SERIES NG 800
ROAD PAVEMENTS - (05/01) UNBOUND, HYDRAULICALLY BOUND AND OTHER MATERIALS

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ROAD PAVEMENTS - (05/01) UNBOUND, HYDRAULICALLY BOUND AND OTHER MATERIALS

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NG 800 (05/01) General

1 (05/04) Advice on design and construction of subbases and bases (roadbases) is published in The Design Manual for Roads and Bridges (DMRB) Volume 7. The Clauses in Series 800 now refer to BS EN 13285, Unbound mixtures – specification. The new standard applies to unbound mixtures of natural, manufactured aggregates such as slags and recycled aggregates. DMRB also includes advice on the use of recycled materials, see HD 35: Conservation and The Use Of Secondary and Recycled Materials (DMRB 7.2.1).

NG 801 (05/04) General Requirements for Unbound Mixtures for Subbase

1 BS EN 13285 specifies the requirements for unbound mixtures used for the construction and maintenance of roads and other trafficked areas. All unbound mixtures used in subbase layers must comply with BS EN 13285. The requirements for the properties of aggregates used in unbound mixtures are defined by appropriate cross-reference to BS EN 13242.

2 Because BS EN 13285 aims to satisfy differing custom and practice across many member states of the European Economic Area (EEA), the standard contains many choices, which are set out in tables. The structure of the tables allows the user to choose an appropriate category for each mixture property. None of the combinations of categories from BS EN 13285 give a mixture that is directly equivalent to the established types of granular subbase material specified in previous editions of Specification for Highway Works (SHW).

3 After detailed review of established practice and the capability of UK suppliers, the unbound mixtures in Table 8/1 have been chosen. The table defines each mixture using a combination of categories for:

i) designation - in terms of lower sieve size (d) and the upper sieve size (D). The lower size sieve (d) = 0 for all unbound mixtures defined by BS EN 13285.

ii) maximum fines - as measured by the percentage by mass passing the 0.063 mm size sieve.

iii) oversize - in terms of the percentage by mass of particles passing a sieve size two times the upper sieve size ($2D$) and retained on the upper sieve size (D).

iv) overall grading - the combination of overall grading category and designation define the grading envelope.

For some mixtures, the overall grading category defines additional requirements to control the grading of individual batches, as detailed in Tables 8/5, 8/6 and 8/7.

4 It is unlikely that a single source of supply will routinely comply with the requirements for all three of the mixtures. Compliance depends upon the type of aggregate and the capability of the production process. Other BS EN 13285 mixtures not detailed in Table 8/1 should only be used after consultation with the Overseeing Organisation.

5 The limiting values for sulfate characteristics in sub-Clauses 801.2 and 801.3 have been chosen to ensure that problems do not occur due to oxidation of reduced sulfur compounds such as pyrite. Further guidance is given in sub-Clause NG 601.8.

6 The scope of BS EN 13285 is limited to the properties of unbound mixtures at the point of delivery; it does not include water content or the properties of the finished layer. To assist in the selection of an appropriate source and to help control compaction, the system of factory production control required for the unbound mixture includes an annual declaration of a typical value of laboratory dry density and optimum water content for each unbound mixture.

Frost susceptibility, plasticity, CBR and trafficking trials are outside the scope of BS EN 13285. The requirements of Series 800 apply to these mixture properties.

Aggregates Used in Unbound Mixtures

7 BS EN 13285 requires the aggregates used in unbound mixtures to comply with BS EN 13242, Aggregates for unbound and hydraulically bound materials for use in civil engineering work and road construction. Because BS EN 13242 aims to satisfy differing custom and practice across many member states of the EEA, the standard contains many choices, which are set out in tables. The structure of the tables allows the user to choose an appropriate category for each required aggregate property. BS EN 13242 also

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permits the use of the category "No requirement" for properties that are not relevant to a particular end use or origin of the mixture, in the interest of efficiency and economy. Further guidance on the use of BS EN 13242 is given in the Published Document PD 6682-6 'Aggregates for unbound and hydraulically bound materials for use in civil engineering work and road construction - Guidance on the use of BS EN 13242' published by BSI.

