INTRODUCTION

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1 The Specification for Road Works is published as Volume 1 and Volume 2 of the Manual of Contract Documents for Road Works and in addition to the Introduction contains 28 Series.

The series 1400, 1500, 1600, 1700, 1800, 1900, 2100, 2200, 2300, 2500, 3000, and NG000 will be dealt with in the second version of the Specifications.

001 Not Used

002 Terms and Abbreviations

1. Unless specifically defined otherwise the definitions of terms used in the Specification and associated documents are those in BS 6100, Glossary of Building and Civil Engineering Terms.

The term Overseeing Organisation means the Malta Transport Authority.

2 Abbreviations are in accordance with the recommendations given in BS 5775. Abbreviations listed in Table 0/1 have the meanings shown therein.

003 Appendices

1 Numbered Appendices (identified by digits, e.g. 17/2) contain Contract-specific information and requirements. The Numbered Appendices incorporated in the Contract are listed in Appendix 0/3.

004 Maltese Standards, British Standards, British Standard Codes of Practice, Harmonised European Standards, European Standards and Other Reference Documents

1 The following publications are made reference in the Specification:

(i) Maltese Standards (Published by the Malta Standards Authority;
(ii) British Standards;
(iii) British Standards Codes of Practice;
(iv) British Standard Drafts for Development (DD) Documents;
(v) European Standards;
(vi) International Standards;
(vii) UK Department of Transport Publications;
(viii) Transport Research Laboratory Reports;
(ix) Acts and Statutory Instruments;
(x) British Board of Agreement Certificates;
(xi) International Board of Agreement Certificates;
(xii) Miscellaneous;

TABLE 0/1: Abbreviations

Abbreviation	Meaning
AASHTO	American Association of State Highway and Transportation Officials
AAV	Aggregate Abrasion Value
ADT	Malta Transport Authority
AISI	American Iron and Steel Institute
AMD	Amendment to British Standard
ASR	Alkali Silica Reaction
ASTM	American Society for Testing and Materials
BBA	British Board of Agreement
BRE	Building Research Establishment Ltd
BS	British Standard
BSI	British Standards Institution
CBM	Cement Bound Material
CBR	California Bearing Ratio
CHS	Circular Hollow Section
CP	British Standard Code of Practice
EN	European Standard
FTD	Flat Traffic Delineator
HAPAS	Highway Authorities Product Approval Scheme
HMSO/SO	Her Majesty's Stationery Office/The Stationery Office
HSE	Health and Safety Executive
ISO	International Organization for Standardization
MCV	Moisture Condition Value
MDPE	Medium Density Polyethylene
MSA	Malta Standards Authority
NG	Notes for Guidance on the Specification for Road Works
PC	Portland Cement
PCD	Percentage Impact Compactor Density
PSV	Polished Stone Value
PVC	Polyvinyl Chloride
RCD	Road Construction Detail
RHS	Rectangular Hollow Section
SRW	Specification for Road Works
SI	Statutory Instrument
SMC	Saturation Moisture Content
TRL	Transport Research Laboratory (formerly Transport and Road Research Laboratory)
UKAS	United Kingdom Accreditation Service
PVC-U	Unplasticised Polyvinyl Chloride
XLPE	Cross-linked Polyethylene
Dc	Direct current

Dft	Dry film thickness
Ggbs	Ground granulated blast furnace slag.
Mc	Moisture content
Mdft	Minimum dry film thickness (of paint)
Omc	Optimum moisture content
Pfa	Pulverised fuel ash.

2 Maltese Standards, British Standards and British Standard Codes of Practice incorporated in the Contract by a reference which does not include a date shall be the respective editions current on the date stated in the Contract, and incorporating all amendments current on that date. Maltese Standards, British Standards and British Standard Codes of Practice incorporated in the Contract by a reference that includes a date shall be deemed to exclude amendments issued after that date except any such amendments shown in brackets immediately following the stated date.

3 In respect of all other references the date of the edition applicable to the Contract shall be that stated in the Specifications or, where no date is stated, the date of the edition current on the date stated in the Contract and incorporating all published amendments current on that date.

4 Where a Maltese Standard or a British Standard incorporated in the Contract has been superseded by a Harmonised European Standard, or a European Standard, issued prior to the date stated in the Contract then such Harmonised European Standard or European Standard shall be substituted for the Maltese Standard or British Standard and any amendments thereto contained in the Specification.

005 Thickness of Material and Tolerances

1 Unless stated to the contrary, the thickness of material described shall mean the finished or compacted thickness.

2 The requirements for tolerances, where necessary, are incorporated in the Specification, on the Drawings and by reference in the publications stated in the Specification.

006 Acknowledgements

1 The Malta Transport Authority acknowledge the permission given by HMSO on whose publication ‘Standards for Highway Works’, the ADT Specification for Road Works is based.

2 The Malta Transport Authority also acknowledges the permission given by the German Road and Transportation Research Association (FGSV) for adapting the specifications established by its Committees, in the preparations of the ADT Specification for Road Works.

MANUAL OF CONTRACT DOCUMENTS FOR ROAD WORKS
VOLUME 1 SPECIFICATION FOR ROAD WORKS

SERIES 100

PRELIMINARIES

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PRELIMINARIES

101 Temporary Accommodation and Equipment for the Overseeing Organisation

1 The Contractor shall provide, maintain, service and remove all accommodation including contents, access roads and hardstanding thereto, as described in Appendix 1/1, for the use of the Overseeing Organisation.

2 Equipment, furnishings, fittings and supplies shall be located as described in Appendix 1/1. All temporary initial accommodation shall be ready for occupation on the date for commencement of the Works and all other accommodation complete with contents, access roads and hardstanding shall be ready for occupation and use by the Overseeing Organisation within four weeks of the date for commencement of the Works unless otherwise stated in Appendix 1/1.

3 Where stated in Appendix 1/1 the Contractor shall furnish and service accommodation made available by the Overseeing Organisation.

4 Telephones shall have a separate connection direct to a telephone exchange of a telecommunication code system with privacy for conversation for the exclusive use of the Overseeing Organisation.

5 All accommodation shall be regularly cleaned for so long as it is in use and suitable arrangements be made for the disposal of any waste arising from use of such accommodation.

6 All equipment supplied by the Contractor shall be of a quality and precision appropriate to its proposed use and shall be delivered in a serviceable condition. The Contractor shall maintain all such equipment in serviceable condition and replace, if necessary, any that becomes unserviceable. The Contractor shall ensure that any equipment needing periodic calibration is calibrated on delivery, annually and/or at other times as and when required by the Overseeing Organisation.

7 When major components of the Works are manufactured off the Site the Contractor shall arrange to make available adequate and secure accommodation as described in Appendix 1/1 at or adjacent to the place of, and during the period of, manufacture and testing.

102 Vehicles for the Overseeing Organisation

1 The Contractor shall provide transport as described in Appendix 1/2 for the exclusive use of the Overseeing Organisation for any purpose in connection with the Works. The vehicles shall be delivered and maintained in good roadworthy condition. They shall have a current VRT Certificate where necessary, be licensed and insured for use on the public road and shall have comprehensive insurance cover for any qualified driver authorised by the Overseeing Organisation together with any authorised passengers and the carriage of goods or samples. The Contractor shall provide fuel, oil and maintenance in conformity with the vehicle manufacturer's recommendations and shall keep clean the vehicles inside and out on a regular basis as described in Appendix 1/2. A suitable replacement shall be provided for any vehicle out of service for more than 8 working hours.

103 Communication System for the Overseeing Organisation

1 When required in Appendix 1/3 the Contractor shall provide a communication system for the Overseeing Organisation as described therein, within 4 weeks of the date for commencement of the Works unless a different date for provision is required in Appendix 1/3.

2 The system, unless otherwise described in Appendix 1/3, shall be entirely separate from any provision for a communication system provided by the Contractor for his own use except that any aerial installation may be shared.

3 The system shall have an operating range which ensures reception throughout the Site.

4 The Contractor shall maintain the system, dismantling and removing it at the end of the period stated in Appendix 1/3. If the system is inoperative for any reason, it shall either be repaired or a replacement provided within 24 hours.

104 Standards, Quality Assurance, Agrément Certificates and Other Approvals Standards

1 Except where the specified standard implements or is technically equivalent to a Harmonised European Standard or to a European Standard adopted for use after 31 December 1985, any requirement for goods or materials to comply with the specified standard shall be satisfied by compliance with:

(i) a relevant standard or code of practice of a national standards body or equivalent body of any Member State of the European Economic Area;

or

(ii) a relevant international standard recognized for use in any Member State of the European Economic Area;

or

(iii) a technical regulation of any Member State of the European Economic Area;

or

(iv) traditional procedures of manufacture of any Member State of the European Economic Area where these are the subject of a written technical description sufficiently detailed to permit assessment of the goods or materials for the use specified;

or

(v) a European Technical Approval (ETA) issued in accordance with the Construction Products Directive 89/106/EEC (or, until procedures are available for the issue of ETAs, a specification sufficiently detailed to permit assessment) for goods or materials of an innovative nature or subject to innovative processes of manufacture and which fulfil the purpose provided for by the specified standard

provided that the proposed standard, code of practice, regulation, specification, technical description or European Technical Approval provides, in use, levels of safety, suitability and fitness for purpose equivalent to those required by the specified standard in so far as they are not inconsistent with the 'Essential Requirements' of the Construction

Products Directive (89/106/EEC). This Clause applies also to works only in so far as the means of carrying out such works are indivisibly associated with the goods or materials for which an alternative standard, code of practice, regulation, specification or technical description is proposed.

Quality Assurance

2 Unless otherwise indicated in Appendix 1/24, the Contractor shall institute a quality management system complying with BS EN ISO 9002 : 1994 and describe this in a Quality Plan. The Quality Plan shall also incorporate the requirements of Appendix 1/24 and where relevant, the requirements of the accepted quality management schemes (see sub-Clauses 104.4 and 104.6 below and Appendix A). The Quality Plan shall be submitted to the Overseeing Organisation, within the period(s) given in Appendix 1/24, for acceptance, before any related work is commenced. The Contractor shall allow adequate time for written acceptance to be obtained.

3 Quality Plans and method statements shall indicate "hold points" as follows:

Contractor's hold points:	points where no further work shall proceed without the written approval of a designated person of the Contractor's management, who shall be named in the Quality Plan.
Overseeing Organisation's hold points:	points where no further work shall proceed without the written hold points: approval of a designated representative of the Overseeing Organisation.

The Contractor shall ensure the Quality Plans and associated quality documentation are available to all parties involved with the Works.

4 Where any work, goods or materials to be used in the Works are the subject of the ADT Accreditation Service accredited third party quality management scheme or a Sector Scheme for Quality Management in Road Works listed in Appendix A accredited third party product certification scheme listed in Appendix B, only work, goods or materials conforming with such a scheme shall be used and the Contractor shall in each case submit to the Overseeing Organisation a copy of the certificate of conformity affirming compliance with the scheme, unless the goods or materials bear a prescribed certification mark. Where specific training and/or competency requirements are included in any quality management scheme listed in Appendix A, the Contractor shall provide copies of the relevant training and/or competency assessments certificates and/or registration/skill cards of the workforce to the Overseeing Organisation for acceptance.

5 The requirement for any goods or materials to be manufactured or supplied subject to a quality management scheme listed in Appendix A or product certification scheme listed in Appendix B shall be satisfied by compliance with an equivalent quality management scheme or product certification scheme of any Member State of the European Economic Area, provided that the proposed scheme is designed to ensure in use levels of safety, suitability and fitness for purpose equivalent to those provided for by the scheme specified. This sub-Clause applies also to works only in so far as the means of carrying out such works are indivisibly associated with the goods or materials for which an alternative quality management scheme or product certification scheme is proposed.

6 Where any work, goods or materials to be used in the Works are the subject of a Supplier's quality management scheme listed in Appendix A, the Contractor shall require the Supplier of such items to prepare a Supplier's Quality Plan and submit it to the Overseeing Organisation. The Supplier's Quality Plan shall comply with the requirements of Appendix 1/24 and the individual requirements of the relevant Sector Scheme Documents for Quality Management in Road Works.

Quality Records

7 The Contractor shall make available and shall require a Supplier to make available on request contemporary quality records as identified in BS EN ISO 9002 : 1994 to demonstrate achievement of the required quality and the effectiveness of the quality system. Copies of all quality records shall be made available immediately to the Overseeing Organisation. The Contractor shall report any non-conforming product/service and shall require a Supplier to immediately report any non-conforming product/service to the Contractor. The Contractor shall immediately pass these reports to the Overseeing Organisation, and undertake no further related work until remedial or other measures have been undertaken.

8 The Contractor shall submit the quality records required by this Specification, as indicated in Appendix H, to the Overseeing Organisation. No item of work shall be considered complete until these records have been received by the Overseeing Organisation.
Note: Quality terms used in this Clause are as ISO 8402 (BS 4778).

ADT Board of Agrément Certificates

9 Where any work, goods or materials are required to have a ADT Board of Agrément Certificate only work, goods or materials so certificated shall be used and the Contractor shall in each case submit to the Overseeing Organisation a copy of the certificate. Types of work, goods and materials subject to such requirements are listed in Appendix C.

10 The requirements of Appendix C shall be satisfied by goods or materials having an equivalent Agrément certificate issued in any Member State of the European Economic Area, provided that the goods or materials covered by such certificate offer in use levels of safety, suitability and fitness for purpose equivalent to those incorporated in the ADT Board of Agrément Certificate. This sub-Clause applies also to works only in so far as the means of carrying out such works are indivisibly associated with the goods or materials for which an alternative Agrément certificate is proposed.

Statutory Type Approval

11 The requirements for statutory type approval are embodied in the Traffic Signs Regulations and General Directions 1994, the Zebra, Pelican and Puffin Pedestrian Crossings Regulations and General Directions 1997, and subsequent amending Regulations. Traffic signs requiring such approval are listed in Appendix D. The Contractor shall submit written evidence to the Overseeing Organisation that the relevant statutory type approval has been obtained. Where the Contractor has designed part of the Works for which statutory type approval is required, application to the ADT shall be made through the Overseeing Organisation.

Statutory Authorisation

12 Statutory authorisation is required before any traffic signs are incorporated into the Works where these are of a character and/or are to be used in circumstances which have not been prescribed in the Traffic Signs Regulations and General Directions 1994, the Zebra, Pelican and Puffin Pedestrian Crossings Regulations and General Directions 1997, or subsequent amending Regulations. Where the Contractor has designed part of the Works for which such authorisation is required, application to the ADT shall be made through the Overseeing Organisation.

Type Approval/Registration

13 Where work, goods or materials are required to have type approval/registration only work, goods or materials so approved/registered shall be used and the Contractor shall in each case submit to the Overseeing Organisation a copy of the type approval/registration certificate. Types of work, goods and materials subject to such requirements are listed in Appendix E.

14 Where there is a requirement for work, goods or materials of the types listed in Appendix E to have Departmental type approval/registration this will be granted by the Overseeing Organisation where the work, goods or materials have an equivalent approval/ registration of the national highway authority of any Member State of the European Economic Area, provided that such approval/registration offers in use levels of safety, suitability and fitness for purpose equivalent to those incorporated in the type approval/ registration.

Named Suppliers or Manufacturers

15 Any requirement in the Contract to use goods or materials which are defined by reference to a named supplier or manufacturer shall be construed as referring to those goods or materials or equivalent. For the purposes of this sub-Clause equivalent goods or materials are those supplied from within the European Economic Area which provide in use levels of safety, suitability and fitness for purpose equivalent to those provided by the specified goods or materials in so far as they are not inconsistent with the 'Essential Requirements'of the Construction Products Directive (89/106/EEC).

Provision of Information

16 Unless otherwise specified, two copies of all information, including valid certificates, in respect of work, goods or materials proposed by the Contractor shall be supplied to the Overseeing Organisation. Where the original documentation is in a language other than English, it shall be accompanied by an English translation. Information and certificates shall be supplied at least four weeks prior to the use of the work, goods or materials in the Works.

17 When required in Appendix 1/4, three copies of detailed working and fabrication drawings, prepared by or on behalf of the Contractor, shall be submitted for the Overseeing Organisation's approval and when the drawings have been approved the Contractor shall provide transparencies of the approved drawings to the Overseeing Organisation. Minimum period for submission of the drawings prior to commencement of the related works shall be as stated in Appendix 1/4. Such approval shall in no way relieve the Contractor of his responsibilities for the work under the Contract.

18 When the Contractor proposes to use a different standard, quality management

scheme, product certification scheme, Agrément Certificate or type approval/registration from that specified the Contractor shall provide all the relevant information to enable the Overseeing Organisation to ascertain whether or not the proposal is equivalent to the specified requirement. The information shall be supplied at least 4 weeks prior to commencing the related works, to enable the evaluation of equivalence to be made, taking into account the programme for the Works.

105 Goods, Materials, Sampling and Testing Goods and Materials

1 The Contractor shall maintain a record of the suppliers from whom he proposes to purchase the goods and materials necessary for the execution of the Works. Where a choice of goods or materials is listed in the Contract, the Contractor shall inform the Overseeing Organisation of the goods or materials he proposes to use. Samples of such goods or materials shall be known as 'source samples' and shall be retained for reference purposes. Any subsequent change of suppliers, goods or materials shall also be recorded. Samples which are not source samples but which are either part of material intended for incorporation in the Works, or part of material incorporated in the Works, shall be known as 'production samples'.

Sampling and Testing

2 The testing scheduled in Appendix 1/5, including sampling and provision of the associated samples, shall be undertaken by the Contractor. The Contractor shall carry out each of the tests required in Appendix 1/5 within an elapsed time from the taking of the respective samples which shall be reasonable in all the circumstances unless otherwise prescribed by the Overseeing Organisation. The Contractor shall supply to the Overseeing Organisation, when requested, within 24 hours of the completion of each test, a copy of the results. Where ADT laboratory accreditation is required the results shall be reported on an official ADT accredited laboratory test report or certificate. The following operations are not included in Appendix 1/5:

(i) checking, inspecting, examining, measuring (except in connection with testing);

(ii) trials and demonstrations;

(iii) routine testing carried out by manufacturers and suppliers in compliance with a specified standard or specification;

(iv) testing of plant. Where required in Appendix 1/5 a test certificate, complying with the provisions of the relevant standard or specification where applicable and certifying that the goods or materials have been tested and meet the specified requirements, shall be supplied to the Overseeing Organisation by the Contractor at least four weeks prior to the incorporation of the goods or materials in the Works.

3 Where required in Appendix 1/5 tests and associated sampling shall, except as allowed in sub-Clause 4 of this Clause, be undertaken only by testing laboratories accredited in accordance with EN 45001 by

the ADT

4 Where testing including sampling is carried out in another Member State of the European Economic Area such tests shall be undertaken by an appropriate organisation offering suitable and satisfactory evidence of technical and professional competence and independence. This condition shall be satisfied if the organisation is accredited in a Member State of the European Economic Area in accordance with the relevant parts of the EN 45000 series of standards for the tests carried out.

5 Where goods or materials are accepted on the basis of an equivalent standard, code of practice, specification, technical description, quality management scheme, product certification scheme or Agrément certificate as provided for in Clause 104, testing and sampling as specified in or applicable to such an equivalent standard, code of practice, specification, technical description, quality management scheme, product certification scheme or Agrément certificate is accepted and shall be substituted for those specified in Appendices 1/5 and 1/6 respectively.

6 The Contractor shall provide samples, which shall include source samples, of goods and materials and shall deliver these to the Overseeing Organisation as described in Appendix 1/6. Unless otherwise stated in Appendix 1/6, the Contractor shall arrange for the sampling of such goods and materials to be undertaken by qualified staff of testing laboratories holding ADT accreditation to EN 45001 for such sampling. These samples shall be supplied in sufficient time for them to be tested for acceptability by the Overseeing Organisation, taking into account the programme for the Works. Production samples shall be delivered in a condition which is representative of the material's state for the purpose of the test.

7 The Contractor shall provide for rates of sampling specified in Appendix 1/6. These rates of sampling shall apply at the outset of each of the respective activities and for the duration of each of the activities. Following an initial period of sampling, the Contractor may apply to the Overseeing Organisation for a relaxation in these rates of sampling having demonstrated to the Overseeing Organisation an acceptable level of confidence in control. Provided, at any subsequent time when test results indicate the need for improved control in the opinion of the Overseeing Organisation, the Contractor samples at the rate specified in Appendix 1/6.

8 Where testing is undertaken by a supplier or manufacturer in accordance with the Contract the Contractor shall ensure that each supplier and manufacturer will admit the Overseeing Organisation's representative to his premises during normal working hours for the purposes of inspecting, selecting the samples and witnessing the testing.

106 Design of Permanent Works by the Contractor Structures

1 The Contractor shall design the structures listed in Appendix 1/10 (A) to comply with the design specifications and requirements therein. Where the Contractor proposes to design a structure (for which a choice of designs is offered) listed in Appendix 1/10 (B) he shall comply with the design specification and requirements therein. The Contractor shall follow the technical approval procedures given in the Technical Approval Scheme adopted by the Overseeing Organisation for which purposes

the Contractor shall be deemed to be the designer.

2 Where the Contractor is required to complete an outline Approval in Principle form, the Contractor shall forward two copies of the completed form to the Overseeing Organisation for acceptance.

3 The Contractor shall submit two copies of the completed design certificate and drawings for each structure listed in Appendix 1/10 to the Overseeing Organisation for acceptance.

Structural Elements and Other Features

4 The Contractor shall design the structural elements and other features listed in Appendix 1/11 to comply with the design specifications therein. Alternatively, the Contractor may propose an element or feature designed by the manufacturer. In either case, the Contractor shall submit his proposals to the Overseeing Organisation.

107 Site Extent and Limitations on Use

1 The extent of the Site and any limitations on its use shall be as described in Appendix 1/7.

108 Operatives for the Overseeing Organisation

1 The Contractor shall provide the Overseeing Organisation with, and maintain continuity of, operatives equal to the tasks, and capable of performing the functions, described in Appendix 1/8.

2 For site surveys and setting out, operatives shall be experienced in assisting engineers in such work.

3 For laboratory-related duties, operatives shall be capable of assisting laboratory staff in routine tasks.

4 Operatives provided under sub-Clauses 2 and 3 of this Clause shall have valid driving licences and driving experience suitable for the vehicles supplied in accordance with Appendix 1/2.

109 Control of Noise and Vibration

1 The Contractor shall comply with the recommendations for practical measures to reduce noise set out in BS 5228 : Parts 1, 2 and 4 and with any specific requirements stated in Appendix 1/9.

2 The Contractor shall comply with any specific requirements for the control of vibration stated in Appendices 1/9, 2/4, 6/3, 6/13 and Clause 607.

3 Compliance with sub-Clauses 1 and 2 of this Clause does not confer immunity from relevant legal requirements.

110 Information Boards

1 The Contractor shall, within four weeks of the date for the commencement of the Works provide and erect information boards at the locations and to the specification given in Appendix 1/21. The Contractor shall ensure that they are kept clean and maintained in a safe and legible condition and remove them on completion of the Works.

111 Existing Ground Levels

1 The Contractor shall satisfy himself that the existing ground levels as described in

Appendix 1/12 are correct. Should the Contractor wish to dispute any levels he shall submit to the Overseeing Organisation a schedule of the position of the levels considered to be in error and a set of revised levels. The existing ground relevant to the disputed levels shall not be disturbed before the correct levels are determined.

112 Setting Out

1 The Contractor shall, unless otherwise stated in Appendix 1/12, within 3 weeks of the date for commencement of the Works, carry out a check of the co-ordinates and levels of all permanent ground markers and permanent bench marks described in Appendix 1/12 and shall supply the Overseeing Organisation, if requested, with their position and level in order that they may be checked and revised if necessary. The Contractor shall identify and bring to the attention of the Overseeing Organisation any markers that are missing. The Contractor shall comply with any specific requirements for setting out described in Appendix 1/12.

2 The Contractor shall keep updated schedules and drawings of all bench marks (which shall be based on Ordnance Datum at Newlyn) used in the setting out and shall make these available to the Overseeing Organisation when required.

3 The Contractor shall ensure that where necessary, in order to maintain his programme, lines and levels are set out in such time as to enable Statutory Undertakers' plant and other publicly or privately owned services or supplies to be installed, altered or removed.

4 The Contractor shall survey and record existing details of items which he is required to remove and subsequently replace. The level of survey information to be recorded is described in Appendix 1/12.

113 Programme of Works

1 Subject and without prejudice to the Conditions of Contract, the programme which the Contractor submits to the Overseeing Organisation shall comply with the specific requirements stated in Appendix 1/13.

114 Payment Applications

1 Unless otherwise described in the Contract, the Contractor shall comply with the requirements described in Appendix 1/14 concerning applications for payment.

115 Accommodation Works

1 The Contractor shall undertake and complete the accommodation works as described in Appendix 1/15. The Contractor shall give the Overseeing Organisation at least ten days' notice of the date he intends to start work on individual plots, for the benefit of each owner, lessee or occupier.

116 Privately and Publicly Owned Services or Supplies

1 The Contractor shall satisfy himself as to the exact position of Statutory Undertakers and other publicly and privately owned services or supplies affected by the Works.

2 The Contractor shall, during the progress of the Works take all measures required by any Statutory Undertaker or the management of other publicly or privately owned services

or supplies, for the support and full protection of all such services or supplies.

3 Where privately or publicly owned services or supplies affected by the Works are subject to alteration, removal or addition, the Contractor shall be responsible for all arrangements with the owners and/or their agents for the execution and phasing of such works in accordance with his programme. Details of such work, preliminary arrangements made by the Overseeing Organisation, and/or any orders already placed are given in Appendix 1/16.

4 Where work is being undertaken on a motorway the Contractor shall take all measures required by the Overseeing Organisation for the location and protection of all cabling, ducts and other devices which form part of the motorway communications system or other systems of the Overseeing Organisation. The Contractor shall comply with the "Special Requirements in Relation to Motorway Communications Systems". Where the Road communications system or other system will be affected by the Works the Contractor shall ensure that an alternative system as described in Appendix 1/16 is fully operational prior to interrupting the existing system; any connections or disconnections to the existing system may only be undertaken by the Overseeing Organisation's maintenance agent. The Contractor shall be responsible for liaising, with the Overseeing Organisation's maintenance agent.

5 No services or supplies shall be interrupted without the written consent of the appropriate authority or owner, and the Contractor shall provide a satisfactory alternative before interrupting any existing service or supply, unless otherwise stated in Appendix 1/16.

117 Traffic Safety and Management

1 When planning and undertaking work on roads open to traffic the Contractor shall take account of the Quality Management Sector Schemes detailed in Appendix A and the recommendations contained in the following:

(a) for work on motorways - "Planning for safety: Guidance Notes for the Health and Safety of Workers at In-Service Motorway Roadworks Sites", issued jointly by the Department of Transport, the Welsh Office, the Scottish Office Industry Department and the Federation of Civil Engineering Contractors;

(b) for work on all roads - "Safety at Roadworks: Notes for Guidance (1994 edition)" issued jointly by the Department of Transport and the County Surveyors' Society;

(c) for recovery vehicles - "Code of practice on Health and Safety for Vehicle Recovery Operators" published by the Association of Vehicle Recovery Operators.

2 When planning traffic safety and management measures the Contractor shall take into account the information contained in Appendices 1/17 and 1/18.

3 The Contractor shall, unless otherwise stated in Appendix 1/17, after consultation with any statutory, police or other authority concerned prepare and submit traffic safety and management proposals within the timescale described in Appendix 1/17 to the Overseeing Organisation. These shall show the proposed traffic safety and management measures including provision of safety zones

which he proposes for carrying out the Works. If stated in Appendix 1/17, the proposals shall include the provision of running lanes for the use of emergency vehicles within the Site. If required the Contractor shall make such changes to his proposals as may be necessary to meet the requirements of the Contract. Thereafter the Contractor shall furnish such details and information as may be necessitated by the Works.

4 The Contractor shall design, construct and maintain, or if Appendix 1/17 so provides shall construct and maintain, the central reserve crossovers described in Appendix 1/17 in accordance with the information stated therein. Unless otherwise described in Appendix 1/17, the Contractor shall remove those crossovers when no longer required and reinstate the central reserve to its original condition.

5 If the Contractor intends to construct central reserve crossovers as part of his traffic safety and management proposals he shall submit an outline of the proposals to the Overseeing Organisation in advance, in accordance with the requirements of sub-Clause 3 of this Clause.

6 The Contractor shall submit a formal application, as described in Appendix 1/17, to the appropriate authority for any statutory orders required to be made or notices required to be published in connection with his traffic safety and management proposals. The Contractor shall inform the Overseeing Organisation of details the Contractor has agreed with the ADT for traffic signs, lighting, construction, maintenance and removal of any central reserve crossovers.

7 If stated in Appendix 1/17, the Contractor shall undertake the maintenance functions described therein and to the extent there described, on the lengths of roads there specified, until the issue of the appropriate certificate of completion.

8 The Contractor shall, unless otherwise stated in Appendix 1/17, provide, erect, maintain, reposition, cover and uncover and finally remove traffic signs as required by the Works. In so doing, such other measures shall be taken by the Contractor as may be necessitated by the Works in accordance with any special requirements in Appendix 1/17, recommendations in Chapter 8 of the Traffic Signs Manual published by The Stationery Office and amendments thereto detailed in Annex B of Advice Note TA 61 and in Standard TD 49, and other instructions of the Overseeing Organisation listed in Appendix 1/17. The recommendations of Chapter 8 of the Traffic Signs Manual are further extended by Advice Notes TA 63 and TA 64. Where the circumstances of any particular situation are not covered by the recommendations or described in Appendices 1/17 or 1/18, the Contractor shall submit proposals for dealing with that situation to the Overseeing Organisation.

