
SERIES NG 700

ROAD PAVEMENTS - GENERAL

Contents

Clause	Title	Page
NG 700	General	2
NG 701	Pavement Construction	2
NG 702	Horizontal Alignments, Surface Levels and Surface Regularity of Pavement Courses	2
#NG 706	Excavation, Trimming and Reinstatement of Existing Surfaces	3
NG 710	(11/04) Testing for Constituent Materials in Recycled Aggregate and Recycled Concrete Aggregate	3
NG 711	(05/01) Overbanding and Inlaid Crack Sealing Systems	4
NG 713	(05/01) Saw-cut and Seal Bituminous Overlays on Existing Jointed Concrete Pavements	5
NG 715	(05/01) Saw-cut, Crack and Seat Existing Jointed Reinforced Concrete Pavements	5
NG 716	(05/02) Cracking and Seating of Existing Jointed Unreinforced Concrete Pavements and CBM Bases	6
NG	Sample Appendices	A1

NATIONAL ALTERATIONS OF THE OVERSEEING ORGANISATIONS OF SCOTLAND, WALES AND NORTHERN IRELAND

Northern Ireland

NG 706NI	Excavation, Trimming and Reinstatement of Existing Surfaces	N1
----------	---	----

denotes a Clause or Sample Appendix which has a substitute National Clause or Sample Appendix for one or more of the Overseeing Organisations of Scotland, Wales or Northern Ireland.

ROAD PAVEMENTS - GENERAL

NG 700 General

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

NG 701 Pavement Construction

1 (11/03) Unless otherwise agreed by the Overseeing Organisation all types of pavement construction (flexible, flexible composite, rigid and rigid composite; as defined in Standard HD 26 Pavement Design (DMRB 7.2.3)) should be permitted as alternatives for the main carriageways on new works and reconstruction work and work to side roads on trunk road contracts. Also the alternative component layers and layer materials within these 4 types should wherever possible be permitted.

Where a restriction of pavement types and/or their component layers/materials is considered necessary on the main carriageway in new works and reconstruction work and work to side roads on trunk road contracts, details and justification are to be submitted to the Overseeing Organisation for approval.

2 (05/01) The series of schedules presented in Appendix 7/1 should be completed and referenced to the Drawings.

3 (05/01) Where the subgrade CBR value is estimated to be of a value requiring capping for one type of pavement (eg. rigid or rigid composite) but not for others permitted for the same length of carriageway this should be clearly shown on Schedule 3 in Appendix 7/1 and allowed for in Appendix 6/7.

NG 702 Horizontal Alignments, Surface Levels and Surface Regularity of Pavement Courses

1 (11/04) All levels of pavement courses are related to the specified level of the final road surface. Tolerances and limits in levels and irregularity are given in Tables 7/1 and 7/2 respectively. These should be strictly enforced to maintain a good ride and constant thickness of material. As they are based on the capabilities of most pavers to lay to a level they do not allow for any intentional reduction of the pavement thickness. For Slurry Surfacing referred to in Clause 918, the surface irregularities should meet the appropriate requirements of Tables NG 9/5 to NG 9/7.

2 Surface levels of different pavement courses should be measured at points on a grid described in Appendix 7/1 in order to be able to determine the thickness of each course from the successive measurement of levels at the grid points. The spacing of the grid should normally be 10 m longitudinally and 2 m transversely. Where a greater degree of level control is required, eg at junctions of the carriageway with side roads, on slip roads and roundabouts, but not joints in the carriageway, the grid points should be at some lesser spacing. Measurement of surface levels at points on a grid does not mean that the surface can be outside the permitted tolerances at other points between the grid.

3 (05/02) The tolerances on surface levels of surface courses, and concrete slabs are set in order to provide as good a ride as possible and avoid undulations of an individual or cyclic nature, which are of a wavelength outside the range detectable by the rolling straight-edge or equivalent apparatus. If, however, through a fault in the paving plant the whole surface as laid is consistently high over long lengths, it would be unnecessary to impose the limits of the true surface level tolerances, provided:

- (i) Clearances under bridges are adequate, and allow for overlays.
- (ii) The drainage of the carriageway is not impaired.
- (iii) All tolerances except those on the final road surface design level comply with the Specification.
- (iv) The area affected is of such length as to provide an acceptable ride.

4 (05/04) The limits for surface regularity of subbases under concrete pavement surface slabs is necessarily less when the slabs are laid in a single layer and only compacted by surface compacting beams. With a standard surcharge and a fixed degree of compaction with such equipment, upward variations in the subbase can be reflected in the surface when the concrete is fully compacted, whereas downward variations will result in lack of compaction locally. These tighter tolerances do not apply when internal vibration is used.

5 (05/01) Two categories of road are given in Table 7/2, and for each different section of road the category must be stated in Appendix 7/1. The Overseeing Organisation will decide the category on the

quality and quantity of traffic, on the road layout and potential speeds of traffic. Category B is generally for low speed (under 50 km/h) roads. Table 7/2 does not apply to materials laid in accordance with Clause 918.

6 The surface should be thoroughly swept to remove extraneous matter before measurements are taken. All such measurements should be taken early, and any deficiencies in the pavement should be reported as soon as possible to allow the Contractor sufficient time to complete all remedial work and to allow for concrete to cure before opening the road to traffic. The rolling straight-edge should be used at about 2 km/hour. Some coarse textures can lead to incorrect readings if the surface is traversed too quickly. Areas shown not to comply with the Specification should be rectified as soon as possible and checked by a 3 m straight-edge or, for longer lengths, by the rolling straight edge or equivalent apparatus.

7 Traces from profilometers are useful in picking out particular areas for remedial work from the whole stretch shown not to comply with the Specification by the rolling straight-edge or equivalent apparatus.

8 For rectifying concrete slabs use of a bump cutter with a long wheel base is essential to produce an even plane without local overcutting. Grinding down either side of depressions may improve the riding quality, if they are small. Deeper depressions should normally be rectified by cutting out and refilling.

#NG 706 Excavation, Trimming and Reinstatement of Existing Surfaces

1 Clause 706 describes a method of excavation and reinstatement of existing paved and unpaved surfaces:

- (i) Where the Contractor is required to break into paved areas for the installation of utilities.
- (ii) Where the Contractor unavoidably has to break into work which he has carried out as part of the Works.
- (iii) Where he is required to break into paved areas existing prior to the Works being constructed.
- (iv) Where pavements are constructed to abut or join into existing pavements.

2 (05/02) Instructions on the installation of utilities in roads designed to carry 120 msa or less are given in a Code of Practice entitled 'Specification for the Reinstatement of Openings in Highways' dated June 2002 by the Highway Authorities and Utilities Committee. This Code of Practice was produced as a result of certain provisions of the New Roads and Street Works Act 1991.

3 (05/02) As much information as possible should be provided in Appendix 7/2 and on the Drawings for 1(ii) and (iii) above, especially to show the areas and depth of pavement required to match levels between new and existing construction. The intention is to ensure that at least a new surface course should be provided over the minimum area of existing pavement as will avoid feathering below the minimum thickness of the layer, after preparation of the existing surface by scarifying and planing. Where existing and new concrete pavements abut or join into each other it is normal practice to use a bituminous pavement between the two sections, details of which should be given in Appendix 7/2.

4 Paved areas already constructed as part of the Permanent Works should only be excavated when it is necessary to carry out the Permanent Works or where no other practical means of completing the Permanent Works can be devised.

5 (05/01) Advice and methods of reinstating pavements are given in the 'Design Manual for Roads and Bridges. Volume 7 : Pavement Design and Maintenance : Section 4 : Pavement Maintenance Methods : Parts 1 and 2'.

Advice and methods of reinstating concrete pavements are given in the 'Concrete Pavement Maintenance Manual' published by the Concrete Society.

NG 710 (11/04) Testing for Constituent Materials in Recycled Aggregate and Recycled Concrete Aggregate

1 (11/04) The test method described in Clause 710 and the pro forma worksheet in Sample Appendix 7/10 are based on the component classes in prEN 933-11 (February 2004), Classification test for the constituents of recycled aggregate.

2 (11/04) 'Quality Protocol for the Production of Aggregates' published by Waste and Resources Action Programme is available from WRAP, The Old Academy, 21 Horse Fair, Banbury OX16 0AH. The document is also available on the WRAP website, <http://www.wrap.org.uk/>

Limitations of the Test Method

3 (11/04) This test method specifies a basic procedure for the examination of recycled aggregate and recycled concrete aggregate for the purpose of identifying and quantifying constituent materials. The test is designed to give a reliable go/no go decision rather than to provide a low relative error estimate of constituent contents. The operating characteristics of the test should ensure that materials well within the specification have

little chance of rejection whereas materials well outside the specification have little chance of acceptance.

If a low relative error estimate ($\pm 10\%$) of constituent contents is required, the test portion mass that must be examined can be calculated from the following equation:

$$M = 0.0002(100 - P) (D_{\max})^3 / P$$

where

M is the minimum mass of each test portion in kg

P is the estimated proportion of constituent of interest in % by mass

$D_{\max}$ is the maximum particle size in mm

For example, to obtain an estimate of foreign material content to $\pm 10\%$ relative error when the foreign material is present at approximately the 1% level in 20 mm aggregate, two portions, each consisting of 158 kg, will need to be examined.

4 (05/04) Reference sub-Clause 710.3, experience of the materials under test should allow the laboratory technician to judge the actual mass of test portion required. Variations from the guidelines given in Table 7/3 may be permitted subject to the agreement of the Overseeing Organisation.

(05/04) **Masonry and lightweight Block Masonry Categories**

5 (05/04) Masonry (Class B) includes both brick and block masonry. Lightweight block materials (Class L) are those with an apparent particle density less than 1000 kg/m³ assessed visually.

To separate block masonry particles and lightweight block particles, fill a glass beaker with water and place the fragments onto the surface of the water. If the particle sinks rapidly, it has a density greater than 1000 kg/m³, and is therefore categorised as masonry (Class B). If the particle floats, or sinks slowly in a stream of bubbles, or in case of any doubt, the particle is presumed to have a density apparently less than 1000 kg/m³, and is therefore categorised as lightweight block masonry (Class L). After classification using a beaker of water, re-dry the particles at $(40 \pm 5)^\circ\text{C}$ to constant mass.

Weigh each group and record the masses as M_B and M_L .

NG711 (05/01) Overbanding and Inlaid Crack Sealing Systems

1 (11/02) A crack sealing system is defined in the BBA HAPAS 'Guidelines Document for the Assessment and Certification of Crack Sealing Systems for Highways' as a method of repairing cracks in non-porous (ie. not

porous asphalt) bituminous highway surfaces with macrotexture depths not exceeding 2 mm (volumetric patch technique), or in concrete highway surfaces. Where practicable the colour of system specified should be similar to the adjacent surface.

2 Crack sealing systems are categorised as:

- (i) Simple Overbanding Systems for repairing crack widths up to 5 mm.
- (ii) Fill and Overbanding Systems for repairing crack widths between 5 mm and 20 mm.
- (iii) Inlaid Sealing Systems for repairing crack widths in excess of 20 mm, or adjacent multiple cracks.

3 Inlaid sealing systems are installed by routing or planing out the crack to form a recess and applying the product flush with the adjacent highway surface. They may be used in conjunction with certified overbanding systems along the joints. Inlaid systems used to seal isolated cracks should not be wider than 250 mm, however when sealing multiple cracks this width may be exceeded.

4 Inlaid crack sealing systems are classified by the BBA HAPAS scheme as either Grade F (Flexible) or Grade H (High Modulus). Grade F offers more flexibility but in consequence has a slightly reduced resistance to deformation, ie. rut resistance. Grade H is less flexible but has a high resistance to deformation. Which grade to specify is a matter of judgement. Where significant crack movement is anticipated, for example in cracks in overlays to jointed concrete carriageways, Grade F may be more appropriate. Where cracks do not penetrate through the pavement structure and significant movement is unlikely to occur, or for small patches in the wheel-tracks, then Grade H may be more appropriate.

Expected Minimum Life

5 (05/02) Overbanding systems and Inlaid crack sealing systems are used to seal and repair cracks both longitudinally and transverse to the carriageway. Where pavements are structurally sound and cracking is confined to the surfacing layer or layers, and these remain bonded to the base, then the minimum expected life for overbanding systems predicted in BBA HAPAS Certificates will be 3 or 5 years, dependent on test results, and for inlaid systems 5 years. However, where cracks have penetrated substantially through the pavement depth due to structural failure resulting in significant movement under traffic, no expectation of life can be reliably predicted.