8 The requirements for aggregates in Table 8/2 have been chosen after detailed review of established practice and the characteristics of UK aggregates. The table defines each aggregate used in the mixture as a combination of categories for:

i) **Crushed or broken particles - to ensure adequate aggregate interlock.** Crushed rock aggregates should be assumed to be in Category C90/3 without further testing. Where permitted, the use of Category C50/10 for crushed gravels ensures that not more than 10% of the particles are fully rounded.

ii) **Los Angeles coefficient - to control resistance to fragmentation.** The Los Angeles test replaces the Ten Percent Fines (TPV) and the Aggregate Impact Value (AIV) tests. The Los Angeles test can only test aggregate in a dry condition. There is not a direct correlation between the Los Angeles test and the BS 812 tests it replaces.

iii) **Magnesium sulfate soundness - to ensure resistance to freezing and thawing.** Category MS_{35} provides a level of resistance that is directly equivalent to the BS 812-121 value of greater than 65.

9 The micro-Deval test is used in some countries, notably France, to measure the resistance of aggregate particles to the abrasion caused when interlocking particles are subjected to repeated loading in the presence of water; particularly in thinner pavements with greater strains in the lower layers. The property measured by the micro-Deval test is not normally specified so Category M_{DE}NR (no requirement) is used. The supplier of the mixture is required to monitor micro-Deval values as part of the system of factory production control required by BS EN 13242. The value for the aggregate used should be stated to aid comparison between sources and so that the potential for the future use of this property can be reviewed.

10 Water absorption is not normally specified so Category WA_{24}NR (no requirement) is used. The supplier of the mixture is required to monitor water absorption values as part of the system of factory production control required by BS EN 13242. The value for the aggregate used should be stated. If necessary, the value may be used to provide a baseline for routine water absorption tests on delivered material. If any result from the tests on routine deliveries exceeds the declared value (d) by more than 0.5% further investigation will be required. Routine water absorption tests are not generally required for aggregates with a declared value of 2.0% or less.

11 In previous editions, blast furnace and steel slags were identified separately from other materials. The requirements for these materials, including those in BS 1047, are now incorporated into BS EN 13242. Table 8/2 defines requirements using categories for:

i) Volume stability for blast furnace slags - in terms of disintegration tests based on established UK requirements from BS 1047.

ii) Volume stability of steel (BOF and AEF) slags - in terms of a steam expansion test for which there is limited UK experience. Where permitted, the specified category is the most onerous. Evidence of recent satisfactory use of steel slag aggregate from the same source should also be obtained.

Recycled Aggregates

12 BS EN 13285 includes manufactured (such as slags and ashes) and recycled aggregates within its scope without specific mention in the requirement clauses. The approach adopted is blind to the source of the aggregate used in the mixture. The suitability of mixtures containing manufactured and recycled aggregates for use in subbase should be assessed in accordance with the requirements of the Series 800 Clauses.

13 The test procedure adopted in Clause 710 for identifying and quantifying constituent materials in recycled coarse aggregate and recycled concrete aggregate is a qualitative method. Where constituents other than those deemed to comply with the particle density requirements by the qualitative classification can be shown to be of a higher particle density, they may be included within these higher density fractions provided that written agreement has been given by the Overseeing Organisation.

14 Sub-Clauses 803.4, 804.4, and 805.4 describe requirements for material passing the 0.425 mm sieve. Were the foreign materials component of recycled coarse aggregate or recycled concrete aggregate to be 'clay lumps', the material may fail these tests and hence fail to meet the Specification.

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Unbound Mixtures Produced as Part of The Works

15 BS EN 13242 (see Annex C) and BS EN 13285 (see Annex D) specify the operation of a factory production control system to confirm conformance with the relevant requirements of the standards. Although unbound mixtures produced on site as part of the Permanent Works are not placed on the market, a factory production control system (or a quality plan with equivalent requirements) is still required to provide the necessary level of assurance.

Frost Heave

16 The frost heave test described in BS 812-124 is costly and time consuming and is not suitable for routine control checks on Site. The test has been developed from earlier test methods to overcome problems of repeatability and reproducibility. The test is primarily intended as a method to establish whether or not an aggregate from a particular source is likely to be frost-susceptible when used in an unbound condition within that part of the road pavement subject to frost penetration. Material for the frost heave test must be representative of the source and comply with all other requirements of the Specification otherwise the test is superfluous. Once a material has been established as non-frost-susceptible the test need only be repeated if the material varies from the original sample, or where the source is changed.