9 Where a temporary speed limit at road works has been imposed and the Works have been temporarily terminated, with the removal of traffic management measures, the Contractor shall ensure that the temporary speed limit signs are covered or taken down for the duration of the cessation of the Works. Where the temporary speed limit signs are covered, the covering material shall be of a glare-resistant type and securely fastened.

10 Traffic signs shall comply with the appropriate Clauses in Series 1200 of the Specification. The Contractor shall unless otherwise stated in Appendix 1/17 keep traffic signs clean, secure and legible and ensure that all signs required to be lit,

whether by external or internal lighting, are so lit during periods when road vehicles are required to display lights.

11 Where the Contract provides that the Contractor shall not erect, maintain or reposition traffic signs, the Contractor shall not change in any manner the permanent or temporary traffic signs without instruction from the Overseeing Organisation and shall give such notice as is stated in Appendix 1/17 to indicate when signs should be moved compatible with the progress of the Works.

12 All traffic safety and management measures necessitated by the works shall be fully operational before the Contractor commences any work, which affects the public road or the use of it.

13 Any area of the road that has been closed because of the Works shall not be re-opened until all appropriate traffic safety and management measures have been completed and the road is in a suitable condition for public use.

14 Where work is carried out on, or adjacent to a road open to traffic the Contractor shall ensure that vehicles and mobile plant under his control operating frequently or regularly on or adjacent to that road in the execution of the Works shall be painted in a conspicuous colour and shall have sign boards reading Road Maintenance or where appropriate 'Motorway Maintenance'. The signs shall be in accordance with Diagram 7404 of Schedule 12, Part V of the Traffic Signs Regulations and General Directions 1994. The lettering shall be 150 mm x height for vehicles and plant except that for light vans and cars it shall be the largest x height that can be accommodated out of the following heights: 37.5, 50, 62.5, 75 or 100 mm. In addition each such vehicle or item of plant shall be provided with one or more suitable roof mounted amber beacons fitted and operated in accordance with paragraph 2.3.7.4 of Chapter 8 of the Traffic Signs Manual and The Road Vehicle Lighting Regulations.

15 Temporary lighting shall be provided in accordance with Clause 1405 where required by Appendix 1/17, or by the Contractor in the execution of the Works.

16 Temporary Emergency Telephones shall be provided in accordance with Clause 1529 where required by Appendix 1/17, or by the Contractor in the execution of the Works in accordance with sub-Clause 117.3.

17 The Contractor shall provide and suitably sign points of entry to and exit from the Site, for vehicles and plant engaged on the Works. The Contractor shall ensure that when any vehicle or item of plant is reversing within the Site on or adjacent to a road open to traffic, it does so only under the supervision of a person designated for the purpose of regulating traffic within the Site who shall be readily distinguishable from the remainder of the work force.

18 Where work is carried out on or adjacent to a road open to traffic the Contractor shall ensure that the workforce and the site supervisory staff at all times wear high visibility warning clothing complying with BS EN 471. Clothing shall be to Table 1, Class 2 or 3 (Class 3 on motorways or other high speed roads) and shall comply with the requirements of para 4.2.3(b). In addition on motorways or other high speed roads full length sleeves meeting the requirements of para 4.2.4 shall be provided for coveralls and jackets. The colour of the clothing shall normally be "fluorescent yellow" or "fluorescent orange-red" complying with Table 2. The retroreflective material used shall be to Class 2 as defined at Table 5.

Clothing complying with other specifications may be used in accordance with Clause 104.2 where they offer equivalent levels of performance in so far as the specification given is not inconsistent with the basic health and safety requirements set out in Annex 2 of the Personal Protective Equipment Directive (89/686/EEC). The Contractor shall ensure that the person in charge of the workforce is readily distinguishable from the person designated in sub-Clause 19 of this Clause and from the remainder of the workforce.

19 Where required in Appendix 1/17, the Contractor shall appoint a Traffic Safety and Control Officer who shall make all arrangements necessary for traffic safety and control including the provision and operation of breakdown recovery vehicles. The Traffic Safety and Control Officer shall have one or more nominated deputies. The Contractor shall provide the Overseeing Organisation with the names of this Officer and his nominated deputies and with telephone numbers or details of other means by which they or one of them can be contacted at any time. Unless otherwise described in Appendix 1/17 the Traffic Safety and Control Officer or a nominated deputy shall be on the Site at all times when traffic management is in operation and shall be readily available to deal with matters related to traffic safety and control (including breakdown recovery vehicles).

20 If an accident or breakdown occurs on a carriageway or hard shoulder open to traffic within or in the vicinity of the Site, the Contractor and operators of recovery vehicles provided in accordance with Clause 120 shall act as requested by police officers acting under their statutory powers.

21 Where required in Appendix 1/17, the Contractor shall provide, erect, maintain and remove Driver Information Signs in accordance with sub-Clauses 22 to 31 of this Clause.

22 Sign face layouts shall be in accordance with Signs 7004 and 7005 of the Traffic Signs Regulations and General Directions 1994.

23 Legends shall be selected as appropriate from Table 1/1 unless stated otherwise in Appendix 1/17.

24 Sign 7004 shall describe the work activity taking place. It shall be sited either:

(i) Two miles from major maintenance works and Type A works, as defined by Topic 4 of Chapter 8 of the Traffic Signs Manual, on high speed dual carriageways; or

(ii) One mile from routine and minor maintenance works and Type B works, as defined by Topic 5 of Chapter 8 of the Traffic Signs Manual, on high speed dual carriageways.

25 Sign 7005 shall indicate how long delays are possible. It shall be sited one mile from major maintenance and Type A works. At the commencement of Works the legend shall read, for example ".... until Sept 02". At least ten days before the end of carriageway restrictions the date shall be specified more precisely, for example ".... until 30 Sept". This date shall be further updated, if necessary, until the restrictions are removed.

26 Sign 7004 shall be located within roadworks when part of the road is coned off, and the reason for this is not apparent from the carriageway, for any period

exceeding 30 minutes, or one hour if road capacity is maintained.

27 Signs located within roadworks shall only be used where they can be located at least 50 metres beyond the downstream end of a taper and in a position which does not prejudice traffic safety.

28 If needed, Information Signs shall be sited at the beginning and at one kilometre
30 The Contractor shall provide adequate storage facilities clear of any safety zone. Storage within the central reserve or in front of safety fencing shall not be permitted.

31 Information signs shall only be displayed within roadworks where they accurately reflect the reason for the inactivity.

32 Where required in Appendix 1/17, a Temporary Automatic Speed Camera System for the Enforcement of Mandatory Speed Limits at Roadworks (TASCAR) shall be provided in accordance with the requirements therein.

intervals through the Works. They shall not be placed where they may distract drivers negotiating traffic management provisions

29 Signs shall either be sited for the duration of the works where it is safe and appropriate to do so or provision made to enable their use at short notice.

TABLE 1/1: (05/01) Legends for Driver Information Signs at Roadworks

ADVANCE SIGN AT MAJOR WORKS (sited at 2 miles)			
Replacing worn out road	Renewing damaged bridge deck	Repairs to weak surface	Repairs to weak bridge supports
Bridge painting	Repairs to bridge	Installing new hard shoulder	Installing new drainage system
Installing new road markings	Installing new cabling*	Installing new lighting	Installing new safety fencing
Installing sign gantry	Building service area access	Ground survey works	Widening and road repairs
*This legend may be used for both electrical supply and communications cabling.			
ADVANCE SIGN AT MAJOR WORKS ONLY (sited at 1 mile)			
Delays possible until Sept* 02†	Delays possible until 30 Sept*		
*Month to read - Jan, Feb, Mar, Apr, May, June, July, Aug, Sept, Oct, Nov or Dec †Year to read - 02 or 03 etc.			
ADVANCE SIGN AT ROUTINE AND MINOR WORKS (sited at 1 mile)			
Essential maintenance	Repairs due to road accident		
SIGN USED WITHIN ROADWORK SITES			
Work suspended Unsuitable weather	Repair work on bridge below	Lane closed for safety	
Road repairs Materials hardening	Further works ahead Lane remains closed for safety purposes	Lane closed to protect workforce	

118 Temporary Diversions for Traffic

1 The provisions of this Clause do not apply to any temporary access or accommodation works which the Contractor may construct for his sole use in the execution of the Works.

2 Each temporary diversion for traffic shall be made operative in advance of any interference with the existing arrangements and shall be maintained to the standard stated in Appendix 1/18 or if no standard is so stated, in accordance with sub-Clause 6 of this Clause.

Temporary Diversions for Traffic Specified by the Overseeing Organisation

3 The Contractor shall construct, maintain, remove and reinstate each temporary diversion for traffic specified in Appendix 1/18 in accordance with the details stated therein. Where stated in Appendix 1/18, the Contractor shall design each temporary diversion for traffic, including any temporary structures, in accordance with the details stated therein. Unless otherwise described in Appendix 1/18, the Contractor shall remove each temporary diversion for traffic as soon as it is no longer required.

Temporary Diversions for Traffic Proposed by the Contractor

4 If the Contractor proposes to construct a temporary diversion for traffic as part of his intended traffic safety and management measures, he shall submit an outline of his proposals to the ADT for their agreement and consultation with the police.

5 The Contractor shall submit a formal application to the appropriate authority for any statutory orders required to be made or notices required to be published through the Overseeing Organisation, allowing such time as is stated in Appendix 1/18 for the orders to be made and notices to be published.

6 The standard and siting of every temporary diversion for traffic shall be suitable in all respects for the class or classes of traffic using it, and its width shall be not less than that of the existing way except where indicated in Appendix 1/18.

7 The Contractor shall inform the Overseeing Organisation of any details agreed with the ADT for traffic signs, lighting, construction, maintenance, removal and reinstatement of any temporary diversion for traffic proposed by the Contractor.

119 Routeing of Vehicles

1 The Contractor shall comply with the requirements described in Appendix 1/19 in connection with routeing of vehicles.

120 Recovery Vehicles for Breakdowns

1 When so required in Appendix 1/20 the Contractor shall have available for immediate use recovery vehicles of a single recovery firm as described in Appendix 1/20. The Contractor shall arrange for the recovery vehicles to be inspected as described in Appendix 1/20 such that certificates confirming successful completion of the inspections are dated not less than 14 days and not more than 28 days prior to the date of commencement of vehicle recovery operations. The Contractor shall submit these certificates to the Overseeing Organisation.

2 The Contractor shall ensure that recovery vehicles operatives work to the directions of the Traffic Safety and Control Officer or his deputy in accordance with sub-Clause 117.19.

3 Recovery vehicles shall not be changed without the agreement of the Overseeing Organisation. Any replacement recovery vehicle shall have been inspected as described in Appendix 1/20 and a roadworthiness certificate issued.

4 The Contractor shall ensure that all light recovery vehicles have seating capacity for four adult passengers in addition to the recovery operatives.

5 The Contractor shall ensure that each light recovery vehicle has a crew of at least one operative and that each heavy recovery vehicle has a crew of at least two operatives.

6 The Contractor shall ensure that recovery vehicle operatives hold a certificate which certifies successful completion of a course on breakdown recovery applicable to the type of breakdown recovery vehicle(s) being operated.

7 The Contractor shall submit to the Overseeing Organisation, prior to commencement of the recovery operations, copies of such certificates together with copies of the driving licences of the operatives.

8 The hours to be worked by recovery operatives shall not exceed those stated in Appendix 1/20. The Contractor shall submit weekly to the Overseeing Organisation daily record sheets for each operative each of which sheets shall state the name of the operative and the times and hours worked.

9 The Contractor shall take out and maintain in force, insurance to cover the operation of recovery vehicles.

10 The Contractor shall ensure that, once a recovery firm has been appointed, changes are only made with the approval of the Overseeing Organisation or as in sub-Clause 11 of this Clause.

11 The Contractor shall ensure that all the recovery vehicles are stationed at the points specified in Appendix 1/20, subject to specific requests otherwise from police officers acting under their statutory powers.

12 In addition to the recovery crew stated in sub- Clause 5 of this Clause, all incidents shall be attended and supervised by a trained recovery operative whose prime responsibility is traffic safety in relation to the recovery operation.

13 The Contractor shall ensure that the recovery vehicles are used to remove vehicles that are stationary due to mechanical breakdown or accident damage or abandoned on a road open to vehicles. The Contractor shall ensure that the recovery vehicle operatives comply with the provisions contained within Appendix 1/20 in connection with this service, subject to specific requests from police officers acting under their statutory powers. The recovery service is to be provided between the 'Roadworks Ahead - 2 miles' sign and the 'Road Works End' sign unless otherwise stated in Appendix 1/20.

14 The Contractor shall provide the facilities required by Appendix 1/20 and shall ensure that broken-down, accident damaged or abandoned vehicles are not removed by the recovery vehicles other than to the location(s) described in Appendix 1/20

unless some other location has first been agreed with the police.

15 The Contractor shall make no charge for this recovery service to the owner or driver of the recovered vehicle.

16 The Contractor shall ensure that, after depositing a broken-down, accident damaged or abandoned vehicle at one of the designated locations, the recovery vehicle returns immediately to its station described in Appendix 1/20. The Contractor shall ensure that recovery vehicle operatives at no time attempt to repair vehicles that have broken down.

17 The Contractor shall ensure that the recovery vehicle operatives issue leaflets, as described in Appendix 1/20, before the tow commences to the drivers of vehicles requiring assistance.

18 Each recovery vehicle shall display a sign with the legend "FREE RECOVERY TO END OF ROAD WORKS". This sign shall be securely mounted on the recovery vehicle in such position as to be clearly visible from the driving seat of a car at a distance of 3 m from the rear of the recovery vehicle. This sign shall at all times be clean and legible and shall not be obstructed.

19 The Contractor shall submit weekly to the Overseeing Organisation, (a) duplicate completed information sheets logging the assistance given by the recovery vehicles and (b) duplicate completed log sheets which record daily checks made on each recovery vehicle. These shall be on printed forms provided by the Contractor in accordance with the samples given in Appendix 1/20.

20 The Contractor shall provide and maintain equipment for communication as described in Appendix 1/20. The communication system shall be fully operational before the Contractor undertakes any work, which requires recovery vehicles.

21 The Contractor shall provide recovery vehicle operatives with personal protection equipment as described in Appendix 1/20. The Contractor shall also ensure that vehicle recovery operatives, at all times when carrying out a recovery, display an identity card and wear a reflective jacket which complies with sub-Clause 117.18, and which displays the name of the Contractor. The Contractor shall also ensure that the garments are maintained in a clean condition.

22 A lighting board as described in Appendix 1/20 shall be secured to the rear of the vehicle being towed. The board shall be clearly visible to other drivers of vehicles approaching from the rear. It shall be maintained in good working order and shall be clean.

23 Prior to the commencement of the works, the Contractor shall consult with the local representative of the Police Comissioner to establish procedures, including contact telephone numbers, for (a) clearing shed loads, and (b) vehicle recovery which may be beyond the capabilities of the free recovery operation.

121 Tidal, Flowing and Standing Water

1 The Contractor shall take measures and carry out any operation necessary for dealing with tidal, flowing or standing water within the Site.

122 Progress Photographs

1 The Contractor shall arrange, as described in Appendix 1/22, to have record photographs of the Works taken by a professional photographer.

2 All prints shall be marked on the reverse side with the date of exposure, name and address of photographer, identification reference number, and brief description of the work or features including chainage and direction of view. Digital photography is not acceptable for record photographs.

3 The copyright of all photographs shall be vested in the Employer and the negatives and prints shall be delivered to the Overseeing Organisation within 4 weeks of exposure. The photographs shall not be used for any purpose whatsoever without the Overseeing Organisation's approval.

123 Not Used

124 Health and Safety Restrictions, Precautions and Monitoring

1 The Contractor shall implement the requirements described in Appendix 1/23 to protect members of the public and persons visiting the site from risks arising from the use of equipment, materials or substances defined therein.

125 Temporary Closed Circuit Television (CCTV) System for the Monitoring of Traffic General

1 Where required in Appendix 1/25, the Contractor shall design, provide, install, maintain, operate and, at the completion of the requirement, remove the temporary CCTV system as specified in this Clause. The Contractor shall be responsible for obtaining any licences, power supplies and approvals required, including structural approvals, prior to the installation of any equipment.

2 The system shall be designed such that the whole of the works area, including both carriageways and hardshoulders, is covered at all times. There shall be sufficient overlap between the areas covered by adjacent cameras such that there are no blind spots. Supplementary cameras shall be provided in accordance with sub-Clause 6 of this Clause.

3 The system shall be completely independent from, and not cause any interference to, the motorway communications network.

4 The Contractor shall restore each site to its original condition following the removal of cameras and other equipment.

Cameras

5 All cameras shall provide blanket coverage of the works area and shall be fixed in direction of view. The orientation of all cameras on each carriageway shall be the same.

6 Where specified in Appendix 1/25, the Contractor shall design, provide, install, maintain, operate and, at the completion of the requirement, remove supplementary cameras at the locations specified in Appendix 1/25. These supplementary cameras shall have pan, tilt and zoom facilities providing an unimpaired view of traffic in all directions.

7 The cameras and their location shall take account of the sun and lighting such that

their effectiveness is not reduced by glare over a 24 hour period.
8 Cameras shall be of a type that provides 24 hr/day operation.

Camera Supports

9 The Contractor shall be responsible for the design, provision, construction, maintenance, operation and, at the end of the requirement, removal of all necessary supporting structures and associated safety fencing, paving, steps and hand rails.

Maintenance

10 The minimum requirements for maintenance shall be:

(i) any faults shall be repaired or the equipment replaced within 4 hours of any fault or failure;

(ii) the whole system (including cameras, monitors and video recording equipment) shall be in full working order for no less than 160 hours in any 7 day period.

11 The cameras shall be located such that they can be removed, replaced and maintained without the need for traffic management.

Monitoring

12 The Contractor shall provide, train and maintain suitable staff for the monitoring of the works area covered by the temporary CCTV system.

13 The Contractor shall provide, maintain and, at the end of the requirement, remove suitable temporary accommodation for monitoring equipment and staff.

14 The monitoring staff shall be competent in the use of the system and shall be responsible for the reporting of breakdowns and faults to the Contractor.

15 The monitoring staff shall maintain a daily log of all incidents within the roadworks area. This log shall be available for inspection by the Overseeing Organisation and the police at all times. The monitoring staff shall report all incidents immediately to the Contractor's Traffic Safety and Control Officer. The Contractor shall provide a suitable communications system for use by the monitoring staff.

16 The monitoring equipment shall include:

(i) 450 mm monitors;

(ii) VHS video recorders and sufficient tapes for the duration of the requirement;

(iii) time and date generator. The system shall be such that the image on the monitor and any video recording taken from it shall provide a legible image of the registration plate of any stationary vehicle within 150 metres of the camera. All monitor images shall include the date, time and unique camera reference.

17 The Contractor shall provide, install, operate, maintain and, at the completion of the requirement, remove a dedicated communication link to the Police Control Office as detailed in Appendix 1/25.

SERIES 200

SITE CLEARANCE

Contents

SITE CLEARANCE

201 Clearing

1 The Contractor shall demolish, break up and remove buildings and structures as described in Appendix 2/1 and superficial obstructions on the Site in the way of or otherwise affected by the Permanent Works. He shall clear each part of the Site at times and to the extent indicated on the Drawings. The extent of any partial demolition of structures is described in Appendix 2/1. The Contractor shall ensure that individual trees, shrubs and other features and areas stated on the Drawings to be preserved, are suitably identified and protected. Should any trees, shrubs and other planting features and planting areas which it is intended to preserve be killed, removed or damaged by the Contractor during the course of the Works, they shall be replaced by the Contractor with plants of the same species and equal in size to those killed, removed or damaged, all in accordance with Series 3000; or made good by arboricultural work in accordance with Clause 3010, or as directed by the Overseeing Organisation; or replaced or made good to the satisfaction of the Overseeing Organisation. Such work shall be carried out at the Contractor's own expense.

2 Where the line of an existing fence, hedge or wall is cut by the Site boundary the severance shall be made good unless otherwise described in Appendix 2/1; either by the continuation of the fence, hedge or wall in a different direction, or by its termination. In the case of a strained wire or chain link fence a straining post shall be installed and the fence re-strained.

3 Underground structures, chambers and foundations described in Appendix 2/1 shall be demolished to the depths prescribed, properly cleaned out, and filled. To permit free drainage, holes shall be made at 500mm centers over the whole area of slabs, basements, etc, which are not removed and which are liable to hold water.

4 Disused soil and surface water drains, sewers, cables and ducts together with any bed or haunch or surround within 1 m of formation level shall be removed and over 1 m below formation shall be left unless otherwise described in Appendix 2/2. The ends of existing drains and sewers no longer required because of alterations to the drainage layout shall be sealed in accordance with Clause 506. All trenches shall be backfilled in accordance with Clause 505 unless otherwise described in Appendix 2/2.

5 The Contractor, subject to any instructions or contrary directions in accordance with the Contract, shall take all measures required by any Statutory Undertaker, the management of other publicly owned services, or owners of privately owned services or supplies, for disconnection and proper sealing off of all redundant drains, services and supplies.

6 All materials arising from site clearance which are not required, or unacceptable for use in the Permanent Works and not included in Appendix 2/3, shall become the property of the Contractor and shall be disposed of by him. Materials included in Appendix 2/3 shall be carefully dismantled, taken up or taken down, cleaned and retained for re-use, stacked, labeled and protected or loaded, and transported to store as described in Appendix 2/3 and items damaged in this operation shall be replaced. All replacements shall be of equivalent quality to the original materials. When required in Appendix 2/3, voids left by items that have been removed shall be backfilled immediately in accordance with the appropriate Clauses in Series 600.

7 Topsoil excavated to enable parapet or boundary walls to be set back to new lines, or to be erected on the boundaries of the Site shall be reserved for re-use. After erection of the walls the topsoil shall be spread over the disturbed ground, any surplus being disposed of as
described in Clause 602.

8 All existing road markings and road studs on carriageways open to traffic shall be removed as soon as they become superfluous or a hazard to traffic and the carriageway reinstated in accordance with the requirements of Appendix 2/3. Road markings shall be removed in accordance with sub-Clause 1212.18.

9 Existing tensioned safety fencing shall be detensioned before raising or removing a section of fencing. The post shear bolts shall be slackened between those tensioning assemblies which are at least three beam lengths beyond the ends of the section to be raised or removed. The adjuster bolts at these assemblies and at each intermediate assembly shall then be loosened. Any post shear bolts that are slackened shall be removed and replaced with new bolts.

202 Existing Trees, Bushes and Hedges

1 Trees, bushes and hedges shall be uprooted or cut down as near to ground level as possible and all felled timber disposed of by the Contractor unless otherwise described in Appendix 2/3.

2 Stumps and roots from trees, bushes and hedges shall be grubbed up or blasted in accordance with Clause 203 and disposed of by the Contractor. Holes left by removal of the stumps or roots shall, within one week, be filled with acceptable material, as defined in Clause 601 and Table 6/1, and be compacted in compliance with Clause 612 and Table 6/4.

3 Where shown on the Drawings, existing trees, bushes and hedges shall be cut back to the lines shown on the Drawings in accordance with Clause 3010. For the purposes of this sub-Clause, trees shall be defined as a woody plant greater than 2 m in height and a bush shall be defined as a woody plant of 2 m height or less.

203 Explosives and Blasting

1 Blasting for site clearance shall comply with Clause 607 except that references to Appendix 6/3 shall be replaced by Appendix 2/4 and such blasting shall be confined to the locations and be within the limits stated therein.

204 Hazardous Materials

1 The treatment of hazardous materials encountered in site clearance shall comply with any specific requirements stated in Appendix 2/5

2 Compliance with sub-Clause 1 of this Clause does not confer immunity from relevant legal requirements

SERIES 300

FENCING

Contents

FENCING

301 General

1 Temporary and permanent fences shall comply with this Series and the quality management schemes detailed in Appendix A.

302 Requirements for Temporary and Permanent Fences

1 As soon as the Contractor is placed in possession of any part of the Site he shall immediately erect fencing on the boundaries of the land as shown on the Drawings. In places where permanent fencing cannot be erected immediately or where none is required, the Contractor shall erect, and when and where necessary, re-erect and maintain, temporary fencing and subsequently take down and remove as necessary. The type of temporary fencing shall be chosen by the Contractor, unless otherwise described in Appendix 3/1, and may be selected from the four standard types for road works described in Clause 303, taking into account the usage of the adjoining land. Unless otherwise described in Appendix 3/1, the Contractor shall not use barbed wire in areas accessible to the general public. Access shall be made in temporary fencing as necessary for the use of the occupiers of adjacent lands.

2 Temporary fencing shall remain in position either until it is replaced by permanent fencing or until its removal on completion of the Works, unless otherwise described in Appendix 3/1.

3 When concrete for post footings is required, it shall comply with Clause 2602.

303 Temporary Fencing

1 Temporary fencing shall be appropriate to the usage of the adjoining land and, unless otherwise described in Appendix 3/1, may be selected from the following types:

(i) Post and wire fencing type SW 120 complying with BS 1722 : Part 2 in accordance with RCD Drawing Number H1 with at least two of the wires being barbed.

(ii) Post and wire fencing as sub-Clause (i) above but with no barbed wires.

(iii) Cleft chestnut pale fencing type CW 120 complying with BS 1722 : Part 4 in accordance with RCD Drawing Number H2.

(iv) Wooden post and wire fence type C8/80/30 complying with BS 1722 : Part 2 in accordance with RCD Drawing Number H2.

2 If temporary fencing is removed temporarily for the execution of any part of the Works it shall be reinstated as soon as possible and in the meantime the gap in the fencing shall be patrolled so that no unauthorised entry on to adjoining land takes place and no stock escapes from the adjoining land.

3 Unless otherwise described in Appendix 3/1, timber for temporary fencing need not have preservation treatment.

304 Timber Quality

1 Timber for use in permanent works shall be either of appropriate natural durability or be treated with wood preservatives in compliance with Clause 311. Where natural durability is used, the timber shall be of class 1 if used in ground contact and of class 2 or better if used out of ground contact according to the classification given in BS EN 350-1.

2 Unless otherwise described in this specification and in Appendix 3/1, timber for permanent fencing shall comply with BS 1722-7, timber for field gates and posts shall comply with BS 3470; and timber for stiles, bridle gates and kissing gates shall comply with BS 5709.

3 All timber for permanent fencing, field gates and posts, stiles, bridle gates and kissing gates shall be stress graded and marked to comply with BS 4978, BS 5756 or BS EN 519 or other grading rules accepted in BS 5268-2 and BS EN 1912.

4 For checking compliance with strength requirements, samples shall be taken by the manufacturer or supplier in accordance with the suggested sampling plan in Annex B of BS 1722-7.

305 Fittings

1 Bolts, screws and nuts shall comply with ISO 4016, 4018 and 4034, for ISO 898 property class 4.6 or 4.8 unless otherwise described in Appendix 3/1. Washers shall comply with BS 4320. Nails shall comply with BS 1202. Bolts washers and nails shall be galvanized to comply with BS EN ISO 1461 unless they are stainless steel.

306 Permanent Fencing

1 Permanent fencing shall comply with this Clause and the additional requirements described in Appendix 3/1. All permanent fencing, unless otherwise described in Appendix 3/1, shall be erected to present a flowing alignment both in plan and elevation following approximately the level of the ground and the Contractor shall trim the ground along the line of the fence when required in Appendix 3/1. Where the ground is uneven or undulating the Contractor shall provide extra posts, stakes and ground anchors as necessary to ensure that the bottom line wire in planting works fencing does not rise more than 50 mm above ground level. The fencing shall be neatly and effectively joined to existing hedges, fences and to other structures and parapets, to comply with RCD Drawing Number H36, unless otherwise described in Appendix 3/1. Planting works fencing shall be joined to existing boundaries providing a secure joint capable of withstanding entry by rabbits or larger animals.

2 Timber fencing for motorways shall be wooden post and rail fence with four rails type SPR 13/4 complying with BS 1722 : Part 7, to dimensions shown on RCD Drawing Number H3. Both ends of posts and rails shall be cross cut at right angles to the length of the piece. The timber species and preservation treatment shall comply with Clause 311 and any additional stockproofing required shall be as described in Appendix 3/1. Painting, if required in Appendix 3/1, shall comply with Clause 312 and concrete surround to posts, if required in Appendix 3/1, shall comply with sub-Clause 302.3.

3 Wire dropper fences for motorways shall be as shown on RCD Drawing Numbers H4, H5, H6 and H7. They shall comply with BS 1722 : Part 2 Sections 6 and 7, with the following Clauses amended as below and with any additional requirements described in Appendix 3/1.

On completion of the tensioning of the line wires all fittings, droppers and connections shall be painted with plastic paint of the same colour as the fence posts and wire, within 24 hours of erection when required in Appendix 3/1.

Clause 6.1.1 Delete text and insert:

"High tensile wire, zinc and plastic coated, complying with Clause 2605, shall be used unless otherwise stated in Appendix 3/1."

Appendix B, Clause B.2 Delete text and insert:

"Steel posts and struts shall be galvanized and plastic coated to comply with Clause 2604."
Clause 4.4.4 Add:

"Only dowelled ends to straining and intermediate posts, and struts shall be used. Turning posts shall be provided and fitted with 225 mm x 150 mm x 3 mm thrust plates complying with Clause 2.4.2.2.

As an alternative to being holed, a steel fillet may be welded to the straining post to allow for bolting the strut and post together."

Clause 4.6.6 Add:

"Fence post rivets and wire vices shall be as described in Appendix 3/1."

