageways	< 12%	2
Lightly Trafficked Single Carriageways	< 15%	1

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

9 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.

10 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 maintenance 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.

11 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.

12 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.

13 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.

14 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.

15 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 Employers 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 Employers 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.

16 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 Sprays

Bond Coats and Tack Coats

1 This Clause specifies tack coats and bond coats for coated macadam, 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.

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 594-2 and BS 4987-2 for hot rolled asphalts and coated macadams, 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 and the British Standards as appropriate. 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 texture of Bituminous Surface Courses

1 The depth of surface macrotexture is more important on high speed roads than on low speed roads.

2 Embedment of chippings, resulting in loss of surface macrotexture and reduced resistance to skidding at high speeds, accompanies deformation. This problem occurs most frequently in the slow lane of roads carrying a high volume of heavy commercial traffic.

3 The level of surface macrotexture on high speed roads required for 1000 metre sections of carriageways with bituminous surfacings is an average of 1.5 mm or more. This is easily achieved with surface dressings. Experience with rolled asphalt surface course indicates that the required macrotexture can be consistently achieved if proper attention is paid to all the relevant factors at time of laying and applying the chippings.

4 To achieve high rates of spread, chippings must be of good shape and free flowing. The chipping machine must be capable of spreading coated chippings at a uniform and consistently high rate. Regular checking of the rate of spread, together with any necessary adjustments to the machine, should be carried out throughout the laying of the surface course.

5 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, may be used as a screening procedure, as recommended by BS 598: Part 105.

6 Calibration trials should be undertaken at the start of work to derive a relationship between the volumetric patch technique and the TRL Mini Texture Meter.

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

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

9 Sensor Measured Texture Depth (SMTD) is numerically different from macrotexture depth measured by the volumetric patch technique. Volumetric patch macrotexture depth is a measurement of the average depth of the hollows in the surface below the general level of the peaks. SMTD is the standard deviation of the sample height measurements.

NG 922 Not Used

NG 923 Not Used

NG 924 Resin Based High Skid Resistant Surface Treatment

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 are highly effective in reducing traffic accidents on sites with high traffic density and skidding risk. Typical sites are the approaches to signal controlled junctions, roundabouts and pedestrian crossings subject to a heavy flow of vehicles.

3 These surfacings are very expensive, particularly where productivity is affected by the geometry of the site and the number of areas to be treated. 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 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 and Their Component Materials

1 Methods of sampling and testing of mixtures or materials not covered by a British Standard or European Norm, eg sampling plates behind the paver, should be specified in Substitute or Additional Clauses. Non-standard sampling procedures are not recommended.

2 Where alternative sampling procedures are given in the British Standard or European Norm it is recommended that site sampling should be adopted.

3 The frequency of acceptance testing for mixed materials should be approximately one test for every 100 tonnes of material laid in straight runs, but not less than two samples of mixed material manufactured to any one specification should be taken daily. On contracts where the output of mixed materials is large, frequency of testing may be reduced if the quality of the material being supplied is consistently satisfactory.

NG 926 Not Used

NG 927 Not Used

NG 928 Not Used

NG 929 Design, Compaction Assessment and Compliance of Base and Binder Course Macadams

1 The Specification for Road Works (SRW) requires that where a design mix is approved for bitumen macadam, DBM50 or heavy duty macadam (HDM50), for use as base or binder course, then compaction trials shall be carried out, unless otherwise stated in Appendix 7/1.

2 Clause 929 permits Contractors to design macadams to meet an 'end product' specification and represents a major departure from the traditional 'recipe' approach previously used in Ireland and the UK. BS 4987-1 sets out well established recipes for macadams based on past experience but regardless of material source or type. Clause 929 requires that a Contractor's proposed target aggregate grading and target binder content lie within the fixed composition envelopes and binder contents specified in BS 4987-1. However, in order to allow as much freedom as possible to the

Contractor in designing a mix appropriate to the materials to be used, the tolerances that may be applied to the proposed target aggregate grading and the target binder content are set out in Table 9/5. The Contractor's design trials may involve mixtures compacted in the laboratory or field laying trials, at the option of the Contractor. This note should be read in conjunction with NG 929.11.

3 BS 4987 provides no guidance on the design of mixes to achieve stable mixtures resistant to deformation nor any guidance on trials to validate mix designs. The objectives of the Job Mixture Approval trial are to demonstrate that the mix will be stable and resistant to deformation and that it will be durable. This should be achieved by ensuring that there is always a minimum air void content in the mixture even at the ultimate state of compaction at the Refusal Density, as determined by the procedures set out in BS 598: Part 104, and by ensuring that the in situ void content is not excessive. It should be noted that a design procedure is not being proposed, rather a means by which a Contractor's proposals for a macadam mixture may be evaluated.

4 Nuclear density gauges in general use typically penetrate to a depth of approximately 80 mm. Where layer thicknesses exceed 80 mm it is especially important that cores are visually inspected to ensure that they are reasonably uniform. A slight increase in voidage at the base may be expected but it should not be excessive. If voidage is excessive additional cores will establish the area affected. Further information regarding the use of nuclear density gauges is given in the Transport and Road Research Laboratory Supplementary Report SR 754.

5 The average binder content by volume at each location in the trial area is determined to check that the minimum binder content of the Contractor's mix design exceeds the minimum volume specified to ensure the durability of the mixture.

6 The stiffness modulus and deformation resistance determined from cores in the trial area are required to enable both Contractors and Employers Representatives to gain experience of values achievable with mixtures currently in use.