17 Clause 6 of BS 812-124 sets down the procedure for adjusting the water level in the self-refrigerated unit (SRU). A possible problem has been identified that with the tolerances given to the dimensions for the cradle and specimen carriers it is possible for the porous discs in the specimen carriers to be located incorrectly in relation to the water level. In order to guard against this it is recommended that before testing commences the cradle and specimen carriers be put into the SRU without samples. A check is then made to ensure that discs are set at the level specified in the above-mentioned standard.

18 The requirement for material to be non-frost susceptible within 450 mm of the surface of a road or paved central reserve may be reduced to 350 mm if the Mean Annual Frost Index (MAFI) of the site is less than 50. The Frost Index is a measure of the severity of a period of cold weather and provides a means of assessing likely penetration of frost into a road. Frost index is measured in 'degree days Celsius below zero' and is calculated by taking the mean air temperature for each twenty four hour period and adding those values together. Frost penetration into a modern road in the British Isles may be estimated using the formula $x = 40\sqrt{I}$ where x is the approximate penetration in mm and I is the frost index for the freezing spell. The Annual Frost Index is the frost index accumulated over a year commencing September 1st. Mean Annual Frost Index (MAFI) is the average of all the frost index values computed for each year since September 1959. The MAFI for a site is determined using records from one or more meteorological stations close to the site, taking account of local geographical variation, such as high ground or frost hollows. Different requirements for different parts of a contract length may be used.

Further information on the MAFI can be found in HD 25.

Advice relating to any site, including the MAFI calculated for that site, may be purchased from:

Customer Centre
The Met. Office
Powell Duffryn House
London Road
Bracknell
Berks
RG12 2SY

Tel. No: 0845 300 0300
Fax No: 0845 300 1300
E-mail: climate@meto.gov.uk

NG 803 (05/04) Type 1 Unbound Mixtures for Subbase

1 The inclusion of up to 10% natural sand passing the 4 mm test sieve is permitted at the discretion of the supplier to adjust the material grading. Maximum limits of material content are included for asphalt and foreign material in recycled coarse aggregate and recycled concrete aggregate.

2 BS EN 13285 details additional requirements to control individual batches of unbound mixtures with an overall grading Category G_P, within a system of factory production control. Table 8/5 in Clause 803 illustrates this. The supplier must nominate a supplier declared value for the intermediate sieves in the grading envelope as part of the system of factory production control for the mixture. The nominated value must lie within the supplier declared value grading range in Table 8/5. Individual batches are then assessed using the tolerances in Table 8/5, applied to the supplier declared values. As explained in Annex B (informative) of BS EN 13285, the use of tolerances does not change the overall grading range.

3 Table 8/5 also includes requirements for the calculated difference between the values of percentage by mass passing selected adjacent sieves. These requirements are taken from BS EN 13285 and ensure a 'well graded' mixture by controlling the continuity of the grading curve.

4 Because the requirements for aggregates used in the unbound mixtures now refer to the requirements of BS EN 13242, confirmation of conformity with the

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categories for Los Angeles coefficient and magnesium sulfate soundness can be obtained from the CE Mark Certificate for the aggregates used in the mixture. If a CE Mark Certificate is not available to confirm the suitability of the source, test certificates should be provided from a testing laboratory accredited by an appropriate organisation accredited in accordance with sub-Clauses 105.3 and 105.4 for the test, showing a value in excess of the minimum specified and dated not more than 6 months prior to the start of the contract.

5 Whilst there is no specified moisture content for laying and compacting unbound mixtures to Clause 803, in order to satisfy the requirements of sub-Clauses 802.8 and 803.7 it will be necessary to carry out these operations at optimum moisture content or thereabouts.

Mixtures Containing Crushed Gravel Aggregates

6 Previous editions of Clause 803 excludes all gravels from granular subbase material Type 1 but crushed gravel aggregate is permitted by BS EN 13285. Where local experience indicates that mixtures containing crushed gravel materials can be used successfully, the Overseeing Organisation may permit their use.

7 This edition of Clause 803 incorporates the requirements for crushed gravel subbase materials previously published as Clause 850SE. Trafficking trials of crushed gravel subbases used in Scotland have produced rut depths well within the upper limit (30 mm) recommended by the Transport Research Laboratory for the assessment of subbase materials if laid on Works contracts provided that:

(i) strict control over the grading is maintained; and

(ii) the crushed, broken and totally rounded particles requirements are met.