Clause 4.7 Delete text and insert:

"Concrete for surrounding the base of posts and struts shall comply with Clause 2602."

Table3. Add:

Turning Posts	
Length m	**Section CHS mm x mm**
2.27	76.1 x 4.0
2.72	88.9 x 4.0
3.02	88.9 x 4.0

Clause 5.2.1 Delete paragraphs 2 to 5 and insert:

"All posts and struts shall be set in concrete and the concrete surround shall be filled to within 75 mm of the ground level."

Clause 7.2.2 Add:

"Turning posts and fittings shall be provided as described in Appendix 3/1."

Clause 7.3.4 Amend 2nd sentence to read

"The interval between a dropper and a post or between adjacent droppers, shall be as shown on RCD Drawing Numbers H4, H5 and H6".

Planting Works Fencing

4 Fencing for the protection of planted areas shall be one of the following types, required as described in Appendix 3/1:

(i) Hexagonal wire netting fencing complying with BS 1722 : Part 2 Section 8 and in accordance with RCD Drawing Number H39.

(ii) Rectangular wire mesh and hexagonal wire netting fencing complying with BS 1722 : Part 2 Section 8 and in accordance with RCD Drawing Number H40.

(iii) Wooden post and four rail fencing type SPR 13/4 complying with BS 1722 : Part 7 and in accordance with RCD Drawing Number H3.

(iv) Wooden driven post fencing in accordance with RCD Drawing Number H44.

5 The 'turned out' portion of the hexagonal wire netting of rabbit-proof fencing shall be treated in accordance with one of the methods given below, as described in Appendix 3/1:

(i) 100 mm of netting buried vertically into the ground beneath the fence, with a further 150 mm turned out towards the rabbit harbourage. The excavation shall be backfilled and rammed.

(ii) 250 mm of netting turned out towards the rabbit harbourage, laid flat to the ground contours and pegged at 400 mm centres with 300 mm long x 4 mm diameter galvanized wire pins bent hairpin pattern.

(iii) 50 mm of netting buried vertically into the ground beneath the fence, with a further 200 mm of netting turned out towards the rabbit harbourage and covered with turves. The Contractor shall cut and lift sections of turf at least 30 mm thick from the inside of the planting area and transfer them to cover the whole of the 'turned out' portion of the netting.

(iv) The netting shall be buried vertically, to a depth of 250 mm below existing ground level. The excavation shall be backfilled and rammed.

Wire Mesh to Permanent or Existing Fencing

6 Where required in Appendix 3/1, wire mesh shall be attached to permanent or existing fencing in accordance with RCD Drawing Numbers H46, H47 and H48.

7 The Contractor shall check the condition of the lengths of existing fencing to which mesh is to be attached before commencing work. Where there is damage to the existing fencing, the Contractor shall report this to the Overseeing Organisation before commencing attachment of the mesh.

Fenced Tree Guards

8 Where required in Appendix 3/1, fenced tree guards shall be provided in accordance with RCD Drawing Number H43.

307 Permanent Fencing for Accommodation Works

1 Permanent fencing shall be provided for accommodation works and shall comply with this Series and the particular requirements described in Appendix 1/15.

308 Gates and Stiles

1 Field gates and posts shall comply with BS 3470 and Clauses 304 and 311. They shall be provided to the dimensions shown on RCD Drawing Numbers H17 to H22. Painting, if required in Appendix 3/1, shall comply with Clause 312. Fittings for field gates shall be as shown on RCD Drawing Numbers H26-H33.

2 Stiles, bridle gates, kissing gates and gates in planting works fencing shall comply with BS 5709 and Clauses 304 and 311. They shall be provided to the dimensions shown on RCD

Drawing Numbers H23, H24, H25, H34, H35, H41 and H42.

3 Concrete for post foundations shall comply with Clause 2602.

4 Any additional stock proofing required to gates and stiles shall be as described in Appendix 3/1.

5 Where access gates are to be provided in a length of fencing that incorporates wildlife mesh, the underside of the gate shall include the measures described in Appendix 3/1.

Badger Gates

6 Where required in Appendix 3/1, badger gates shall be provided in accordance with RCD Drawing Number H45. Marine ply timber shall comply with BS 1088.

309 Removing and Re-erecting Existing Fences and Gates

1 Where required in Appendix 2/3, existing fences, gates and stiles, with posts shall be carefully taken down, laid aside, removed or later re-erected in compliance with Clauses 306, 307 and 308 as specified in sub-Clause 201.6.

2 Fences, gates, stiles and posts which are to be re-erected shall have any existing paint removed and shall be prepared and treated to comply with Clause 312.

3 If any posts, rails or lengths of fencing are removed to facilitate repairs or renewal of existing fences, the gap in the fencing shall be patrolled or closed with appropriate temporary fencing in accordance with Clause 303 together with any existing wildlife mesh attachments.

310 Not Used

311 Preservation of Timber

1 Prior to preservation treatment and when the moisture content is 28% or below, determined in accordance with BS EN 13183-1 or BS EN 13183-2, the timber quality shall comply with Clause 304. Defects unaffected by moisture content shall not be accepted at any time.

2 The preservation of timber shall be in accordance with the system described in BS EN 351-1.

(i) Unless otherwise specified in Appendix 3/1, the preservative used shall comply with the biological testing requirements of a hazard class 4 preservative as specified in BS EN 599-1, including the ground contact field test BS 7282.

Where the preservative is a copper/ chromium/arsenic (CCA) preservative complying with BS 4072, the preservative retention in the analytical zone shall be not less than 4.15 kg/m^3 for an oxide-based formulation and 6.83 kg/m^3 for a salt-based formulation.

Where the preservative is a creosote formulation complying with BS 144, the preservative retention in the analytical zone shall be not less than 130 kg/m^3.

Where the preservative is any other acceptable formulation, the effective preservative retention in the analytical zone shall be derived from 10 years field test data according to BS 7282.

(ii) If any sapwood is present in the timber, Irrespective of the natural durability of the heartwood, the timber shall be treated with preservative.

(iii) Following treatment, the sapwood shall comply with penetration class P8 of BS EN 351-1, i.e. when assessed using the

sampling scheme described in v) below, the batch of treated timber shall show complete sapwood penetration.

(iv) Timber required to be painted following treatment shall not be treated with creosote.

(v) To demonstrate that full sapwood penetration has been achieved, the sampling scheme recommended in BS EN 351-1 for direct testing shall be followed. The number of posts to be sampled at random from the treated batch shall be determined using general inspection level II as defined in ISO 2859-1. Penetration shall be assessed for each selected post from borings taken as recommended in BS EN 351-2. To determine whether the treated batch has achieved the required penetration, an acceptable quality level (AQL) of 10% for permeable timbers and an AQL of 25% for resistant timbers shall be used to establish pass/fail criteria from ISO 2859-1.

(vi) The minimum retention of preservative in the analytical zone associated with penetration class P8 of BS EN 351-1, shall be equivalent to 4.15 kg/m³ of copper/ chromium/arsenic oxide formulation to BS 4072 : 1999 when tested according to BS EN 599-1.

(vii) Compliance with the retention requirement within a batch of treated timber shall be calculated from results of analysis of the borings taken to determine penetration. The average retention shall be equal to or greater than the value given in (vi) above.

312 Painting of Timber Fences, Gates, Stiles and Posts General

1 Painting shall be carried out in accordance with the recommendations in the Code of Practice BS 6150.

2 All timber fabricated into units before delivery to the Site and which is required to be painted shall be primed at the works.

Priming

3 Surfaces of wood shall be clean and dry before being primed. Priming paint shall comply with either Type C primer to BS 7956 or ready mixed aluminium priming paint complying with BS 4756.

Undercoats and Finishing Coats

4 After erection, all exposed primed surfaces shall be painted with one coat of undercoat as described in Appendix 3/1.

5 Two finishing coats of the colour and type described in Appendix 3/1 shall be applied.

Coloured Wood-Stain

6 Coloured wood-stains shall be applied as described in Appendix 3/1.

SERIES 400

SAFETY FENCES, SAFETY BARRIERS AND PEDESTRIAN GUARDRAILS

Contents

SAFETY FENCES, SAFETY BARRIERS AND PEDESTRIAN GUARDRAILS

401 Performance Criteria for Safety Fences and Safety Barriers Safety

1 Safety fences and barriers shall comply with the following performance criteria:

Testing Criteria

(i) On impact a safety fence or barrier shall contain and redirect a vehicle of 'A' kg mass travelling at a velocity of 'B' km/h at an angle of incidence of 'C' degrees to the fence or barrier. Values of 'A', 'B' and 'C' shall be as follows:

(a) Normal level of vehicle containment:

'A' = 1500 ±75 kg
'B' = 113 ±5 km/h
'C' = 20 ±1°

(b) Lower level of vehicle containment:

'A' = 1500 ±75 kg
'B' = 80 ±5 km/h
'C' = 20 ±1°

(c) Intermediate level of vehicle containment:

'A' = 10000 ±300 kg
'B' = 70 km/h +7%, -0%
'C' = 15 +1.5°, -1.0°

(d) Higher level of vehicle containment:

'A' = 30000 ± 900 kg
'B' = 65 ±3 km/h
'C' = 20 ±1°.

The centre of gravity of the 1500 kg test vehicle prior to impact shall be 500 ± 30 mm above the ground.

(ii) After impact, defined in (i) above, the vehicle shall be contained by the fence or barrier and be redirected in a stable manner, on to a path adjacent to the line of the fence or barrier. The vehicle shall be redirected so that no part of the vehicle crosses the line drawn parallel with and 4.0 m from the original alignment of the traffic face of the fence or barrier within a distance of 10 m from the last point of initial impact with the fence or barrier, in the direction of adjacent traffic flow. The vehicle shall neither turn on its side nor roll over.

(iii) The lateral deflection of each type of fence or barrier shall be established as part of the type approval procedure.

Durability

2 Safety fences and barriers shall comply with the following durability criteria:

(i) All components of a safety fence shall be designed to achieve a serviceable life of not less than 20 years and for concrete barriers 50 years, except for Temporary Vertical Concrete Safety Barriers where the nominal service life shall be not less than 10 years.

Type Approval

3 Only safety fences or safety barriers which have received type approval by the Overseeing Organisation shall be incorporated into the Works. The safety fences and barriers listed in Tables 4/1 and 4/2 and described in this Series and in the RCD: Section 2, have been approved by the Overseeing Organisation and are deemed to meet the performance criteria contained in this Clause. If the Contractor proposes to use a safety fence or barrier not listed in Tables 4/1 and 4/2 then he must first obtain type approval from the Overseeing Organisation.

TABLE 4/1: (05/01) **Performance Testing Criteria for Safety Fences**

Type of Safety Fence	Ref. Code	Single/ Double Sided	Post Spacing m	Vehicle Mass kg	Vehicle Impact Speed km/h	Angle of Incidence Degrees
Tensioned Corrugated Beam (TCB)	TS1	Single	3.2	1500±75	113±5	20±1
Tensioned Corrugated Beam (TCB)	TS2	Single	1.6	1500±75	113±5	20±1
Tensioned Corrugated Beam (TCB)	TD1	Double	3.2	1500±75	113±5	20±1
Tensioned Corrugated Beam (TCB)	TD2	Double	1.6	1500±75	113±5	20±1
Untensioned Corrugated Beam (UCB)	US1	Single	3.2	1500±75	80±5	20±1
Untensioned Corrugated Beam (UCB)	US2	Single	1.6	1500±75	80±5	20±1
Open Box Beam (OBB)	BS1	Single	2.4	1500±75	113±5	20±1
Open Box Beam (OBB)	BS2	Single	1.2	1500±75	113±5	20±1
Open Box Beam (OBB)	BSB	Single on brackets fixed to structure	1.2	1500±75	113±5	20±1
Open Box Beam (OBB)	BD1	Double	2.4	1500±75	113±5	20±1
Open Box Beam (OBB)	BD2	Double	1.2	1500±75	113±5	20±1
Open Box Beam (OBB)	BDS	Double with spacers and stiffeners	2.4	1500±75	113±5	20±1
Double Rail Open Box Beam (DROBB)	DR1	Single	2.4	1500±75 10000±300	113±5 70+7%-0%	20±1 15+1.5-1
Wire Rope (WR)	WR	Single/Double	3.2	1500±75	113±5	20±1
Tensioned Rectangular Hollow Section Beam (RHS) (100 x 100mm)	RH1	Double	3.2	1500±75	113±5	20±1
Tensioned Rectangular Hollow Section Beam (RHS) (200 x 100mm)	RH2	Single or Double	3.2	1500±75	113±5	20±1

402 Components for Safety Fences and Safety Barriers

General

1 Materials and fabrication of components and fittings shall be as described below, in the HCD: Section 2, in BS 6579 : Part 8, and as particularly identified and described in Appendix 4/1.

TABLE 4/2: (05/01) **Performance Testing Criteria for Safety Barriers**

Type of Safety Barrier	Ref. Code	Vehicle Mass kg	Vehicle Impact Speed km/h	Angle of Incidence Degrees
Permanent Vertical Concrete Safety Barrier	VCB	1500±75	113±5	20±1
Higher Permanent Vertical Concrete Safety Barrier	HVCB	30000±900	65±3	20±1
Temporary Vertical Concrete Safety Barrier	TVCB(80)	1500±75	80±5	20±1
Temporary Vertical Concrete Safety Barrier	TVCB(110)	1500±75	113±5	20±1
Temporary Higher Vertical Concrete Safety Barrier	THVCB	30000±900	65±3	20±1

Materials

2 (05/01) Materials used shall be as given below unless otherwise shown on the Drawings.

(i) Steel Main Components

Component Type	Material
Corrugated and open box beams	BS EN 10 025 Grade S275
'S' and 'Z' posts and plates	BS EN 10 025 Grade S275
'S' and 'Z' posts and plates for Wire Rope Safety Fence	BS EN 10 025 Grade S275 Note: Grade S355 for deflection and restraining posts
Rolled hollow sections	BS EN 10 210 Grade S275JO or S355JO Note: Grade S355JO for 100 mm x 100 mm beams in Rectangular Hollow Section (RHS) Safety Fence
Angles	BS EN 10 025 Grade S275, Section BS 4848: Part 4
Channels	BS EN 10 025 Grade S275, Section BS 4: Part 1
Reinforcement	BS 4449 Grade 250
Bar	BS EN 10 025 Grade S275
Wire for component and tail ropes	BS 2763, 3 mm, Grade 1370
Wire for safety check ropes	BS 2763, Grade 1770

Tolerances on stock thicknesses of steel plate shall be Class C to BS EN 10 029.

(ii) For 'S' and 'Z' posts, defects occurring during fabrication such as edge laminations and minor cracks shall be repaired by grinding, welding and dressing.

(iii) Fittings:

(a) Bolts, screws and nuts shall, unless otherwise shown on the Drawings, comply with BS EN 24016, BS EN 24018 and BS EN 24034.

(b) Washers shall comply with Section 2 of BS 4320. The steel used for the manufacture of washers shall be cold rolled carbon steel strip CS4 complying with BS 1449 : Part 1.

(c) Stainless steel bolts, screws and nuts shall comply with BS 6105, Grade A4-80. The dimensions and tolerances of the bolts, screws and nuts shall comply with ISO 4016, 4018 and 4034.

(d) Stainless steel washers shall comply with BS 4320 and be made from stainless steel strip type 304 or 316 to BS 1449 : Part 2.

(e) For Wire Rope Safety Fences, component ropes and tail ropes shall be 3 x 7 (6/1) coreless construction

complying with BS 302 : Part 1. Safety check ropes shall be 6 x 19 (9/9/1) IWRC complying with BS 302 : Part 2.

(iv) Concrete:

(a) Concrete in foundations and anchor blocks shall comply with Clause 2602 and be of the grade described therein.

(b) Concrete and reinforcement for the Vertical Concrete Safety Barriers shall comply with the RCD: Section 2 and with Series 1700, and have a minimum characteristic strength of 50 N/mm² or 40 N/mm² if an air entraining agent is used.

Protective Finishes

3 All components except stainless steel items, reinforcing rings and reinforcing bars shall be galvanized as described in Clause 1909 unless otherwise described below:

(i) For Wire Rope Safety Fences, threaded terminals shall be galvanized in compliance with Clause 1909.

(ii) For Wire Rope Safety Fences, component and tail ropes shall be Class A finally zinc coated in compliance with BS 2763. Safety check ropes shall be Class A finally zinc coated or drawn zinc coated in compliance with BS 2763.

(iii) Coating weight on items other than in above shall comply with the following:

Items	**Minimum average coating weight for any individual test area**
Items of which all parts are 5.5mm thick or over	610 g/m^2
Items of which any part is less than 5.5mm thick	460 g/m^2
Bolts, screws, nuts, washers rigging screws, fork terminals and thimbles	305 g/m^2

Items Minimum average coating weight for any individual test area

Items of which all parts are 5.5 mm 610 g/m² thick or over Items of which any part is less than 460 g/m² 5.5 mm thick Bolts, screws, nuts, washers rigging 305 g/m² screws, fork terminals and thimbles.

(iv) Bolts, screws, nuts and washers shall be centrifuged. Nuts shall be tapped up to 0.4 mm oversize after galvanizing and the threads shall be oiled. Small items such as connecting straps may be centrifuged but the coating weight shall comply with the minimum values specified in (iii) above.

Tolerances

4 (i) Fabrication tolerances shall be as shown on the Drawings. Components which are to be galvanized or metal coated shall be measured before galvanizing or metal coating.

(ii) The tolerance on hole diameters shall be +1 mm, -0 mm.

Welding

5 (i) General. Arc welding of carbon manganese steels shall comply with BS 5135. Weld symbols shown on the Drawings are as described in BS 499 : Part 2. Welding shall not be used except where detailed on the Drawings. Processes other than arc welding shall be to the approval of the Overseeing Organisation.

(ii) Procedures. Written welding procedures shall be used with testing to BS EN 288: Parts 1, 2 and 3 and shall apply to all production and repair procedures. These shall be subject to re approval after a period of seven years. When applying BS EN 288 : Parts 1, 2 and 3, the welding consumables and procedures used shall be such that the mechanical properties of deposited weld metal will not be less than the respective minimum specified values of the parent metal being welded. Approval shall be by an Independent Inspecting Authority using Registered Welding Engineers or Registered Welding Quality Engineers or equivalent. Testing shall be by a laboratory appropriately accredited for weld testing.

(iii) Welder Qualification. All welders shall be approved to BS EN 287 : Part 1. The tests shall include in addition an application test on transverse butt welds in beams. Welders carrying out fillet welds only may be approved to BS 4872 : Part 1. Approval shall be by an Independent Inspecting Authority using Registered Welding Engineers, Registered Welding Quality Engineers or Welding Inspectors certified by the Certification Scheme for Weldment Inspection Personnel (CSWIP) or equivalent. Testing shall be by a laboratory appropriately accredited for weld testing.

(iv) Production Inspection and Testing. The manufacturer shall provide suitable personnel to carry out inspection of production welds as required in (a) to (c) below. Personnel conducting visual inspection shall have a nationally recognized certificate of competence appropriate to the type of welding being inspected. Personnel conducting non-destructive testing (NDT) shall be certified according to a nationally recognized certification scheme appropriate to the equipment used and the weld groups inspected. Evidence of training and qualification shall be retained and made available for examination when required. The results of all weld inspections shall be recorded.

(a) Visual Inspection. All welded joints, except those on driven posts, shall be subject to visual inspection in accordance with BS 5289 prior to any NDT and galvanizing. Welded joints on driven posts shall be visually inspected at a rate of 1 post per 20. Weld surfaces shall be free of slag residues and sharp edges. All surfaces shall be free of traces of weld spatter, arc strikes and contaminants. The apparent throat dimensions of butt welds and the apparent leg length and apparent throat dimensions of fillet welds, as measured by a welding gauge, taking into account any known lack of fit, shall not be less than those specified, except that local shortfalls up to 1 mm may be accepted, provided the average over any 50 mm length is not

less than the specified dimension. The toe angle shall not be less than 90°. The surface of all welds shall be free from cracks, lack of fusion including overlap, and slag. Isolated discontinuous porosity may be accepted provided it is not detrimental to the galvanizing process. Undercut shall not result in a section loss of more than 5% over any 50 mm length of joint, nor shall its depth exceed 0.5 mm or 10% of the thickness, whichever is the less.

(b) Magnetic Particle Inspection (MPI) and Liquid Penetrant Inspection. MPI shall be applied in accordance with BS 6072 to joints selected in accordance with (d) below, where any of the material thickness exceeds 20 mm. Notwithstanding the requirements of (d) below, MPI or liquid penetrant inspection in accordance with BS 6443, shall be applied as appropriate where on visual inspection the presence of cracking or lack of fusion may be suspected. To aid inspection, the profile of the weld may be dressed by burr grinding provided that the specified throat size and leg length is still maintained. The surface of the weld shall be free of cracks, lack of fusion and slag.

(c) Ultrasonic Testing. All butt joints in material 8 mm thick or greater selected in accordance with (d) below shall be ultrasonically tested in accordance with BS 3923. The weld shall be free of cracks. The height of buried slag, lack of fusion or lack of penetration shall not exceed 3 mm and within 6 mm of the outer surface their individual lengths shall not exceed 10 mm. The resulting net throat area loss over any 50 mm length of weld shall not exceed 5% of the specified throat area.

(d) Frequency of NDT. Joints shall be selected as follows: All joints of each type up to a batch size of 10 components and 10% of additional components thereafter. If non conformances are found the scope of NDT shall be doubled. If further non conformances are found, the whole batch shall be tested.

(e) Reporting. Inspection records for production welds shall be retained by the manufacturer for three years and those covering the production periods relating to the components supplied shall be made available for examination.

(v) Destructive Testing. Copies of certified reports of destructive tests on components supplied under earlier contracts with the Overseeing Organisation shall be provided on request.

The Contractor shall supply components, or sample joints cut from components, for destructive testing. The basis of selection shall be as follows:

(a) For batches of less than 100 beam assemblies with transverse butt welds, 1 sample joint shall be supplied unless an identical

sample joint from the same works has been destructively tested within the previous four weeks. For batches exceeding 100 or more, 1 sample joint shall be supplied for each subsequent sampling lot not exceeding 100.

(b) Welded adjuster brackets shall be supplied at the rate of 1 for each sampling lot not exceeding 300.

(c) Each type of driven post shall be supplied at the rate of 1 post for each sampling lot not exceeding 1000.

(d) Each type of surface mounted post shall be supplied at the rate of 1 post for each sampling lot not exceeding 100.

(e) Each type of anchor frame, parapet connection and connection piece shall be supplied at an interval not exceeding 6 months for each manufacturer's works.

(f) Other welded components shall be supplied at an interval not exceeding 12 months for each manufacturer's works.

The acceptance criteria shall be as specified in (iv) above, except that in (iv) (a) above the throat and leg dimension of the weld shall apply to the true rather than the apparent dimension.

In the event that there is a non-conformance arising from a serious deviation in materials, preparation, assembly or welding procedure, the batch concerned shall be rejected and further production of the components affected stopped until such time as the fault has been corrected. A minor non-compliance shall only be accepted on the basis that further sampling and testing shows that the fault is not repetitive and will not in that instance impair structural integrity.

If the problem can be traced to a particular manufacturing period, operator, piece of equipment or batch of materials and if proper traceability to individual batches of components can be assured, only those batches affected may be subject to rejection.

The destructive test reports shall be retained by the manufacturer and recorded in a register for a period of three years. The destructive test samples shall be retained for a period of 18 months. These shall be made available for examination on future contracts with the Overseeing Organisation.

(vi) Remedial Work. Welds which do not comply with the Specification may be repaired to an approved procedure, as described in (ii) above.

Marking

6 (i) All components, including rope terminals and rigging screws but excluding fasteners, reinforcing rings and bars, shall be clearly and durably marked with the manufacturer's identification mark and digits indicating month and year of manufacture.

(ii) In addition to the marking requirements of BS EN 20898, fasteners, except Items F18 and F19, shall be clearly marked with the following:

(a) safety fence manufacturer's identification mark;

(b) fastener number.

Workmanship and Testing

7 (i) All components shall be manufactured so as to permit the construction of safety fences or barriers within the tolerances described in sub-Clauses 403.2, 403.5 and 408.4. During fabrication of components any necessary straightening or forming shall be carried out so as not to deface or weaken the material and they shall be assembled in such a manner that they are not bent, twisted or otherwise damaged.

(ii) All fabrication of components except wire ropes and threaded terminals for Wire Rope Safety Fences shall be completed before galvanizing or metal coating.

(iii) The Contractor shall provide the Overseeing Organisation with evidence that the manufacturer of wire rope terminals has arranged for tensile tests to destruction to be carried out by a testing laboratory annually and whenever the production technique is changed. The test shall be carried out on a test piece of a Wire Rope Safety Fence consisting of a threaded terminal and a length of rope such that the minimum test length is 600 mm. The method of measuring the breaking load shall comply with BS 302 : Part 1. The minimum breaking load of component and tail ropes shall be 17.7 tonnes. The minimum breaking load of the rope fitted with the threaded terminal shall be 16.7 tonnes. For safety check ropes the minimum breaking loads shall be 4.1 tonnes and 3.9 tonnes respectively.

(iv) The component ropes and tail ropes of Wire Rope Safety Fences shall be prestressed in the factory by applying a cyclic loading which shall be continued until all initial extension has been removed, eg. the lower limit of cyclic loading may be 1.7 tonnes and the upper limit 8.9 tonnes. The rope shall exhibit a minimum modulus of elasticity of 8,300 kg/mm² (based on an area of 283 mm²) after prestressing.

Handling and Storage

8 All components shall be protected from damage and handled and stacked in such a way that permanent damage is not caused, particularly to threaded components. Means shall be provided to avoid damage to galvanized coatings and any damage that does occur shall be made good in accordance with BS EN ISO 1461. Component ropes and tail ropes for Wire Rope Safety Fences shall be supplied on reels with a barrel diameter of not less than 450 mm. Ropes shall not be twisted or kinked.

403 Installation of Safety Fences

Overall Requirements

General

1 Installation shall be as described in this Series, in the RCD: Section 2, in BS 7669 : Part 3 and as particularly described in Appendix 4/1.

Layout

2 (i) The overall layout of safety fences and barriers shall be as described in Appendix 4/1.

(ii) All safety fences and barriers shall be erected to present a flowing alignment and in accordance with the following:

(a) The overall alignment on plan of safety fences shall not depart from the prescribed alignment

by more than ±30 mm, nor deviate in any 10 m length from the straight or required radius by more than ±15 mm.

(b) Beams and wire ropes shall be at the heights shown on drawings included in the RCD: Section 2.

Excavation for Concrete Foundations and Anchor Blocks

3 (i) Excavations for concrete foundations and anchor blocks shall have vertical sides.

(ii) Where the side of excavations cannot be maintained vertical until concrete is placed, suitable permanent or temporary casings shall be used. The casings shall be installed immediately after excavation and any lateral overbreak of the excavation shall be filled with mix ST1 concrete. Where such concrete is placed the outside face of the temporary casing shall be coated with a release agent in accordance with Clause 1708 and the casing either rotated or slightly moved to break the bond with the overbreak concrete 24 hours after its placing. Temporary casings shall be withdrawn carefully to minimise disturbance to the surrounding material. The maximum taper on temporary casings to facilitate withdrawal shall be 2º.

(iii) Impermeable plastic sheeting 125 microns thick shall be laid at the base of in situ concrete post foundations located in filter drains.

(iv) Precast concrete post foundations shall be installed on a firm and level base. Any lateral overbreak of the excavation shall be filled with mix ST1 concrete.

Concrete in Foundations and Anchor Blocks

4 In addition to the requirements of Clause 2602 concrete shall be compacted by internal vibration, and the curing period shall be not less than 4 days. In the case of tensioned safety fences, the Contractor must ensure that the concrete has reached the specified 28 day characteristic compressive strength prior to any tensioning taking place.

Beams

5 Notwithstanding the manufacturing tolerances permitted for individual beams, the cumulative length tolerance shall be such that beams and posts can be positioned within 30 mm of their prescribed location and the requirements of sub-Clause 403.2 can be met. With the exception of any special closure pieces necessary to complete lengths of fencing, beam lengths shall not differ from those described in the RCD: Section 2.

Posts

6 Posts and foundations shall be of the types described in the RCD: Section 2, and as particularly described in Appendix 4/1 and shown on the Drawings. The radiused edge of all ‘S’ and ‘Z’ posts shall be presented to the adjacent traffic flow. Where posts are mounted in cast-in post sockets these shall be filled where described in Appendix 4/1, after erection, with a non-setting passive filler to prevent the collection of water.

Cutting of Components

7 (i) No drilling, cutting (including flame cutting) or welding of beams and posts will be permitted after galvanizing.

(ii) Special closure pieces shall be fabricated before galvanizing.

(iii) Damaged galvanizing and any areas of bare steel shall be made good in compliance with BS EN ISO 1461.

Assembly

8 Direct contact between dissimilar metals shall be avoided by interposing non-metallic sleeves, washers or coatings to prevent galvanic corrosion.

Anchorages and Attachment Systems for Surface Mounted Posts

9 (i) Unless otherwise described in Appendix 4/1, at least 4 weeks before installation, the Contractor shall submit to the Overseeing Organisation well attested and documented evidence that proposed anchorages and attachment systems in drilled holes, are capable of resisting the ultimate design tensile loads given in Table 4/3. Anchorages of an expanding type, other than undercut anchorages, shall not be used.

TABLE 4/3: Design and Test Loads for Safety Fence Anchorage and Attachment Systems in Drilled Holes

Nominated Post Section mm	Ultimate Design Tensile Load		Anchorage Tensile Test Load kN
	Anchorage kN	Attachment System kN	
100 x 32 x 6 (100 x 32 x 5) 110 x 49 x 5	65	55	40
125 x 90 x 6	125	100	75

Note: Loads are per bolt/stud.