6 The most severe wear from trafficking (primarily by heavy goods vehicles) occurs within the wheeltrack

zones, approximately between 0.5 m and 1.1 m, and between 2.55 m and 3.15 m from the centre of the nearside lane markings for each traffic lane. In the wheeltrack zones, the expected minimum life of crack sealing systems is unlikely to be exceeded. Conversely for cracks outside the wheeltrack zones, provided the pavement surface is otherwise sound, the expected minimum lives in terms of skidding and deformation resistance are likely to be exceeded. The most onerous conditions occur during summer months on heavily trafficked south facing carriageways with significant gradients in cuttings and on the surface of pavements carried by elevated structures, when surface temperatures can approach or exceed 50°C. Should surface temperatures exceed this figure for periods in an exceptional summer, then the expected minimum lives of products installed in the wheeltrack zones may not be attained.

Narrow Isolated Cracks

7 (11/04) Narrow isolated cracks less than 20 mm in width, in surfacings unlikely to ravel away from the crack, may be sealed without overbanding or inlay using a hot applied joint sealant Type N2 to BS 2499-1 in accordance with the recommendations of DMRB (7.4.1).

NG 713 (05/01) Saw-cut and Seal Bituminous Overlays on Existing Jointed Concrete Pavements

1 Generally, where there is an existing mid-bay crack in a reinforced concrete slab, no surface treatment is required.

2 Where there is existing bituminous surfacing greater than 40 mm thick, it may be appropriate to only remove the surfacing in a transverse strip symmetrically about a joint and replace with bituminous inlay. This is then saw-cut and sealed to sub-Clause 713.4. Otherwise, all the existing bituminous surfacing will require to be planed off, as specified in sub-Clause 713.2.

3 When the total thickness of bituminous overlay to the existing concrete pavement is designed to be 40 mm or less, saw-cut and seal techniques to Clause 713 should not be used. In such cases, reflection cracks should be routed out and sealed with hot-applied sealant to comply with BS 2499. Saw-cut and seal techniques to Clause 713 should not be used when the total thickness of bituminous overlay is designed to be 180 mm or greater.

4 As part of the design assessment, and before any laying of bituminous surfacing, attention needs to be paid to the consequences of previous part-bay repairs,

particularly in situations where there is lack of a continuous or co-linear transverse joint.

5 Jointed reinforced concrete pavements with bays exceeding 6 m in length may first be prepared by 'Saw-cut, crack and seat' to Clause 715, prior to bituminous overlay. However, this may depend on the condition of a slab and its support.

6 (11/04) Bituminous overlays may be selected from the following Clauses:

Regulating course	Binder course	Surface course *
907 and either 903 or 904	906	911**
or 929 (DBM and HDM only)	929	942
or 931	931	943
or 937	937	
* surfacing shall also meet appropriate noise requirements		
** lightly trafficked roads only		
High modulus materials to Clause 929 should not be used.		

7 (11/04) When monitoring the co-linearity of existing concrete joints and new saw-cut grooves in connection with sub-Clauses 713.7 and 713.9, it may be helpful to adopt special investigatory techniques, for example, radar. See DMRB (7.3.2). This would be in addition to the careful application of survey control methods required under the Clause.

8 (11/04) The tolerance on co-linearity of the crack-initiation slot with the underlying joint or saw-cut should be specified in Appendix 7/13. This should be based on the following guidelines:

- ± 5 mm for target overlay thickness less than 100 mm,
- ± 10 mm for target overlay thickness 100 mm and greater.

9 The Overseeing Organisation should monitor sealant temperatures to ensure compliance with the manufacturer's recommendations.

NG 715 (05/01) Saw-cut, Crack and Seat Existing Jointed Reinforced Concrete Pavements

1 In Appendix 7/15, the following values have been used successfully in trials:

The prefixes (6)(i) etc. refer to the prefixes in Appendix 7/15.

- (6) Saw-cuts:
- (i) Spacing of transverse saw-cuts:
- (a) When there is to be an overlay which is to be saw-cut and sealed to Clause 713, 1 m from existing joints and the remainder of the bay divided equally such that the saw-cuts are at not greater than 5 m centres.
- (b) When there is to be an overlay which is **not** to be saw-cut and sealed, 1 m from existing joints and the remainder of the bay divided equally such that the saw-cuts are at 1 m to 2 m centres. This has been found to provide an adequate effective stiffness modulus.

Whatever spacing is specified a tolerance of ± 25 mm should give about the right result; the spacing may need to be adjusted depending on the length of the concrete slab. If the saw-cut and seal technique is not to be applied to the surface, the saw-cuts need to be at closer centres and the overlay thickness increased to reduce reflective cracking.

- (ii) Avoiding damage to saw-cut: A suggested procedure is to place a rectangular steel strike plate along the length of the saw-cut, and strike this with the guillotine blade.

(8) Assessment of Cracking:

- (i) Core diameter:
150 mm diameter cores are satisfactory. This may be reduced to 100 mm diameter.

(9) Seating:

It has been found that 6 passes of a pneumatic tired roller of not less than 20 tonnes deadweight has seated pavements satisfactorily in UK.

2 In cases where the 'saw-cut and cracked and seated' pavement is re-opened to highway traffic and kept in use for a significant length of time before overlaying with a bituminous overlay, the saw-cuts and cracks should be sealed as follows. Otherwise sealing of the cracked concrete is not required. The following requirements should be included at the end of Appendix 7/15:

Sealing of saw-cuts: Hot-applied sealant to Clause 1017.

Sealing of cracks:

- (a) (05/02) Medium ($0.5 < > 1.5$ mm): 'Over-banding' with a bitumen of penetration reference 50.
- (b) Wide (>1.5 mm): Chase out cracks and seal with 15D x 10W D3406 sealant.

3 The location of the trial should be representative of the main body of the work under this Clause, for example, it should be neither at the thickest part of the cementitious pavement layer nor at the part which is cracked already, nor over the worst formation.

4 If it is known that there are differing pavement constructions within the scheme, more than one trial will be required and should be specified in Appendix 7/15.

5 In Appendix 7/15, the following section should be completed by the compiler as noted:

(5) FWD Testing & Measurements:

- (i) When there is a bituminous overlay followed by 'Saw-cut and Seal', FWD testing of effective stiffness is not necessary.
- (ii) When there is a bituminous overlay but 'Saw-cut and Seal' is not being specified, FWD testing of joint efficiency may be necessary.

(11/04) Bond Coat

6 (11/04) The treated surface should be bond coated in accordance with Appendix 7/4 prior to overlaying.

NG 716 (05/02) Cracking and Seating of Existing Jointed Unreinforced Concrete Pavements and CBM Bases

1 In Appendix 7/16, the following values have been used successfully in trials:

The prefixes (5)(i) etc. refer to the prefixes in Appendix 7/16.

(5) Cracking:

- (i) The spacing of transverse cracks for the main trial should be specified as two or three alternatives in item (5)(i) of Appendix 7/16, all of which should be trialled in accordance with sub-Clause 716.16(iii). From previous trials, the spacing of cracks should be

between 0.75 m and 2 m. For pavement quality concrete, the spacing alternatives to try in the main trial should be chosen such that the crack spacing divides equally into the bay length.

- (iv) (05/02) A tolerance on the spacing of transverse cracks of $\pm 5\%$ is achievable. It may need to be based on average values over a bay length or a 5 m run for cement-bound bases.

- (vi) On the main production work, cores should be extracted through all layers of cementitious material to provide data on thickness for the analysis of FWD measurements to calculate effective stiffness modulus. For unreinforced pavement quality concrete (PQC) of two-layer construction with a slip layer between or of single layer construction on a dry-lean concrete sub-base, it is only necessary that the cracks penetrate through the upper layer of the PQC. The lower cementitious layers will inevitably be cracked but not necessarily directly below the crack in the upper layer.

- (vii) Ideally, cores should be taken through single induced cracks. They should neither be taken where there is an intersection with a secondary crack nor where the surface crack might have bifurcated near the end of the guillotine blade impact line. However, in some instances this is difficult to achieve and the cracking should not be considered as failed if a core has inadvertently been taken in such a location. The cracking does not comply with Clause 716 if the concrete is shattered or the crack is bifurcated vertically; this type of cracking results from too high an impact force.

- (ix) Where it is necessary to make two or more passes of the guillotine, the transverse alignment of the cracks should be within ± 50 mm. In this situation, it might be necessary to apply a lighter impact load on the first pass in order not to over-crack the concrete; the second adjacent pass should ensure that the first crack penetrates the full depth of the concrete layer. For bays wider than twice the guillotine blade width by 1 m or more, an alternative procedure is to induce a longitudinal crack along the

centreline of the bay in order to produce two narrower bays that can be cracked transversely provided that the induced longitudinal crack is not located closer than 1 m from any wheel track zone. The coring should be conducted on the trial bays after the complete bay has been cracked and after two or more passes of the guillotine have been completed, when this is necessary.

(7) Seating:

- (i) It has been found generally that 6 passes of a pneumatic-tyred roller of not less than 20 tonnes deadweight has seated pavements satisfactorily in UK.
- (ii) If there are concerns that 6 passes are insufficient, the seating requirement could be specified in terms of a maximum level difference (mm) from the preceding level at every grid point from the previous pass of the roller.

In this event, the Overseeing Organisation should assess the efficacy of the seating in Stage 2 and in subsequent Stages of the main trial by measurements of the surface levels which will be taken on a grid of points located as described in Appendix 7/16.

For the required grid, described in Appendix 7/16, the following values have been used successfully:

2.5 m longitudinally

1.0 m transversely

The grid intersection points should be painted on the surface.

The initial level of each grid point should be determined after cracking but before seating. Comparison should then be made of corresponding surface levels of the cementitious pavement layer after measured numbers of passes of the roller over the grid points until sequential passes of the roller cause changes in the level of the cementitious pavement layer at each point which are no greater than the value specified. The measured levels and the numbers of roller passes should be recorded. This should determine the number of passes of the roller required at each point in the main work (subject to not less than 6 passes).

When so required, these changes to the seating requirement of the specification may be effected by an addition to Appendix 7/16.

2 The requirements of sub-Clause 716.2 concerning removal of overlays do not apply to removal of existing surface dressing. At this stage it is considered that removal operation may be detrimental to the subsequent correct development of cracks and their observation. The presence of surface dressing will prevent examination of the surface crack pattern in accordance with sub-Clauses 716.4 and 716.5, but this will not prevent coring and observation of cracks in cores.

3 In cases where the 'cracked and seated' pavement is re-opened to traffic and kept in use for a significant length of time before overlaying with a bituminous overlay, cracks should be sealed as follows and these requirements should be included at the end of Appendix 7/16:

Sealing of cracks:

- | | |
|---------------------------------|--|
| (a) Medium
(0.5 < > 1.5 mm): | 'Over-banding' with 50 or 70 pen bitumen. |
| (b) Wide (>1.5 mm): | Chase out and seal with 15D x 10W D3406 sealant. |

4 The location of the trial should be as directed by the Overseeing Organisation in accordance with sub-Clause 716.15. This location should be representative of the main body of the work under this Clause, for example, it should be neither at the thickest part of the cementitious pavement layer nor at the part which is cracked already, nor over the worst formation. See Note 1, (5)(i) above. If the road pavement to be treated contains known areas where there are significant differences in the concrete thickness or strength or in the foundation conditions, then a main trial should be specified in each such area. Also, if it is known that there are differing pavement constructions within the scheme, more than one trial will be required and should be specified in Appendix 7/16.

Tack Coat and Bond Coat

5 The treated surface should be tack or bond coated in accordance with Appendix 7/4 prior to overlaying.

Spacing of Transverse Cracks

6 The spacing of transverse cracks for the main trial should be specified as two or three alternatives in Item (5)(i) of Appendix 7/16, all of which should be trialled as required by sub-Clause 15 (iii). See Note 1, (5)(i) above.

7 Reference sub-Clause 716.19, if the crack spacing on the main work is narrower than that specified

following the main trial, it might cause a reduction in the effective stiffness as determined from the FWD measurements. The details of the locations where the crack spacing is less than specified should have been entered in the 'Cracking Plant and Equipment Progress Record' in accordance with sub-Clause 716.8. This is to enable the assessment of the effect on the stiffness modulus of the concrete and make any necessary design changes.

Main Trial in Different Lanes

8 Experience has shown that it may be prudent to carry out a production cracking re-assessment trial before resuming main work in another lane.

Pre-contract Feasibility Trial

9 In cases where it is considered prudent to carry out a pre-contract feasibility trial, Clause 716 may be used but only providing sub-Clauses 716.18 to 716.22 (approx.) are deleted and certain cross-referencing is checked and amended as necessary.