8 No limiting value of design traffic has been imposed for Type 1 unbound mixtures for subbase containing crushed gravel. However their use on roads designed to carry more than 1500 commercial vehicles per lane per day should be clearly identified in the As-Built Records.

9 For flexible roads with Type 1 unbound mixtures for subbase containing crushed gravel and carrying a traffic loading of more than 2 msa, the subbase strength should be at least an equivalent of CBR 30%. Further guidance about CBR is given in Clause NG 804. A trafficking trial should be considered for flexible roads carrying a traffic loading of more than 2 msa.

NG 804, Type 2 Unbound Mixtures for Subbase

1 Current design requirements exclude Type 2 unbound mixtures for subbase from flexible roads carrying a traffic loading of more than 5 msa. Where local experience indicates that these materials can be used successfully at higher traffic levels, the Overseeing Organisation may require that a Substitute Clause should be written to permit their use. Mixtures containing a high proportion of asphalt arisings have been shown to perform well at design traffic levels higher than 5 msa, but performance should be assessed using a trafficking trail.

2 Table 8/6 in Clause 804 includes requirements for the calculated difference between the values of percentage by mass passing selected adjacent sieves. These requirements are taken from BS EN 13285 and ensure a 'well graded' mixture by controlling the continuity of the grading curve.

3 The value of CBR required for materials to Clause 804 will depend upon traffic loading. For flexible roads carrying a traffic loading of more than 2 msa the subbase strength should be at least an equivalent of CBR 30%. For traffic ranges below 2 msa the strength may be reduced to CBR 20%.

4 If more than 15% of the material is retained on a 16 mm test sieve the whole material can be assumed without test to have a CBR value of 30% or more. CBR tests should be carried out (when necessary) on specimens which are compacted at a density and moisture content which represent equilibrium conditions under the completed pavement. In most cases the moisture content and density specified in sub-Clause 804.7 will apply but where this is not so it will be necessary to specify separately the required values of density and moisture content for the CBR test. The density relating to a particular air voids content can be calculated using the formula given in BS 1377 : Part 4. Compaction into the CBR mould should be carried out in such a way that the required density is obtained uniformly. The number of surcharge discs used in the CBR test should be equivalent to the weight of road construction above the subbase.

5 Although parameters related to the control of the construction of the pavement layer are outside the scope of BS EN 13285, it is appropriate to make information available to assist the purchaser's choice of unbound mixture. BS EN 13285 requires the laboratory dry density and optimum water content of an unbound mixture to be declared at least once each year, as part of the system of factory production control. BS EN 13285 permits choice from a list of four test methods for these properties, reflecting the range of mixtures and techniques used across Europe. In the UK, it is

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recommended that the vibrating hammer test (BS EN 13286-4) is used. This method is very similar to the established UK method defined in BS 1377-4. BS EN 13286-4 also includes a test method similar to that developed as BS 5835. That test procedure for the determination of optimum moisture content was developed specifically for graded aggregates and gives more reproducible results than the vibrating hammer test for these materials.

Mixtures Containing More Than 50% Asphalt Arisings

6 Trafficking trials of mixtures containing a high proportion of asphalt arisings (previously known as Type 4 granular subbase material) carried out by TRL have produced rut-depths well within the upper recommended limit of 30 mm.

However, the effects of this material on the surrounding environment should be fully assessed, and approvals from statutory bodies obtained where necessary, before including this material as a permitted option in Appendix 7/1.

7 When dry, asphalt arisings exhibit a considerable resistance to compaction due to the friction of the bitumen coating. The addition of water has a significant effect on the state of compaction by reducing the friction between the bitumen coated particles. Mixtures containing more than 50% asphalt arisings should therefore be compacted at moisture contents close to the declared value of optimum water content discussed in sub-clause NG 804.5.

8 The particle size distribution of asphalt arisings is best described by the term 'lump size distribution' because of the binding effect of bitumen. The grading envelope obtained will be dependent on the duration of shaking, the temperature at which the determination is carried out and the grading of the mineral particles within the asphalt arisings.