(ii) Steel anchorages and attachment systems shall be used for securing surface mounted posts to a concrete or steel base. Attachment systems shall use M20 bolts or studs as appropriate.

(iii) For anchorages in drilled holes, the hole location shall be checked to ensure that the hole will be clear of reinforcement before drilling is carried out.

(iv) Before installation of anchorages in drilled holes, the hole shall be sound, clean and dry and the tolerance of the hole shall be within the values given by the anchorage manufacturer.

(v) Where surface mounted posts are to be installed on bridge decks, the anchorages shall include an internally threaded component to receive the attachment system ie. holding down bolt or stud. All parts of anchorages on bridge decks (where the anchorage is within 80 mm of the upper surface of the supporting concrete or where the anchorage parts are threaded to receive the holding down bolt) shall be of stainless steel grade 316 S 31 or 316 S 33 to BS 970 : Part 1. Holding down bolts, studs and nuts on bridge decks shall be stainless steel grade A4-80 to BS 6105. Washers on bridge decks shall comply with BS 4320 and be made from stainless steel strip grade 316 S 31 or 316 S 33 to BS 1449 : Part 2.

(vi) The threads of steel anchorages shall be lined with grease having a high resistance to creep and being suitable for hot or cold smearing. The grease shall provide protection to the threads for a minimum of either 18 months under cover or 6 months exposed on Site.

(vii) Attachment systems shall be tightened to the appropriate torque and have the minimum thread engagement specified by the manufacturer of the system.

(viii) Except where surface mounted posts are attached to a steel base they shall be bedded on mortar complying with

Clause 2601. The bedding mortar shall have a minimum thickness of 10 mm and a maximum thickness of 30 mm.

(ix) All voids in anchorages, attachment systems and base plates shall be filled with a non setting passive filler to prevent the collection of water.

404 Site Testing

Anchorages in Drilled Holes

1 The Contractor shall carry out loading tests on anchorages in drilled holes. For the purpose of this sub- Clause the types of fixing referred to in Clause 1 of BS 5080 : Part 1 : 1993 shall include "anchorages". Where anchorages are tested they shall be loaded incrementally in tension in accordance with BS 5080 : Part 1 : 1993 except that they shall be capable of resisting the test load given in Table 4/3 in lieu of testing to failure. Incremental loads shall be held for not less than half a minute and the test load for not less than five minutes. Readings shall be taken immediately after applying load and at the end of the time intervals stated above.

2 The total movement of the anchorage shall not exceed 1.0 mm during the test. Any evidence of slip during loading up to the test load, as demonstrated by a significant change in the slope of the load/extension curve, shall constitute failure. A test rig deemed to be equivalent to that shown in BS 5080 : Part 1 : 1993 Figure 3 is contained in the RCD: Section 2, Series ATR 53.

3 The testing frequency shall be in accordance with Appendix 1/5. In addition, testing shall comply with any special requirements given in Appendix 4/1.

Post Foundations

4 (i) Where stated in Appendix 4/1, the Contractor shall provide the test equipment and carry out loading tests on post foundations. Testing shall be carried out as described in the RCD: Section 2 on Drawing Number PTE 09 (for TCB, OBB, WR and RHS post foundations) or Drawing Number PTE 10 (for UCB and DROBB post foundations). Details of test equipment are given on Drawing Numbers PTE 01 to PTE 08. The tests shall be carried out and the results submitted to the Overseeing Organisation on Form PTE (Revision A) at least one week prior to installation of the relevant lengths of fence, unless otherwise stated in Appendix 4/1.

(ii) Where stated in Appendix 4/1, the Overseeing Organisation will provide the test equipment and carry out loading tests on post foundations installed by the Contractor for that purpose. The Contractor shall make available a vehicle of not less than 5 tonnes for the Overseeing Organisation's use while carrying out the tests.

(iii) The Contractor shall install test posts and foundations after completion of the finished ground.

(iv) On completion of loading tests the Contractor shall remove the test posts and foundations and make good the finished ground.

(v) Where appropriate, the Contractor shall establish and maintain traffic safety and management measures complying with Clause 117 during installation, loading and removal of the test posts and foundations.

405 Tensioned Corrugated Beam Safety Fence (TCB)

Assembly and Tensioning

1 Tensioned Corrugated Beam Safety Fence shall be assembled and tensioned in accordance with BS 7669 : Part 3, Section 2.1.

2 Beams shall be connected by lap joints using M16 screws, nuts and washers as described in the RCD: Section 2, Drawing Numbers GA/11 to GA/13 and SF/00.

3 Tensioning between any two limits shall not proceed until each limit is anchored sufficiently securely to resist the load effects due to tensioning.

4 Tensioning shall be undertaken only when the ambient temperature is between 25°C and -5°C.

5 Adjuster assemblies shall be located not more than 70.5 m apart and each installation shall incorporate at least one adjuster assembly.

6 On completion of tensioning, the centre of each screw securing beams to posts shall be not closer than 25 mm ±2 mm to the end of the slotted hole in the beam.

406 Untensioned Corrugated Beam Safety Fence (UCB)

Assembly

1 Untensioned Corrugated Beam Safety Fence shall be assembled in accordance with BS 7669 : Part 3, Section 2.2.

2 Beams shall be connected by lap joints using M16 screws, nuts and washers as described in the RCD: Section 2, Drawing Numbers GA/18, GA/19 and SF/00.

407 Open Box Beam Safety Fence (OBB) Assembly

1 Open Box Beam Safety Fence shall be assembled in accordance with BS 7669 : Part 3, Section 2.3.

2 Beams shall be connected by butt joints using fish plates and M16 bolts, nuts and washers as described in the RCD: Section 2, Drawing Numbers SF/22 and SF/00. Fences shall be as described in the RCD: Section 2, Drawing Numbers GA/20 to GA/28.

3 An expansion assembly (detailed on Drawing Number SF/35) shall be provided at not more than 100 m spacing on all continuous lengths of open box beam fence exceeding 100 m overall length.

408 Double Rail Single Sided Open Box Beam Safety Fence (DROBB)

Assembly

1 Double Rail Single Sided Open Box Beam Safety Fence shall be assembled in accordance with BS 7669 : Part 3, Section 2.3.3.

2 Beams shall be connected by butt joints using fish plates and M16 bolts, nuts and washers as described in Appendix 4/1.

3 An expansion assembly (detailed on Drawing Number SF/35) shall be provided on each rail at not more than 100 m spacing on all continuous lengths of double rail single sided open box beam fence exceeding 100 m overall length.

4 Notwithstanding the manufacturing tolerance permitted for individual beams, and the tolerances described in sub-Clause 403.2, the cumulative length tolerance shall be such that the position of the upper beam joint is within ±40 mm longitudinally of the lower beam joint.

409 Wire Rope Safety Fence (WR) Assembly

1 Wire Rope Safety Fence shall be installed in accordance with BS 7669 : Part 3, Section 2.5.

2 Driven line posts shall be installed to the prescribed levels without damage to the slot in the top of the post.

Ropes

3 The ropes shall be installed to the layouts as shown in Appendix 4/1.

Tensioning

4 Tensioning between any two limits shall not proceed until each limit is anchored sufficiently securely to resist the load effects due to tensioning.

5 Tensioning shall be undertaken only when the ambient temperature is between 30°C and 10°C.

6 Before tensioning the ropes the ambient temperature shall be agreed with the Overseeing Organisation. The tension shall be measured using a tension indicating device approved by the Overseeing Organisation.

7 Before putting the safety fence into service the tension in each rope shall be checked and it shall be retensioned if necessary.

410 Tensioned Rectangular Hollow Section Safety Fences (RHS)

Beams

1 Beams shall be either 200 mm x 100 mm section mounted either on top of posts or on the side of posts or 100 mm x 100 mm section mounted on top of posts, as detailed on the Drawings. They shall be connected using internal steel plates, bolts and washers as detailed in the RCD: Section 2.

Assembly and Tensioning

2 Assembly and tensioning shall be carried out in accordance with BS 7669 : Part 3, Section 2.4.

3 (i) The installation shall be as detailed in the RCD: Section 2, Series RHS 47 and RHS 48.

(ii) Tensioning between any two limits shall not proceed until each limit is anchored sufficiently securely to resist the load effects due to tensioning and that the safety fence has been completely assembled and connected to the anchorages.

(iii) Tensioning shall be undertaken only when the ambient temperature is between 10°C and 20°C.

(iv) Tensioner assemblies shall be located not more than 70.5 m apart and each installation shall incorporate at least one tensioner assembly.

411 Concrete Safety Barriers

1 The Permanent Vertical Concrete Safety Barrier (VCB) shall comply with the details in the RCD: Section 2.

2 The Temporary Vertical Concrete Safety Barrier (TVCB) shall comply with the details in the RCD: Section 2.

Where required in Appendix 4/1, the Contractor shall provide Temporary Vertical Concrete Safety Barrier units, and on completion of the Works, remove to the location stated therein.

Where Temporary Vertical Concrete Safety Barrier units are to be provided by the

Overseeing Organisation, the Contractor shall remove the barrier units from, and return on completion of the Works to, the location stated in Appendix 4/1.

412 Pedestrian Guardrails

1 Pedestrian guardrails shall comply with BS 7818 and with any other requirements described in Appendix 4/2.

DRAINAGE AND SERVICE DUCTS

Contents

DRAINAGE AND SERVICE DUCTS

501 Pipes for Drainage and for Service Ducts

General

1 Where the term drain is used in this Series it shall be deemed to include the terms sewer and piped culvert. The Contractor shall design the piped culverts listed in Appendix 1/10 in accordance with the requirements of Clause 106.

2 All drains constructed of pipes as well as piped culverts up to and including 900 mm internal diameter shall comply with this Series and any additional requirements in Appendix 5/1. Drains constructed using pipes exceeding 900 mm internal diameter as well as box and piped culverts shall comply with the 2500 Series. Unless otherwise described in Appendix 5/1 only one type of pipe shall be used within any individual drain or service duct between consecutive chambers. The Contractor shall ensure that plastics
pipes are not subject to deterioration due to sunlight during the period between manufacture and installation in the ground.

Pipes for Drainage

3 Pipes for drainage shall be selected from the alternatives in Table 5/1 and shall comply with the standards and particular requirements therein. The Contractor shall show that the pipes he selects have hydraulic flow capacity equal to that adopted in the hydraulic design of the system as described in Appendix 5/1. Pipes and fittings other than those included in Table 5/1 shall be permitted provided that they hold a current Malta Transport Authority certificate (or equivalent) stating that they are a suitable alternative for the usage specified in Table 5/1. On completion of the whole of the drainage works, the Contractor shall provide the Overseeing Organisation with a schedule showing details of all pipe types used, including quality, joints and name of manufacturer.

Corrugated Steel Pipes

4 Corrugated steel pipes shall be manufactured from either:

(i) bolted segmental plate pipes complying with sub-Clause 6 of this Clause and having plate thicknesses as described in Appendix 5/1; or

(ii) galvanized steel sheet suitable for lock seam fabrication complying with BS EN 10142 grade DX51D + Z600, or aluminium coated steel sheet complying with AASHTO specification M274-87I. Corrugated steel pipes complying with (ii) above shall be manufactured from steel of minimum thickness 1.25 mm unless otherwise described in Appendix 5/1.

5 Where described in Appendix 5/1 corrugated steel pipes shall be provided with additional protection of hot applied bitumen complying with AASHTO specification M190-80, or an equivalent coating system.

6 Bolted segmental plate pipes shall meet the following requirements:

(i) Steel for the plates shall comply with BS 1449 : Part 1, Grade 3 or Grade 4, Condition HR.

(ii) After forming, the depth of the corrugations shall be within a tolerance of ± 6% and the pitch of the corrugations within a tolerance of ± 4% of the nominal dimensions. Plates shall have a minimum lip of 45 mm beyond each end crest. Cut edges shall be free from notches, gouges, rust or burrs.

(iii) Bolts and nuts for connecting plates shall comply with ISO 4014, 4017 and 4032, for ISO 898 property class 8.8, nominal size M20; or with BS 4395, nominal size M20; or with ISO 898 Parts 1 and 2, property class 10.9.

(iv) When all the plates have been assembled, the nuts shall be tightened against a domed washer. The tightening shall be repeated if necessary to achieve the torque recommended by the manufacturer.

(v) Steel plates shall be galvanized in compliance with Clause 1909. Plates shall be galvanized after forming the corrugations and completing all necessary cutting, punching and drilling. Units in which the zinc coating has been burned by welding or otherwise damaged in fabrication, transport or handling at Site shall be made good in compliance with Clauses 1907 and 1908. Bolts and nuts shall be galvanized in compliance with Clause 1909.

TABLE 5/1: Pipes for Drainage

Material	Usage	Standard	Paritcular Requirements
Vitrified clay	Foul drains	BS 65 or BS EN 295	'Normal' pipes as definied in BS 65
	Surface water drains	BS 65 or BS EN 295	'Normal' or 'Surface water' pipes as definied in BS 65
	Filter drains	BS 65 BS EN 295	Umperforted, not exceeding 2.0m in length with spigot and socket open joints OR Perforated with flexible mechanical joints
Concrete (With Portland cement or surface-resisting cement when required in Appendix 5/1. supersulfated cement shall not be used)	Foul & surface water drains not exceeding 900mm internal diameters	BS 5911: Part 100 (Ordinary reinforced or unreinforced)	
		BS 5911: Part 103	
	Surface water drains not exceeding 900 mm internal diameter	BS 5911 : Part 110	For use with joints complying with sub-Clause 504.4
	Filter drains	BS 5911 : Part 114 (Porous with ogee or rebated joints)	
		BS 5911 : Part 110	Unpeforated not exceeding 2m in length with open joints with the total slot area between castellated being at least 1000mm² per metre length of pipe OR Perforated with circular holes not greater than 10mm nor less than 3mm in diameter
Glass reinforced plastics (GRP)	Foul and surface water drains	BS5480	Class to be as specified in Appendix 5/1
Iron	Foul and surface water drains	BS 437 (Cast Iron) BS EN598 (Ductile iron)	

TABLE 5/1: Pipes for Drainage (continued)

Material	Usage	Standard	Particular Requirements
Thermoplastic solid wall pipes and fittings not exceeding 900mm diameter Unplasticised polyvinyl – chloride (PVC-U)	Foul and surface water drains	BS 4660 or BS 5481 or BS EN 1401 (PVC-U) BS EN 1852-I (PP) prEN 12666-1 (PE)	See the UK national forward to the relevant BS EN. The grade appropriate for use without structural calculations shall be used i.e. SN8 for PP & PE and SN4 (SDR 41) for PVC-U
Polypropylene (PP) Polyethylene (PE)	Filter drains	BS 4660 or BS 5481 or BS EN 1401 (PVC-U) MSA 1852-1 (PP) PrEN 12666-1 (PE)	Perforated with not less than 1000mm² of holes per metre length of pipe. The perforation shall not reduce the pipe stiffness by more than 5%. Circular perforations not greater than 10mm nor less than 3mm in diameter or rectangular slots not greater than 4mm nor less than 0.6mm in width
Thermoplastics structured wall pipe and fittings not exceeding 900mm diameter	Surface water drains	Clause 518	Unperforated with watertight joints and with a pipe stiffness class, creep ration and impact resistance as described in Appendix 5/1
	Filter drains	Clause 518	Perforated with not less than 1000 mm² of holes per metre length of pipe. The perforation shall not reduce the pipe ring stiffness by more than 5%. Circular perforations not greater than 10mm nor less than 3mm in diameter or rectangular slots not greater than 4mm nor less than 0.6 mm in width.
Corrugated steel	Subsoil field drains	BS 4962 or Clause 518	
	Surface water drains, filter drains not exceeding 900mm internal diameter	AASHTO specification M36M-891 except as otherwise required in sub-clauses 501.4, 5 and 6	
All drains exceeding 900mm internal diameter shall comply with series 2500.			

Pipes for Service Ducts

7 Pipes for service ducts, excluding those in use in motorway communications installations, shall be selected from the alternatives in Table 5/2 and shall comply with the standards and particular requirements therein. Pipes for use in motorway communications installations shall comply with Series 1500. Pipes for service ducts shall have a smooth internal bore without any sharp edges to the ends of pipes. They shall comply with any additional requirements described in Appendix 5/2, and be of 100 mm internal diameter unless otherwise described therein. Their alignment shall be tested in accordance with sub-Clause 509.10. The use of pipes and fittings other than those included in Table 5/2 shall be permitted provided that they hold a current British Board of Agrement Roads and Bridges Certificate (or equivalent) stating that they are a suitable alternative to those listed in Table 5/2.

8 Each duct shall be fitted with a pigmented, stranded polypropylene or equivalent rot-proof material draw rope of 5 kN breaking load and having a design life of not less than 20 years, the ends of which shall be either made fast to marker blocks as shown on HCD Drawing Number I1 or secured inside chambers. The ends of a duct shall be either sealed by removable stoppers

immediately it has been laid, or terminated in chambers of the type specified in Appendix 5/2.

TABLE 5/2: Pipes for Ducts

Material	Standard	Particular Requirements
Vitrified clay	BS65 or BS EN 295	Plain-ended, self-aligning flexible sleeve jointed with internal ends radiused to 3mm minimum
Iron	BS EN 5908 (Ductile iron)	
Glass reinforced plastics	BS 5480	Glass to be as specified in Appendix 5/2
Thermoplastic solid wall Unplasticised polyvinyl-chloride (PVC-U) Polyproplene (PP) Polyethylene (PE)	BS 4660 or BS5481 or BS 3505 (class C) or BS 3506 (Class C) or BS EN 1404, BS EN 1452 class PN 10 BS EN 1852-1 (PP) PrEN 12666-1 (PE)	When pipes to BS 3505 (Class C) or BS 3506 (Class C) are used, joints shall comply with BS 4346 : Part 2
Thermoplastics single wall corrugated (Restricted to ducts buried a minimum of 600mm below the surface)	BS EN 50086-2-4	Ducts to BS EN 50086-2-4 should be classified as normal duty, have a degree of protection against ingress of foreign objects classification rating of 3 or 4 and a degree of protection against ingress of water classification rating of 7. Appendix 5/2 shall state the resistance to bending requirements
Thermoplastics structured wall	BS EN 50086-2-4 and Clause 518	Ducts to BS EN 50086-2-4 should be classified as normal duty, have a degree of protection against ingress of foreign objects classification rating of 3 or 4 and a degree of protection against ingress of water classification rating of 7. Appendix 5/2 shall state the resistance to bending requirements
Pipes for use in motorway communications installations shall comply with series 1500		

502 Excavation for Pipes and Chambers

1 Excavation shall comply with Clause 602 and with the following:

(i) soft spots existing below the bottom of an excavation shall be removed and the resulting voids backfilled with Type 1 subbase material complying with Clause 803 or pipe bedding material complying with Clause 503, both well compacted, or mix ST1 concrete;

(ii) any additional excavation below the bottom of an excavation that is required because the Contractor has allowed the bottom to become soft or otherwise unacceptable for the construction of the pipeline or chambers shall be made good as described in sub-Clause 1(i) of this Clause;

(iii) any excavation greater than the net volume required for the Permanent Works below the level of any pipe surround shall be made good as described in (i) above.

2 Unless otherwise described in Appendix 5/1, all pipes in or under new embankments shall be laid only when the embankment has been formed and compacted to formation level under paved areas, to finished earthworks level in other areas, or to a level which will give a minimum cover of 1.2 m to the pipes, whichever is the lowest.

503 Bedding, Laying and Surrounding of Pipes

1 Immediately following the excavation of the trench, the pipes shall be laid and jointed on the pipe bed. Pipes shall be laid so that each one is in contact with the bed throughout the length of its barrel. The pipes shall be laid at the level and gradients shown on the Drawings and schedules. The deviation in level rom that specified at any point shall not exceed 20 mm and in addition the algebraic difference of the deviation in level at any two points on each pipe shall not exceed 30 mm. In the case of socketed or sleeve jointed pipes the bed shall be cut away and removed at each socket or sleeve to give a clearance of at least 50 mm, or 100 mm for trenches in material designated as Hard Material, so that the socket or sleeve does not bear on the bed. Pipes shall be laid on setting blocks only where a concrete bed or cradle is used. Pipes and fittings shall be examined for damage and the joint surfaces and components shall be cleaned immediately before laying. Measures shall be taken to prevent soil or other material from entering pipes, and to anchor each pipe to prevent movement before the work is complete.

2 Pipes complying with BS 4962 : 1989 which are corrugated coilable perforated pipes shall, unless otherwise permitted in Appendix 5/1, be laid only by automatic single pass drain laying machines.

3 Drainage pipe and bedding combinations shall be selected from the alternatives described in Appendix 5/1. Where recycled coarse aggregate or recycled concrete aggregate is used in this Series, it shall have been tested in accordance with Clause 710.
Pipe bedding, haunching and surrounding material shall be as shown on HCD Drawing Numbers F1 and F2, and shall comply with the following:

(i) For pipes on beds shown on HCD Drawing Number F1 as Types B, F and S the granular material consisting of natural and/or recycled coarse aggregate or recycled concrete aggregate shall have:

a) a grading in accordance with Table 5/3; and

b) a water soluble sulfate content of less than 1.9 grams of sulfate (as SO3) per litre when tested in accordance with BS 812 : Part 118 Clause 5.

(ii) For pipes on beds shown on HCD Drawing Number F1 as Types N and T the granular material consisting of natural and/or recycled coarse aggregate or recycled concrete aggregate shall comply either with sub-Clause 3(i) of this Clause or with Table 5/4, with the water soluble sulfate content complying with (i) above.

TABLE 5/3: Granular Materials to BS 882 and Recycled Aggregates to Clause 710

Normal Pipe Diameter	BS 882 : 1992 Coarse Aggregate (Table 3)	
	Graded Aggregate Ranges (mm)	Single Sized Aggregate Sizes (mm)
Not exceeding 140	20 to 5 or 14 to 5	10
Exceeding 140 but not exceeding 400		10,14 or 20
Exceeding 400	14 to 5, 20 to 5 or 40 to 5	10, 14, 20 or 40

TABLE 5/4:Granular Materials to BS 882 and Recycled Aggregates to Clause 710

Nominal Pipes Diameter (mm)	BS 882 : 1992Sand (Table 4)	BS 882 : 1992 All-in-Aggregate (Table 5)
	Limits	Nominal Sizes (mm)
Not exceeding 140	Overall Limits	10
Exceeding 140 but not exceeding 400	Overall Limits	10 or 20
Exceeding 400	Overall Limits	10, 20 or 40

(iii) For pipes on beds shown on HCD Drawing Number F1 as Types A and Z concrete shall be mix ST4 and mix ST2 respectively. Backfilling shall not be carried out until after the concrete has cured.

(iv) Except for filter drains a further surround above the bed, haunch and surround described above shall be provided to a height of 300 mm above the top of the pipe consisting of Class 8 lower trench fill material as described in Table 6/1 and in compliance with Series 600.

(v) Unless otherwise described in Appendix 5/1 the materials used for the bedding, haunching and surrounding of filter drains shall comply with the appropriate bedding, haunching and surrounding materials specified in sub-Clauses 503.3.(i) to 503.3.(iv) and with the requirements for backfilling specified in sub-Clause 505.3.

(vi) Granular materials used for bedding, haunching and surrounding of pipes shall nhave a 10% fines value of not less than 50 kN when tested in accordance with BS 812 : Part 111, with samples in a soaked condition.

4 Except where the pipeline is to be tested in compliance with Clause 509 before backfilling, the completion of the bedding, haunching and surrounding of the pipes is to be carried out immediately after jointing. The bed, haunch and surround shall be brought up equally on both sides of the pipe ensuring that it is in contact with the underside of the pipe barrel and be carefully compacted in layers not exceeding 150 mm thickness ensuring full compaction next to the trench walls. Pipes shall be maintained to line and level during the bedding, haunching and surrounding operations. Where pipelines are to be tested before being covered the bedding haunching and surrounding material shall only be brought up sufficiently to support the pipeline and the joints shall be left exposed until the test is completed satisfactorily.

5 Duct construction shall comply with the requirements of Appendix 5/2.

504 Jointing of Pipes

1 Rigid joints shall mean joints made solid by caulking the sockets, or bolting together flanges integral with the pipes. Flexible joints shall mean joints made with deformable rings or gaskets held between pipe spigots and sockets, sleeves or collars.

2 Joints in surface water drains shall be watertight complying with sub-Clause 3 of this Clause or partly watertight complying with sub-Clause 4 of this Clause as described in Appendix 5/1. Foul drains shall have watertight joints. Filter drains shall have joints complying with sub-Clause 6 of this Clause. Ducts need not have watertight joints unless otherwise described in Appendix 5/2.

3 Watertight joints shall comply with the appropriate ADT Standards, the manufacturer's instructions and the following:

(i) Rigid joints shall be used only where permitted in Appendix 5/1. Spigots and sockets of rigid joints may be caulked with tarred rope yarn or equivalent and the socket completely filled with mortar designation (i) complying with Clause 2404, excluding lime; a fillet of mortar being worked around the socket extending for a length of not less than 50 mm from the face of the socket. Iron pipes with open sockets shall have rigid joints caulked with lead wool or equivalent.

(ii) Joints in PVC-U pipes shall not be made with plastic solvent.

(iii) Flexible mechanical joints may be used with surface water pipes complying with BS 65.

(iv) Joints for cast iron pipes to BS 437 shall comply with BS 6087.

(v) Joints in thermoplastics structured wall pipe shall comply with clause 518.

4 Partly watertight joints for surface water drains shall be tested in accordance with sub-Clause 509.7 and shall be ADT Standard joints or non- ADT Standard joints. Push fit joints shall have a register to ensure that the pipe is fully pushed into the joint. Corrugated steel pipes of lock seam fabrication, not exceeding 900 mm internal diameter, shall be joined in accordance with the manufacturer's instructions. Bolted segmental plate pipe arches or circular pipes, not exceeding 900 mm internal diameter, shall be joined in accordance with sub-Clause 501.6 (iv) and the manufacturer's instructions.

5 Where a concrete bed, cradle, arch or surround is used with rigid pipes having flexible joints, joint filler board complying with Clause 1015 shall be placed in contact with the end of the socket at a pipe joint and shall extend through the full thickness of the concrete in contact with the pipe. Such joints in the concrete bed, haunch or surround shall be at intervals not exceeding 5 metres except where the spacing of joints in the pipe exceeds 5 metres when they shall be at each pipe joint.

6 Joints in pipes for filter drains shall comply with the appropriate ADT and with the following:

(i) Non-porous and unperforated concrete and clay pipes with spigot and socket, rebated or ogee joints shall be laid with unsealed joints and with a gap of 10 mm between the end of the pipe and the inner end of the socket or rebate. The pipes shall be supported with tarred rope yarn or equivalent flexible jointing material within the sockets over the lower third of the circumference so that there are no vertical steps between one pipe and another. Such pipes shall only be used with Type B filter material as described inClause 505.

(ii) The ends of perforated, castellated or porous concrete pipes with rebated joints and perforated clayware pipes with rebated or with flexible sleeve joints shall be pushed tightly together. The width of slots measured along the length of the pipeline formed by jointing castellated pipes shall not exceed 10 mm.

(iii) Perforated or slotted thermoplastics pipes with spigots and sockets or sleeves may be dry-jointed or jointed as described in sub- Clauses 3 and 4 of this Clause.

(iv) Other perforated pipes shall be jointed as unperforated pipes of the same material.

7 Joints in pipes for service ducts shall comply with the appropriate British Standard and with the following:

(i) Pipes for ducts shall be jointed so that no silt, grit, grout or concrete surround is able to enter the duct. Pipes with push-fit joints shall have a register to ensure that the pipe is fully pushed into the joint.

(ii) Joints in pipes to BS 3506 or BS 3505 shall comply with BS 4346 : Part 2.

505 Backfilling of Trenches and Filter Drains

1 Backfilling shall be undertaken immediately after the required operations preceding it have been completed.

2 Except where otherwise described in Appendix 5/1, trenches other than filter drain trenches shall be backfilled above the pipe surround material described in Clause 503, with Class 1, 2, or 3 general fill material complying with Series 600.

3 Filter drains shall be backfilled as described in Appendix 5/1 with Type A, Type B or Type C filter material which shall:

(i) be well graded (except for Type B which shall be uniformly graded) and comply with the requirements of Table 5/5 when determined by the washing and sieving method of BS 812 : Part 103;

(ii) be non-plastic when tested in accordance with BS 1377 : Part 2;

(iii) have a 10% fines value of not lless than 50 kN when tested in accordance with BS 812 : Part 111 with samples in a soaked condition;

(iv) meet the sulfate requirement described in sub-Clause 503.3(i)(b). Filter materials, when tested in accordance with sub- Clause 509.8 shall have permeability requirements as described in Appendix 5/1. When Type A material is used with pipes other than porous pipes at least 15% of the material shall be larger than the diameter of hole or larger than 1.2 times the width of slot in the pipe.

4 Backfilling shall be deposited and compacted in compliance with Clause 612. Filter material for filter drains shall be deposited in layers not exceeding 225 mm loose depth; each layer being compacted in compliance with Table 6/4 Method 3.

5 Material shall be deposited in even layers and shall not be heaped in the trench before being spread. Spreading and compaction shall be carried out evenly without dislodging, distorting or damaging the pipe. Power rammers shall not be used within 300 mm of any part of the pipe or joint.