Falling Weight Deflectometer (FWD) Tests

10 Concerning sub-Clause 716.4, FWD tests to establish the deflection under load of the cracked slabs should be carried out using a Dyna test machine. The analysis of the test results should be carried out using a linear elastic multi-layer analysis software programme. The compatibility of different methods of analysis by different testing consultants still needs to be assessed; acceptable methods currently in use are those developed by TRL and Scott Wilson Pavement Engineering. Until these and related matters have been resolved, FWD testing and analysis remains within the control of the Overseeing Organisation.

Each FWD test takes approximately 2 minutes. This includes movement between test points.

Sequence of Working

11 In cases where the Overseeing Organisation considers there are grounds for restricting the sequence of works, for example, the sequence in which each lane is cracked in order to maintain side restraint, or to avoid secondary widening of cracks in the outer lanes), the restriction should be clearly stated in Appendix 1/13.

NG SAMPLE APPENDIX 7/1: (05/01) PERMITTED PAVEMENT OPTIONS

1 PERMITTED PAVEMENT OPTIONS - SCHEDULE 1

[Note to compiler: Complete Schedule 1. See NG 701.2].

Schedule 1: Permitted Pavement Options						
Drawing Ref.	Area	General Requirements	Permitted Pavement Option			
	Area A	Schedule 2A	A1	A2	A3	etc.
	Area B	Schedule 2B	B1	B2	B3	etc.
	Area C	Schedule 2C	C1	C2	C3	etc.
	etc.	etc.	etc.	etc.	etc.	etc.

[Note to compiler: The above schedule should include all options for flexible, flexible composite, rigid and rigid composite construction for all areas, with each permitted pavement option given a unique reference number, for example, A1. An appropriate drawing reference should be inserted for each area.]

2 GENERAL REQUIREMENTS - SCHEDULE 2

[Note to compiler: Complete Schedule 2. See NG 701.2 Where necessary, a separate General Requirements Schedule should be completed for each of the Areas identified in Schedule 1].

Schedule 2: (11/02) General Requirements - Area [.....]		
Grid for checking surface levels of pavement courses [702.4]:	Longitudinal dimension:	
	Transverse dimension	
Surface regularity [702.5, Table 7/2]	Category of Road:	
Interval for measurement of longitudinal regularity [702.7]:		
Interval for measurement of transverse regularity [702.8]:		
Whether surface macrotexture is required [921.2]:		
Whether measurement of surface macrotexture is required [1044.27]:		
Average:		
Maximum:		
Minimum:		

3 PERMITTED CONSTRUCTION MATERIALS - SCHEDULE 3

[Note to compiler: Complete Schedule 3. See NG 701.2. A separate Permitted Construction Materials Schedule should be completed for each of the Permitted Pavement Options identified in Schedule 1.]

Schedule 3: (11/04) Permitted Construction Materials				
	Pavement Option [eg A1]		Pavement Option [eg A2]	
Pavement Layer	Material Ref.	Thickness (mm)	Material Ref.	Thickness (mm)
Surface Treatment	STA1**		STA2**	
Concrete surface slab	CSA1**			
Surface Course	SCA1**			
Binder Course	BCA1**			
Base	HBM C8/10 to Clause 821 with rock aggregate	180	HBM C8/10 to Clause 821 with gravel aggregate	220
Upper roadbase				
Lower roadbase	HBM C8/10 to Clause 821, 831 etc	200	HBM C6/8 to Clause 821, 831 etc	250
Subbase	803, HBM T3 to Clause 821, 831 etc	225		
[Other - eg regulating]				
Total Thickness				
Capping is not required/is required* as described in Appendix 6/7. [*Compiler to indicate as appropriate]				

[** Compiler's unique reference for insertion in Schedule 5]

4 GENERAL REQUIREMENTS FOR CONSTRUCTION MATERIALS - SCHEDULE 4

[Note to compiler: Complete Schedule 4. See NG 701.2.].

Schedule 4: (11/04) General Requirements for Construction Materials	
Clause	Requirement
801.2	Limiting distance for deposition of unbound mixtures referred to in sub-Clause 801.2
801.3	Limiting distance for deposition of unbound mixtures referred to in sub-Clause 801.3
801.7	Whether any material shall not comply with sub-Clause 801.7.
802.4	Whether unbound materials up to 225 mm compacted thickness can be spread in more than one layer.
802.14	Thickness of compacted layer
901.2 and 942.5	Requirements for resistance to fragmentation (hardness), resistance to freezing and thawing (durability) and cleanness of aggregates if different from the requirements of sub-Clauses 901.2 and 942.5.
901.19	Requirements for determination of compaction level of base and binder course macadams, if different from the requirements of sub-Clause 901.19. [Compiler to list pavement materials applicable]
901.28	Requirements for PSV of temporary running surface if different from sub-Clause 901.28. [Compiler to list pavement materials applicable]
1001.2	Requirements for concrete conformity if different from sub-Clause 1001.2.
1004.7	Testing requirements for concrete cubes.
1028	Requirements for trial lengths.
1033.10	Permission for butt welding.

5 (05/02) REQUIREMENTS FOR CONSTRUCTION MATERIALS – SCHEDULE 5

[Note to compiler: Schedule 5 should be completed for every permitted construction material identified in Schedule 3. Compiler is to amend as appropriate the PSVs values stated in sub-Clause 901.28. These values should only be increased if justified by volume and period of trafficking. Mix designs for base and binder course macadams should be in accordance with the requirements of the relevant British Standard, or in accordance with the requirements of Clause 929. A minimum binder content for macadam should not be specified in this Appendix if the macadam is to be designed in accordance with Clause 929.]

Schedule 5: (11/04) Requirements for Construction Materials			
Material Ref.	Clause	Description	Requirement
	803	Type 1 unbound mixture	Mixtures containing crushed gravel coarse aggregate: - permitted [803.1]: - minimum CBR [803.8]: - trafficking trial [803.8]:
	804	Type 2 unbound mixture	Minimum CBR: - required [804.6]: - minimum value [804.6]: Mixtures containing more than 50% asphalt arisings: - permitted [804.1]: - trafficking trial [804.11]:

Schedule 5: (05/05) Requirements for Construction Materials (continued)

Material Ref.	Clause	Description	Requirement
	820	Aggregates for HBM	Rock coarse aggregates [820.2]
	821	Cement bound granular mixtures A	Aggregate requirements: LA_{50} or LA_{60} [821.2, Table 8/13] Laboratory mechanical performance category: C 3/4, C 5/6, C 8/10; T1, T2, T3 [821.4 and Table NG 8/2]
	822	Cement bound granular mixtures B	Aggregate requirements: LA_{50} or LA_{60} [822.2, Table 8/13] Laboratory mechanical performance category: C 8/10, C 12/15, C 16/20, C 20/25; T3, T4, T5 [822.4 and Table NG 8/2]
	823	Cement bound granular mixtures C	Aggregate requirements: LA_{50} or LA_{60} [823.2, Table 8/13] Laboratory mechanical performance category: C 8/10, C 12/15, C 16/20, C 20/25; T3, T4, T5 [823.4 and Table NG 8/2]
	824	Cold Recycled Cement Bound Material	Describe requirements for cracks induced during construction [824.50] (05/05)
	830	Slag bound mixture B1-2 (SBM B1-2) Fly ash bound mixture 1 (FABM 1), Hydraulic road binder bound mixture 1 (HRBBM 1)	Aggregate requirements: $C_{90/3}$, or $C_{50/30}$; LA_{50} , or LA_{60} [830.2, Table 8/13] Laboratory mechanical performance category: C 6/8, C 9/12, C 12/16, C 15/20, C 18/24; T2, T3, T4 [830.5 and Table NG 8/2]
	831	Slag bound mixture B2 (SBM B2), Fly ash bound mixture 2 (FABM 2) and Hydraulic road binder bound mixture 2 (HRBBM 2)	Aggregate requirements: LA_{50} or LA_{60} [831.2, Table 8/13] Laboratory mechanical performance category: C 6/8, C 9/12, C 12/16, C 15/20, C 18/24; T2, T3, T4 [831.5 and Table NG 8/2]
	832	Slag bound mixture B3 (SBM B3), Fly ash bound mixture 3 (FABM 3) and Hydraulic road binder bound mixture 3 (HRBBM 3)	Aggregate requirements: LA_{50} or LA_{60} [832.2, Table 8/12] Laboratory mechanical performance category: C 3/4, C 6/8, C 9/12, C 12/16, T1, T2, T3 [832.4 and Table NG 8/2]
	834	Fly ash bound mixture 5 (FABM 5)	Laboratory mechanical performance category: C 3/4, C 6/8; T1, T2 [834.3]
	840	Soil cement (SC), Soil treated by slag (SS), Soil treated by HRB (SHRB) and Soil treated by fly ash (SFA)	Laboratory mechanical performance: C 0.8/1, C 1.5/2, C 3/4, C 6/8, C 9/12, T1, T2, T3 [Table 8/14 and Table NG 8/2]
	870	Testing, control and checking of cement and other hydraulically bound mixtures	Average mechanical performance of specimens manufactured, cured and tested in accordance with Table 8/16 [870.10]
	880	Laboratory mixture design procedure for HBM	Any other particular requirements [see also Clause NG 880] [880.1]

Schedule 5: (11/04) Requirements for Construction Materials (continued)			
Material Ref.	Clause	Description	Requirement
	903	Dense Macadam Base	Whether DBM not in accordance with Clause 929 [903.1]: Whether sub-Clauses 945.1 and 945.2 do not apply [945.6]: BS 4987-1 Clause Nos [903.1]: Binder Penetration [903.3]:
	904	Rolled Asphalt Base	Minimum delivery temperature [945.5]: Maximum wind speed [945.5]: Minimum air temperature [945.5]: BS 594-1 : Table No: and Column No [904.1]: Binder Penetration [904.3]:
	905	Rolled Asphalt Binder Course	Minimum delivery temperature [945.5]: Maximum wind speed [945.5]: Minimum air temperature [945.5]: BS 594-1 : Table No: and Column No [905.1]: Binder Penetration [905.3]:
	906	Recipe Mixtures: Dense Base and Binder Course Macadams with Paving Grade Bitumen	Whether DBM50, or DBM125 or DBM190 [906.1]: Whether 0/20 mm or 0/32 mm grading range [906.1]: Whether sub-Clauses 945.1 and 945.2 do not apply [945.6]: BS 4987-1 Clause Nos. [906.1]:
	907	Regulating Course	Permitted materials for Regulating Course [907.3]:
	909	Dense Macadam Surface Course (0/6 mm)	BS 4987-1 Clause No [909.1]: Traffic Category [909.2]: Minimum declared PSV [909.3]: Maximum AAV [909.3]: Binder [909.4]:
	910	Rolled Asphalt Surface Course (Recipe Mix)	Minimum delivery temperature [945.3, 945.4]: Thickness [945.3, 945.4]: Maximum wind speed [945.3, 945.4]: Minimum air temperature [945.3, 945.4]: BS 594-1: Table Nos [910.1]: Column Nos [910.1]: Binder [910.2]: Coarse aggregate percentage [910.3]: Aggregate Types: Coated chippings size [910.4]: Minimum declared PSV [915.3]: Maximum AAV [915.3]:
	911	Rolled Asphalt Surface Course (Design Mix)	Minimum delivery temperature [945.3, 945.4]: Thickness [945.3, 945.4]: Maximum wind speed [945.3, 945.4]: Minimum air temperature [945.3, 945.4]: BS 594-1 : Table Nos [911.1]: Column Nos [911.1]: Binder: Grade of binder is not to be specified when the surface course is to comply with Clause 911. Coarse aggregate percentage [911.3]:

Schedule 5: (11/04) Requirements for Construction Materials (continued)