Agglomeration of lumps can occur in stockpiled material especially in hot weather or when the material is stored for long periods. It is important that, at the time of placing, the asphalt arisings comply with the specified lump size distribution and care should be taken to ensure that material taken from a stockpile is to the required grading. It may be necessary to demonstrate that the material actually placed meets the grading specification rather than to rely on tests at an earlier time.

Lumps, or individual particles of aggregate separated by the planing process, should be angular in appearance. Rounded particles that can be present when using arisings containing gravel aggregates can lead to difficulties in meeting the rutting criterion.

9 Particle durability in terms of the magnesium sulfate soundness test need not be verified for mixtures containing a high proportion of asphalt arisings as the aggregates will have been tested prior to the introduction of bitumen.

10 Particle hardness in terms of the Los Angeles test need not be verified for mixtures containing a high proportion of asphalt arisings as the test is unsuitable for materials containing bitumen and because the aggregate components will have been tested prior to the introduction of bitumen.

11 The performance of unbound mixtures in subbases is dependent on the bearing strength of the compacted material. The measurement of bearing capacity in terms of CBR should not be specified for mixtures containing a high proportion of asphalt arisings. The measurement of CBR for mixtures containing bitumen is problematical because the results are dependent upon the temperature at the time of compaction, the temperature at the time of testing and the duration of loading. However, as the grading envelope ensures that less than 10% of the material is retained on the 16 mm test sieve, it can be assumed without test that the material will have an adequate CBR value.

NG 805 (05/04) Type 3 (open graded) Unbound Mixtures for Subbase

1 Current design requirements permit the use of open graded mixtures in subbase in circumstances where a free draining layer is to be preferred. Type 3 (open graded) unbound mixtures for subbase is similar to the granular subbase materials previously known as Type 3 (Clause 850NI) and Type 1X, a grading derived by TRL.

2 BS EN 13285 details additional requirements to control individual batches of unbound mixtures with an overall grading Category G_O, within a system of factory production control. Table 8/7 in Clause 805 illustrates this. The supplier must nominate a supplier declared value for the intermediate sieves in the grading envelope as part of the system of factory production control for the mixture. The nominated value must lie within the supplier declared value grading range in Table 8/7. Individual batches are then assessed using the tolerances in Table 8/7, applied to the supplier declared values. As explained in Annex B (informative) of BS EN 13285, the use of tolerances does not change the overall grading range.

3 Table 8/7 also includes requirements for the calculated difference between the values of percentage by mass passing selected adjacent sieves. These requirements are taken from BS EN 13285 and ensure a

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'well graded' mixture by controlling the continuity of the grading curve.

4 Because the requirements for aggregates used in the unbound mixtures now refer to the requirements of BS EN 13242, confirmation of conformity with the categories for Los Angeles coefficient and magnesium sulfate soundness can be obtained from the CE Mark Certificate for the aggregates used in the mixture. If a CE Mark Certificate is not available to confirm the suitability of the source, test certificates should be provided from a testing laboratory accredited by an appropriate organisation accredited in accordance with sub-Clauses 105.3 and 105.3 for the test, showing a value in excess of the minimum specified and dated not more than 6 months prior to the start of the contract.

5 The chosen category for resistance to fragmentation in Table 8/2 is LA_{40}. A maximum Los Angeles coefficient of 35 is more appropriate for aggregates that have been used successfully in similar mixtures, but BS EN 13242 does not permit the choice of this value. Aggregate sources with a Los Angeles coefficient of 35 or more should be used with caution. Unless local experience indicates otherwise, aggregate sources with a Los Angeles coefficient in the range 30 to 35 should generally be considered as acceptable.

6 Whilst there is no specified moisture content for laying and compacting unbound mixtures to Clause 805, in order to satisfy the requirements of sub-Clauses 802.8 and 805.5 it will be necessary to carry out these operations at optimum moisture content or thereabouts.

NG 809 (05/04) Slag Bound Mixtures

General

1 The Overseeing Organisation should be contacted for design guidance.

2 (05/04) Slag Bound Mixtures (SBM) is a combination of aggregate, granulated blastfurnace slag (GBS) and an activator, that has a moisture content compatible with compaction by rolling and is used in the construction of subbases and bases (roadbases). Compaction will need to be carried out at or close to optimum moisture content. This is of particular importance due to the slow curing nature of the SBM and the reliance on its granular structure to provide adequate strength and durability over the early period of its early life.