TABLE 5/5: Grading Requirements for Filter Drain Material

	Percentage by Mass Passing Sieve							
	BS Sieve Sizes							
	Millimetres						Microns	
	63	37.5	20	10	5	1.18	600	1
Type A Type B	10	100 85-100	85-100 0-25	50-100 0-5	35-90	15-50	5-35	0
Type C	As described in Appendix 5/1							

6 Except in carriageways, other paved areas and locations described in Appendix 5/1, backfill of trenches shall be brought up to ground level. Where topsoil is at the surface on the line of the trench the upper section of the backfill shall be topsoil of the thickness described in Appendix 6/8, or of the same thickness and quality of topsoil as the surrounding ground where no thickness is specified. For trenches in carriageways or other paved areas the backfill shall be brought up to formation level, or sub-formation level where capping is required, unless a lower level is described in Appendix 5/1. Sheeting and other excavation supports shall be removed as the filling proceeds unless otherwise described in Appendix 6/3.

7 The position of service ducts shall be marked where the trenches are backfilled and permanent marker blocks and location posts provided as described in Appendix 5/2.

506 Connecting to Existing Drains Chambers and Channels

1 Where described in Appendix 5/1, existing drain shall be extended, connected and jointed to new drains, chambers or channels. All such connections shall be made during the construction of the new drain or other work and their positions recorded by the Contractor who shall hand to the Overseeing Organisation a copy of the record of the connections made the previous day. Where pipe connections are made to existing brick concrete or stone drains, chambers or channels, the pipes shall be well and tightly built into the concrete, brick or masonry work and be so placed as to discharge at an angle not greater than 60° to the direction of flow of the drain or channel and with the end of the pipe carefully cut to the necessary angle. Where the connections are between pipe drains, special connecting pipes shall be laid and jointed as described in Appendix 5/1.

2 Before entering or breaking into an existing sewer or drain, the Contractor shall give notice of his intention to do so to the authority responsible for the pipeline to which the connection is to be made.

3 Existing drains no longer required shall, as required by Appendix 5/1, be sealed with mix ST2 concrete or removed and replaced with general fill material complying with Clause 601 and Table 6/1 and compacted in compliance with Clause 612, or grouted with a 1:10, cement: pfa mix. The grout shall use the minimum quantity of water to ensure the fluidity necessary to render it capable of being pumped to the ends of the pipe. It shall be used within one hour of mixing but when the mix contains a retarding admixture this time may be extended in accordance with the manufacturer's instructions. The cement shall comply with BS 12 and the pulverised-fuel ash (pfa) with BS 3892 : Part 2, fineness to Zone B and sulfate content not exceeding 1.5%.

507 Chambers

1 Chambers, other than those used in motorway communications installations, shall include manholes, catchpits, inspection

chambers, draw pits and walled soakaways. Chambers shall be of the type specified in Appendix 5/1, constructed in accordance with HCD Drawing Numbers F3 to F12 and F25 to F27 as appropriate to that type. Chambers for use in motorway communications installations shall comply with Series 1500.

2 Foundations to chambers shall be of mix ST4 concrete. Channels for chambers shall be formed and finished smooth in the foundation concrete or constructed of preformed half circle channels, with sides benched in mix ST4 concrete, or mortar designation

(i) complying with Clause 2404 excluding lime. Alternatively for inspection chambers not exceeding 1.3 metres in depth to invert, complete plastics units or other units in equivalent material surrounded by 150 mm of mix ST4 concrete may be used.

3 Brickwork shall comply with Series 2400 and be built with mortar designation (i) in English bond. The joints of brickwork where exposed shall be finished as specified for unpointed joints in Clause 2412. The ends of all pipes shall be neatly built into the brickwork and finished flush with mortar designation (i).

4 Precast concrete chambers shall comply with BS 5911 : Part 200. Cast in situ concrete chambers shall be constructed of mix ST4 concrete complying with Clause 2602 unless otherwise described in Appendix 5/1.

5 Corrugated galvanized steel chambers shall comply with Clause 501 with in situ mix ST4 concrete inverts and precast concrete cover slabs complying with BS 5911 : Part 200 and the particular requirements described in Appendix 5/1. They shall be surrounded with well graded granular material Class 6M as described in Table 6/1 compacted in accordance with Clause 612.

6 Where the depth of invert of chambers, excluding inspection chambers, exceeds 900 mm below the finished surface of the carriageway or the adjacent ground, manhole steps complying with BS 1247 : Part 1 or Part 2 shall be built in as specified in BS 5911 : Part 200. Steelwork used for ladders, handholds and other fittings shall comply with BS 970 : Part 1 and be galvanized in compliance with Clause 1909 after fabrication. Threaded components shall be galvanized in compliance with Clause 1909.

7 Excavation around chambers, except those described in sub-Clause 5 of this Clause, shall be backfilled with general fill material as described in Table 6/1 and compacted in compliance with Clause 612. Where mechanical compaction is impracticable, the excavation shall be backfilled with mix ST2 concrete. Where there are precast concrete access shafts to precast concrete chambers, the shafts shall be surrounded by a minimum thickness of 150 mm of mix ST4 concrete, and the remaining excavation backfilled with general fill material as described in Table 6/1 compacted in compliance with Clause 612.

8 Chambers for foul drains shall be tested for watertightness as and where required in Appendix 5/1.

9 Chamber covers, gratings and frames shall be as described in Appendix 5/1 and shall comply with BS EN 124 and sub-Clauses 10 and 15 of this Clause.

10 Class D 400 units and above shall incorporate a permanent non-rock feature either triangular point suspension or machined faces.

11 Bolts supplied for loosely coupling separate sections of covers and gratings shall be steel hexagon headed, complying with the requirement of ISO 4016, 4018 and 4034 and be galvanized in compliance with Clause 1909. They shall not be less than size M16 complete with hexagon nut and shall be provided with means to prevent undue tightening of unit sections.

12 Unless otherwise specified in Appendix 5/1, all covers, gratings and frames shall be supplied in a fine cast (uncoated) condition. Where a coating is specified in Appendix 5/1, the coating shall only be applied when the surfaces of the casting are clean, free from rust and dry.

13 Requirements for special duty covers for use in carriageways shall be as described in Appendix 5/1.

14 Gratings for catchpit chambers shall have a minimum waterway area as described in Appendix 5/1.

15 Two sets of lifting keys shall be delivered to the Overseeing Organisation for each type of cover supplied. At least two keyways, as detailed on HCD Drawing No. F17, shall be provided in each complete cover, one in each segment for segmental covers. A recess for a prising bar shall be incorporated in manhole covers unless other means of loosening the cover from the frame are provided.

16 Frames for chamber covers and gratings shall be set in cement mortar designation (i) complying with Clause 2404 or a proprietary quick setting mortar of equivalent strength.

17 For all pipelines except those constructed with corrugated pipes the nearest joint to any chamber shall be not more than 500 mm from the inner face of the wall and shall not be restricted by any concrete. Between this and the next joint, the length of the articulated pipe shall be in accordance with Table 5/6.

TABLE 5/6: Length of Articulated Pipe

Nominal Pipes Diameter (mm)	Length of Pipe (mm)
450 and less	500 to 750
Greater than 450	750 to 1000

18 Where the adjustment or replacement of existing frames and covers or gratings is required, the units shall be taken up and re-fixed or removed and replaced with new units complying with sub-Clauses 9 to 15 of this Clause, or as described in Appendix 5/1. On taking up or removal of the unit, any concrete or mortar bedding shall be broken out and the surface prepared. Where existing frames and covers or gratings are to be adjusted, the Contractor shall take up the unit and clean it for re-use. The adjusted or replaced units shall be laid on a mortar bed complying with sub-Clause 16 of this Clause. The finished thickness of the mortar bed shall be between 10 mm and 25 mm. Where required in Appendix 5/1, covers and gratings shall be bedded using a proprietary quick setting high strength mortar. Details of such mortar shall be to the approval of the Overseeing Organisation. Unless otherwise described in Appendix 5/1, adjusted or replaced frames and covers or gratings shall be set flush with the new surface. Any additional adjustments shall be by modifying the brickwork in compliance with sub-Clause 507.3 or by using a frame of a suitable depth. On completion of the works, each cover shall be lifted and the frame and seating cleaned.

508 Gullies and Pipe Junctions

1 Gullies shall be trapped or untrapped as described in Appendix 5/1 and be in accordance with HCD Drawing Numbers F13 and F14.

2 Gullies shall be constructed so that no part of the spout or trap has a cross-sectional area less than 2/3rd that of the outlet. The depth of water seal in trapped gullies shall be not less than 50 mm.

3 Precast concrete gullies shall comply with BS 5911 : Part 230 and clay gullies with BS EN 295. In situ concrete gullies shall be as described in Appendix 5/1 and constructed of mix ST4 concrete of 150 mm minimum thickness, using permanent or removable shuttering. Where in situ concrete gullies are formed with permanent shuttering, such shuttering shall have a current British Board of Agrement Roads and Bridges Certificate (or equivalent).

4 Gully gratings, kerb type gully covers and frames shall comply with BS EN 124 and the following and shall be of the classes and sizes described in Appendix 5/1.

5 The upper surface of gully gratings shall be flat except where otherwise described in Appendix 5/1. Slots in gratings or between gratings and frames shall not be orientated parallel to the direction of traffic except where the slots are less than 150 mm long or less than 20 mm wide. Minimum waterway areas shall be as specified in Appendix 5/1. Unless otherwise specified in Appendix 5/1, all gratings and frames shall be supplied in a fine cast (uncoated) condition. Where a coating is specified in Appendix 5/1, the coating shall only be applied when the surfaces of the casting are clean, free from rust and dry. Frames shall be bedded on mortar complying with sub-Clause 507.16. Brickwork shall comply with sub-Clause 507.3.

6 Backfilling to precast gullies shall be carried out up to sub-formation level with general fill material Class 1, as described in Table 6/1 compacted in compliance with Clause 612. Where mechanical compaction is impracticable, the backfilling shall be in mix ST2 concrete. The remainder of the backfilling shall be in appropriate capping and road pavement materials except that where mechanical compaction of capping or granular sub-base is impracticable mix ST2 concrete shall be used.

7 Gully connection pipes shall be either flexible or rigid not exceeding 0.7 m in length with flexible joints for a distance of 2 m from the gully and shall be in accordance with sub-Clause 507.17 when entering chambers. Junction pipes shall be manufactured of the same type and class of material as the remainder of the pipes in the run. Junction pipes which are laid but not immediately connected, shall be fitted with temporary stoppers or seals and the position of all such junctions shall be clearly defined by means of stakes or tracing wires properly marked or labelled. Saddles may be used to form junctions only where permitted in Appendix 5/1. No internal projections greater than 5 mm will be permitted. Saddles for asbestos cement and plastics pipes shall be installed in accordance with the manufacturer's recommendations. Saddles with clay pipes shall be jointed with mortar designation (i) complying with Clause 2404, excluding lime. Saddles and pipes shall be surrounded with mix ST2 concrete.

8 Where the adjustment or replacement of existing frames and gratings is required, the units shall be taken up and re-fixed or removed and replaced with new units complying with sub-Clauses 4 and 5 of this

Clause, or as described in Appendix 5/1. On taking up or removal of the unit, any concrete or mortar bedding shall be broken out and the surface prepared. Where existing frames and covers or gratings are to be adjusted, the Contractor shall take up the unit and clean it for re-use. The adjusted or replaced units shall be laid at a level, unless otherwise described in Appendix 5/1, 6 mm below the adjoining road surface on a mortar bed complying with sub-Clause 507.16. The finished thickness of the mortar bed shall be between 10 mm and 25 mm. Where required in Appendix 5/1, covers and gratings shall be bedded using a proprietary quick setting high strength mortar. Details of such mortar shall be to the approval of the Overseeing Organisation. Any additional adjustment shall be made by modifying the brickwork in compliance with sub-Clause 507.3 or by using a frame of suitable depth. On completion of the works, each grating shall be lifted and the frame and seating cleaned.

509 Testing and Cleaning

1 Drains required in Appendix 5/1 to have watertight joints shall be tested as described in Appendix 1/5 in sections, eg. between chambers, by means of the air test described in sub-Clause 2 of this Clause. If a pipeline is rejected because of a failed air test, as part of the rectification work, a water test as described in sub- Clause 3 of this Clause may be carried out as an alternative acceptability test. Before testing, the ends of the pipeline to be tested, including those of short branches, shall be plugged and sealed.

2 For the pipeline air test, air shall be pumped in by suitable means until a stable pressure of 100 mm head of water is indicated in a U-tube connected to the system. The air pressure shall not fall to less than 75 mm head of water during a period of 5 minutes without further pumping, after an initial period to allow stabilization. Drains with traps shall be tested to 50 mm head of water and the permissible loss shall then be no more than 13 mm head of water in 5 minutes without further pumping after the initial stabilising period.

3 For the pipeline water test, the pipes shall be filled with water under a head of not less than 1.2 m above the crown of the pipe at the high end and not more than 6 m above the pipe at the low end. Steeply graded pipelines shall be tested in sections so that the above maximum is not exceeded. The test shall commence not less than two hours after filling the test section at which time the level of water at the vertical feed pipe shall be made up to produce the required 1.2 m minimum test head. The loss of water over a 30 minute period shall be measured by adding water at regular 10 minute intervals to restore the original water level and recording the amounts so added. The drain will have passed the test if the volume of water added does not exceed one litre per hour per linear metre of drain per metre of nominal internal diameter.

4 All pipelines less than 350 mm diameter, excluding service ducts shall be checked by drawing through each completed length of pipe a spherical mandrel of a diameter 10% less than the nominal bore of the pipes being tested.

5 During the progress of the Works all existing chambers, gullies and rodding eyes shall be kept clean and free from obstruction. On completion of the whole of the Works, all chambers, gullies and drains including verge/surface water drains and french surface water drains but excluding all fin and narrow filter drains shall be flushed from end to end with water and left free from obstructions. Unless otherwise required

in Appendix 5/1 foul drains shall be surveyed by a video camera and a recording supplied to the Overseeing Organisation. Catchpit chambers shall be left clean and free from silt.

6 The pipes and filter material of filter drains shall at all times be left clean and free from silt and obstruction.

7 Where described in Appendix 1/5, samples of one or more partly watertight joints for pipelines up to and including 900 mm diameter shall be tested with a head of water kept level with the crown of the pipe. The joint will not be accepted if the flow through the joint in litres per minute exceeds 20 times the square of the nominal internal diameter of the pipe in metres.

8 Permeability tests shall be as described in Appendix 5/1.

9 Service ducts shall be checked by drawing a wooden mandrel, as shown on HCD Drawing Number I2, through as the ducts are laid but where a set has to be given to the line of ducts the wooden mandrel shall be replaced by an iron mandrel 250 mm long but of the same diameter as the wooden version.

510 Surface Water Channels and Drainage Channel Blocks

1 Surface water channels and drainage channel blocks shall be constructed as described in Appendix 5/3.

2 Surface water channels shall comply with Clause 1103.

3 Drainage channel blocks shall comply with Clause 1101.

511 Land Drains

1 Existing land drains which are permanently severed by the Works shall be located and connected into a new drain, pipe or ditch all as described in Appendix 5/1. The lengths remaining within the Works shall be cleaned out from the new drain trench face as necessary. Any pipe disturbed by the Works shall be relaid to ensure a free discharge into the new drain. Disused ends of intercepted land drains shall be adequately sealed with mix ST2 concrete in compliance with Clause 2602.

2 Where an existing land drain is exposed and severed by temporary trench excavation, the Contractor shall mark the position of the drain and record it. The drain shall be diverted into an existing drain or watercourse. Alternatively, the normal functioning of the drain shall be continued by the construction of a pipeline or channel adequately supported across the excavation, until permanent restoration is made on the original line.

3 The Contractor shall notify the Overseeing Organisation of any land drain which is blocked or is otherwise defective when the drain is first exposed.

4 Severed mole drains shall be led straight into new drains; alternatively they shall where required in Appendix 5/1 be intercepted by the construction of a land drain. Where they have been disturbed mole channels shall be cleaned out and filled locally with Type A filter material or as otherwise described in Appendix 5/1.

512 Backfilling to Pipe Bays and Verges on Bridges

1 Unless otherwise described in Appendix 5/1, filling to pipe bays and verges on bridges shall be well graded granular material not exceeding 20 mm size containing not more than 3% of material passing the 75 micron BS sieve and with a uniformity coefficient of more than 5. It shall be laid and compacted in compliance with sub- Clause 505.4 and 5. The material shall meet the sulfate requirement described in sub-Clause 503.3.

513 Permeable Backing to Earth Retaining Structures

1 Unless otherwise described in Appendix 5/1, permeable backing shall consist of one of the following materials except when the filling adjacent to the structure is selected cohesive material (Class 7A), selected conditioned pulverised-fuel ash (Class 7B) or chalk:

(i) A minimum thickness of 300 mm of granular material complying with the requirements of Clause 505 for Type A or Type C material and, in addition, satisfying the following criteria:

Piping ratio, defined as

$$\frac{\text{15 per cent size of the drainage material}}{\text{85 per cent size of the backfill material}} < 5$$

Permeability ratio, defined as

$$\frac{\text{15 per cent size of the drainage material}}{\text{15 per cent size of the backfill material}} > 5$$

where the per cent size of a material is the size of particle corresponding to the given per cent ordinate of the particle size distribution graph.

(ii) Porous no-fines concrete, cast in situ 225 mm thick complying with the requirements of Clause 2603.

(iii) Precast hollow concrete blocks complying with the BS 6073 : Part 1 laid in stretcher bond with dry joints in 225 mm thick walling with holes vertical.

2 When the filling adjacent to the structure is selected cohesive material (Class 7A), selected conditioned pulverised-fuel ash (Class 7B) or chalk, the permeable backing shall be a minimum thickness of 300 mm of sand grading C or M complying with BS 882 unless otherwise described in Appendix 5/1.

514 Fin Drains General

1 Fin drains shall comply with this Clause and the special requirements described in Appendix 5/4. The terms thickness, width, height and core shall have the meanings indicated on HCD Drawing Number F18 unless otherwise described in Appendix 5/4. The term fin drain shall mean a planar geocomposite structure designed to perform the same function as a narrow filter drain.

2 Where fin drains are designed for lateral entry of water from one side only the requirements for flow rates in sub-Clauses 4 and 5 of this Clause shall apply to the face or plane designed to admit or transmit water.

3 The materials of which the drain is made shall be treated so that they are protected from the deleterious effects of short term exposure to ultraviolet light, and shall be resistant to degradation by acids, alkalis, common chemicals, bacteria, fungi and moulds occurring in soils and road construction materials. After exposure to

ultraviolet light the Overseeing Organisation may require evidence that the materials still comply with the requirements of this Clause. The drain shall be protected from damage and ultraviolet light and be labelled to identify the grade and manufacturer or supplier. Where necessary, the side intended for entry of water and the direction of in-plane flow shall be identified.

Geotextile

4 The geotextile shall:

(i) in both machine and cross-machine directions, sustain a tensile load of not less than 5.0 kN/m at break and have a minimum failure strain of 10% when determined in accordance with BS 6906 : Part 1;

(ii) have a minimum puncture resistance of 1200 N when determined in accordance with BS 6906 : Part 4;

(iii) have a minimum tear resistance of 200 N when determined in accordance with ASTM Standard D4533-85;

(iv) have a size distribution of pore openings such that the apparent opening size O90 when determined in accordance with BS 6906 : Part 2, or other appropriate test, is as stated in Appendix 5/4;

(v) allow water to flow through it, in either direction, normal to its principal plane at a rate of not less than that stated in Appendix 5/4 under a constant head of water of 100 mm and a maximum breakthrough head of 50 mm when determined in accordance with BS 6906 : Part 3.

Composite Drain

5 The composite drain shall:

(i) have a flow rate through each face of the drain of more than 75% of the value specified in sub-Clause 4(v) of this Clause on the side or sides where inflow occurs. This value may be found by either:

(a) direct measurement of the composite drain using a modified version of BS 6906 : Part 3; or

(b) calculation based on the flow rate obtained by the standard test in BS 6906 : Part 3 and the percentage contact area of the drainage core obtained from sub-Clause 13 of this Clause or other appropriate method;

(ii) have values of long term in-plane flow rates as stated in Appendix 5/4 when determined in accordance with sub-Clauses 14 and 15 of this Clause. The values of hydraulic gradient and minimum applied stresses shall be as given in Table 5/7.

TABLE 5/7: Applied Stresses (kN/m²) and Hydraulic Gradient

HCD Drain Type	5	6	7	10
Sub-Clause 14: Normal Stress Shear Stress	 50 10	 50 10	 50 10	 100 10
Sub-Clause 15: Normal Stress	 100	 100	 100	 100
Sub-Clause:15 Hydraulic Gradient	0.1 1.0	1.0	1.0	0.1 1.0

Joints

6 Fin drains shall be capable of being jointed longitudinally or laterally into pipe systems or chambers for inflow and outflow purposes and be self jointing either directly or through purpose made attachment pieces for forming continuous drain lengths. All such joints shall be formed so as to prevent the ingress of soil particles or other extraneous material into the drain. Fin drain joints transverse to the direction of flow shall have values of in-plane flow rates not less than that required by sub-Clause 5(ii) of this Clause. Fin drain joints parallel to the direction of flow and any exposed edges shall be protected from the ingress of soil by a geotextile wrapping with a minimum overlap of 150 mm.

Pipes

7 For drain Type 6 pipes shall be perforated or porous and comply with sub-Clause 501.3. Pipes complying with BS 4962 : 1989 shall have a minimum Ultimate Pipe Stiffness (STES) value of 1400 N/m2. For drain Type 7 pipes shall be unperforated thermoplastics pipe complying with BS 4660, BS 5481, BS EN 1401, BS EN 1852-1 or prEN 12666-1 slotted longitudinally along the top surface and stress relief treated (if required) in accordance with the system manufacturer's published specification.

8 Pipe joints shall comply with the requirements of the relevant British Standard for the pipe used or Clause 518.

Backfill and Surround Material

9 Pipe surround material for drain Types 6 and 7 shall comply with sub-Clause 503.3(i) or 503.3(ii) or Type A or C material complying with sub-Clause 505.3. Where fin drains are installed in a trench backfill material shall be the original as-dug material from the trench unless otherwise specified in Appendix 5/4.

Dimensions

10 Unless otherwise described in Appendix 5/4 the dimensions of the fin drain shall be as shown on HCD Drawings F18 and F21. The pipe diameter shall be as stated in Appendix 5/4. The drain slope angle (x), as shown on Drawing F19, shall be not greater than 15° from the vertical unless otherwise stated in Appendix 5/4.

Installation and Handling

11 Installation of fin drains shall be as shown on HCD Drawing Numbers F19 to F21. Where fin drains are assembled on site the assembly area shall be clean and dry and free of wind-borne pollutants. Any material which becomes contaminated must be replaced. No geotextile or core material shall be exposed to daylight (or any source of ultraviolet radiation) for a period exceeding a cumulative total of 50 hours. Any geotextile or core material exposed to daylight (or any source of ultraviolet light) for a period exceeding a cumulative total of 50 hours shall be replaced unless it can be demonstrated that the materials of the drain still comply with the requirements of this Clause. Where fin drains are laid in trench, the trench bottom shall be free of irregularities and to the required levels given in Appendix 5/4. Rock and other hard protuberances shall be removed and any excess cut in the trench bottom filled and compacted back to the required grade with suitable excavated or imported material.

The drain shall be laid with the appropriate face against the side of the trench adjacent to the carriageway and in the appropriate direction. This side of the trench shall have walls sufficiently clean to enable the fin

drain to come into close contact with the wall when the trench is backfilled and compacted. Compaction shall be in accordance with Clause 612. Fin drains installed as part of the Permanent Works shall be protected from surface water, contamination, and accidental damage during construction. The fin drain, pipe surround and backfill shall be installed so as to cause no damage to the fin drain. Where any damage does occur, the damaged materials shall be replaced by new material.
After the installation of the fin drain has been completed a marker tape shall be laid approximately 75 mm above the fin drain in the position shown on HCD Drawing Numbers F19 and F20. The tapes shall be green self-coloured PVC or polythene plastic not less than 0.1 mm thick and 150 mm wide.

Identification

12 The Contractor shall obtain and make available the following information for each separate consignment of fin drain delivered to Site:

(i) geotextile and core name, grade/number and mass per unit area;

(ii) names and addresses of system producer, and geotextile, core and pipe manufacturers;

(iii) manufacturing characteristics and constituents of geotextile and core. This shall include composition and type of constituent filaments, threads, fibres, films, tapes and other components;

(iv) consignment number and delivery date;

(v) a copy of the site delivery note.

Test Method for the Percentage Contact Area of Drainage Core

13 (i) The test determines the area of one face of a drainage core which will be in contact with a geotextile filter as a percentage.

(ii) The apparatus required is as follows:

(a) loading device able to apply a compressive load of at least 2 kN and having a flat steel base;

(b) flat steel loading plate 200 mm x 200 mm;

(c) printers ink and roller (or pad);

(d) sheet of thin compressible rubber;

(e) planimeter.

(iii) The test procedure shall be as follows. Cut three representative test specimens 200 mm x 200 mm (±2 mm). Apply ink to one 200 mm x 200 mm face of a specimen and cover with a sheet of plain paper and a thin compressible rubber sheet. Place the prepared specimen in to the loading device and gradually apply the load of 2 kN and maintain for 5 minutes. Release the load and remove the specimen and separate it from the paper. Using the planimeter find the total area of the paper which has received an imprint. Repeat for all specimens.

(iv) The percentage contact area = total area of imprint area of test specimen

(v) The report shall include:

(a) a reference to this method;

(b) sample identification details;

(c) individual and mean percentage contact areas;

(d) details of any deviation from the specified test procedure.

(vi) Alternative methods of determining the percentage contact area may be employed with the prior approval of the Overseeing Organisation.

Test Method for Determining the Thickness of Fin Drains Under Specified Normal and Shear Stresses

14 (i) The test determines the thickness of the fin drain under sustained normal and shear stresses. A long term thickness (at 100,000 hours) is calculated by extrapolation and a short term equivalent normal load which produces the long term thickness is determined.

(ii) The apparatus required is as follows:

(a) a suitable compression testing machine, which shall have a vertical travel at least the nominal thickness of the specimen. It shall be capable of sustaining the necessary loads to within 1% accuracy for the duration of the test;

(b) the compression testing apparatus, which shall include a fixed base plate and parallel moveable top plate with flat steel surface with sufficient friction to permit the development of the required shear forces;

(c) a means of measuring the mean thickness of the specimen to an accuracy of 0.01 mm. As an alternative to (a) and (b), an appropriate inclined plane and kentledge system may be employed to produce the normal and shear loads. The test procedure shall be as follows:

(iii) Cut six representative specimens of minimum size 100 mm x 100 mm symmetrically about the core design. Three specimens shall be tested in accordance with

(v) below and three in accordance with

(vi) below.

(iv) The test specimen shall be placed symmetrically on the base plate and covered by the top plate. The means of measuring thickness shall be attached and the initial thickness measured.

(v) Apply the load smoothly and as quickly as possible to the top plate. The full load (normal and shear) should be applied in less than 20 seconds and sustained for at least 1000 hours. The applied stresses shall be those given in Table 5/7. At least four measurements of thickness should be made during each unit of logarithmic time after the first minute. Determine the long term thickness of the specimen as the thickness of the specimen at 1000 hours reduced by 2T where T is the difference in thicknesses of the specimen thickness

recorded at 100 hours and 1000 hours. Repeat the test on the two other specimens. The test specimens shall be maintained at a constant temperature of 20°C ± 2°C throughout the test period.

(vi) Apply increasing increments of normal load to the specimen. Determine the short term equivalent load which shall be the load which when applied for a period of 20±5 minutes produces a specimen thickness equal (within an accuracy of ±0.05 mm) to the long term thickness of the specimen obtained at (v) above. Repeat the test on the other two specimens.

(vii) The report shall include:

(a) a reference to this method;

(b) sample identification details;

(c) the initial thickness of the sample;

(d) the applied load;

(e) the thickness of each sample at 100 and 1000 hours and the mean of the three results;

(f) a plot of percentage reduction in thickness against logarithmic time;

(g) the mean long term thickness;

(h) the mean short term equivalent load;

(i) any deviations from the specified test procedure.

Determining In-plane Flow Under Compressive Loading

15 In-plane flow shall be determined in accordance with BS 6906 : Part 7 except that the following conditions shall apply:

(a) the applied normal stress shall be the greater f the value given in Table 5/7 for sub-Clause 15) or the mean short term equivalent stress as determined in sub-Clause 14 (vi) of this Clause;

(b) the sample shall be tested such that the measured flow (or flows) is in the same direction as the principal flow (or flows) when the fin drain is in service;

(c) the foam rubber option of the test procedure shall be used (details of the foam rubber to be used may be obtained from the Overseeing Organisation);

(d) the hydraulic transmissivity shall be reported for each of the hydraulic gradients employed.

Test Methods

16 Notwithstanding the requirements of sub-Clauses 13, 14 and 15 of this Clause, variations in the test methods specified therein shall be made where deemed necessary by the ADT following consultation with the manufacturer. All such variations shall be recorded in the report.

Certification

17 Fin drains and constituent materials shall have a current British Board of Agrement Roads and Bridges Certificate (or equivalent) certifying the appropriate

physical properties when tested in accordance with this Clause.

515 Narrow Filter Drains General

1 Narrow filter drains shall comply with this Clause and the special requirements described in Appendix 5/4. The term narrow filter drain refers to drain Types 8 or 9 indicated in the HCD Drawing Number F18. They consist of a porous or perforated pipe laid in a narrow trench surrounded by granular material where the granular material and/or the pipe is enclosed by a layer of geotextile filter. Narrow filter drains and fin drains perform the same function.