Material Ref.	Clause	Description	Requirement
	911	(continued)	Marshall Stability range [911.4]: Marshall Flow [911.4]: Aggregate Types: Coated chippings size [910.4]: Minimum declared PSV [915.3]: Maximum AAV [915.23]:
	912	Close Graded Macadam Surface Course	BS 4987-1 sub-Clause number [912.1]: Aggregate size [912.1]: Traffic Category [912.2]: Minimum declared PSV [912.3]: Maximum AAV [912.3]: Binder Penetration [912.4]:
	914	Fine Graded Macadam Surface Course	BS 4987-1 sub-Clause number [914.1]: Aggregate size [914.1]: Traffic Category [914.2]: Minimum PSV [914.3]: Maximum AAV [914.3]: Binder [914.4]: Coated chippings size [914.5]: Minimum declared PSV [915.3]: Maximum AAV [915.3]:
	916	Open Graded Macadam Surface Course	BS 4987-1 sub-Clause number [916.1]: Aggregate size [916.1]: Minimum declared PSV [916.2]: Maximum AAV [916.2]: Binder Penetration [916.3]:
	924	High Friction Surfaces	Type Classification [924.3 and Table NG 9/24]: Minimum declared PSV [924.4]:
	929	Designed Mixtures: Dense Base and Binder Course Macadams	Whether DBM50 or HDM50 or HMB35 Whether 0/20 mm or 0/32 mm grading range [929.1]: Whether sub-Clauses 945.1 and 945.2 do not apply [945.6]: Whether Clauses 944 or 952 applies
	931	Recipe Mixtures: Heavy Duty Base and Binder Course Macadams Paving Grade Bitumen	Whether HDM50 base or HDM50 binder course [931.1]: Whether 0/20 mm or 0/32 mm grading range [931.1] BS 4987-1 Clause Nos [931.1]:
	937	Stone Mastic Asphalt (SMA) Binder Course and Regulating Course	Bitumen penetration reference if sub-Clause 937.7 not required [937.7]: Sampling and testing requirements [937.21]: Requirement for cores [937.26]: Temperature at which wheel-track testing is to be carried out [937.31]: Maximum wheel-tracking rate and rut depth [937.31]: Requirements for laying and compaction if not Clause 901 [937.42]: Deformation values [937.38, Table NG 9/34, Table NG 9/35 and Table NG 9/36]:

Schedule 5: (11/04) Requirements for Construction Materials (continued)

Material Ref.	Clause	Description	Requirement
	938	Porous Asphalt Surface Course	PSV [938.2]:
	942	Thin Surface Course Systems	Traffic count [942.1 - commercial traffic in each lane]: Site definition and stress level [942.1, Table NG 9/27]: Minimum declared PSV of coarse aggregate [942.5 HD 36 Pavement Design and Maintenance: Skidding Resistance (DMRB 7.5.1)]: Maximum aggregate abrasion value of coarse aggregate for thin surface course systems based on surface dressing and slurry surfacing techniques [942.5 - HD 36 (DMRB 7.5.1)]: Maximum aggregate abrasion value of coarse aggregate for thin surfacing systems not based on surface dressing or slurry surfacing techniques [942.5 - HD 36 (DMRB 7.5.1)]: Minimum wheel-tracking level required on British Board of Agrément HAPAS Roads and Bridges Certificate [942.7 - Table NG 9/28 and Table NG 9/29]: Road/tyre noise level relative to hot rolled asphalt required on British Board of Agrément HAPAS Roads and Bridges Certificate [942.8, Table NG 9/30]: If required, minimum and/or maximum compacted layer thickness permitted [942.9]: The average macrotexture depth of each lane kilometre if not 1.5 mm and the average minimum value if not in accordance with sub-Clause 942.13 Guarantee period [942.14 - normally 2 years but 3 years under certain conditions, NG 942.4 and NG 942.13]: Surface Macrotexture - Performance requirements if not in accordance with sub-Clause 942.16
	943	Hot Rolled Asphalt Surface Course and Binder Course (Performance-Related Design Mix)	Minimum delivery temperature [945.3, 945.4]: Thickness [945.3, 945.4]: Maximum wind speed [945.3, 945.4]: Minimum air temperature [945.3, 945.4]: Thickness if not 45 mm or 50 mm [943.2]: Provision of Data [943.5]: Site classification: Coated chippings size [943.12]: Minimum declared PSV [915.3]: Maximum AAV [915.3]:
	944	Performance-Specified Base and Binder Course	Stiffness requirements. [944.1, 944.9, 944.12]: Deformation values [944.12(ii), Table NG 9/34, Table NG 9/35 and Table NG 9/36]:
	946	China Clay Sand Asphalt Base	Whether sub-Clauses 945.1 and 944.2 do not apply [945.6]: Whether the stiffness requirements of Clause 944 are required [946.1]:

Schedule 5: (11/04) Requirements for Construction Materials (continued)

Material Ref.	Clause	Description	Requirement
	947	Slate Macadam Base	Whether sub-Clauses 945.1 and 944.2 do not apply [945.6]: Target aggregate grading if different from the grading for 0/20 mm or 0/32 mm size dense binder course given in BS 4987-1 [947.3]:
	952	Deformation Resistance of Binder Course and Base	Whether vacuum RLAT or wheel tracking or contractors choice [952.4] Level of deformation resistance [952.4 and 952.6]
	1001 to 1034 and 1044	Unreinforced concrete slabs (URC)	Maximum spacing (m) of Transverse joints [1009.1]: 1. Maximum transverse joint spacing may be increased by 20% if limestone coarse aggregate is used throughout the depth of the slab. 2. Alternatively when the slab is constructed in two layers with the top layer not exceeding 50 mm nominal thickness the maximum transverse joint spacing may be increased by 20% if limestone coarse aggregate is used throughout the lower layer. For exposed aggregate concrete surfaces: Size of coarse aggregate [1044.5]: Minimum declared PSV [1044.5]: Maximum AAV [1044.5]:
	1001 to 1034 and 1044	Jointed reinforced concrete slabs (JRC)	Maximum spacing (m) of Transverse joints [1009.1]: Transverse joints for jointed reinforced slabs adjacent to CRCP ground beam anchorages shall be provided in accordance with Highway Construction Details C18 and C20. Longitudinal steel reinforcement:.....mm ² /m width. 1. The range of reinforcement and max transverse joint spacings corresponds to slab thicknesses given and intermediate values may be interpolated. 2. Max transverse joint spacings may be increased by 20% if limestone coarse aggregate is used throughout the depth of the slab. 3. Alternatively when the slab is constructed in two layers with the top layer not exceeding 50 mm nominal thickness the maximum transverse joint spacing may be increased by 20% if limestone coarse aggregate is used throughout the lower layer. 4. Transverse reinforcement:.....mm dia. atspacing [1008.8] For exposed aggregate concrete surfaces: Size of coarse aggregate [1044.5]: Minimum declared PSV [1044.5]: Maximum AAV [1044.5]:
	1001 to 1034 and 1044	Continuously reinforced concrete slabs (CRCP)	Longitudinal steel reinforcement: 16 mm dia. atspacing [1008.9]. 1. Transverse reinforcement shall be 12 mm dia at 600 mm spacing and shall be at 90 degrees to the longitudinal bars. [1008.11]

Schedule 5: (11/04) Requirements for Construction Materials (continued)

Material Ref.	Clause	Description	Requirement
	1001 to 1034 and 1044	(continued)	2. Anchorages shall be provided at ends and any discontinuities in the pavement (ground beam or wide flange beam conforming to HCD). 3. Expansion joints are required at the approach slabs to anchorages. For exposed aggregate concrete surfaces: Size of coarse aggregate [1044.5]: Minimum declared PSV [1044.5]: Maximum AAV [1044.5]:
	1001 to 1034	Continuously Reinforced Concrete Roadbase (CRCR)	Longitudinal steel reinforcement: 12 mm dia. atspacing [1008.9]. 1. Transverse reinforcement shall be 12 mm dia at 600 mm spacing and shall be at 90 degrees to the longitudinal bars. [1008.11] 2. Anchorages shall be provided at ends and any discontinuities in the pavement (ground beam conforming to HCD) 3. 100 mm surfacing shall comprise binder course and surface course as described elsewhere in Appendix 7/1. For exposed aggregate concrete surfaces: Size of coarse aggregate [1044.5]: Minimum declared PSV [1044.5]: Maximum AAV [1044.5]:
	1030	Wet lean concrete 1 to 4	

6 (11/04) THIN SURFACE COURSE SYSTEMS: INFORMATION TO BE PROVIDED BY THE CONTRACTOR - SCHEDULE 6

[Note to Contractor: Complete one sheet per system or variant of system that may be used]

The Contractor shall provide the following information with his tender:

- (i) (11/04) A copy of the British Board of Agrément HAPAS Roads and Bridges Certificate or Certificates for the thin surface course system or systems that are proposed for use in the works, together with a copy of the Installation Method Statement associated with each Certificate [942.1]
- (ii) (11/04) For any Certificate that covers several variants of one thin surface course system, proposed variant or variants of the system to be used in the Works *[variants of a system occur from any option that results in different values being reported on the Certificate for one or more properties, and could involve changes in nominal maximum aggregate size, aggregate type, aggregate grading, binder type, binder content, fibres or other additives, type and rate of spread of bond coat]*
- (iii) If requested, or if the thin surface course system is not produced under a Sector Scheme, the proposed component materials to be used in the thin surface course system and their proportions for each proposed system [942.4]
- (iv) Proposed source or sources of coarse aggregate together with statement of properties including polished stone value, ten per cent fines value, aggregate abrasion value and flakiness index [942.5]
- (v) If regulating material is to be used, evidence of its deformation resistance either independently or in combination with the thin surface course system [942.10]

7 (11/04) BINDER DATA REQUIREMENTS [911.2, 929.4, 937.9, 938.1, 943.5 and 943.8] - SCHEDULE 7

The following data shall be provided to the Overseeing Organisation as required in sub-Clauses 937.9, 938.1, 943.5 and 943.8 and for materials designed in accordance with 911, 929, 944 or 952 in respect of the proposed binder [note: all these Clauses cover materials that are designed by the supplier]. The data should not be more than 6 months old. A table in which the binder data may be recorded is given at the end of this section.

For work carried out for the Highways Agency, a copy of all the data should be handed to the Overseeing Organisation, to be forwarded to: Pavement Engineering Team at Highways Agency, Bedford Office.

I. (05/05) Binder Samples

Bituminous binders shall be sampled from the delivery according to BS EN 58. For modifiers blended with the other component materials of the mixture at the mixer a simulated binder shall be prepared. Such modifiers are generally less intimately mixed with the bitumen and less well dispersed throughout the mixture than when pre-blended. Evidence that the simulated binder offers the same performance as the binder produced when the modifier is added at the mixer shall be provided.

II. (11/04) Penetration

Binder penetration at 25°C (BS EN 1426), 100g 5 secs and at 5°C 200g 60 secs, before and after hardening in the Rolling Thin Film Oven Test (RTFOT) in accordance with BS EN 12607-1, or alternatively, after RTFOT and Ageing in accordance with Clause 923.

III. (11/04) Product Identification Test and Rheological Properties

Results for the binder(s) proposed shall comprise rheological data for each binder in the form of complex shear (stiffness) modulus (G^*) and phase angle (δ) determined in accordance with Clause 928 for binder as supplied, after RTFOT and Ageing in accordance with Clause 923.

IV. (11/04) Storage Stability Test

All binders shall be stored strictly in accordance with the manufacturer's instructions. Polymer modified binders claimed to remain homogeneous in storage without agitation shall be tested for storage stability in the manner described in Clause 941. The mean of the differences in softening point between the top and bottom samples, of not less than five pairs of such samples shall not exceed 5°C. Manufacturers of pre-blended modified binders shall state what precautions are necessary to ensure that adequate homogeneity is maintained during storage.

V. Photomicrograph

A typical photomicrograph of the modified binder and binder using ultra-violet or other technique to provide maximum contrast of the polymer structure to the binder before modification shall be supplied together with details of sample preparation techniques.

VI. (11/04) Cohesion

Vialit Pendulum cohesion test curve of the binder, in accordance with Clause 939 for the binder as supplied, after RTFOT and after RTFOT and Ageing in accordance with Clause 923.

VII. (11/04) FRAASS Brittle Point

FRAASS brittle point measured using BS EN 12593 shall be provided on the binder as supplied, after RTFOT and Ageing in accordance with Clause 923.

(11/04) **Summary of binder data**

Manufacturer of Binder:	Product name		
Binder type:		Batch ref:	
Binder source:			
Softening point difference in storage stability test			
Test	Supplied binder	After RTFOT	After Ageing
Penetration at 25°C 0,1 mm (100g and 5 secs)			
Penetration at 5°C 0,1 mm (200g and 60 secs)			
Vialit pendulum cohesion see Clause 939 maximum peak value J/cm ²	#	#	#
Product identification test Complex shear (stiffness) modulus (G*) and phase angle (ä) data. See Clause 928	#	#	#
Fraass brittle point			
Other properties the Contractor considers useful			

Where indicated with # the Contractor shall attach a graphical output to this schedule.