7 When assessing trials, it is necessary to ensure the materials can be laid to achieve the regularity requirement specified in the Series 700.

8 On completion of successful trials, the target aggregate grading and target binder content are established by the Contractor. This becomes the mixture (referred to as 'the job standard mix' in some specifications), about which the tolerances in Table 9/5 are applied for the purposes of assessing compliance.

9 The compaction of macadam layers should be checked for compliance as each constructed layer is completed. The maximum depth of sample permitted in the PRD test is 150 mm. This is also the maximum layer thickness permitted in BS 4987.

10 If a layer exceeds 150 mm thickness it should not do so by more than the tolerance permitted in Clause 702, which is 30 mm. The maximum layer thickness (core length) is therefore 180 mm. Should a core exceed 150 mm in this manner, then the lower excess portion should be removed by saw-cutting which will increase the core density slightly. This is not unexpected and reflects the boundary conditions known to exist.

11 Some aggregate types do not readily compact in laboratory trials and 'full' refusal density will not be obtained. It has been noted in TRL research (SR 717) that a difference in compaction level can be achieved with loose mixtures compacted to refusal in the laboratory, compared to a core of the same mixture compacted to refusal after being laid in the field, with the field mixtures giving lower air void contents. For this reason, checking of air void contents at refusal should be performed on cores from the mat. Nevertheless, Contractors may use a laboratory compaction technique in order to gain an indication of the possible levels of air void content that might be achieved on site.

12 Problems have sometimes been experienced in achieving complete coating of coarse aggregates in base and

binder course macadams and this is often related to the use of a particular aggregate source. The use of a design approach should assist Contractors to overcome this by permitting designed adjustments to the grading and binder content of the mixture, subject to meeting the requirements set out in Clause 929. This note should be read in conjunction with NG 930.

NG 930, NG 932, NG 933 and NG 934 Heavy Duty Macadam and Dense Bitumen Macadam with Grade 40/60 Penetration Binder, Base and Binder Course

1 The stiffer binder in these materials requires a higher mixing temperature to achieve the required binder viscosity and coat the aggregate properly. A longer mixing time should be expected with the increased proportion of filler in heavy duty macadam in order to distribute the binder and coat the aggregate properly. It may be possible for manufacturers to avoid increased mixing times by increasing the binder content within the permitted range. Inspectors should ensure that the material is properly mixed and coated, especially with the first deliveries to the site. Laying temperatures will normally be higher to achieve the required workability with stiffer binder.

2 For binder course, the traffic category in relation to the tables of BS 4987-1 should be specified in Appendix 7/1. BS 4987-1 Category A traffic may be taken as being equivalent to 2.5 million standard axles (msa), or more, for a 20 year design life.

3 Attention is drawn to the notes to Clause 4.5.1 of BS 4987-1.

NG 935 Not Used

NG 936 Not Used

NG 937 Not Used

NG 938 Porous Asphalt Surface Course

1 Guidance to the requirements specified in Clause 938 is contained in HD 27 (DMRB 7.2.4).

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.

NG 942 Thin Surface Course Systems

1 Thin surface course systems are proprietary bituminous products with suitable properties to provide a surface course that is laid at a nominal depth of less than 40 mm. As such, this classification can include hot-mixed asphalts.

2 This Specification for thin 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.

3 In accordance with HD36 and the NRA Addendum to HD36 (NRA DMRB Vol. 7 Section 5, Part 1) thin surfacings are for use with restriction. All thin surfacings proposed for use shall have obtained prior approval from the National Roads Authority and in addition approval for the specific site where the system is to be installed.

Quality Control for Manufacture

4 The initial assessment as to the suitability of thin surface course systems relies on the systems, at a minimum, complying with the quality control requirements in sub-Clauses 942.2, 942.3 and 942.4 of the specification for road works. Due to the introduction of European (CEN) Norms in the near future, Clause 942 of the specification attempts to introduce the methodology employed in specifying thin surfacings to these standards and the concept of Factory Production Control. However, 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 thin 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.

5 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 thin surfacing.

6 The minimum polished stone value of the coarse aggregate should be selected from Table 3.1 and the maximum aggregate abrasion value from Table 3.2 in HD 36 (DMRB 7.5.1).

Performance Levels

7 The deformation resistance of thin 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 9/18 of series 900 of the specification. The wheel tracking level of the thin surface course system are as stated in table 9/18, however other applications on the Non-National network may reference lower levels in accordance with their requirements.

8 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

9 The minimum macrotexture depth required from hot rolled asphalt surfacing on high-speed National Roads is 1.5 mm. There are no surface macrotexture requirements for low speed roads (a road where the 85 percentile traffic speed is less than 50 km/h) surfaced with hot rolled asphalt, reliance being placed on the macrotexture produced by the minimum rate of chippings required by BS 594-2. However, the surface macrotexture obtained with a thin surfacing cannot necessarily be compared to that of a conventional single surface dressing or hot rolled asphalt. With thin surfacings , the choice of target aggregate grading is the Contractor's provided that the limits specified in table 9/16 are satisfied and the specified minimum surface macrotexture is achieved. To ensure that a macrotexture is provided and maintained on all roads, 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.

10 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. For thin 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 50 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.

11 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.

12 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.

13 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.

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

15 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.

16 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

17 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

18 Contraflow and maintenance operations often require the application of temporary retroreflecting 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.

19 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

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

This page is intentionally blank.