Materials 2

The geotextile materials used in the drain shall be stored so that they are protected from the deleterious effects of short term exposure to ultraviolet light, and shall be resistant to degradation by acids, alkalis, common chemicals, bacteria, fungi and moulds occurring in soils and road construction materials. After exposure to ultraviolet light the Overseeing Organisation may require evidence that the materials still comply with the requirements of this Clause. They shall be protected from damage and ultraviolet light and be labelled to identify the grade and manufacturer or supplier.

3 The geotextile used in narrow filter drains shall comply with all requirements of sub-Clause 514.4 for geotextiles used in fin drains.

For drain Type 8 the geotextile surround to the pipe shall consist of a prefabricated continuous close fitting sock. Alternatively the pipe shall be firmly wrapped in a single layer of geotextile with an overlap of between 50 and 75 mm and secured around the pipe in a manner so as to prevent the ingress of soil particles or other extraneous material and without affecting the permeability of the wrapped material. Splices between lengths of sock or layer shall have overlaps within these dimensions and be securely tied. For drain Type 9 the geotextile surround to the granular material shall have a minimum overlap of 250 mm including 100 mm down-tuck. Splicing of lengths of geotextile shall consist of minimum 600 mm overlap secured with pins or mechanical ties. Where an outlet pipe passes through the geotextile a separate piece of geotextile shall be wrapped round the outlet pipe, flared against the geotextile in the filter drain and secured. Where drain lengths are terminated at chambers, the geotextile shall be secured against the chamber walls by suitable means so as to prevent the ingress of soil particles or other extraneous material into the drain.

4 Pipes and fittings shall comply with sub-Clauses 514.7 and 514.8. Where coilable pipes to BS 4962 : 1989 are used they shall be capable of being straightened so as to lie flat without restraint in the trench bottom before backfilling.

5 The granular material used for trench infill shall comply with the requirements for non-plasticity, 10% fines value and sulfate content of sub-Clause 505.3 and have a grading within the limits of Table 5/8. The material when tested in accordance with sub-Clause 509.8 shall meet the permeability requirements described in Appendix 5/4.

TABLE 5/8: Narrow Filter Drain: Trench Infill Grading Requirements

HCD Drain Type	8	9
Maximum Particle Size mm	37.5	37.5
D5 Size mm	>0.15	>0.15
D15 Size mm	As stated in appendix 5/4	-
D85 Size mm	-	> Hole Diameter or 1.2 times Width of Slot in Pipe
Uniformity Coefficient (C_u)D60/D10	5 to 12	5 to 12 or if C_u<5 D5> 1.18mm

Dn = Sieve size passing n% by weight of material

Dimensions

6 Unless otherwise described in Appendix 5/4 the dimensions of the narrow filter drain shall be as shown on HCD Drawing No. F18. The pipe diameter shall be as stated in Appendix 5/4. The drain slope angle (x), as shown on Drawing F20, shall be not greater than 15% from the vertical unless otherwise stated in Appendix 5/4.

Installation and Handling

7 Narrow filter drains shall be installed as shown on HCD Drawing Number F20. Before during and after installation the geotextile shall be protected from contamination, damage and exposure to ultraviolet radiation in accordance with sub-Clause 514.11.

The excavated trench bottom shall be free of irregularities and to the required levels given in Appendix 5/4. Rock and other hard protuberances shall be removed and any excess cut in the trench bottom filled and compacted back to the required grade with suitable excavated or imported material. Drain Type 9 shall have trench walls sufficiently clean to enable the geotextile to come into close contact with the wall when the granular material is placed inside it. The deposition and compaction of infill shall be in accordance with sub-Clause 505.4 for filter drains.

Narrow filter drains installed as part of the Permanent Works shall not be used for the disposal of surface water run-off during construction. Narrow filter drains exposed to surface water ingress shall be temporarily protecter. Marker tapes shall conform and be installed in accordance with sub-Clause 514.11.

8 The Contractor shall obtain and make available the information required in sub-Clause 514.12 in respect of the geotextile and pipe.

Certification

9 The geotextile shall have a current British Board of Agrement Roads and Bridges Certificate (or equivalent) certifying the appropriate physical properties when tested in accordance with this Clause.

516 Combined Drainage and Kerb Systems

1 The Contractor shall design the combined drainage and kerb systems listed in Appendix 1/11 in accordance with the design requirements given in Appendix 5/5.

Where in Appendix 5/5 the strength requirements of the system are described as Class D or Class C, the system shall comply with the requirements of sub-Clause 517.20 except that:

(i) the load testing procedure described in sub- Clause 517.20 ii) shall be carried out using the test blocks as detailed in Table 1 of Appendix 5/5; and

(ii) precast systems shall be considered acceptable when the crack width described in sub-Clause 517.20 (iii) is less than 0.2 mm.

2 Combined drainage and kerb systems shall permit lateral entry of surface water either continuously or at intervals not exceeding 1 m.

3 When used adjacent to porous asphalt surfacing materials, units shall incorporate side entry inlets to permit drainage of water held within the proous asphalt. Inlets shall comply with the requirements of Appendix 5/5 and shall have the capacity to drain porous asphalt.

4 Combined drainage and kerb systems shall be suitable for their intended application in the Works. The Contractor shall provide evidence of such suitability for the purpose to the Overseeing Organisation.

5 Proprietary systems shall be laid and jointed in accordance with the manufacturer's written instructions.

6 Adjacent carriageway, footway, verge or central reserve construction shall not take place within 3 days of any bedding, backing, surrounding or jointing of combined drainage and kerb units.

7 Joints between units and between the channel and units, shall be designed to avoid leakage of surface water. Joints between bridge deck waterproofing and component parts passing through the waterproofing shall be watertight. Sealants shall be compatible with the waterproofing system.

8 The system shall be cleaned out by low pressure high volume flushing or other appropriate means on completion of the Works. The system shall be left clean and free from all obstruction.

517 Linear Drainage Channel Systems General

1 The linear drainage channel systems listed in Appendix 1/11 shall be treated as structural elements and other features to be designed by the Contractor. The linear drainage channel systems shall be designed in accordance with this Clause and with the design requirements in Appendix 5/6. Each linear drainage channel system shall be deemed to include all the linear drainage channel in a single continuous run, together with its associated outlet(s) through which it drains, and with all associated surrounding bedding, haunching and other material. In cases where a single run of linear drainage channel drains from a crown or crowns in opposite directions to two or more separate outlets, that shall be deemed to be a single linear drainage channel system.

2 A linear drainage channel shall comprise a longitudinal sub-surface closed profile hydraulic conduit into which surface water is drained via longitudinal or angled slots situated above the conduit. Construction shall be in either manufactured units or in situ concrete. Channels shall be Class D or Class C within this Clause.

3 Design flows given in Appendix 5/6 shall be accommodated without surcharge within the main channel section and beneath the underside of any inlet slot sections.

4 Width and depth of channel units shall not exceed the dimensions given in Appendix 5/6.

5 Dimensions of inlet slots shall comply with the following criteria: The width of straight slots orientated along axes between 0° and 45°, also between 135° and 180° to the direction of traffic flow shall be between 10 mm and 32 mm. Slots within these orientations which are less than 18 mm in width shall not be restricted as to their length, but slots greater than 18 mm in width shall not exceed 170 mm in length.

Straight slots orientated along axes between 45° and 135° to the direction of traffic flow shall be between 10 mm and 42 mm in width and shall not be restricted as to their length. Slots in other shapes, eg curved slots, shall be designed such that a 170 mm x 170 mm x 20 mm gauge is unable to enter the slot. A tolerance of ± 0.5 mm shall apply to the gauge dimensions.

These slots shall also have adequate hydraulic capacity in accordance with sub-Clause 17 of this Clause.

6 Linear drainage channel systems shall be set flush with contiguous surfaces falling towards the systems and shall permit entry of surface water from such surfaces. Notwithstanding other tolerances in the Specification, the finished level of the units comprising the system shall not be higher nor more than 10 mm lower than the finished level of the adjacent carriageway.

7 When used adjacent to porous asphalt surfacing materials, units shall also incorporate side entry inlets to permit drainage of water held within the porous asphalt. Inlets shall comply with the requirements of Appendix 5/6 and shall have the capacity to drain porous asphalt.

8 Joints between units comprising the system and between adjacent construction and the system shall be designed to avoid leakage of surface water. Joints between bridge deck waterproofing and component parts passing through the waterproofing shall be watertight. Sealants shall also be compatible with the waterproofing system.

9 Junctions, connecting pipes and other fittings comprising the linear drainage channel system shall comply with sub-Clause 501.3 and shall be as described in Appendix 5/6. The linear drainage channel shall incorporate measures to enable rodding of the outfall pipework and adequate access for flushing by water jetting equipment into the system.

10 The system shall be cleaned out in accordance with sub-Clause 516.7.

Manufactured Systems

11 Manufactured systems shall be comprised of either one-piece preformed channel units with a closed profile incorporating a continuous or intermittent longitudinal inlet slot on the top, or alternatively of units with integral or non-integral grating systems. An integral grating system is a system in which the grating is either:

(a) cast or preformed as part of the channel; or

(b) chemically bonded to the channel base unit by the manufacturer.

A non-integral grating system is one which requires the connection of gratings to channel base units to be made by bolts or other suitable means.

The Contractor shall provide attested and documented evidence to demonstrate the integrity of fixity of all grating systems both for manufactured and in-service conditions.

Non-integral grating systems shall be acceptable with Class C channel systems only and shall not be acceptable with Class D channel systems.

Joints shall be designed to avoid leakage of water, with a smooth transition and with no constriction of the cross-section.

Systems shall be laid, jointed, bedded and haunched in concrete in accordance with the manufacturer's written instructions.

Adjacent carriageway, footway, verge or central reserve construction shall not take place within 3 days of any bedding, backing, surrounding or jointing of linear drainage units.

In Situ Systems

12 In situ systems shall comply with the requirements of sub-Clauses 1103.1, 1103.3 and 1103.4. They shall also comply with the requirements of sub-Clause 1103.2 except that concrete for in situ systems shall be considered as plain concrete within the terms of this sub-Clause, irrespective of the inclusion of reinforcement.

13 In situ systems shall be slip formed except for sections at gullies which shall be hand formed. Full depth joints shall be constructed at the interface at each side of gullies with a 25 mm thick filler board complying with Clause 1015 and sealed in accordance with Clauses 1016 and 1017.

14 The central void may be formed by an inflated tube which is then removed, or by an in situ suitable pipe or similar former fit for the purpose. At gully positions the inner former should be pre-sleeved with a suitable pipe or similar former fit for the purpose which shall be of sufficient length to overlap the two joints on either side of the gully.

15 The central void shall be checked in accordance with sub-Clause 509.4. Verification of slot widths shall be determined by suitable templates.

16 Reinforcement shall comply with Series 1700. Cover to reinforcement shall be not less than 75 mm.

Hydraulic Capacity

17 The following hydraulic design criteria shall apply:

(i) The top slots required in sub-Clause 5 of this Clause shall be capable of taking 100% of the design run-off over the relevant area.

(ii) In cases where side-entry inlets are required under sub-Clause 7 of this Clause, these shall comply with requirements of Appendix 5/6. The top slots shall also separately comply with the requirements of sub-Clause 17 (i) above.

(iii) Flows from the systems shall be discharged into the chambers as shown on the Drawings. The Contractor shall provide full details of proposed connection pipes and fittings to discharge flows from the systems into the chambers.

(iv) The Contractor shall provide calculations to demonstrate the adequacy of his design and these shall include the following information:

(a) flow calculations;

(b) hydraulic cross sections of the units;

(c) roughness coefficient of the units;

(d) design flows and in-bore flow capacities of the system at each outfall position;

(e) capacities of the outfall connections from the system at each outfall position.

Dimensions

18 The tolerance on the cross section dimensions shall be within 2% of the required profile dimension but slot widths shall be within the limits specified in sub-Clause 5 of this Clause. Internal dimensions of the waterway channel section shall not be less than 100 mm, measured in any direction.

Channels may be of constant depth, or constructed with an in-built gradient to the channel which, if incorporated, shall be at not less than 0.5%. The depth shall not exceed the maximum depth, if any, specified in Appendix 5/6.

A system may comprise channels of different constant depths, but all invert steps in such systems shall be accommodated by purpose built transition channels or fittings to provide a smooth continuity of invert.

Materials

19 Channel units shall be manufactured from any of the following materials:

(i) reinforced or unreinforced concrete;

(ii) synthetic resin concrete;

(iii) fibre concrete;

(iv) flake graphite cast iron;

(v) spheroidal graphite cast iron;

(vi) stainless steel.

All materials used shall be suitable for their intended application in the systems, in particular being resistant to surface water, de-icing agents, and the effects of weather, abrasion and absorption. The Contractor shall provide evidence of suitability for such purposes to the Overseeing Organisation. Materials shall comply with relevant standards.

For any materials not covered by relevant standards the requirements of this Clause shall be met and the Contractor shall submit to the Overseeing Organisation proposals for the establishment of any other relevant requirements and testing procedures.

Strength Requirements and Testing

20 Strength requirements and testing shall be as follows:

(i) Channel units Class D and Class C in their in-service condition shall be capable of withstanding a full test load of 400 kN and 250 kN respectively. Gratings and covers for channel units with clear internal waterway conduit widths greater than or equal to 250 mm shall be capable of withstanding the same full test load as the channel unit for their respective Class. Gratings and covers for channel units with clear internal waterway conduit widths of less than 250 mm shall be capable of withstanding a test load (kN) equal to:

(full test load applicable to the Class) x clear internal waterway conduit width (mm) 250 but not less than 0.6 x full test load.

(ii) The load testing procedure shall be carried out in accordance with this sub-Clause using test blocks as detailed in Table 1 of Appendix 5/6 capable of uniformly distributing the test load over the whole surface of the test block.

(iii) Test pieces, whether manufactured or in situ construction, shall be not less than 500 mm and shall be bedded and secured against lateral displacement in a manner that reflects the in-service requirements and manufacturer's installation instructions, where applicable. For non-integral grating systems, gratings or covers shall be fitted to the units before testing. They shall be placed on the table of a suitable testing rig with the test load being applied vertically to the geometrical centre of the test piece centrally via a test block as detailed. Allowance may be made for surface irregularities by interposing a layer of soft wood, fibre board, felt, rubber or similar between the applied road and the test piece.

The load shall be steadily increased at a rate of 2 ± 1 kN/s until the test load specified has been achieved. The load shall then be released.

To be considered acceptable the test piece shall show no visible cracks or flaking likely to impair its serviceability except that in the case of steel reinforced concrete or fibre concrete units cracking up to a width not exceeding 0.2 mm at 67% of the test load is acceptable.

(iv) The test machine shall be capable of applying a load at least 25% greater than the specified test loads. The dimensions of the bed of the test machine shall be greater than the bearing area of the piece to be tested.

(v) For manufactured units the manufacturer shall establish suitable strength tests as part of his quality control procedures. Details of quality control procedures shall be supplied to the Overseeing Organisation.

(vi) Trial lengths and testing of in situ channels shall be undertaken in accordance with BS 5931 : 1980, Sections 6 and 8.6.

(vii) The Contractor shall provide test certificates verifying compliance with this Clause in accordance with the requirements of Appendix 1/5.

518 Thermoplastics Structured Wall Pipes and Fittings

General

1 Thermoplastics structured wall pipe shall comply with this Clause and the special requirements described in Appendix 5/1.

The term structured wall pipe shall mean all types of smooth bore pipe except solid wall homogeneous pipe. Typical forms of construction classified as structured wall pipes include: single wall externally structured smooth bore, twin wall, foamed core and spirally wound.

The term fitting shall mean a product used in conjunction with the pipe to form the system but excluding gullies manhole chambers, inspection chambers and access chambers.

Materials

2 The materials from which the pipe and fittings are made, shall be treated so that they are protected from the deleterious effects of short term exposure to ultraviolet light, and shall be resistant to degradation by acids, alkalis, common chemicals, bacteria, fungi and moulds occurring in soil, road construction materials and road drainage systems. In addition, the materials from which the pipe and fittings are made, shall not incorporate any additives in quantities sufficient to cause microbiological degradation or to impair the conformity to the chemical, physical and mechanical properties or impact resistance requirements given in sub-Clause 5 of this Clause. The specification of the raw material shall be agreed between the certification body, as defined in sub-Clause 15 of this Clause, and the manufacturer and may incorporate re-processable and/or recyclable material. The agreed specification shall incorporate tolerances for each of the relevant characteristics defined in the appropriate clause of pr EN 13476. The Contractor shall submit to the Overseeing Organisation, prior to commencement of the Works, completed information sheets in accordance with Appendix 5/7.

Dimensions

3 Systems for carrier drainage shall be between 150 mm and 900 mm nominal internal diameter. Pipes for narrow filter drains shall be 110 mm or 150 mm nominal internal diameter. Pipes for service ducts shall have nominal internal diameters of between 50 mm and 150 mm. Pipes for sub-soil drainage shall incorporate slots or holes with a minimum cross sectional area of 1000 mm2 per metre run of pipe.

The bore of the pipe and fittings shall be in accordance with the standard tolerances for nominal bores given in BS EN 476.

Appearance

4 The system shall have a smooth bore and be free from any burs, flash or other inconsistencies that could have a detrimental effect on the performance of the system. Pipes and fittings for drainage should be externally coloured either terracotta or black. The colour of ducting pipes should be in accordance with requests of ADT. Any variation in the colour shall be described in Appendix 5/2.

Structured Wall Pipe

5 The structured wall pipe shall have the properties defined in Table 5/9.

TABLE 5/9: Requirements for Structured Wall Pipe

Property	Redevant Standard	Requirements
General	PEN ISO 3126 and ISO 11922	Dimensions to be specified
Ring Stiffness	EN 9969	6kN/m² minimum. Lower stiffness values are permitted if design calculations to BS EN 1295 (UK National annex), base on site specific installations conditions, indicate satisfactory performance.)
Creep Ratio	EN 9967	PVC-U – maximum 2.5 PP and PE – maximum 4.0
High volume low pressure flushing	WRc Jetting Test Method	Minimum acceptable failure pressure 137 bar.
Longitudinal bending	Sub-Clause 518.11	Pipes with nominal diameters ≤ 350mm to have a difference in dimensions when measured in the vertical axis of less than 5% of the pipe length and no local permanent deformation occurs during the test.
Impact resistance at 0 °C	EN 1411 with d25 striker of 1 Kg	Prelimimary test – test 10 pieces as describe33 in EN 1411, dropping the striker from a height of 1m If any test pieces fail, subject the pipe to the full test given in clause 7.3 of EN 1411 stating the striker from a drop height of 400mm. This mean minus 1.64 times the standard deviation must exceed 1m.
Impact Resistance at 23 °C	EN 1411 with strike as above	Value to be derived from the same batch of pipe as used in the impact rese test at O °C. The H50 (mean) value – 10% to be used as the minimum value for quality control testing. Alternatively the U °C test can be used as a QC test if the manufacturer chooses.
Rodding Resistance	Sub-Clause 518.12	Pipes with nominal diameters ≤350mm to have an average failure energy >3 joules
Static friction coefficient (ducts)	TS 12-24	Pass
Creep at elevated temperatures (ducts)	EN 9967	Test to be carried out at 45 °C, creep ratio to be less than 2 times the values to EN 9967
Resistance to point loads (ducts)	Sub-Clause 518.13	No perforation at 10% rod travel
Tensile strength of a seam	EN 1979	prEN 13476

Fittings

6 The fittings for use with structured wall pipe shall have the properties defined in Table 5/10.

Table 5/10: Requirements for Fittings

Property	Relevated Standard	Requirement
General	PrEN ISO 3126 and ISO 11922	Dimensions to be specified
Ring stiffness (excluding couplers)	ISO 13967	6 kN/m² minimum
Rodding resistance	Sub-Clause 518.12	Fittings with nominal dimensions ≤350mm to have an average failure energy >3 joules
Strength and flexibility of fabricated fittings	EN 12256	En 12256
Impact Resistance (drop test)	Drop Test to BS EN 12061: 1999	Fall height 1000mm at a temperature of O °C. Product less than ND 300 shall show 'no danage'. Other may fail but must be identified as 'handle with care'
Water tightness of fabricated fittings	EN 1053	0.5 bar for 1 minute

Pipe and Fittings

7 The pipe and fittings shall have the properties defined in Table 5/11.

TABLE 5/11 Requirements of the Systems

Property	Relevant Standard	Requirements
Leaktightness of joints – diameter distortion (watertight joints)	**BS EN 1277 Method 4 Condition B Temperatue** (23 ± 2)°C	**Use default values fom BS EN 1277**
Leaktightness of joints –angular deflection (watertight joints)	**BS EN 1277 Method 4 Condition C Temperature** (23 ± 2)°C	**Use default values from BS EN 1277**
Leakage rate from patially watertight joints	**EN 1437 adapted to suit HA loading conditions**	**Less than 20 times the square of the ID of the pipe in metres shall flow through the joint in litres per minute**
Resistance to wheel load		**Less than 5% deformation when loaded to 100kN (for unequal branches only**

Bedding, Backfill and Surround Material

8 All systems shall be installed in accordance with the pipe and bedding combinations given in Advice Note HA 40. Other combinations shall be supported by calculations in accordance with BS EN 1295-1 UK National Annex. Bedding, backfill and surround materials are classified in Clause 503 and Clause 505.

Installation and Handling

9 The bedding, surround and backfill shall be installed so as to cause no damage to the pipes and fittings. Installation of the pipe and fittings, particularly, procedures for preparation and execution of jointing operations, shall be in accordance with the manufacturer's instructions.

Identification

10 The Contractor shall maintain records with the following information for each separate consignment of structured wall pipe or fittings delivered to Site:

(i) system name, ring stiffness grade/number and size;

(ii) name and address of the system manufacturer;

(iii) consignment number and delivery date; and

(iv) a copy of the site delivery note.

Test Method for Longitudinal Bending

11 (i) The test specimen shall be a six metre length of pipe or the maximum length available from the manufacturer (if less than six metres).

(ii) The apparatus shall include:

(a) two level support blocks at least 250 mm wide and of sufficient height to allow the pipe to sag over its length without touching the ground;

(b) a means of measuring the vertical distance between the pipe at the center of the span and a fixed point of reference to an accuracy of ±0.5 mm.

(iii) The test procedure shall be as follows:

(a) condition the specimen for at least 1 hour at 23°C ± 2°C;

(b) set the supports at a distance apart equal to the length of pipe minus 500 mm;

(c) place the pipe symmetrically on the supports;

(d) measure the distance between the top of the supports and the fixed point of reference, in the vertical axis through the centre line of the pipe;

(e) after a period of two minutes measure the distance between the underside of the pipe at mid span and the fixed point of reference;

(f) record the difference in readings as a percentage of pipe length.

Test Method for Rodding Resistance (Internal Puncture)

12 (i) The test specimens shall be:

(a) twenty specimens cut from the structured wall pipe, each specimen to be 242 mm to 246 mm in length and a quarter section of the circumference or;

(b) twenty specimens cut from a number of identical fittings.

(ii) The apparatus shall include:

(a) a standard drop weight pipe testing apparatus capable of dropping a tup from a height of 1 m;

(b) a 300g tup which can be varied in 30g multiples with a striker consisting a steel rod 18 mm in diameter with a 9 mm hemispherical end;

(c) a 250 mm x 250 mm box containing dry Leighton Buzzard sand (Garside quarry) such that there is at least 100 mm of sand beneath the test specimen when bedded down.

(iii) Procedure shall be as follows:

(a) mark the intended point on the inside of the pipe on the intersection of the center lines. With profiled pipes the point of impact shall be at the point nearest the intersection that mid way between the ribs or in the middle of a hollow corrugation;

(b) alternatively mark the intended point of impact on the section of fitting;

(c) condition the test specimens in air at a temperature of 4°C ± 2°C for a period of at least one hour before the test;

(d) locate the box under the drop tube of the impact apparatus;

(e) embed the specimen into the sand using a vibrator with the inner surface exposed and facing upwards;

(f) locate the specimen such that the marked point of impact is under the centre line of the tup;

(g) drop the tup from a height of 1 m on to the inner surface of the specimen within 10 seconds of removing the specimen from the conditioning environment;

(h) examine the specimen for damage. Damage is defined as a puncture or crack of the inner layer. Ductile bending or "whitening" is not considered to be damage;

(i) if the specimen exhibits no damage the next test should be conducted with a tup of 30 g greater mass. If the specimen does exhibit damage the next test should
be conducted using a tup of 30 g smaller mass;

(j) after having completed the 20 strikes calculate the average of the energies where a pass (no damage) was recorded and the average of the energies where a failure (damage) was recorded,

then calculate the average of the two averages.

(iv) The test report shall include:

(a) identification of the samples;

(b) the overall average;

(c) whether or not the specimens were damaged.

Test Method for Resistance to Sharp Objects

13 (i) Test specimens shall be three samples of duct each 300 mm long.

(ii) The apparatus shall include:

(a) a compression testing machine;

(b) a 4.7 mm diameter steel rod with an hemispherical end;

(c) and a 120° steel vee block at least 300 mm long.

(iii) The test method shall be as follows:

(a) condition the test specimens for at least 1 hour at 23°C ± 2°C;

(b) insert the steel rod in the jaws of the moveable platen of the compression testing machine so that the hemispherical end protrudes at least 15% of the nominal pipe diameter;

(c) position the specimen in the vee block and placed directly below the steel rod, for twin-walled pipe the specimen shall be positioned firstly so that the rod strikes on the corrugation or rib, and secondly in the valley (where possible);

(d) set the machine to lower at a rate of 5 mm/min;

(e) allow the rod to travel into the pipe a distance equal to 10% of the nominal internal diameter of the pipe (T10 mm) or until the pipe wall is perforated. When the outer skin of a twin wall pipe is perforated before 10% is attained, the rod travel up to the point of failure shall be recorded (Tf mm) and the rod allowed to travel to the inner wall. The rod travel shall be continued to a total of 10% (ie T10 - Tf) or until complete penetration occurs.

(iv) For each test specimen: pipe size, reference, maximum load and rod travel shall be recorded.

14 Notwithstanding the requirements of sub-Clauses 11, 12 and 13 of this Clause, variations in the test methods specified therein shall be made where deemed necessary by the British Board of Agrement Roads and Bridges Certificate (or equivalent) following consultation with the manufacturer and in agreement with the Overseeing Organisation. All such variations shall be recorded in the report.

Certification

15 Pipes and fittings shall have a current British Board of Agrément Roads and Bridges Certificate (or equivalent) certifying the appropriate physical properties when tested in accordance with this Clause.

519 Concrete Bagwork

1 Concrete mix ST4 shall be used throughout. The concrete filling to the bags shall have a low workability with a slump of 25 mm.

2 The bags shall be hessian sand bags complying with BS 1214. The size of the bags shall be such that when filled, the dimensions shall be 450 mm x 300 mm x 150 mm. The bags shall be placed in position and shaped to the profile shown on the Drawings by striking
with a flat timber board until all faces are flat and all edges square.

3 The finished exposed faces of the bagwork shall not be punctured or torn and no tucked ends shall be visible.

4 Each concrete bag is to be spiked to the one below and the bottom row spiked to the foundation with 10 mm x 200 mm mild steel dowel bars. Where the concrete bags have a concrete backing, alternate rows of bags shall be spiked to the backing concrete with
10 mm x 200 mm mild steel dowel bars at 45 degrees to the horizontal with one dowel per bag in the row.

5 Where bagwork forms a headwall, headwall foundations are to be cast against the excavated face and any overdig filled with concrete mix ST4.

6 Formed concrete surfaces shall be to Class F1 finish and unformed surfaces to Class U1 finish in accordance with Clause 1708.

7 Where bagwork is provided to protect watercourses, before placing the bags, the banks shall be cut into horizontal steps to provide a suitable foundation and shall be covered in geotextile to the requirements of Clause 609. The bottom course of bags shall be at least 450 mm below the stream bed and all succeeding courses shall be horizontal and all vertical joints shall be staggered in alternate courses. Headers shall be placed at every third bag in alternate courses.

8 The bagwork shall be thoroughly soaked with water upon completion of the construction to saturate the hessian bags.

520 The Cleaning of Existing Drainage Systems

1 Where stated in Appendix 5/1, the Contractor shall clean existing drainage systems in accordance with this Clause.

2 The Contractor shall take measures when clearing blocked drains to ensure that adjacent water courses or groundwater via soakaways, will not be contaminated.
Contamination includes mud or soil being washed or flushed into streams as well as other more obvious contaminants including diesel fuel, oil and chemicals.

3 Initial attempts to clear blocked drains prior to flushing, should be undertaken by hand rodding and any debris and silt removed by the operation shall be removed off Site. The Contractor shall report any localised blockages that cannot be cleared by rodding to the Overseeing Organisation.

4 Where flushing is required in Appendix 5/1 the following procedures should be followed:

(i) Flushing shall take place from downstream of the blockage in an upstream direction. The pipe shall be plugged below the flushing point to prevent contaminants flowing to the watercourse. The flushing shall take

place from a chamber, although it may be necessary to make a temporary excavation into the pipeline in some circumstances.

(ii) If the Contractor finds it is not possible to flush in an upstream direction, the pipe shall be plugged below the blockage and the jetter then used to "back flush" to a suction pipe.

Cleaning of Gullies, Catchpits, Soakaways and Oil Separators

5 At each chamber all mud and vegetation in the vicinity of the chamber likely to impede the flow of water shall be removed. After lifting the cover or grating the chamber shall be cleansed of all water, detritus, debris and silt, refilled with clean water to the outlet level, and all covers and gratings replaced and evenly bedded.