8 (11/04) **MIXTURE DATA REQUIREMENTS [919, 929, 944, 952 or 953] - SCHEDULE 8**

The following data should be provided to the Overseeing Organisation as required in sub-Clauses 937.9, 938.1, 943.5 and 943.8 and for materials designed in accordance with 911, 929, 944, 952 or 953 in respect of the proposed mixture as appropriate [note: all these Clauses cover materials that are designed by the supplier].

For work carried out for the Highways Agency, a copy of all the data should be handed to the Overseeing Organisation, to forwarded to: Pavement Engineering Team at Highways Agency, Bedford Office.

I. Mixing and compaction temperatures

Maximum and minimum mixing temperatures should be stated. Maximum and minimum compaction temperatures and any wind chill factor differing from conventional hot rolled asphalt utilising unmodified bitumen shall be stated.

II. Mix Sensitivity Analysis

Wheel-tracking rate for the proposed mixture but with the binder content by mass increased above the target to the maximum binder content anticipated by the Contractor, but not more than + 0.6% above the target.

III. Repeated Load Axial Test (RLAT) to DD 226 : 1996 (for correlation to performance in terms of deformation).

IV Indirect Tensile Fatigue Test (ITFT) - after ageing, see LINK Protocol (for correlation to performance in terms of fatigue)

V Saturation Ageing Tensile Stiffness (SATS)

NG SAMPLE APPENDIX 7/2: (05/01) EXCAVATION, TRIMMING AND REINSTATEMENT OF EXISTING SURFACES

[Note to compiler: Include here:]

- 1 Locations of any trenches, pits, etc, which require to be excavated in existing paved surfaces in order to carry out the Works. Reference to any drawings giving further details. [706.2]
- 2 Locations and estimated areas of existing paved areas which require to be trimmed, regulated and reinstated to match levels where new and existing pavements abut or where new construction overlays existing pavement. Reference to Appendices 7/1 and 7/9, and to any drawings giving further details [706.2, 706.9]. Acceptable material for reinstating other areas [706.8].
- 3 Cross-section diagram of typical trench reinstatement in bituminous and concrete pavements giving details of materials. [Examples are given in HCD Drawing Number K4.]
- 4 References to drawings which show construction at junctions between the following pavement materials. [706.10]
 - (i) concrete/concrete,
 - (ii) concrete/bituminous,
 - (iii) concrete/porous asphalt,
 - (iv) bituminous/porous asphalt,
 - (v) bituminous/bituminous,
 - (vi) porous asphalt/porous asphalt

(11/03) For junctions with porous asphalt see HD 37 Bituminous Surfacing Materials and Techniques (DMRB 7.5.2).
- 5 Full depth repairs and reinstatements
 - (i) Repair criteria if different from sub-Clause 1033.4
 - (ii) Requirement for full bay replacement [1033.7]
 - (iii) (05/04) Reinstated subbase material [1033.9]
 - (iv) Stitched crack repair type [1033.12]
 - (v) Filling of slots [1033.13]
 - (vi) Longitudinal joint grooves to be re cut [1033.15]
 - (vii) Transverse joint grooves to be re cut [1033.16]
- 6 Joint Seals
 - (i) Colour of the joint seal material [1017.1]

NG SAMPLE APPENDIX 7/3: (05/01) SURFACE DRESSING - PERFORMANCE SPECIFICATION

SHEET 1: Information to be provided by the compiler

(11/04) [Notes to compiler: Complete one sheet per section. For footways the compiler need not specify all of the requirements and should use judgement and experience to determine which to omit]

- 1 Location [922.1 - eg road number, name, OS grid reference of start and finish, lane]
- 2 (11/03) Limitations on binder cohesivity [922.6 - minimum peak Table NG 9/13 and HD 37 (DMRB 7.5.2)]
- 3 (11/03) Minimum declared PSV of chippings [922.8 - HD 36 (DMRB 7.5.1) and HD 37 (DMRB 7.5.2)]
- 4 (11/03) Maximum AAV of chippings [922.8 - HD 36 (DMRB 7.5.1) and HD 37 (DMRB 7.5.2)]
- 5 Special traffic control requirements [speed limit when first opened and minimum period of control 922.2]
- 6 Class of spraybar accuracy required [922.7 - Table NG 9/14]
- 7 Class of chipping spreader required [922.9 - Table NG 9/15]
- 8 Class for tolerance of designed rate of spread of binder [922.7 - Table NG 9/16]
- 9 Class for tolerance of designed rate of spread of chippings [922.9 - Table NG 9/17]
- 10 Guarantee period [922.3, normally 2 years for motorways and trunk roads, 1 year for less heavily trafficked or low stressed roads]
- 11 Traffic count [922.1 - total and commercial vehicle count required for each lane]
- 12 Traffic speed, 85 percentile [922.2]
- 13 (11/03) Category of site [922.1 - letter category from HD 36 (DMRB 7.5.1)]
- 14 (11/02) Description of existing surface [922.1 and 922.4 - Macrottexture, existing defects, variability, etc.]
- 15 Road hardness [922.1, Road Note 39 and BS 598-111]
- 16 System of Surface Dressing permitted [922.1 and 922.4 - for example: any, not single, racked-in, double or multiple-layered when tyre-road noise emission to be minimised]
- 17 (11/02) Minimum macrottexture depth at end of guarantee period [922.19 - NG 9/18 and NG 9/19 minimum of 1.2 mm for racked-in dressings on high speed moderately heavily trafficked roads and 1.0 mm for lower tyre-noise emission double and multiple-layered dressings, the lowest limit of 0.8 mm may be specified for lightly trafficked low-speed carriageways]
- 18 (11/03) Maximum macrottexture depth after 4 weeks trafficking [922.19 - only required where noise is a problem, normally 3 mm macrottexture depth, see HD 37 (DMRB 7.5.2)]
- 19 (11/02) Maximum percentage decrease in macrottexture between 12 months and 24 months after start of trafficking [922.2 and 922.19 - normally 40%, not specified for 1 year guarantee period contracts]
- 20 Frequency of testing for roads other than trunk roads and motorways [922.14, NG 922.22]
- 21 (11/04) Category of fatting up, tracking and bleeding (% Area - P_1) acceptable [922.20 - Table NG 9/20 and HD 37 (DMRB 7.5.2)]
- 22 (11/04) Category of scabbing and tearing (% area affected - P_2) acceptable [922.20 - Table NG 9/21 and HD 37 (DMRB 7.5.2)]
- 23 (11/04) Category of fretting (% chipping loss - P_3) [922.20 - Table NG 9/22 and HD 37 (DMRB 7.5.2)]
- 24 (11/04) Category of streaking (Length of streaking - P_4) [922.20 - Table NG 9/22 and HD 37 (DMRB 7.5.2)]
- 25 (11/04) Special restrictions [922.13, 922.15 and 922.16 - for example: maximum road surface temperature at which working permitted is 40°C]

[Note to compiler: If a number of sites are involved then it would be convenient to set out the above data in tabular form]

NG SAMPLE APPENDIX 7/3: (05/01) SURFACE DRESSING - PERFORMANCE SPECIFICATION

SHEET 2: Information to be provided by the Contractor

The Contractor shall provide the following information with his tender:

A copy of the binder data shall be sent to: Pavement Engineering Team at Highways Agency, Bedford Office.

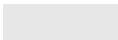
- 1 (11/04) A copy of BS EN ISO 9001 certificate showing at least the name of the Company, the name of the certification body and the reference number and date of the certificate. A copy of the relevant part of the company Quality Assurance (QA) document showing the appropriate scope and limitations of the certification. The Overseeing Organisation will wish to inspect all or any of the company's QA documentation as part of the vendor assessment system and may wish to satisfy itself on the nature of the QA systems of the company's material suppliers. [922.2]
- 2 (11/04) Proposed binders together with their data sheets, product identification data and cohesivity data as specified. [922.5 and 922.6] *[Note to compiler: A suitable Sheet for the provision of binder data is attached to this Appendix, other layouts are permitted but all the required data should be supplied]*
- 3 (11/03) Proposed source or sources of chippings together with statement of properties including target grading, target flakiness, minimum declared PSV and AAV. [922.8]
- 4 A method statement for each site or group of similar sites showing how it is proposed to carry out the works in conformance with the specification. *[The Contractor will be expected to commit enough resources to carry out the proposed design in one single continuous pass, for example, if a double dressing is proposed on a heavily trafficked road then 2 sprayers, 2 chip spreaders, 2 rollers and 2 sweepers will be a minimum requirement. The type of plant, age and number should be detailed for example 2 computer controlled sprayers three years old].*
- 5 Proposals for traffic control and aftercare for each site, and reaction times for carrying out remedial measures, sweeping and site visits with the Overseeing Organisation. [922.12, 922.15, 922.16, 922.17]
- 6 Contingency plans in the event of any breakdown of plant or failure of the dressing and provision for dusting. [922.16]
- 7 A TAIT certificate within the Sector Scheme for the Production of Surface Dressing or in the event of no certificates being issued a statement of any previous applications on roads similar in site type and road hardness to the Contract sites containing the same data as listed in NG Sample Appendix 7/3 Sheet 3. [922.4]
- 8 A statement of relevant experience and expertise, naming managers supervisors and teams responsible for and allocated to the Contract. [922.4]
- 9 Design proposal for Surface Dressing for each location. [922.2]
- 10 Estimated design life of the Surface Dressing for each location. [922.2]
- 11 For the performance specification, the results of any other tests or other data the Contractor considers would assist the Overseeing Organisation in assessing the technical merit of the design.
- 12 An 'As Built Manual' as specified. [922.18]

Binder Data Sheet - Appendix 7/3 (11/04)		Surface Dressing - Performance Specification	
Manufacturer of Binder:	Product name:		
Binder type:	Batch no:		
Binder Grade (highlight as required)	Conventional	Intermediate	
	Premium	Super-premium	
Binder source:	Supplied Binder	Aged Binder	Recovered Binder
Test	As supplied to site	Recovered in accordance with Clause 923	Age Binder in accordance with Clause 923
Penetration at 25°C 0,1 mm (100g and 5 secs)			
Penetration at 5°C 0,1 mm (200g and 60 secs)			
Manufacturer’s QA viscosity test for supplied cutback binder within temperature range 100°C to 160°C or alternatively penetration at 5°C 0,1 mm (100g and 5 secs)	†		
Vialit pendulum cohesion see Clause 939 maximum peak value J/cm²	†#	#	#
Product identification test sub-Clause 922.6. Complex shear (stiffness) modulus (G*) and phase angle (δ) data. See Clause 928.			#
Minimum viscosity STV 4 mm cup at 40°C or Redwood II at 85°C; (required to prevent binder flow on road - normal camber)	‡		
Other properties the Contractor considers useful			
Weather limits - information from binder manufacturer: road or air temperatures; humidity; wind chill adjustment; tolerance of surface dampness; etc.	Temperature max: Temperature min: Other:		

Where indicated with # the Contractor shall attach a graphical output to this schedule.

† Cutback binders only.

‡ Emulsions only.

 Shaded cells do not require data.

NG SAMPLE APPENDIX 7/3: (05/01) SURFACE DRESSING - PERFORMANCE SPECIFICATION

SHEET 3: TAIT Certificate Information to be provided by the Contractor

The Contractor shall provide the TAIT Certificate containing at least the following information with his tender:

Company Name and Address:

QA reference number and certifying body:

TAIT reference number:

Date of TAIT:

Self-certified within the Sector Scheme for the Production of Surface Dressing or certified by British Board of Agrément (BBA)

Proprietary Name:

Description of material:

Design procedure or method:

Material thickness (if applicable):

(11/02) Macrotexture depth at 1 year (as measured and as a percentage of the initial value):

Colour retention (if applicable):

(11/02) Other optional claims as declared by the installer (eg Profile improvement, reduced tyre-road noise emission or RSI, ability to accommodate a variable substrate, skid resistance if greater than PSV and macrotexture would indicate, etc.)