Batching and Mixing

3 To ensure even distribution of the GBS and the relatively small quantities of activator, mixing should preferably be carried out in a forced action mixer, selected to produce a uniform and consistent SBM. If the Contractor proposes a mixer other than a forced action mixer he should ensure during trials that adequate mixing is achieved.

Laying

4 SBM is a slow curing material that may be affected by freezing conditions for a considerable time after compaction. Material should usually be laid from March to September. These restrictions may be varied by the Overseeing Organisation depending on the expected likelihood of freezing conditions in the month following compaction of the SBM at a particular construction site, and the thickness of protecting layers over this period.

5 At construction joints between consecutive day's work it may be found that compacted material has not set to a degree where a vertical face can be achieved by cutting back the edge of the material. In this case, full bonding is likely to be achieved between the two days work and it is not essential to obtain a completely vertical construction joint. However, compacted wedges of material should be cut back to a position where full depth was achieved to avoid compacting the new material onto already compacted material, causing a discontinuity within the layer.

Compaction

6 SBM is a slow curing material, taking up to 1 year to reach design strength. Indeed before being compacted it may be several days before the material reaches a point where it is unworkable or lacking in its full reactive potential. A 6 hour time limit has been placed on the compaction of this material following the addition of the GBS and activator for a combination of two reasons: 6 hours allows comfortable time for the majority of construction works; the shelf life of the un-compacted material will vary greatly depending on temperature, reactivity and fineness of the GBS and the activator used. This time limit may be varied at the Contractor's risk, and with the authorisation of the Overseeing Organisation. If relaxed all other aspects of the specification must be met.

Curing

7 The application of a curing system helps prevent moisture loss. In particular this helps prevent the surface becoming friable, a particular problem due to the long curing times of SBM. Overlay with a bituminous material has the additional benefit of also protecting the SBM from damage by construction plant.

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NATIONAL ALTERATIONS OF THE OVERSEEING ORGANISATION OF SCOTLAND

NG 850SE (05/01) Crushed Gravel Sub-base Material Type 1

General

1 Trafficking trials of crushed gravel sub-bases used in Scotland have produced rut depths well within the upper limit (30 mm) recommended by the Transport Research Laboratory for the assessment of sub-base materials if laid on Works contracts provided that:

(i) strict control over the grading is maintained;

and

(ii) the crushed face requirements are met.

2 (05/01) Any unusual behaviour of the laid material under construction plant should be investigated and, if considered necessary, the Contractor's laying and compaction methods should be carefully examined. Guidance on the protection of the subgrade and sub-base is already given in NG 801.

3 (05/01) No limiting traffic design has been imposed for crushed gravel Type 1 Granular Sub-Base complying with Clause 850SE. However its use on roads designed to carry more than 1500 commercial vehicles per lane per day should be clearly identified in the As-Built Records required in accordance with SDD Circular No 27/1989.

4 (05/01) Where the soundness test is used as a means of confirming source suitability, a certificate from a testing laboratory accredited in accordance with EN 45002 by the United Kingdom Accreditation Service (UKAS) for that test, showing a value in excess of the minimum specified and dated not more than 6 months prior to the start of the contract, should be provided.

For those sources seeking suitability based on historical evidence of satisfactory use, the following should be provided:

(i) dated certification showing supply of materials conforming with all other aspects of Clause 803 or (804);

(ii) copies of dated delivery tickets showing materials, source and site supplied;

(iii) documentary evidence of material source, site and tonnage supplied.

Evidence should be provided for at least 2 major sites.

Routine water absorption tests should be made on the delivered material. If any result from these tests exceeds the declared value (d) by more than 0.5 ie, $> (d + 0.5)\%$, further investigation will be required.

Trafficking Trial Procedure

Introduction

5 The Transport Research Laboratory has recommended that deformation under controlled trafficking provides a suitable criterion for assessing sub-base stability. Research has indicated that 30 mm rut depth after 1000 standard axles is an acceptable limiting criterion, and this has been adopted as the basis of assessment of crushed gravels offered as alternatives to Type 1 sub-base materials.

Location

6 (i) The trial area shall be located on suitable prepared sub-formation compacted in accordance with the Specification. The trial area may be located so that it can be incorporated within the Permanent Works if the resistance to wheel track rutting complies with sub-Clause 850.9SE.