6 Cleaning of chambers shall be by mechanical means. The vehicle used to clean existing chambers shall be equipped with a 125 mm dia gulley arm with boom jets, an exhauster with a minimum output of 5.95 cum/min and minimum 5455 litres capacity. Sediment, detritus and liquor from the chamber shall not be permitted to discharge into the outlet. This may be achieved either by plugging the outlet during cleaning, or by simultaneous flushing and abstraction of liquor from the chamber using a tanker fitted with low
pressure high volume water jets around the boom. Surplus water and detritus shall be removed off Site.

7 Gullies and chambers not cleaned for whatever reason, blocked connections and broken or cracked covers, gratings or frames shall be marked to aid subsequent identification.

8 Oil separators shall be refilled with uncontaminated water following the cleaning operation.

9 The Contractor shall dispose of all surplus water, debris and arisings from the works off Site.

Cleaning or Testing of Piped Drainage Systems and Subway Drainage Channels

10 Routine cleaning or testing of piped drainage systems and subway drainage channels shall be carried out by rodding or low pressure high volume flushing.

11 The location of any obstruction that cannot be removed by flushing shall be marked on the ground using a wooden peg or other semi-permanent means and reported to the Overseeing Organisation.

12 All covers which have been removed for cleaning operations shall be replaced and evenly bedded.

13 The Contractor shall report any damage and defects to the drainage system or components to the Overseeing Organisation each day, or immediately if considered a safety hazard.

Cleaning Kerb or Channel Offlet Pipes

14 Where necessary all vegetation and debris shall be removed from around metal kerb weirs and the cover lifted for cleaning.

15 Offlets shall be cleaned such that all silt and loose obstructions are removed from the pipe. This shall be achieved by rodding or by using lorry-mounted drain clearance equipment comprising combination pressure jetting with high air flow suction equipment. The vehicle shall also be equipped with a hydraulically powered grid lifter.

16 The Contractor shall ensure that each end of the offlet is free from vegetation or other obstructions including any material expelled from the pipe. Where the invert of the outlet is below the invert of the ditch, the bottom of the ditch shall be excavated until the invert of the pipe is exposed and the ditch invert regraded to facilitate flow from the outlet.

17 The location of any obstruction that cannot be removed shall be marked on the ground using a wooden peg or other semi-permanent means and reported to the Overseeing Organisation.

18 All covers lifted for cleaning operations shall be replaced and evenly bedded.

Cleaning of Bridge Drainage Systems

19 Cleaning of bridge bearing shelves, subway sumps, grit chambers and other bridge drainage systems shall be carried out by one of the following methods:

(i) vacuum/air suction having the ability to remove materials from depths of up to 9.0 m with a suction facility capable of displacing 55 m^3/min of air at 95% vacuum;
(ii) low pressure high volume flushing;

(iii) sweeping.

20 All adjacent surfaces of the structure shall be protected to prevent staining by arisings from the cleaning operation. All arisings shall be taken off Site.

21 The Contractor shall report to the Overseeing Organisation any damage or defects to the bridge drainage system.

SERIES 600
EARTHWORKS

Contents

EARTHWORKS

601 Classification, Definitions and Uses of Earthworks Materials

General Classification

1 Earthworks materials shall fall into one or other of the following general classifications:

(i) Acceptable material: material excavated from within the Site or imported on to the Site which meets the requirements of Table 6/1 and Appendix 6/1 for acceptability for use in the Permanent Works;

(ii) Unacceptable material Class U1 as defined in sub-Clause 2 of this Clause: material excavated from within the Site which, unless processed so that it meets the requirements of Table 6/1 and Appendix 6/1, shall not be used in the Permanent Works;

(iii) Unacceptable material Class U2 as defined in sub-Clause 3 of this Clause: material excavated from within the Site, which shall not be used in the Permanent Works.

2 Unacceptable material Class U1 shall be:

(i) material which does not comply with the permitted constituents and material properties of Table 6/1 and Appendix 6/1 for acceptable material;

(ii) material, or constituents of materials, composed of the following unless otherwise described in Appendix 6/1:

a) material similar to:

b) logs, stumps and perishable material;

c) materials in a frozen condition;

d) clay having a liquid limit determined in accordance with BS 1377 : Part 2, exceeding 80 or plasticity index determined in accordance with BS 1377 : Part 2, exceeding 55;

e) material susceptible to spontaneous combustion

f) non-hazardous materials other than those permitted in Table 6/1 and Appendix 6/1.

3 Unacceptable material Class U2 shall be:

(i) material having hazardous chemical or physical properties requiring special measures for its excavation, handling, storing, transportation, deposition and disposal.

4 Where required in Appendix 6/1 unacceptable material shall be processed by mechanical, chemical or other means to render the material acceptable for use in the Permanent Works in accordance with the requirements of Table 6/1 and Appendix 6/1.

Definitions

5 Chalk shall mean:

(ii) Any porous material of natural origin composed essentially of calcium carbonate and identified as chalk on the maps produced by the Maltese Geological Survey;

(iii) Material designated as Class 3 in Appendix 6/1.

6 Argillaceous rock shall mean shale mudstones siltstones slates and micaceous schists composed of particles of clay and silt and mica.

7 Formation shall be the top surface of capping. Where no capping is required formation shall be the surface of the subgrade or embankment directly below the pavement, unless otherwise shown on the Drawings.

8 Sub-formation shall be the top surface of earthworks at the underside of capping.

9 Stabilization shall mean the spreading of cement or lime or both on a layer of deposited or intact granular or cohesive material, and the subsequent process of pulverizing and mixing followed by appropriate compaction to form the whole or a constituent layer of a capping. In Malta the term cement stabilization is used for cement bound material, which is a constituent layer of the pavement.

10 Where 'recycled aggregate' is used in this Series, the material shall be aggregate resulting from the processing of material used in a construction process. The aggregate shall have been tested in accordance with Clause 710, and the content of all foreign materials (including wood, plastic and metal) shall not exceed 1% by mass. Where 'recycled aggregate except recycled asphalt' is used in this Series, the aggregate shall have been tested in accordance with Clause 710 and shall not contain any mineral aggregate with a bituminous binder, and the content of all foreign materials shall not exceed 1%.

Use of Fill Materials

11 In addition to any grading requirements the maximum particle size of any fill material shall be no more than two-thirds of the compacted layer thickness except that cobbles having an equivalent diameter of more than 150 mm shall not be deposited beneath verges or central reserves within 1.30 m of the finished surface.

12 Isolated boulders with a equivalent diameter less than 250mm may be incorporated in embankments not of rock fill provided the specified compaction requirements are met. These boulders shall not be placed less than 600mm below formation level of carriageways or hard-shoulders where there is no capping; or less than 600mm below sub formation where there is capping.

13 Materials with a water soluble sulfate content exceeding 0.25 grams of sulfate (expressed as SO_3) per liter when tested in accordance with BS 1377 : Part 3 shall not be deposited within 500 mm, or other distances described in Appendix 6/3, of metallic items forming part of the Permanent Works.

14 For recycled aggregate, the requirements for water soluble sulfate content shall be defined and tested in accordance with BS 812: Part 118, Clause 5.

602 General Requirements

1 The Contractor shall employ only plant and working methods which are suited to the materials to be handled and traversed. He shall be responsible for maintaining the nature of the acceptable material so that when it is placed and compacted it remains acceptable in accordance with the Contract. Acceptability shall be determined in accordance with Table 6/1 and any special requirements in Appendix 6/1.

2 Haulage of material to embankments or other areas of fill shall proceed only when sufficient spreading and compaction plant is operating at the place of deposition to ensure compliance with Clause 612.

3 No excavated acceptable material or unacceptable material required to be processed, other than surplus to the requirements of the Contract, shall be removed from the Site unless indicated otherwise in Appendix 6/1. Material, which is unacceptable only by reason of being frozen, shall be retained on Site when in that condition. Where the Contractor is permitted to remove acceptable material, or unacceptable material required to be processed, from the Site to suit his operational procedure, then he shall make good any consequent deficit of material arising therefrom.

4 If any acceptable material or unacceptable material required to be processed is, where permitted by Appendix 6/1, used by the Contractor for purposes other than for general fill, sufficient acceptable fill material to occupy, after full compaction, a volume corresponding to that which the excavated material occupied shall be provided by the Contractor.

5 Acceptable material (other than Class 5A or any Class 5B material replacing Class 5A material in accordance with sub-Clause 3 of this Clause) surplus to the total requirements of the Permanent Works and all unacceptable material Class U2 and Class U1 not required to be processed shall, unless indicated otherwise in Appendix 6/1, be run to spoil in tips provided by the Contractor. In the case of unacceptable material Class U2 the Contractor shall comply with any specific requirements for disposal described in Appendix 6/2.

6 Where the excavation reveals a combination of acceptable and unacceptable materials the Contractor shall, unless indicated otherwise in Appendix 6/3, carry out the excavation in such a manner that the acceptable materials are excavated separately for use in the Permanent Works without contamination by the unacceptable materials. Unless otherwise described in the Contract Classes of fill material required to be deposited separately shall be excavated separately without contamination by other Classes of material.

7 The Contractor shall make his own arrangements for stockpiling of acceptable material, and unacceptable material to be processed, and for the provision of sites for the purpose.

8 The Contractor shall ensure that he does not adversely affect the stability of excavations or fills by his methods of stockpiling materials, use of plant or sitting of temporary buildings or structures.

9 Existing topsoil material shall, except where it is to be left in place in the locations described in Appendix 6/8, be stripped to depths as described in Appendix 6/8 for Class 5A material from all areas of cutting and from all areas to be covered by embankment or by other areas of fill.

10 Topsoil shall wherever practicable be used immediately after its stripping and if not shall be stored in stockpiles of heights not exceeding 2 m or other heights stated in Appendix 6/8. Unless otherwise stated in Appendix 6/8, topsoil shall not be stockpiled for more than two years. Topsoil shall not be unnecessarily trafficked either before stripping or when in a stockpile. Stockpiles shall not be surcharged or otherwise loaded and multiple handling shall be kept to a minimum.

11 All Class 5A topsoil arising from the Site, or any Class 5B material replacing Class 5A material in accordance with sub-Clause 3 of this Clause, in excess of the requirements for topsoiling, shall be subject to the requirements described in Appendix 6/8.

12 Excavations for foundations and trenches in unstable subgrade shall be adequately supported at all times, and except where otherwise described in Appendix 6/3, shall not be battered. Where excavations are permitted to be battered they shall be benched as described in Appendix 6/3 prior to backfilling and compaction. The additional work and materials shall be provided by the Contractor. Sheeting and other excavation supports shall be removed as filling proceeds except where they are required in Appendix 6/3 to be left in position.

13 Excavations requiring backfilling shall remain open only for the minimum period necessary.

14 Excavations requiring backfilling in existing paved or other surfaces, including those paved areas to be reconstructed or repaired, shall be carried out and reinstated in compliance with Clause 706.

15 The Contractor shall keep earthworks free of water including:

(i) Arranging for the rapid removal of water:

  a. Shed on to the earthworks;

  b. Entering the earthworks from any source;

(ii) Lowering and maintaining by appropriate measures, the water level in excavations, sufficiently to enable the Permanent Works to be constructed.

16 In carrying out the requirements of sub-Clause 15 of this Clause the Contractor shall:

(i) form and maintain cuttings, embankments and other areas of fill with appropriate falls and gradient and sealed surfaces;

(ii) provide where necessary temporary watercourses, drains, pumping and the like;

(iii) discharge accumulated water and groundwater into the permanent

outfalls of the drainage system where practicable;

(iv) provide adequate means for trapping silt on temporary systems discharging into permanent drainage systems.

17 The Contractor shall carry out and maintain any groundwater lowering or other treatment required in Appendix 6/1.

18 Where materials are designated in the Contract as Class U2 hazardous material, the Contractor shall carry out any special requirements for their handling described in Appendix 6/2. Where hazardous materials are encountered during the progress of the Works, the Contractor shall make all necessary arrangements for their safe handling and disposal as Class U2 material after consultation with the Engineer and the appropriate statutory bodies

603 Forming of Cuttings and Cutting Slopes

1 Cuttings shall be excavated to the lines and levels described in Appendix 6/3.

2 Cutting slopes or toes of cuttings shall only be undercut when required in the Contract for trench or other excavations. Such excavations shall be restricted in extent as described in Appendix 6/3 and where they require backfilling shall remain open only for the minimum period necessary, so as to prevent risk to the Permanent Works.

3 Except where otherwise described in Appendix 6/3, the excavation of cuttings may be halted at any stage providing at least 300 mm of material as a weather protection is left in place above the formation or above the sub-formation, subject to the requirements of Clauses 613 and 616. Where directed by the Engineer for the purpose of improving the strength of the sub-grade, the Contractor shall install the permanent drainage as soon as practicable but in any event before the bulk excavation reaches a level 300mm above formation. The base of cuttings shall be kept well drained at all times. The contractor shall ensure that plant utilized in the earthworks operation does not in any way damage or alter the location or levels of drainage works already constructed.

(i) to achieve a natural appearance, when the stratum permits and when pre-split blasting is not adopted, have the face left irregular within tolerances as agreed with the Engineer; and

(ii) have boulders or other rock fragments that can be moved by hand without tools, removed; and

(iii) where required in Appendix 6/3 have material that can be blown away by airline hose, having pressures no greater than those stated therein, so removed; and

(iv) have adequate access to enable inspection to be carried out to determine the extent of work required by this sub-Clause.

6 Where required in Appendix 6/3, faces of cuttings which are not required to receive topsoil shall have one or more of the following measures carried out as

appropriated and as agreed with the Engineer:

(i) Isolated patches of soft, fragmented and insecure material shall each be excavated to a depth of at least 200 mm unless other depths are stated in Appendix 6/3 and replaced as soon as practicable with concrete mix (Series 2600) well rammed into the cleaned out void.

(ii) Areas of cutting face requiring their surface to be made stable shall be trimmed back by a nominal 50 mm or other amount required in Appendix 6/3 and the resulting surface together with an area of any surrounding intact material as detailed in Appendix 6/3, shall have a suitable cement based grout or sprayed concrete, applied by pressure to form a total nominal thickness of 40 mm unless the required thickness is stated in Appendix 6/3. Where required in Appendix 6/3, reinforcement shall be fixed to the surface before application of the concrete or grout. Weep holes using permanent formers shall be constructed to the requirements of Appendix 6/3 and at the locations described in Appendix 6/3 or as required by the Engineer.

(iii) Soft or insecure material, interlayered with rock shall be excavated to the depth behind the face described in Appendix 6/3. The resulting cavity shall be filled with concrete mix ST2 or with masonry infill complying with the Series 2400 and provided with weep holes all in accordance with requirements in Appendix 6/3.

(iv) Netting or other sheet covering as described in Appendix 6/3 or rock bolts as described in Appendix 6/10.

7 Where required in Appendix 6/3 or where required by the Engineer, faces of cuttings which are to receive topsoil shall have one or more of the following measures carried out as appropriates and as agreed with the Engineer:

(i) Be benched to retain topsoil as described in Appendix 6/3.

(ii) Be harrowed to a depth of 50 mm. Such harrowing shall be carried out immediately prior to topsoiling, diagonally, at an angle between 5º to 45º to the line of the toe, measured on the plane of the slope.

(iii) Isolated patches of soft, fragmented or insecure material shall be excavated and either:

(a) filled by well ramming in a Class of fill with similar characteristics as the surrounding intact material; or

(b) excavated and dealt with as described in sub-Clause 6(i) of this Clause.

(iv) Other areas required to be made stable shall be dealt with as stated in Appendix 6/3.

8 The concrete, referred to in sub-Clauses 6(i) and 6(iii) of this Clause,

permanently exposed on the face of the cutting shall have surface features as nearly as possible matching those of the adjacent intact face. Such concrete and the grout referred to in sub-Clause 6(ii) of this Clause shall have a consistent colour as nearly as possible matching that of the adjacent intact face.

604 Excavation for Foundations

1 The bottom of all foundation excavations shall be formed to the lines and levels shown on the Drawings. Pockets of soft soil or loose rock shall be removed and the resulting voids and any natural voids shall be filled with mix ST1 concrete (Series 2600) (or other material as required by Appendix 6/3) except in excavations for corrugated steel buried structures when Class 6K lower bedding fill material complying with Table 6/1 shall be used.

After placing of any blinding concrete shown on the Drawings, no trimming of the side faces of the excavation shall be carried out for 24 hours.

2 The Contractor shall make good:

(i) any lateral over break of the excavation above the bottom of the foundation greater than the net volume required for the Permanent Works with material of the same Class as used for fill above structural concrete foundations to comply with Clause 611 (except that for corrugated steel buried structures Class 6K lower bedding material shall be used) or, where the excavation is too narrow to allow the compaction of earthworks materials, with mix ST1 concrete;

(ii) any additional excavation at or below the bottom of foundations, including that resulting from removal of material which the Contractor has allowed to deteriorate, with mix ST1 concrete (or other material required by Appendix 6/3) except that under corrugated steel buried structures Class 6K lower bedding material shall be used.

3 Class 6K lower bedding material referred to in this Clause shall be deposited and compacted in compliance with Clauses 608 and 612 and Table 6/1.

605 Not Used

606 Watercourses

1 The clearance and modification of existing, or the construction of new watercourses, including ditches, streams, rivers, lagoons and ponds, shall be as described in Appendix 6/3 including any protection, lining, revetment or other works and shall comply with sub-Clauses 2 to 4 of this Clause.

2 Clearance of existing watercourses shall include the removal of vegetation, vegetable matter and all other deposits within the watercourse profile. Materials resulting from this clearance shall be dealt with as unacceptable material.

3 New watercourses and cleared existing watercourses shall be maintained in a clear condition.

4 Redundant watercourses shall, where required in Appendix 6/3, be drained and cleared in accordance with sub-Clause 2 of this Clause and material outside the watercourse profile excavated and dealt with as unacceptable material. The excavations shall be to the dimensions stated in the Contract and the whole filled with general or selected fills of the Class described in Appendix 6/3 complying with Table 6/1 deposited and compacted in compliance with Clause 608 and 612. Where the surface is to remain exposed it shall be topsoiled and seeded, or receive other treatment, all as described in Appendix 6/3.

607 Explosives and Blasting for Excavation

1 Blasting for excavation shall not be employed unless permitted or required in Appendix 6/3 and such blasting shall be confined to the locations and to within the time limits stated therein.

2 The Contractor shall:

(i) Not carry out plaster shooting;

(ii) For each location where blasting is to be undertaken, give written notice to the Overseeing Organisation of the programme of blasting, including trial explosions, at least 10 days before it commences and give written notice of each blasting event as described in (v) below, at least 12 hours beforehand;

(iii) Carry out trial explosions starting with reduced quantities of explosive in order to determine the size of the actual explosive charges and their disposition, for use in the main blasting operations, so as not to exceed the values for vibrational amplitude and vibrational peak particle velocity stated in (iv) Below at the positions described therein;

(iv) Determine danger zones likely to be created by the blasting operations, including trial explosions, within which blasted material may be projected and utilise suitable arrangements including Temporary Works, to retain such projectiles and ensure that no injury or damage is caused to persons or property thereby;

(v) Limit blasting to a small number of events during permitted hours per day, where an event shall comprise a single explosion or a group of explosions each separated by a short time interval, the group lasting less than a minute;

(vi) Ensure that:

(a) Structures and earthworks, existing or under construction, on and off the Site, do not experience, during blasting operations including trial explosions, a vibrational amplitude exceeding 0.2 mm and a resultant peak particle velocity exceeding 50 mm per second, or other limits stated in Appendix 6/3, at the same time or individually; and

(b) Peak overpressures, of magnitude such as to

endanger windows and glazed areas of structures, do not occur.

(vi) Where instrumentation and monitoring is appropriate:

(a) rigidly fix to structures and insert in earthworks described in (vi) (a) above, suitable instruments to measure the vibrational amplitude and resultant vibrational peak particle velocity, and peak overpressures, experienced during blasting operations including trial explosions;

(b) make available details of the proposed instrumentation within the Site;

(c) unless otherwise stipulated in Appendix 6/3, make his own arrangements for installing instruments on property off the Site including negotiating with landowners and other interested parties;

(d) read such instruments and take measurements throughout the period of blasting operations, including trial explosions;

(e) for instruments on structures or earthworks on the Site and, where required in Appendix 6/3, on property off the Site, make available the results to the Overseeing Organisation at the end of each day's blasting.

(vii) Take measurements of vibrational amplitude and peak particle velocity in each of three mutually perpendicular planes and determine the peak value, taken as the maximum resultant calculated by vector summation of the three components of amplitude and velocity respectively, measured as instantaneously as the resolution of the recording instrument permits;

(viii) Ensure that noise from blasting operations is controlled in accordance with Clause 109;

(ix) Use explosives in the quantities and in the manner recommended by the manufacturer;

(x) Store explosives in registered premises in a licensed store or magazine provided with a separate compartment for detonators or use them under an Immediate Use Certificate issued by the police;

(xi) Only permit explosives to be used or handled by or under the immediate control of a competent person;

(xii) Ensure there is no unauthorized issue or improper use of explosives brought on the Site and maintain a strict check on quantities issued and consumed;

(xiii) Comply with the requirements of BS 6657 in respect of the use of electrical detonators in the vicinity of static and mobile radio transmitters, including normal radio and television broadcasting

stations and radar units associated with aircraft movements, electricity generating plant and transmission lines.

608 Construction of Fills

1 All fills, including embankments, shall be constructed:

(i) in the locations described in Appendix 6/3 to the lines and levels stated therein;

(ii) of Classes of materials required or permitted in Appendix 6/1, complying with Table 6/1 with, unless otherwise described in the Contract, only Class 6A material deposited into open water;

(iii) by depositing, as soon as practicable after excavation, in layers to meet the compaction requirements of Clause 612 as required for each Class of material in Table 6/1, except that:

a. material requiring end product compaction shall be deposited in layers not exceeding 250 mm uncompacted thickness;
b. material placed into open water shall be deposited by end tipping without compaction;

c. material deposited in areas to receive dynamic compaction complying with Clause 630 shall be deposited and compacted to the requirements therein.

(iv) to the requirements of this Clause and any other requirements for fill in this Series.

2 Starter layers of Classes 6B or 6C materials as described in Appendix 6/3 shall be deposited as the first layer or layers of fill above existing ground level or, if appropriate, above any ground improvement required by Appendix 6/13. Plant movement across starter layer material shall be restricted to that plant which is necessary for its deposition, spreading and compaction in compliance with this Clause and Clause 612 and any plant required to carry out any ground improvement beneath it if required by Clause 630. The Contractor shall take all reasonable measures to prevent damage to the underlying strata, which may include use of lighter spreading plant or a reduction of the number of passes of compaction plant.

3 Coarse granular material Classes 1C and 6B shall, before compaction, be spread in layers by a crawler tractor of not less than 15 tonnes total mass. After compaction each layer shall, if voids remain, be blinded with an approved Class of granular material complying with Table 6/1 so that all surface voids are filled before the next layer and before any capping or sub-base is constructed.

4 Embankments and other areas of fill shall, unless otherwise required in the Contract, be constructed evenly over their full width and their fullest possible extent and the Contractor shall control and direct constructional plant and other vehicular traffic uniformly over them. Damage by constructional plant and other vehicular traffic shall be made good by the Contractor with material

having the same characteristics and strength as the material had before it was damaged.

5 Embankments and other areas of unsupported fills shall not be constructed with steeper side slopes, or to greater widths than those described in Appendix 6/3, except to permit adequate compaction at the edges before trimming back, or to obtain the final profile following any settlement of the fill and the underlying material. However any oversteepening or increase in width shall not exceed any limits described in Appendix 6/3 and shall remain only for the minimum periods necessary consistent with the safety of the Permanent Works.

6 Staged construction of fills and any controlled rates of filling, shall be carried out, in accordance with any requirements described in Appendix 6/3 including installation of instrumentation and its monitoring, in compliance with Clause 629.

7 Where required in Appendix 6/3 the Contractor shall surcharge embankments or other areas of fill, as described therein for the periods stated. If settlement of surcharged fill results in any surcharging material, which is unacceptable for use in the fill being surcharged, lying below the formation or, where there is a capping, the sub-formation, the Contractor shall remove this unacceptable material and dispose of it in accordance with Clause 602. He shall then bring the resultant level up to formation or sub-formation, as appropriate, with acceptable material.

8 Where pipes in embankments or in other areas of fill are permitted in Appendix 5/1 to be constructed other than in a trench, the fill shall be brought up to and over them equally on both sides. The fill shall be deposited in even layers and shall not be heaped above the pipe. Spreading and compaction shall be carried out evenly without dislodging, distorting or damaging the pipe. Power rammers are not to be used within 300 mm of any part of the pipe or joint.

9 The last 600 mm depth of fill up to sub-formation level, or formation level as appropriate, shall, unless otherwise required in the Contract, be carried out for the full width of embankments, or between the outer extremities of the verges in other areas of fill, in a continuous operation. The Contractor shall then continue without delay to carry out either (i) or (ii) below:

(i) form the sub-formation or formation, all in accordance with Clauses 613 and 616, following immediately either by:

   a. the construction of the full thickness of capping or sub-base as appropriate; or

   b. if permitted in Appendix 6/3, the construction of a lesser thickness of capping or sub-base as described therein laid as a weather protection layer;

(ii) place an additional 300 mm minimum compacted thickness of material above subformation level or formation level as appropriate for the full width of the filling to form a weather protection. This weather protection shall be composed of the same material as the sub-formation or formation and compacted in compliance with

Table 6/1. The material shall be provided from the Contractor's own resources and the protection layer shall be constructed in a continuous operation. For stabilised capping, the protective layer shall consist of unstabilised material.

10 Whenever fill is to be deposited against the face of a natural slope, or sloping earthworks face including embankments, cuttings, other fills and excavations, such faces shall be benched or otherwise shaped as required in Appendix 6/3 immediately before placing the subsequent fill.

11 All permanent faces of side slopes of embankments and other areas of fill formed in Classes 2 or 7 cohesive materials, shall, subsequent to any trimming operations, be re-worked and sealed by tracking a tracked vehicle, suitable for the purpose, on the slope, or by other suitable methods.

609 Geotextiles Used to Separate Earthworks Materials

1 Geotextiles required as part of the Permanent Works to separate earthworks materials at locations described in Appendix 6/5 shall be manufactured from synthetic or other fibres as required therein and be in the form of thin permeable membranes.

2 The Contractor shall provide evidence to the Overseeing Organisation, before the geotextile is incorporated in the Permanent Works, that the geotextile will be sufficiently durable, when installed in contact with the materials to be separated, to maintain its integrity for at least the life period required in Appendix 6/5.

3 Geotextiles shall be protected at all times against mechanical or chemical damage. Those susceptible to damage by light shall not be uncovered between manufacture and incorporation in the Permanent Works. Temporary exposure shall not exceed 5 hours.

4 The method of selection and the required number of samples are as described in Appendix 6/5. Samples shall be taken from the consignment of geotextile to be used in the Permanent Works. Samples and test pieces cut from them shall comply with sub-Clause 7 of this Clause and test pieces shall be tested at a laboratory to prove that the geotextile meets the following criteria or other criteria described in Appendix 6/5:

(i) The geotextile shall sustain a tensile load of not less than that value given in Appendix 6/5, determined in a 'wide strip' tensile test carried out in accordance with BS 6906 : Part 1. The characteristic strength shall be taken as the value of the strength of the material below which not more than 5% of the test results may be expected to fall. This represents the strength at 1.64 standard deviations below the mean strength.

(ii) The geotextile shall allow water to flow through it, at right angles to its principal plane, in either direction, at a rate of not less than 10 litres/m²/s under a constant head of water of 100 mm, determined in accordance with BS 6906 : Part 3. The flow rate

determined in the test shall be corrected to that applicable to a temperature of 15°C using published data on variation in viscosity of water with temperature.

(iii) The geotextile shall have a size distribution of pore openings such that the mean $^{0}90$, is between 100 microns and 300 microns, determined in accordance with BS 6906 : Part 2.

5 The geotextile shall be laid and lapped as described in this Clause or as described in Appendix 6/5 and where lapping is employed adjacent sheets or strips of geotextile shall be overlapped by at least 300 mm, or other dimension described in Appendix 6/5.

6 The layer of material on which the geotextile is to be placed shall not have protrusions or sharp projections which are likely to damage the geotextile during installation or in service. The method of installation shall ensure that the geotextile is in continuous contact with the surface on which it is to be placed and the geotextile shall not be stretched or bridged over hollows or humps. Operation of construction plant directly on the installed geotextile will not be permitted and its covering with fill material shall take place immediately after its laying.

7 All samples and test pieces cut from them shall be maintained in a clean and dry condition, except for normal contamination and wetting during testing, and shall be retained by the Contractor in accordance with Appendix 6/5. Prior to determination of pore size and tensile strength, test pieces shall be conditioned and brought into equilibrium at a temperature of 20° ± 2°C, and a relative humidity of 65 ± 5%. The dry weight of the geotextile tested shall be quoted in g/m².

8 The number of tests on samples shall be as required in Appendix 6/5.

610 Fill to Structures

1 This Clause shall apply to fill to structures other than:

(i) fill for reinforced earth structures, including associated drainage layers;

(ii) fill for anchored earth structures including associated drainage layers;

(iii) fill for surround and bedding of corrugated steel buried structures;

(iv) fill above structural concrete foundations unless otherwise required in Appendix 6/6.

2 Materials, as required or permitted in Appendix 6/6 of Classes 6N and 6P and complying with Table 6/1 shall be used as fill to structures, in the locations described in Appendix 6/6.

3 The Contractor shall compact, in compliance with Clause 612, end-product compaction, Class 6N and 6P, material to satisfy the compaction requirements for those Classes as listed in Table 6/1, but subject to the restrictions in sub-Clauses 4 and 5 of this Clause.