Expected life (Estimated Design Life)

Field of application for the particular material:

Traffic - maximum commercial vehicles per lane per day:

Traffic - total traffic per lane per day:

Traffic - Speed limit:

(11/03) Degree of Site difficulty, see HD 36 (DMRB 7.5.1) for categories:

Constraints on application for the particular material:

Time of year:

Temperature:

Variability of existing surface hardness or type:

Other as declared by the installer:

Name and signature of company representative responsible for the TAIT:

NG SAMPLE APPENDIX 7/4: (05/01) BOND COATS, TACK COATS AND OTHER BITUMINOUS SPRAYS

SHEET 1: Information to be provided by the compiler

[Note to compiler: Complete one sheet per section]

- 1 Location. drawing reference number [920.1 - eg road number, name, OS grid reference of start and finish, lane, etc]
- 2 Site specific limitations *[Note: any access restrictions, timing constraints etc should be specified in Appendix 1/13]*
- 3 (11/03) Type of treatment required and details of the existing surface and overlay material [901.24, 920.1 and 920.12 eg bond coat: premium grade, intermediate grade, non-tack type with or without breaking control; tack coat and type permitted for the overlay; or other bituminous spray]
- 4 Surface preparation required [920.6]
- 5 Masking of street furniture, drop-kerbs, etc. [920.6]
- 6 (11/04) Rate of spread required [920.8 - 4987-2 or 594-2 with appropriate adjustment for variable surface characteristics or as detailed in the BBA/HAPAS Roads and Bridges Certificate]
- 7 (11/03) Type of blinding material to be used [920.13]

NG SAMPLE APPENDIX 7/4: (05/01) BOND COATS, TACK COATS AND OTHER BITUMINOUS SPRAYS

SHEET 2: Information to be provided by the Contractor

The Contractor shall provide the following information with his tender, or prior to the commencement of the work:

- 1 (11/04) The product or products he proposes to use together with their data sheets, product identification data, cohesivity data as specified. [920.2, 920.3, 920.4, 920.5] *[Note to compiler: A suitable Sheet for the provision of binder data is attached to this Appendix, other layouts are permitted but all the required data should be supplied]*
- 2 (11/04) For each product, a copy of the BS EN ISO 9001 certificate showing the name of the manufacturer, the name of the certification body and the reference number and date of the certificate.
- 3 The spraying equipment proposed, and a test certificate. [920.7, 920.9]
- 4 (11/03) The source or sources of blinding material proposed. [920.13]
- 5 Contingency plans in the event of any breakdown.
- 6 The results of any other tests or other data the Contractor considers would assist the Overseeing Organisation in assessing the technical merit of the treatment such as:
 - (i) Tackiness test and/or trafficability time and methods of test.
 - (ii) Breaking time test results for different weather conditions and substrates.
 - (iii) (11/04) Test results for bond to newly laid concrete *[eg. from a BBA/HAPAS certificate if available]*. The data supplied should not be more than 6 months old.

Binder Data Sheet – Appendix 7/4 (11/04)		Bond Coats, Tack Coats and Other Bituminous Sprays	
Manufacturer of Binder:		Product name:	
Binder type:		Batch no:	
Binder Grade (highlight as required)			
Conventional	Intermediate	Premium	Super-premium
			Non-tack
			Other
Binder	Source →	Recovered Binder	Recovered Binder after Ageing Test
	Test ↓	Recovered in accordance with Clause 923	Aged in accordance with Clause 923
Penetration at 25°C 0,1 mm (100g and 5 secs)			
Penetration at 5°C 0,1 mm (200g and 60 secs)			
Vialit pendulum cohesion see Clause 939 maximum peak value J/cm ²		The Contractor shall attach a Report and graphical output to this schedule as specified in Clause 939.	The Contractor shall attach a Report and graphical output to this schedule as specified in Clause 939.
Product identification test. The provision of data for identification and ageing is optional for unmodified bituminous emulsions to BS 434 and for bitumen to BS EN 12591 and cutback bitumen to BS 3690. Complex shear (stiffness) modulus (G*) and phase angle (δ) data. See Clause 928.		The Contractor shall attach a Report and graphical output to this schedule as specified in Clause 928.	The Contractor shall attach a Report and graphical output to this schedule as specified in Clause 928.
Other properties the Contractor considers useful:			
Minimum Binder Content			
Binder temperature range for spray application			
Emulsion Properties and Viscosity			
Break time			
Breaking Agent type			
Weather limits - information from binder manufacturer: road or air temperatures; humidity; wind chill adjustment; tolerance of surface dampness; etc.			
Temperature max:			
Temperature min:			
Other:			

NG SAMPLE APPENDIX 7/5: IN SITU RECYCLING - THE REMIX AND REPAVE PROCESSES

[Note to compiler: Include here details of the following, cross-referring with Appendix 7/1 as required]

- 1 Location:
- 2 Requirements for milling [926.1]:
- 3 (05/02) Requirements for surface course material:
 - (i) Thickness [926.3]
 - (ii) Materials [926.11, 16]
 - (iii) Proportions of new and existing bituminous material and road surface levels [926.12]
Stability and flow [926.21]

NG SAMPLE APPENDIX 7/6: BREAKING UP OR PERFORATION OF EXISTING PAVEMENT

(05/01) *[Note to compiler: Include here details of the treatment required, cross-referring to drawings as necessary.][707]*

NG SAMPLE APPENDIX 7/7: (05/01) SLURRY SURFACING INCORPORATING MICROSURFACING

SHEET 1: Information to be provided by the compiler

[Note to compiler: Complete one sheet per section]

- 1 Location [918.1 - eg road number, name, OS grid reference of start and finish, lane include a plan where appropriate]
- 2 Traffic count [918.1 - total and commercial vehicle count required for each lane]
- 3 Traffic speed, 85 percentile and site speed limit
- 4 (11/03) Category of site [918.1 - letter category from HD 36 (DMRB 7.5.1)]
- 5 (11/02) Description of existing surface [918.2 and 918.4 - Macrotexture, existing defects, variability, etc.]
- 6 Thickness of Slurry Surfacing [918.11, normally not required, nominal 15 mm, for microsurfacing]
- 7 Guarantee period if not 2 years [1 year, or 2 years for roads carrying traffic towards the upper limit permitted using this Clause]
- 8 (11/03) Minimum declared PSV of coarse aggregate [918.6, HD 36 (DMRB 7.5.1)]
- 9 (11/03) Maximum AAV of coarse aggregate [918.6, HD 36 (DMRB 7.5.1)]
- 10 Preparation and masking requirements [918.13, 918.18 and 918.21]
- 11 Definition of colour required [918.8]
- 12 Surface finish required for footways (if not by transverse brushing) [918.21]
- 13 (11/02) Minimum macrotexture depth at end of guarantee period [918.31 and NG 9/1 - eg. minimum 1 mm for more than 50 cv/lane/day roads with a speed limit of 50 mph, no requirement may be specified for very lightly trafficked low-speed carriageways or footways]
- 14 Maximum texture depth after 4 weeks trafficking [918.31 - only required where tyre-road noise emission is a problem normally 3 mm Sand Patch texture depth]
- 15 (11/02) Maximum percentage decrease in macrotexture initially measured and at the end of the guarantee period [918.2 and 918.31 - normally 40%]
- 16 (11/04) Category of area defects (% area affected) acceptable [918.33 - Table NG 9/2]
- 17 (11/04) Category of linear defects (m per 100 m) acceptable [918.33 - Table NG 9/3]
- 18 Class of transverse regularity [918.32 and Table NG 9/5 - eg. Class 0 if only sealing and improvement to surface characteristics are required]
- 19 Class of longitudinal regularity [918.32 and Table NG 9/7 - eg. Class 0 if only sealing and improvement to surface characteristics are required]
- 20 Special restrictions [918.17, 918.24, 918.28 and 918.29 - for example: minimum road surface temperature at which working permitted is 4°C and maximum is 40°C]

[Note to compiler: If a number of sites are involved then it would be convenient to set out the above data in tabular form with columns left for contractor's proposals]

NG SAMPLE APPENDIX 7/7: (05/01) SLURRY SURFACING INCORPORATING MICROSURFACING

SHEET 2: Information to be provided by the Contractor:

- 1 (11/04) A copy of BS EN ISO 9001 certificate showing at least the name of the Company, the name of the certification body and the reference number and date of the certificate. A copy of the relevant part of the company Quality Assurance (QA) document showing the appropriate scope (Slurry Surfacing and Sector Scheme) and limitations of the certification. The Overseeing Organisation may wish to inspect all or any of the Company's QA documentation as part of the vendor assessment system and may wish to satisfy himself on the nature of the QA systems of the Company's material suppliers. [918.2]
- 2 Design Proposal for Slurry Surfacing for each location and target binder content with tolerances. [918.2]
- 3 Estimated Design Life of the Slurry Surfacing for each location. [918.2]
- 4 A copy of the TAIT Certificate within the Sector Scheme for Slurry Surfacing for the proposed system together with its supporting data. In the event of no certificates being issued a statement of any previous applications on roads similar in site type to the Contract sites containing the same data as listed in NG Sample Appendix Sheet 3. [918.4]
- 5 A method statement for each site or group of similar sites showing how it is proposed to carry out the works in conformance with the specification. *[Contractors will be expected to commit enough resources to carry out the proposed design; the type and age of the Slurry Surfacing Machine should be detailed].*
- 6 (11/03) Proposed source or sources of coarse aggregate together with statements of properties including target grading, declared PSV and AAV. [918.6]
- 7 Proposed source or sources of fine aggregate including target grading and other constituents together with statements of properties. [918.6]
- 8 (11/04) Proposed binder together with data sheets and cohesivity data. For work carried out for the Highways Agency, a copy of all the data should be handed to the Overseeing Organisation, to be forwarded to: Pavement Engineering Team at Highways Agency, Bedford Office. [918.7. Note to compiler: a suitable form for the provision of data is attached to this Appendix, other layouts are permitted but all the required data should be supplied]
- 9 Proposals for traffic control and aftercare for each site, and reaction times for: carrying out remedial measures; sweeping; and site visits with the Overseeing Organisation. [918.15, 918.18, 918.29]
- 10 Contingency plans in the event of any breakdown of plant or failure of the Slurry Surfacing. [918.28]
- 11 An 'As Built Manual' as specified. [918.30]
- 12 If available the following information should be provided in order to assist the Overseeing Organisation to assess the technical merits of the Design Proposal:
 - (i) Test method for binder content.
 - (ii) Test for thickness of Slurry Surfacing.
 - (iii) Trafficability time, including method of test.
 - (iv) Wheel tracking test results at 45°C or 60°C or other suitable measure of the ability of the proposed system to resist deformation and flow.
 - (v) Water sensitivity test results from the test used by BBA/HAPAS thin surfacing Guidelines Document or from wet wheel tracking (whichever is available).
 - (vi) Permeability test carried out on the system, if it is claimed that the process seals the existing surface together with the method of test.
 - (vii) Accelerated ageing test results in accordance with the appropriate BBA/HAPAS test.

- (viii) Bond test results using the BBA/HAPAS test on either a bituminous or a concrete substrate as appropriate to the site or Bond Coat binder BBA/HAPAS certificate.
- (ix) (11/04) Shaking Abrasion test results.
- (x) Slurry surfacing mix cohesion.
- (xi) The results of any other tests or other data the Contractor considers would assist the Overseeing Organisation in assessing the technical merit of the Design Proposal.

Binder Data Sheet - Appendix 7/7 (11/04)		Slurry Surfacing Incorporating Microsurfacing	
Manufacturer of Binder:	Product name:		
Binder type:	Batch no:		
Binder source:			
Test	Binder as supplied to site	Recovered binder in accordance with Clause 923	Aged binder in accordance with Clause 923
Penetration at 25°C 0,1 mm (100g and 5 secs)			
Penetration at 5°C 0,1 mm (200g and 60 secs)			
Vialit pendulum cohesion see Clause 939 maximum peak value J/cm ²		#	#
Product identification test sub-Clause 918.7. Complex shear (stiffness) modulus (G*) and phase angle (δ) data. See Clause 928.		#	#
Other properties the Contractor considers useful			
Weather limits - information from binder manufacturer: road or air temperatures; humidity; wind chill adjustment; etc.	Temperature max: Temperature min: Other:		

Where indicated with # the Contractor shall attach a graphical output to this schedule.

Shaded cells do not require data.