(ii) The trial area shall be not less than 60 metres long and be not less than 20 metres wide.

Materials

7 (i) If required within the Permanent Works, suitable capping layer material in sufficient quantity shall be provided to construct a platform approximately 50 metres long by 10 metres wide compacted to the thickness required in the contract.

(ii) The crushed gravel sub-base material complying with the requirements of Clause 850SE shall be provided in sufficient quantity to construct a trial area approximately 50 metres long and having a base width of 7.5 metres to 8 metres compacted to the thickness specified in the contract.

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Placement

8 (i) (05/01) The materials shall be placed and compacted using the equipment proposed for use in the Works.

(ii) If required in the Contract, the capping layer material shall be placed and compacted in accordance with Clause 613 at a moisture content within the range 1% above to 2% below the optimum moisture content determined in accordance with BS 5835.

(iii) The crushed gravel sub-base material shall be placed on top of the compacted capping layer or the prepared sub-formation as appropriate and compacted in accordance with Clause 801 at a moisture content within the range 1% above to 2% below the optimum moisture content determined in accordance with BS 5835.

(iv) The trial area shall be ramped at each end and rigid beams (wooden sleepers or similar) shall be incorporated into each end of the area for a distance of approximately 5 metres and shall have their upper faces level with the surface of the compacted crushed gravel sub-base. This will assist correct tracking by the test vehicle and minimise dynamic effects of the vehicle bouncing on its springs.

Trafficking

9 (i) A convenient test vehicle is a 3-axle tipper lorry loaded to a gross mass of 24 tonnes (1 pass is equivalent to 3 standard axles). The selection of the test vehicle however shall reflect actual site conditions and the equivalent standard axle loading shall be calculated for monitoring.

(ii) Longitudinal string lines shall be laid out on the trial embankment to help the driver maintain the same track on each pass and to achieve channelled rutting. Five transverse string lines shall be laid out at equal spacing along the length, covering the full width of the trial embankment. The end string lines shall be positioned at least the length of the lorry from the rigid beams at the ends of the trial area.

(iii) Vertical deformation shall be measured in all the wheel tracks using an optical level at monitoring points on each of the 5 transverse string lines after 5, 15, 50, 100, 180 and 350 passes. The mean vertical deformations at the previously mentioned lorry passes shall be plotted against the respective passes and the vertical deformation corresponding to 1000 standard axles shall be interpolated.

(iv) The crushed gravel sub-base material shall be deemed to be an acceptable alternative to Type 1 granular sub-base materials specified in Clause 803 if the mean vertical deformation corresponding to 1000 standard axles is less than 30 mm when tested in accordance with the trafficking procedure given in this Clause.

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NATIONAL ALTERATIONS OF THE OVERSEEING ORGANISATION OF NORTHERN IRELAND

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NG 801NI (05/01) General Requirements for Unbound, Hydraulically Bound and Other Materials

1 The permitted alternatives for sub-bases include Types 1, 2 and 3 granular sub-base material. For granular sub-bases under cement bound roadbases, where good drainage of the sub-base and subgrade is certain and there is no chance of water standing under cemented material, the Overseeing Organisation may, in order to make significant financial or environmental gains, such as removal of spoil heaps, accept sub-base material with a water soluble sulfate content of up to 2.2 g/litre, provided structures are isolated by 500 mm of sulfate-free material or precautions are taken to protect them (See NG 1704).

2 Sub-Clause 801.12NI(viii) permits combinations of different types of compacting equipment provided each type contributes its correct proportion of the total compactive effort. Thus if a machine when operated singly is required in Table 8/1NI to apply X passes and that same machine actually applies K passes, then the sum of the values of K/X for each of the types of plant used in combination should equal or exceed unity.

Frequency of Sampling

3 The recommended rate of sampling for the determination of grading, plasticity and quality should be one sample for every 200 tonnes of material supplied. For schemes using less than 200 tonnes one sample should be taken.

Use of surfaces by Traffic and Construction Plant

4 Under the Conditions of Contract the Contractor is responsible for care of the Works including the protection of the roadbase, sub-base and subgrade. The choice of permitted materials is intended to allow the Contractor to make the most economical use of available materials suitable for his method of construction. It will not be known when drawing up the documents what materials, plant, methods and programme the Contractor will adopt. Therefore, generally, it will not be possible to justify restriction of the choice allowed nor specify measures required specifically for construction, but where any particular circumstances are known any materials which would put the Permanent Works at risk of failure should not be included in Appendix 7/1.