NG SAMPLE APPENDIX 7/7: (05/01) SLURRY SURFACING INCORPORATING MICROSURFACING

SHEET 3: TAIT Certificate: Information to be provided by the Contractor

The Contractor shall provide the TAIT Certificate containing at least the following information with his tender:

Company Name and Address:

QA reference number and certifying body:

TAIT reference number:

Date of TAIT:

(05/02) Self-certified within the Sector Scheme for Slurry Surfacing or certified by BBA:

Proprietary Name:

Description of material:

Design procedure or method:

Material thickness (if applicable):

(11/02) Macrotexture depth at 1 year (as measured and as a percentage of the initial value):

Colour retention (if applicable):

(11/02) Other optional claims as declared by the installer (eg Profile improvement, reduced tyre-road noise emission or RSI, ability to accommodate a variable substrate, skid resistance if greater than PSV and macrotexture would indicate, etc.):

(11/03) Expected life (Estimated Design Life):

Field of application for the particular material:

Traffic - maximum commercial vehicles per lane per day:

Traffic - total traffic per lane per day:

Traffic - Speed limit:

Degree of Site difficulty, see HD 36 (DMRB 7.5.1) for categories:

Constraints on application for the particular material:

Time of year:

Temperature:

Variability of existing surface hardness or type:

Other as declared by the installer:

Name and signature of company representative responsible for the TAIT:

NG SAMPLE APPENDIX 7/10 (05/01) WORKSHEET PRO FORMA FOR RESULTS OF TESTING FOR CONSTITUENT MATERIALS IN RECYCLED COARSE AGGREGATE AND RECYCLED CONCRETE AGGREGATE

RESULTS OF TESTING FOR CONSTITUENT MATERIALS IN RECYCLED COARSE AGGREGATE AND RECYCLED CONCRETE AGGREGATE

Sample reference	
Date	
Tested by	

Mass of test portion, M_{total} , Duplicate 1	
Mass of test portion, M_{total} , Duplicate 2	

(05/04)

Category	Mass $M_{\text{subscript}}$		Percentage $P_{\text{subscript}}$		Mean
	Duplicate 1	Duplicate 2	Duplicate 1	Duplicate 2	
Asphalt (Class A)					
Masonry (Class B)					
Concrete and concrete products (Class C)					
Lightweight particles (Class L)					
Unbound aggregate (Class U)					
Other particles (Class X)					
Sum*					

*Sum is the total of $M_A + M_B + M_C + M_L + M_U + M_X$. If Sum is not within 1% of M_{total} , repeat the test.

NG SAMPLE APPENDIX 7/11: ^(05/01) OVERBAND AND INLAID CRACK SEALING SYSTEMS

[Note to compiler: Include here details of:]

- 1 BBA/HAPAS Grade Classification required for each location [711.4]
- 2 The minimum polished stone value of the source aggregate for chippings [711.5]

NG SAMPLE APPENDIX 7/12: ^(05/01) ARRESTER BEDS

(11/03) [Note to compiler: List in the table below the location and area of each arrester bed to be maintained on the Network;][712]

Reg No	Location	Frequency	Area

NG SAMPLE APPENDIX 7/11: ^(05/01) OVERBAND AND INLAID CRACK SEALING SYSTEMS

[Note to compiler: Include here details of:]

- 1 BBA/HAPAS Grade Classification required for each location *[711.4]*
- 2 The minimum polished stone value of the source aggregate for chippings *[711.5]*

NG SAMPLE APPENDIX 7/12: ^(05/01) ARRESTER BEDS

(11/03) [Note to compiler: List in the table below the location and area of each arrester bed to be maintained on the Network;][712]

Reg No	Location	Frequency	Area

NG SAMPLE APPENDIX 7/13: (05/01) SAW-CUT AND SEAL BITUMINOUS OVERLAYS ON EXISTING JOINTED CONCRETE PAVEMENTS

[Note to compiler: Include here details of the following]

- 1 Location: The Drawing(s) to which reference is made in sub-Clause 713.1 are:

[Compiler to complete]

- 2 Whether the requirement of sub-Clause 713.2 shall apply

Bituminous overlays to be removed: Bituminous overlays are to be removed from cementitious pavements to be repaired prior to re-overlay as follows:

Location (Chainage x to y)	Nominal thickness (mm)

- 3 Dimensions of saw-cuts: [713.7] [Compiler see Figure 7/1]

- 4 (11/03) Tolerances on saw-cuts: [713.7]

(i) Plan position of the centre line of the sealant slot and of the crack-initiation slot relative to the centre line of the existing joint.

[Compiler: State whether ± 5 mm or ± 10 mm see NG 713.8]

(ii) Width of sealant slot.

[Compiler see Figure 7/1]

(iii) Width of crack initiation slot.

[Compiler see Figure 7/1]

NG SAMPLE APPENDIX 7/14: (05/01) PREPARATION OF JOINTED CONCRETE PAVEMENTS PRIOR TO OVERLAYING AND SAW-CUT AND SEAL OF THE BITUMINOUS OVERLAY

[Note to compiler: Items (3) and (4) below are included as a means of providing 'as built' data on the underlying pavement which will be saw-cut and sealed under Clause 714. Depending on where the risks lay, if it is considered that this data need not be provided to tenderers / contractors it may be deleted]

1 Location: The drawing(s) to which reference is made in sub-Clause 714.1 are:

.....[Compiler to complete]

2 Existing cementitious pavement layer to be treated:

Location (Chainage x to y)	Nominal thickness (mm)	Strength range: (yy-zz) (MPa)

3 (05/04) Existing subbase and earthworks materials beneath the cementitious pavement layer:

Location (Chainage x to y)	Subbase type and thickness	Capping type and thickness	Subgrade
			See borehole and trial pit information [give name of document] listed in Appendix 0/4.

4 Concrete Repair Processes

[Note to Compiler: Based on the following repair techniques (eg.), insert below a schedule of repair work which it is certain will be needed to be carried out, giving also its location by reference to carriageway direction, chainage, bay no. etc. Include some reference on work instructions contingent on what is found during inspections made after milling off the existing bituminous overlay.]

- (i) Re-sealing joint grooves
- (ii) Part-bay repairs
- (iii) Thin bonded joint arris repair
- (iv) Full depth repair procedure for jointed slabs
- (v) (05/02) Full depth repair procedure for continuously reinforced slabs and bases (at ends of proposed bituminous overlay)
- (vi) Full depth repair to longitudinal cracks
- (vii) Stitched crack repair procedure
- (viii) Slab lifting

- (ix) *Pressure grouting*
- (x) *Bay replacement repair procedure*
- (xi) *Joint connectors (to transfer load across joints)*
- (xii) *Sealing cracks*
- (xiii) *Checks on load transfer between slabs may be required in order to determine what repair technique(s) is/are necessary.]*

5 (11/04) Bond Coat:

- (i) (11/04) The treated surface should be bond coated in accordance with Appendix 7/4 prior to overlaying.

6 Saw-cuts:

(i) Spacing of saw-cuts to be used:

...* metres adjacent to each joint and equally spaced at not exceeding 5 m c/c to suit a bay length.

(ii) Width of saw-cut: 3 mm

(iii) Tolerance on spacing of transverse saw-cuts: ± 50 mm

(iv) Tolerance on depth of transverse saw-cuts below base of reinforcement: +20 mm -0 mm and not greater than ...* % of nominal pavement slab depth.

(v) Not within 500 mm of any existing transverse joint or crack in that lane.

[Compiler to complete]*

7 Cracking:

(i) Type of crack:

The induced cracks shall be single, predominantly vertical from the bottom of the saw-cut to the bottom of the concrete pavement slab with no shattering or multiple cracking.

(ii) Location of the impacting head of the crack-inducing equipment:

No closer than 0.5 m from any edge of the concrete slabs.

8 Assessment of Cracking:

(i) Core diameter:

Not less than ...* mm diameter.

(ii) Depth of core:

Full depth of the reinforced concrete layer.

(iii) Frequency of coring for main production work:

1 core every 300 m².

(iv) for Stage 2 of main trial and any subsequent trials:

1 core every alternate transverse saw-cut.

[Compiler to complete]*

9 Seating:

(i) Minimum weight of roller:

...* tonnes [Not less than 20 tonnes]

(ii) Number of passes on main production work:

Not less than ...* passes shall be applied.
[Compiler to complete]*

(iii) Number of passes on main work

Not less than 6** passes of the specified roller shall be applied at every point.
*[**Compiler may increase if necessary]*

(iv) Monitoring grid

Points at 2.5 m longitudinally for minimum 25 m length at each trial site and 1.0 m centres transversely across each lane.

NG SAMPLE APPENDIX 7/16: (05/02) CRACKING AND SEATING OF EXISTING JOINTED UNREINFORCED CONCRETE PAVEMENTS AND CBM BASES

[Note to compiler: Include here details of the following][716]

- 1 Location: The drawing(s) to which reference is made in sub-Clause 716.1 are:

Drawings Nos.
[Compiler to complete]

- (i) A main trial area (or areas) of cracking and seating shall be carried out in accordance with sub-Clause 716.15 and shall be assessed in accordance with sub-Clause 716.16 at a location or at locations selected by the Overseeing Organisation to establish (i) the crack pattern, (ii) the depth and severity of cracking, (iii) the settings of the crack inducing equipment to produce the specified cracking and (iv) the spacing of the cracks for the main work. A production cracking re-assessment trial shall be carried out when necessary in accordance with sub-Clause 716.25 at a location selected by the Overseeing Organisation to re-establish (a) the crack pattern, (b) the depth and severity of cracking, (c) the settings of the crack inducing equipment to produce the specified cracking, and (d) the spacing of the transverse cracks for the main work remaining.

- 2 Bituminous overlays to be removed: Bituminous overlays are to be removed from surfaces to be cracked as follows.

- (i) Chainage ...* to ...* ...* mm nominal thickness
(ii) Chainage ...* to ...* ...* mm nominal thickness

[Compiler to complete*]

- 3 Existing cementitious pavement layer to be cracked:

- (i) Nominal thickness: ...* mm
(ii) Strength range: ...* - ...* MPa

[Compiler to complete*]

- 4 (05/04) Existing subbase and earthworks materials beneath the cementitious pavement layer:

- (i) Chainage ...* to ...* ...* mm subbase type ...*
...* mm capping
Subgrade - see data below
(ii) Chainage ...* to ...* ...* mm subbase type ...*
...* mm capping
Subgrade - see data below

[Compiler to complete/amend as appropriate*]

See borehole and trial pit information [Compiler to give name of document] listed in Appendix 0/4.

- 5 Cracking:

- (i) Spacing of transverse cracks for the main trial:
(a) ...* m
(b) ...* m
(c) ...* m
[Compiler to complete*]

- | | | |
|--------|---|---|
| (ii) | Spacing of transverse cracks for the production cracking re-assessment trial: | As directed by the Overseeing Organisation. |
| (iii) | Spacing of transverse cracks for the main works: | Determined from the main trial or from a production cracking re-assessment trial. |
| (iv) | Tolerance on spacing of transverse cracks: | ± 5% |
| (v) | Category of transverse cracks (based on width observed at the surface) | Fine ie < 0.5 mm wide. |
| (vi) | Depth of cracks: | Full depth of cementitious pavement layer. |
| (vii) | Type of crack: | The induced cracks shall be single, predominantly vertical through the layer with no shattering or multiple cracking. |
| (viii) | Location of impacting head of the crack-inducing equipment: | (05/02) No closer than 0.5 m from any edge of the concrete bays or CBM base. |
| (ix) | Tolerance of transverse alignment | ± 50 mm |
- 6 Assessment of Cracking:**
- | | | |
|-------|-------------------|---|
| (i) | Core diameter: | Not less than 150 mm diameter. |
| (ii) | Depth of core: | Full depth of the cementitious layer. |
| (iii) | FWD measurements: | Carried out by the Overseeing Organisation Contractor*. [<i>*Compiler to delete as appropriate</i>] |
| (iv) | FWD assessment: | Carried out by ...** using a 2-layer elastic analysis. [<i>** Compiler to insert the name of an approved organisation as agreed with the Overseeing Organisation</i>] |
- 7 Seating:**
- | | | |
|-------|-------------------------------|---|
| (i) | Minimum weight of roller: | ... tonnes [Not less than 20 tonnes] |
| (ii) | Number of passes on main work | Not less than 6* passes of the specified roller shall be applied at every point. [<i>*Compiler may increase if necessary</i>] |
| (iii) | Monitoring grid | Points at 2.5 m longitudinally for minimum 25 m length at each trial site and 1.0 m centres transversely across each lane. |

APPENDIX 7/17: (05/01) CRACKING PLANT AND EQUIPMENT PROGRESS RECORD

Information to be provided by the Contractor

Sheet no.....

Contract: (Road no. & name)

Site location:

Type of plant and Contractor's plant number.....

Blade lengthmetres

Blade weight.....kg

Month/year work commenced.....

Carriagewaybound
eg E/W/N/S/

Date & time	Chainage and lane no.	Height of Drop (mm)	Crack Spacing (m)	Notes For example: Changes in crack pattern and reasons for any adjustments made to weight, drop or other settings

Name of Contractor:[Block capitals]

Signature of Contractor's representative:Date

Name and post of signatory:[Block capitals]

NG SAMPLE APPENDIX 7/18: (05/01) SITE SPECIFIC DETAILS AND REQUIREMENTS FOR COLD RECYCLED BITUMEN BOUND MATERIAL

[Note to compiler: The following particulars should be read in conjunction with Clause 948]

- 1 Site description, location details and depth of recycling:
 - (i) Overall location reference to plans
 - (ii) Section details reference to plans & sections
 - (iii) Location of services reference to plans & sections
 - (iv) Depth of recycled layer mm
 - (v) Location and condition of drainage reference to plans & sections
 - (vi) Type and severity of deterioration reference to plans & sections
 - (vii) Subgrade bearing capacity and condition
 - (viii) Edge detail and verge condition reference to plans & sections
 - (ix) Future traffic loading
- 2 Type of lime required for modification of cohesive soils
- 3 Locations of stockpiles of excess pulverised materials awaiting re-use elsewhere
- 4 Rate of application of bitumen emulsion sealant spray l/m²
- 5 Minimum elastic modulus within 24 hours obtained using a dynamic plate or penetration test:

Single point value	 MPa	
Mean value	 MPa	
Minimum percentage increase of single point elastic modulus values	%	
Minimum percentage increase of mean elastic modulus value	%	
- 6 Absolute minimum added bitumen content
- 7 Nominal grid pattern [948.49]
- 8 Rolling mean of 10 FWD derived stiffness values shall not be less than..... MPa and no individual result less than 85% of MPa. [948.50]

NG SAMPLE APPENDIX 7/19: (05/01) SITE SPECIFIC DETAILS AND REQUIREMENTS FOR RECYCLED CEMENT BOUND MATERIAL

[Note to compiler: The following particulars should be read in conjunction with Clause 1046]

- 1 Site description, location details and depth of recycling:
 - (i) Overall location reference to plans
 - (ii) Section details reference to plans & sections
 - (iii) Location of services reference to plans & sections
 - (iv) Depth of recycled layer mm.
 - (v) Location and condition of drainage reference to plans & sections
 - (vi) Type and severity of deterioration reference to plans & sections
 - (vii) Subgrade bearing capacity and condition
 - (viii) Edge detail and verge condition reference to plans & sections
 - (ix) Future traffic loading
- 2 Type of lime required for modification of cohesive soils
- 3 Locations of stockpiles of excess pulverised materials awaiting re-use elsewhere
- 4 Rate of application of bitumen emulsion sealant spray l/m²
- 5 Minimum elastic modulus within 24 hours obtained using a dynamic plate or penetration test:

Single point value	 MPa
Mean value	 MPa
Minimum percentage increase of single point elastic modulus values	%
Minimum percentage increase of mean elastic modulus value	%
- 6 Nominal grid pattern [1046.34]
- 7 Rolling mean of 10 FWD derived stiffness values shall not be less than..... MPa and no individual result less than 85% of MPa. [1046.35]

NG SAMPLE APPENDIX 7/19: (05/01) SITE SPECIFIC DETAILS AND REQUIREMENTS FOR RECYCLED CEMENT BOUND MATERIAL

[Note to compiler: The following particulars should be read in conjunction with Clause 824] (05/05)

- 1 Site description, location details and depth of recycling:
 - (i) Overall location reference to plans
 - (ii) Section details reference to plans & sections
 - (iii) Location of services reference to plans & sections
 - (iv) Depth of recycled layer mm.
 - (v) Location and condition of drainage reference to plans & sections
 - (vi) Type and severity of deterioration reference to plans & sections
 - (vii) Subgrade bearing capacity and condition
 - (viii) Edge detail and verge condition reference to plans & sections
 - (ix) Future traffic loading
- 2 Type of lime required for modification of cohesive soils
- 3 Locations of stockpiles of excess pulverised materials awaiting re-use elsewhere
- 4 Rate of application of bitumen emulsion sealant spray l/m²
- 5 Minimum elastic modulus within 24 hours obtained using a dynamic plate or penetration test:
 - Single point value MPa
 - Mean value MPa
 - Minimum percentage increase of single point elastic modulus values%
 - Minimum percentage increase of mean elastic modulus value%
- 6 (05/05) Nominal grid pattern [824.34]
- 7 (05/05) Rolling mean of 10 FWD derived stiffness values shall not be less than..... MPa and no individual result less than 85% of MPa. [824.35]

NG SAMPLE APPENDIX 7/20: (05/01) SITE SPECIFIC DETAILS AND REQUIREMENTS FOR INDUCING CRACKS

[Note to compiler: Include here:][1047]

- 1 (11/04) **Cement and Other Hydraulically Bound Mixtures for Subbase and Base**
 - (i) (11/04) Crack inducing material [818.2]
 - (a) Emulsion: K1-40 bituminous spray to Clause 920.
 - (b) Plastic between 40 and 80 µm and as defined by the OLIVIA technique.

NG SAMPLE APPENDIX 7/21: (05/01) SURFACE DRESSING - RECIPE SPECIFICATION

SHEET 1: Information to be provided by the compiler

[Note to compiler: Complete one sheet per section][919]

- 1 Location. *[919.1- eg road number, name, OS grid reference of start and finish, lane]*
- 2 System of surface dressing required. *[919.1]*
- 3 (11/03) Limitations on binder cohesivity. *[919.2 - minimum peak Table NG 9/1 and HD 37 (DMRB 7.5.2)]*
- 4 Rate of spread of binder, stage 1 of Road Note 39. *[919.1]*
- 5 Chipping size(s) required. *[919.1 Road Note 39]*
- 6 (11/03) Minimum declared PSV of chippings. *[919.5, - HD 36 (DMRB 7.5.1) and HD 37 (DMRB 7.5.2)]*
- 7 (11/03) Maximum AAV of chippings. *[919.5 - HD 36 (DMRB 7.5.1) and HD 37 (DMRB 7.5.2)]*
- 8 Class of spraybar accuracy required. *[919.4, - Table NG 9/9]*
- 9 Class of chipping spreader required. *[919.6, - Table NG 9/10]*
- 10 Class for tolerance of designed rate of spread of binder. *[919.4, - Table NG 9/11]*
- 11 Class for tolerance of designed rate of spread of chippings. *[919.6, - Table NG 9/12]*
- 12 Guarantee period. *[919.1, normally 1 year]*
- 13 Period for monitoring dressing if different from minimum of 2 hours. *[919.15,]*
- 14 Special restrictions. *[919.9;- for example: maximum road surface temperature at which working permitted is 40°C]*

[Note to compiler: If a number of sites are involved then it would be convenient to set out the above data in tabular form]

NG SAMPLE APPENDIX 7/21: (05/01) SURFACE DRESSING RECIPE SPECIFICATION

SHEET 2: Information to be provided by the Contractor

The Contractor shall provide the following information with his tender:

- 1 (11/04) A copy of BS EN ISO 9001 certificate showing at least the name of the Company, the name of the certification body and the reference number and date of the certificate. A copy of the relevant part of the company Quality Assurance (QA) document showing the appropriate scope Surface Dressing and the quality management scheme described in Appendix A and limitations of the certification. The Overseeing Organisation will wish to inspect all or any of the company's QA documentation as part of the vendor assessment system and may wish to satisfy itself on the nature of the QA systems of the company's material suppliers. [919.1]
 - 2 (11/04) Proposed binders together with their data sheets, product identification data and cohesivity data as specified. For work carried out for the Highways Agency, a copy of all the data should be handed to the Overseeing Organisation, to be forwarded to: Pavement Engineering Team at Highways Agency, Bedford Office. [919.2, 919.3] [Note to compiler: A suitable Sheet for the provision of binder data is given to this Appendix, other layouts are permitted but all the required data should be supplied]
 - 3 Proposed source or sources of chippings together with statement of properties including target grading, target flakiness, PSV and AAV. [919.5]
 - 4 A method statement for each site or group of similar sites showing how it is proposed to carry out the works in conformance with the specification. [The Contractor will be expected to commit enough resources to carry out the proposed design in one single continuous pass, for example if a double dressing is proposed on a heavily trafficked road then 2 sprayers, 2 chip spreaders, 2 rollers and 2 sweepers will be a minimum requirement. The type of plant, age and number should be detailed for example 2 computer controlled sprayers three years old].
 - 5 A statement of previous use of the combinations of binders and chippings proposed for use together with any measures or tests undertaken to ensure their compatibility. [919.1; for example - the use of adhesion agents or results of Vialit adhesion tests]
 - 6 Proposals for traffic control and aftercare for each site, and reaction times for carrying out remedial measures, sweeping and site visits with the Overseeing Organisation. [919.9, 919.14, 919.15, 919.16, 919.17]
 - 7 Contingency plans in the event of any breakdown of plant or failure of the dressing and provision for dusting. [919.16]
 - 8 A statement of any previous applications on roads similar, in site type and road hardness, to the Contract sites. [919.1]
 - 9 A statement of relevant experience and expertise, naming managers, supervisors and teams responsible for and allocated to the Contract. [919.1]
- The Contractor shall provide the following information not more than 30 days after completion of the works:
- 10 An 'As Built Manual' as specified. [919.18]

Binder Data Sheet - Appendix 7/21 (11/04)		Surface Dressing - Recipe Specification	
Manufacturer of Binder:		Product name:	
Binder type:		Batch no:	
Binder Grade (highlight as required)	Conventional	Intermediate	
Binder Grade (highlight as required)	Premium	Super-premium	
Binder source:	Supplied Binder	Age Binder	Recovered Binder
Test	As supplied to site	Recovered in accordance with Clause 923	Aged in accordance with Clause 923
Penetration at 25°C 0,1 mm (100g and 5 secs)			
Penetration at 5°C 0,1 mm (200g and 60 secs)			
Manufacturer's QA viscosity test for supplied cutback binder within temperature range 100 °C to 160°C or alternatively penetration at 5°C 0,1 mm (100g and 5 secs)	†		
Vialit pendulum cohesion see Clause 939 maximum peak value J/cm ²	†#	#	#
Product identification test sub-Clause 922.6. Complex shear (stiffness) modulus (G*) and phase angle (δ) data. See Clause 928.			#
Minimum viscosity STV 4 mm cup at 40°C or Redwood II at 85°C; (required to prevent binder flow on road - normal camber)			
Other properties the Contractor considers useful			
Weather limits - information from binder manufacturer: road or air temperatures; humidity; wind chill adjustment; tolerance of surface dampness; etc	Temperature max: Temperature min: Humidity max: Wind chill adjustment: Other:		

Where indicated with # the Contractor shall attach a graphical output to this schedule.

† Cutback binders only.

‡ Emulsions only.

 Shaded cells do not require data.

NG SAMPLE APPENDIX 7/22: (05/01) REPAIRS TO POTHOLES

[Note to compiler: The following should be inserted in the Appendix as appropriate and extended when required; 949]

General

- 1 (i) All loose material shall be removed before filling the hole.
- (ii) All standing water shall be removed before filling the hole.
- (iii) The filling material shall be compacted by a suitable means.
- (iv) The surface of the compacted material shall be level with that of the adjacent road.

Road Stud Holes

- 2 Fill road stud socket with 6 mm bituminous instant road repair material or equivalent.

Holes in Paved Areas

- 3 (i) For holes less than 0.5 m² - fill with 6 mm bituminous instant road repair material or equivalent.
- (ii) (05/02) For holes greater than 0.5 m² - fill with 6 mm nominal size dense bitumen macadam surface course.
- (iii) Holes shall be backfilled with materials compacted to refusal with a circular headed vibrating hammer in layers not exceeding 75 mm thick.

NATIONAL ALTERATIONS OF THE OVERSEEING ORGANISATION OF NORTHERN IRELAND

NG 706NI Excavation, Trimming and Reinstatement of Existing Surfaces

1 Clause 706 describes a method of excavation and reinstatement of existing paved and unpaved surfaces:

- (i) Where the Contractor unavoidably has to break into work which he has carried out as part of the Works.
- (ii) Where he is required to break into paved areas existing prior to the Works being constructed.
- (iii) Where pavements are constructed to abut or join into existing pavements.

2 (05/02) As much information as possible should be provided in Appendix 7/2 and on the Drawings for 1(i) and (ii) above, especially to show the areas and depth of pavement required to match levels between new and existing construction. The intention is to ensure that at least a new surface course should be provided over the minimum area of existing pavement as will avoid feathering below 40 mm thickness, after preparation of the existing surface by scarifying and planing. Where existing and new concrete pavements abut or join into each other it is normal practice to use a bituminous pavement between the two sections, details of which should be given in Appendix 7/2.

3 Paved areas already constructed as part of the Permanent Works should only be excavated when it is necessary to carry out the Permanent Works or where no other practical means of completing the Permanent Works can be devised.

4 (05/01) Advice and methods of reinstating concrete pavements are given in the 'Concrete Pavement Maintenance Manual' published by the Concrete Society.