5 As some unbound sub-bases are moisture susceptible and are unsuitable for construction traffic in wet periods the Contractor's choice of sub-base should be related to the time of year and his programme and method for laying the roadbase and subsequent layers. Long delays could be avoided by the use of cement-stabilised material. Traffic running on the sub-base may cause irreparable damage to the subgrade or capping. Protection of the sub-base against weather can best be achieved by laying the subsequent layers as soon as possible.

6 Some sub-base and roadbase materials degrade during normal laying and compacting operations. If there is any doubt about degradation of the material during laying and compacting then sampling points should be chosen for each material which will be representative of the quality of the laid material.

7 Under wet conditions some Type 2 granular sub-base material can rapidly deteriorate if used by construction traffic and the subgrade can be damaged by rutting, which could result in permanent soft spots. Type 2 granular sub-base material is suitable for its purpose if its moisture content is kept around the optimum. Work should preferably be programmed so that the roadbase is applied before the sub-base is wetted.

8 Any thickening shall be across the full width of that part of the pavement which is in new construction. If temporary haul roads are laid and later removed they must be placed so that drainage of the formation and sub-base surface is not impeded.

Frost Heave

9 The frost heave test described in BS 812 : Part 124 : 1989 is costly and time consuming and is not suitable for routine control checks on Site. The test has been developed from earlier test methods to overcome problems of repeatability and reproducibility. The test is primarily intended as a method to establish whether or not an aggregate from a particular source is likely to be frost-susceptible when used in an unbound condition within that part of the road pavement subject to frost penetration. Material for the frost heave test must be representative of the source and comply with all other requirements of the Specification otherwise the test is superfluous. Once a material has been established as non-frost-susceptible the test need only be repeated if the material varies from the original sample, or where the source is changed.

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10 Clause 6 of BS 812 : Part 124 : 1989 sets down the procedure for adjusting the water level in the self-refrigerated unit (SRU). A possible problem has been identified that with the tolerances given to the dimensions for the cradle and specimen carriers it is possible for the porous discs in the specimen carriers to be located incorrectly in relation to the water level. In order to guard against this it is recommended that before testing commences the cradle and specimen carriers be put into the SRU without samples. A check is then made to ensure that discs are set at the level specified in the above-mentioned standard.

11 The requirement for material to be non-frost susceptible within 450 mm of the surface of a road or paved central reserve may be reduced to 350 mm if the Mean Annual Frost Index (MAFI) of the site is less than 50. The Frost Index is a measure of the severity of a period of cold weather and provides a means of assessing likely penetration of frost into a road. Frost index is measured in 'degree days Celsius below zero' and is calculated by taking the mean air temperature for each twenty four hour period and adding those values together. Frost penetration into a modern road in the British Isles may be estimated using the formula $x = 40\sqrt{I}$ where x is the approximate penetration in mm and I is the frost index for the freezing spell. The Annual Frost Index is the frost index accumulated over a year commencing September 1st. Mean Annual Frost Index (MAFI) is the average of all the frost index values computed for each year since September 1959. The MAFI for a site is determined using records from one or more meteorological stations close to the site, taking account of local geographical variation, such as high ground or frost hollows. Different requirements for different parts of a contract length may be used.

Further information on the MAFI can be found in HD 25.

Advice relating to any site, including the MAFI calculated for that site, may be purchased from:

Customer Centre
The Met. Office
Powell Duffryn House
London Road
Bracknell
Berks
RG12 2SY

Tel. No: 0845 300 0300
Fax No: 0845 300 1300
E-mail: climate@meto.gov.uk

NG 851NI Filter Layer

1 Crushed rock or sand filter layers of 50 mm minimum thickness should be provided immediately below carriageway sub-bases where cohesive materials occur within the top 150 mm of the sub-grade to prevent the ingress of cohesive particles into the sub-base.

Where a capping layer is provided, no filter layer is required at the sub-base or capping layer interfaces but the thickness of the capping layer should be increased by 75 mm if the sub-grade contains cohesive materials.

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