4 Where fill to structures is required to the same level on more than one side of a structural element or buried structure (except where Clause 623 applies) it shall be maintained at heights not differing by more than 250 mm after compaction on opposing sides of the structural element as filling proceeds.

5 The Contractor shall restrict compaction plant used on fill to structures, within 2 m of a structure, to the following items as described in sub-Clause 612.10 and
listed in Table 6/4:

(i) vibratory roller having a mass per metre width of roll, as determined by sub-Clause 612.10, not exceeding 1,300 kg with a total mass not exceeding 1,000 kg;

(ii) vibrating plate compactor having a mass not exceeding 1,000 kg;

(iii) vibro-tamper having a mass not exceeding 75 kg.

The compacted level of the fill within this zone shall not differ during construction from the compacted level of the remainder of the adjoining fill to structures by more than 250 mm.

6 Where required in Appendix 6/6, Class 6N and 6P material shall be shown, by means of a trial utilizing not less than 20 m^3 of the material, deposited and compacted in accordance with this Clause, to be stable, when it is trimmed to a slope of 1 vertical to 1½ horizontal, or other slope described in Appendix 6/6.

611 Fill Above Structural Concrete Foundations

1 Fill deposited above structural concrete foundations shall be, as shown on the Drawings:

(i) Class 6N or 6P selected fill material complying with Clause 610 including compaction requirements;

(ii) Class 6M selected fill material, deposited and compacted in accordance with Clause 623, above the foundation of arch profile corrugated steel buried structures;

(iii) another class of selected fill or general fill complying with Table 6/1 deposited and compacted in compliance with Clauses 608 and 612 and in addition be subject to sub- Clauses 610.4 and 5.

612 Compaction of Fills General

1 Except for dynamic compaction, which shall comply with Clause 630, and unless otherwise described in Appendix 6/3, the Contractor shall carry out compaction in compliance with this Clause, as soon as practicable after deposition, on all those Classes of fill in Table 6/1 which require to be compacted.

2 Compaction shall be either method or end-product as required for the Class of fill in Table 6/1, using plant appropriate to the Class of fill and the site conditions.

3 The Contractor shall obtain permission from the Overseeing Organisation before

carrying out compaction outside normal working hours.

Method Compaction

4 Where method compaction is required to be adopted it shall comply with sub-Clauses 5 to 10 of this Clause.

5 Except as stated in sub-Clause 6 of this Clause, method compaction shall be undertaken using the plant and methods in Table 6/4 appropriate to the compaction requirements as listed in Table 6/1 for the Class of material being compacted.

6 Plant and methods not included in Table 6/4 shall only be used providing the Contractor demonstrates at site trials that a state of compaction is achieved by the alternative method equivalent to that obtained using the specified method.

7 Earthmoving plant shall not be accepted as compaction equipment nor shall the use of a lighter category of plant to provide any preliminary compaction to assist the use of heavier plant be taken into account when assessing the amount of compaction required for any layer.

8 If more than one Class of material is being used in such a way that it is not practicable to define the areas in which each Class occurs, the Contractor shall compact with plant operating as if only the material which requires the greater compactive effort is being compacted.

9 The Contractor or Overseeing Organisation may carry out field dry density tests as described in sub- Clause 15 of this Clause on material compacted to method requirements at a frequency defined in Appendix 6/3. If the results of field tests show densities which indicate the state of compaction to be inadequate, then if this is due to failure of the Contractor to comply with the requirements of the Contract, the Contractor shall carry out such further work as is required to comply with the Contract.

10 For the purposes of Table 6/4 the following shall apply:

(i) The minimum number of passes N is the minimum number of times that each point on the surface of the layer being compacted shall be traversed by the item of compaction plant in its operating mode, or struck by power rammers or falling weight compactors. D is the maximum depth of the compacted layer.

(ii) In column headed N # the number of passes shown is to be doubled for material Classes 1A, 1B, 2A, 2B, 2C and 2D when such materials occur within 600 mm of subformation (if capping is required) or formation. Such extra compaction shall, unless otherwise described in Appendix 6/3, either be carried out for the full width of the embankment or, in other areas of fill which are to receive a pavement, between the outer extremities of the verges.

(iii) The compaction plant in Table 6/4 is categorised in terms of static mass. The mass per metre width of roll is the total mass on the roll divided by the total roll width. Where a smooth wheeled roller has more than one axle the category of the machine shall be determined

on the basis of the axle giving the highest value of mass per metre width.

(iv) A grid roller is a machine with a compacting roll or rolls constructed of heavy steel mesh of square pattern.

(v) A deadweight tamping roller is a machine with a roll or rolls from which 'feet' project and where the projected end area of each 'foot' exceeds 0.01 m² and the sum of the areas of the feet exceeds 15% of the area of the cylinder swept by the ends of the feet. The requirements for tamping rollers apply to machines that have 2 rolls in tandem. If only one tamping roll traverses each point on the surface of the layer on any one pass of the machine, the minimum number of passes shall be twice the number given in Table 6/4 plus any further doubling required to satisfy (ii) above.

(vi) For pneumatic-tyred rollers the mass per wheel is the total mass of the roller divided by the number of wheels. In assessing the number of passes of pneumatic-tyred rollers the effective width shall be the sum of the widths of the individual wheel tracks together with the sum of the spacings between the wheel tracks provided that each spacing does not exceed 230 mm. Where the spacings exceed 230 mm the effective width shall be the sum of the widths of the individual wheel tracks only.

(vii) A vibratory tamping roller, which may be self-propelled or towed, is a machine having a means of applying mechanical vibration to one or more rolls. The roll or rolls have projecting feet where the height of each foot exceeds 10% of the radius of the roll drum, the projected end area of each foot exceeds 0.1% of the roll drum surface area, and the sum of the areas of the feet exceeds 10% of the area of the cylinder swept by the ends of the feet. The requirements for the operation of vibratory tamping rollers shall be the same as those stated for vibratory rollers in sub- Clause (viii) except that vibratory tamping rollers operating without vibration will be classified as deadweight tamping rollers.

(viii) Vibratory rollers are self-propelled or towed smooth-wheeled rollers having means of applying mechanical vibration to one or more rolls except that vibratory rollers employed for Method 5 compaction shall be single roll types. Vibratory rollers operating without vibration will be classified as smooth-wheeled rollers. The requirements for vibratory rollers are based on the use of the lowest gear on a self propelled machine with mechanical transmission and a speed of 1.5 to 2.5 km/h for a towed machine, or a self-propelled machine with hydrostatic transmission. If higher gears or speeds are used an increased number of passes shall be provided in proportion to the increase in speed of travel. Where the mechanical vibration is applied to two rolls in tandem, the minimum number of passes shall be half the

number given in Table 6/4 for the appropriate mass per meter width of one vibrating roll but if one roll differs in mass per metre width from the other the number of passes shall be calculated as for the roll with the smallest value. Alternatively the minimum number of passes may be determined by treating the machine as having a single vibrating roll with a mass per metre width equal to that of the roll with the higher value. Vibratory rollers shall be operated with their vibratory mechanism operating only at the frequency of vibration recommended by the manufacturers. Where more than one amplitude setting is available and/or a range of frequencies is recommended, the machine shall be operated at the maximum amplitude setting and at the maximum recommended frequency for that setting.

(ix) Vibratory rollers shall be equipped or provided with devices indicating the frequency at which the mechanism is operating and the speed of travel. Both devices shall be capable of being read by an inspector alongside the machine.

(x) Vibrating-plate compactors are machines having a base-plate to which is attached a source of vibration consisting of one or two eccentrically weighted shafts and:

a. the mass per square metre of the baseplate of a vibrating-plate compactor is calculated by dividing the total mass of the machine in its working condition by its area in contact with compacted material;

b. vibrating-plate compactors shall be operated at the frequency of vibration recommended by the manufacturers. They shall normally be operated at travelling speeds of less than 1 km/h but if higher speeds are necessary the number of passes shall be increased in proportion to the increase in speed of travel.

(xi) Vibro-tampers are machines in which an engine-driven reciprocating mechanism acts on a spring system through which oscillations are set up in a base-plate.

(xii) Power rammers are machines which are actuated by explosions in an internal combustion cylinder, each explosion being controlled manually by the operator.

(xiii) Dropping weight compactors are machines in which a dead weight is dropped from a controlled height using a hoist mechanism and they include self-propelled machines with mechanical traversing mechanisms capable of compacting soil in trenches and close to structures.

(xiv) In the case of power rammers and dropping weight compactors one pass will be considered as made when the compacting shoe has made one strike on the area in question.

(xv) For items marked * in the Method 3 column of Table 6/4 the roller shall be towed by track-laying tractors. Self-propelled rollers are unsuitable.

(xvi) Where combinations of different types or categories of plant are used, the following shall apply:(a) the depth of layer shall be that for the type of plant requiring the least depth of layer; and

a. the number of passes shall be that for the type of plant requiring the greatest number of passes.

End-product Compaction

11 Where end-product compaction is required it shall comply with sub-Clauses 12 to 15 of this Clause.

12 The Contractor shall at least 7 days before commencement of end-product compaction make available the following to the Overseeing Organisation:

(i) the values of maximum dry density and the optimum moisture content obtained in accordance with BS 1377 : Part 4 using the 2.5 kg rammer method or vibrating hammer method as appropriate for each of the fills he intends to use which meet the requirements of the permitted Class or Classes (where within any Class of material the fill contains material having different maximum dry densities and optimum moisture contents the Class shall be further sub-divided, by extending the identification system, in order to monitor the compacted density);

(ii) a graph of density plotted against moisture content from which each of the values in (i) above of maximum dry density and optimum moisture content were determined and, for Class 7A material, a plot of the 5% air voids curve for each sub-division.

13 Once the information contained in sub-Clause 12 of this Clause has been made available to the Overseeing Organisation it shall form the basis for compaction.

14 Fill compacted to end-product requirements shall have a field dry density, measured in accordance with sub-Clause 15 of this Clause, equal to or greater than the percentage given in Table 6/1 of the maximum dry density for the relevant Class of fill previously made available to the Overseeing Organisation in accordance with sub-Clause 12 of this Clause.

15 In general the following requirements for the compaction degree based on the Standard Proctor according BS 5835 should be achieved.

a. Course soils (DIN 18196)

1. Up to a depth of 0.5m below formation level: $D_{pr} \geq 100\%$

2. Below 0.5m up to the fill base: $D_{pr} \geq 98\%$

b. Composite soils and fine soils (Din 18196)

1. Up to a depth of 0.5m below formation level: $D_{pr} \geq 100\%$

2. Below 0.5m up to the fill base: $D_{pr} \geq 97\%$

The requirements of the 'Directives for the standardization of Pavements For Traffic Areas' concerning the reaction modules Ev_2 have to be observed. The relations of table 6.6 for cause soils may be applied.

Table 6.6 Guidelines for the relation between D_{pr} and Ev_2 for course soils

Soil Group	Compaction degree D_{pr} (%)	Reaction Modules Ev_2 (MN/m²)
CW, GI	≥ 100 ≥ 98 ≥ 97	≥ 100 ≥ 80 ≥ 70
GE, SE, SW, SI	≥ 100 ≥ 98 ≥ 97	≥ 80 ≥ 70 ≥ 60

Additionally the relations E_{v2}/E_{v1} of table 6.2 may be used to evaluate the compaction condition of the soils of table 6.7

Table 6.7: Guidelines for the relative between D_{pr} and Ev_2/Ev_1

Compaction degree D_{pr} (%)	Relative E_{v2}/E_{v1}
≥ 100% ≥ 98% ≥ 97%	≤ 2.3 ≤ 2.5 ≤ 2.6

16 The field dry density referred to in sub-Clause 14 of this Clause shall be measured in accordance with BS 1377 : Part 9, except that nuclear methods shall only be used where required or permitted in Appendix 6/3. Where nuclear methods are used, the gauge shall be calibrated in accordance with BS 1377 : Part 9.

613 Sub-formation and Capping

1 Capping to facilitate construction works on cohesive subgrade, or to meet the bearing capacity requirements on formation level (See Directive) shall be provided only in those locations, and to the extent, particularly stated in

Appendix 6/7 to be constructed with capping. It shall comply with this Clause and in addition, for stabilized capping, with Clauses 614, 615 and 643 as appropriate.

2 Capping shall be constructed with Class 6F1, 6F2, 6F3, 9A, 9B, 9D, 9E or 9F material as required or permitted in Appendix 6/7 and complying with Table 6/1.

3 Unless otherwise described in Appendix 6/7, capping shall either consist of one Class of capping material throughout its depth laid in one or more layers of compacted thickness complying with Clause 612, or be formed of not more than two elements of different capping materials. Each element shall be formed of one or more layers of the same capping material, each of compacted thickness complying with Clause 612. Class 9D or 9E stabilized capping material shall not be placed or constructed above Class 6F granular capping material.

4 Unless otherwise stated in Appendix 6/7, the subformation shall have the same longitudinal gradient, crossfall and surface level tolerances as the formation.

5 The Contractor shall limit any unprotected area of sub-formation, which is to receive capping to suit the output of the plant in use and the rate of deposition of capping.

6 No unprotected subformation, which is to receive capping, shall remain continuously exposed to rain causing degradation, nor be left uncovered overnight.

7 In cuttings the Contractor shall, as permitted or required in Appendix 6/7 carry out one of the following procedures:

(i) for Class 6F1, 6F2 or 6F3 capping, excavate below formation level to a depth to accept the capping, trim the surface to form the subformation and immediately compact with one pass of a smooth-wheeled roller having a mass per m width of roll not less than 2,100 kg or a vibratory roller having a mass per m width of roll not less than 700 kg or a vibrating plate compactor having a mass per m² of not less than 1,400 kg, and immediately deposit and compact above it a capping in Class 6F1, 6F2 or 6F3 material; or

(ii) for Class 9A, 9B,9D, 9E or 9F capping material construct the capping by stabilizing the intact material, providing it complies with Class 6E, 6R 7E, 7F, 7G or 7I material requirements, immediately below formation to form Class 9A, 9B, 9D, 9E or 9F material, respectively; or

(iii) excavate below formation to sufficient depth to enable stabilization of intact Class 6E, 6R, 7E, 7F, 7G or 7I material to be carried out, to produce Class 9A, 9B, 9D 9E or 9F material forming the lower element of the capping (after stabilization of this element, the capping shall be completed by depositing a further layer or layers of Class 6E, 6R 7E, 7F, 7G, or 7I material and stabilizing it to form Class 9A, 9B, 9D, 9E or 9F capping or depositing and compacting Class 6F1, 6F2 or 6F3

material to form the upper element of the capping); or

(iv) excavate to sub-formation level and deposit material complying with Classes 6E, 6R, 7E, 7F, 7G, or 7I to be stabilized to form a capping of Class 9A, 9B, 9D, 9E or 9F layers. Where a stabilized layer is directly overlain by Class 6F1, 6F2 or 6F3 material the stabilized layer shall be compacted as for a sub-formation in 7 (i) above.

8 On embankments and other areas of fill the Contractor shall, as permitted or required in Appendix 6/7 carry out one of the following procedures:

(i) complete the embankment to form the subformation or remove any protection layer and trim the surface to form the subformation, and in both cases compact with one pass of a smooth-wheeled roller having a mass per m width of not less than 2,100 kg or a vibratory roller of not less than 700 kg per m width or a vibrating plate compactor having a mass per m² of not less than 1,400 kg, and immediately construct above it, in one or more layers, Class 6F1, 6F2 or 6F3 capping; or

(ii) construct the embankment to sufficient height and carry out stabilization to form a capping of Class 9A, 9B, 9D, 9E or 9F material in one or more layers utilizing where appropriate any protection layer previously constructed; or

(iii) for multi-element capping, incorporating stabilized material, construct the embankment to sufficient height to carry out the work described in 8(ii) above and immediately construct above it one or more layers of Class 6F1, 6F2 or 6F3 capping.

Where a stabilized layer is directly overlain by Class 6F1, 6F2 or 6F3 material the stabilized layer shall be compacted as for a sub-formation in 8(i) above.

614 Cement Stabilization to Form Capping

1 Where capping is to consist of, either wholly or in part, cement stabilized material Class 9A or 9B this Clause shall apply to the construction of those parts which are stabilized with cement.

2 Material to be stabilized with cement shall be Class 6E or Class 7F materials all complying with Clause 601 and Table 6/1. Unless otherwise described in Appendix 6/7 cement shall be Portland cement complying with Clause 1001.

3 Class 6E or class 7F material to be stabilized shall have added to it, at any point, that quantity of cement measured as a percentage of its dry weight as determined on the demonstration area, to meet the required. Ev_2 value in Appendix 6/1, subject to a minimum of 2% cement.

4 The appropriate quantity of cement shall be uniformly spread, by a suitable spreading machine, on top of the layer to be processed. Using a collecting tray and balance the Contractor shall check the

rate of spread of the machine once for every 500 m² of cement spread.

5 Unless indicated otherwise in Appendix 6/7, Class 6E or 7F material shall be stabilized in a single layer if its compacted thickness is 250 mm or less. If its compacted thickness is greater, the material shall be stabilized in layers not less than 130 mm and not more than 250 mm thick, including any cutting-in required by sub-Clause 9 of this Clause.

6 The Contractor shall not carry out cement stabilization when the shade temperature is below 3°C unless on a rising thermometer above 0°C. Cement stabilization shall not be carried out during periods of rain or when rain is imminent. When cement is spread on material likely to cause premature hydration, processing in accordance with sub-Clause 7 of this Clause shall follow immediately.

7 Unless indicated otherwise by Appendix 6/7, Class 6E or 7F material forming the layer to be stabilized shall be processed by pulverising and mixing in the cement by means of a sufficient number of passes of a suitable mobile stabilizing machine until 95% of the silt and clay fraction is reduced to particles or lumps passing a BS 28 mm sieve after dry sieving and the pulverisation complies with Table 6/1.

8 During processing, only sufficient water shall be available in the material to hydrate the cement and enable satisfactory mixing and compaction to be achieved. Any added water shall be through an integral spray-bar on the stabilizing machine.

9 The stabilizing machine shall be equipped with a device for controlling the depth of processing which shall be maintained at the correct setting at all times. An overlap of 150 mm shall be made between adjacent passes of the stabilizing machine. Where a subsequent layer of material is placed on a layer previously stabilized the tines or blades of the stabilizing machine shall be set so that they cut into the previously stabilized layer below by at least 20 mm.

10 Each layer of Class 9A or 9B processed material shall be compacted as soon as possible after the final pass of the stabilizing machine. Compaction shall be completed within 2 hours following the mixing of the cement into the material to be stabilized. Immediately before compaction Class 9B processed material shall have a Moisture Condition Value (MCV) of not greater than 12 nor less than the figure stated in Appendix 6/1 for Class 9B cement stabilized material, both as determined in accordance with Clause 632. Water shall be added if necessary in a uniform manner to enable this MCV requirement to be met.

11 The compaction of each layer of Class 9A or 9B material shall comply with Clause 612, Table 6/4 Method 6 or Method 7 respectively, except that if layers of Class 9A or 9B greater than 250 mm thickness are to be constructed, the number of passes of the compaction plant shall be determined from the results of a demonstration area as detailed in Appendix 6/7.

12 Class 9A or 9B materials shall be cured in accordance with Clause 1035. During periods when the air temperature is forecast to drop below 3°C or when

ground frost is forecast Class 9A or 9B material shall be protected, to prevent freezing, for a period of 7 days from the time of completion of compaction. Such protection shall be sealed to prevent the ingress of moisture.

13 Class 9A or 9B materials shall not have other material deposited or compacted above them until such time as the required Ev_2 value in Appendix 6/1 has been achieved. The relaxation allowed in sub-Clause 617.2 shall not apply before this time.

615 Lime Stabilization to Form Capping

1 This Clause shall apply only to those capping materials which are to be stabilized with lime to form material Class 9D.

2 Material to be stabilized with lime shall be Class 7E material complying with Clause 601 and Table 6/1.

3 Lime for lime stabilization shall, as required in Appendix 6/7, be either quicklime or hydrated lime complying with BS 890. Quicklime shall when sieved have 100% passing a BS 10 mm sieve and at least 95% by mass passing a BS 5 mm sieve.

4 The Contractor shall make available to the Overseeing Organisation for each source of lime a report of a chemical analysis for 'available lime' made in accordance with sub-Clause 641.2. Such reports shall be made available to the Overseeing Organisation prior to the incorporation of lime in the Permanent Works at weekly or other intervals defined in Appendix 6/7 during periods when lime stabilization is carried out.

5 Class 7E material to be stabilized shall have added to it, at any point, the percentage of its dry weight of lime, as determined on the demonstration area, to meet the required Ev_2 value in Appendix 6/1, subject to a minimum of 2½% by weight of 'available lime' as a percentage of the dry weight of the Class 7E material.

6 Lime of quantity complying with sub-Clause 5 of this Clause shall be uniformly spread by a suitable spreading machine on top of the layer to be stabilized. Using a collecting tray and balance the Contractor shall check the rate of spread by weight, once for every 500 m² of lime spread or a different rate of testing for the rate of spread as described in Appendix 6/7. At the same time the Contractor shall collect samples of lime deposited on the tray and test them for available lime content in accordance with Clause 641.

7 Unless indicated otherwise in Appendix 6/7, the material shall be stabilized in a single layer if its compacted thickness is 250 mm or less. If its compacted thickness is greater, the material shall be stabilized in layers not less than 130 mm and not more than 250 mm thick, including any cutting-in required by sub-Clause 12 of this Clause.

8 Unless indicated otherwise in Appendix 6/7 lime stabilization shall not be carried out during periods of rain or when rain is imminent and when the shade temperature is not below 7°C. Only when the specified Ev_2 value is attainable at a shade temperature less

than 7°C, may lime stabilization be carried out at such lower temperature. Lime stabilization shall be suspended if rainfall will have an adverse effect on the material being stabilized. The spreading of lime shall not be carried out in a manner or under conditions that will result in lime being blown from the site onto adjacent land or property.

9 Unless indicated otherwise in Appendix 6/7, the material forming the layers to be stabilized shall be processed by pulverising and mixing in the lime by means of sufficient number of passes of a suitable mobile stabilizing machine until 95% of the Class 9D processed material passes a BS 28 mm sieve after dry sieving and the pulverisation complies with Table 6/1.

10 During processing only sufficient water shall be available in the material to slake the quicklime (if used) and to enable satisfactory mixing and compaction to be achieved. Any added water shall be through an integral spray-bar on the stabilizing machine.

11 The layer shall receive at least two passes of the stabilising machine to pulverise and mix the lime and soil, after which the processing shall be interrupted by a period of not less than 24 hours and not greater than 72 hours, to enable the lime to react with the soil. Before this period commences the surface of the layer shall be sealed with one pass of a smooth wheeled roller having a mass per metre width of roll of not less than 2700 kg or a pneumatic tyred roller of not less than 1000 kg per wheel. At the end of this period the layer shall receive one further pass of the stabilizing machine or more if required to enable the material to comply with sub-Clauses 9 and 13 of this Clause, adding water uniformly if necessary.

12 The stabilizing machine shall be equipped with a device for controlling the depth of processing which shall be maintained at the correct setting at all times. An overlap of 150 mm shall be made between adjacent passes of the stabilizing machine. Where a subsequent layer of material is placed on a layer previously stabilized the tines or blades of the stabilizing machine shall be set so that they cut into the previously stabilized layer below by at least 20 mm.

13 Each layer of Class 9D processed material shall be compacted as soon as possible after the final pass of the stabilizing machine. Immediately before compaction the processed material shall have a Moisture Condition Value (MCV) of not greater than nor less than the figures stated in Appendix 6/1, for Class 9D lime stabilized material, both as determined in accordance with Clause 632.

14 If there is a delay following the final pass and before commencement of compaction the surface shall be sealed by not less than 2 passes of a smooth-wheeled roller having a mass per metre width of not less than 2,700 kg or of a pneumatic tyred roller of not less than 1,000 kg mass per wheel. On recommencement and before compaction the layer shall be re-processed without the addition of lime, by a sufficient number of passes of the stabilising machine to meet the MCV requirements of sub-Clause 13 of this Clause adding water uniformly if necessary.

15 The compaction of each layer shall comply with Clause 612, Table 6/4 Method 7 except that if layers more than 250 mm thick are constructed the number of passes of the compaction plant shall be those determined from results obtained on a demonstration area as detailed in Appendix 6/7.

16 Class 9D material shall not have other material deposited or compacted above it until such time as the required Ev_2 value ratio in Appendix 6/1 has been achieved. The relaxation allowed in sub-Clause 617.2 shall not apply before this time.

616 Preparation and Surface Treatment of Formation

1 The formation shall, after completion of any subgrade drainage, and immediately before laying subbase on areas of completed formation, have a surface level tolerance within ±20 mm or ±25 mm according to table 7.1 of clause 70, or other level of tolerance defined in Appendix 6/7 relative to its designed level after completion of the following operations as necessary:

(i) Any protection layer shall be removed and any soft or damaged areas shall be rectified by excavating them and replacing with acceptable material having the same characteristics and strength as the surrounding material. The surface of the formation shall be trimmed and immediately cleaned free from mud and slurry which shall be dealt with as unacceptable material Class U1.

(ii) The formation shall immediately be compacted, in addition to the compaction required for the fill. This additional compaction shall for this purpose be assumed to be as for a layer of 250 mm finished thickness compacted in compliance with Clause 612 and Table 6/4 Method 6 except for Class 3 materials where Method 4 shall be used. Immediately after the additional compaction the formation shall be trimmed to achieve the tolerances of this sub-Clause.

2 Where the tolerances in sub-Clause 1 of this Clause are exceeded, the Contractor shall determine the full extent of the area which is out of tolerance and shall make good the formation as follows:

(i) if the surface is too high it shall be re-trimmed and re-compacted in compliance with Clause 612 and sub-Clause 1 of this Clause;

(ii) if the surface is too low it shall be corrected by the addition of acceptable material complying with Table 6/1 having characteristics and strength matching the overlaid material, deposited and compacted in compliance with Clause 608 and 612 and sub-Clause 1 of this Clause. In cohesive materials Classes 2 and 7, where this low surface is less than 150 mm below formation, material shall be removed to a depth of at least 150 mm below formation before the additional material is deposited and compacted.

3 After trimming, or re-trimming if necessary, the formation shall be rolled with one pass of a smooth-wheeled roller having a mass per metre width of roll not less than 2100 kg or, a vibratory roller having a mass per metre width of vibrating roll of not less than 700 kg or a vibrating plate compactor having a mass per m² under the base plate of not less than 1,400 kg.

4 Where required in Appendix 6/7 or where the tolerances in sub-Clause 1 of this Clause cannot be achieved in the preparation of formation in rock then one of the following shall be carried out so as to achieve the above tolerances:

(i) the material shall be excavated below formation to the depth described in Appendix 6/7. The excavated material shall be processed as described in Appendix 6/7 and re-deposited and compacted in compliance with Clauses 608 and 612 and Table 6/4 Method 6 in compacted layers not greater than 250 mm thick; or

(ii) where the rock surface is tabular it shall be regulated by depositing and compacting cement bound material as described in Appendix 6/7, complying with the 1000 Series, or mix ST1 concrete.

5 The Contractor shall limit any areas of completed formation to suit the output of plant in use and the rate of deposition of sub-base. No formation of cohesive material Classes 2 and 7 shall remain continuously exposed to rain causing degradation or be left uncovered overnight.

6 The preparation of formation on existing sub-base material shall be completed as described in Appendix 6/7.

617 Use of Sub-formation or Formation by Construction Plant

1 Construction plant and other vehicular traffic (except that required for the construction of capping) shall not be operated on the sub-formation, unless adequate protection, if necessary in addition to any weather protection, is provided.

2 Construction plant and other vehicular traffic (except for that required for preparation of the formation in compliance with Clause 616) shall not be operated on the formation unless adequate protection, if necessary in addition to any weather protection is provided.

3 In addition to the requirements of sub-Clauses 1 and 2 of this Clause, the Contractor shall make available to the Overseeing Organisation his proposals for the protection of the sub-formation or formation in areas where they are within 300 mm of the existing ground level, after topsoil has been stripped, before using construction plant or other vehicular traffic at or above sub-formation or formation.

618 Topsoiling, Grass seeding and Turfing

1 Topsoiling shall be carried out using Class 5 material complying with Table 6/1.

2 Imported topsoil, Class 5B material, shall only be imported when required in Appendix 6/8 or when permitted or instructed by the Engineer.

3 When required in Appendix 6/8 topsoil shall not be excavated from stockpiles, whether on site or imported:

(i) which have been exposed to a cumulative rainfall exceeding 100 mm, or other figure stated in Appendix 6/8, over the preceding 28 days measured at a point detailed in Appendix 6/8; or

(ii) when heavy rain is falling; or

(iii) with a tracked vehicle.

4 Topsoil shall:

(i) be deposited and spread on the areas, to the thicknesses described in Appendix 6/8, in layers not exceeding 150 mm. Each layer shall be firmed before spreading the next. The thickness shall be reduced where necessary to allow for any subsequent turfing required in Appendix 30/5 (it shall not be spread using a tracked vehicle, when so stipulated in Appendix 6/8);

(ii) have stones and other debris removed and disposed off Site which have:

a. dimensions greater than 100 mm equivalent diameter, unless otherwise permitted in Appendix 6/8; and

b. dimensions greater than 50 mm equivalent diameter which lie within 50 mm of the surface;

(iii) be graded to smooth contours, eliminating all mounds and depressions where water may collect;

(iv) not have stones or other debris protruding above the surface by more than 30 mm, and comply with the further requirements of Clauses 3004 and 3005.

5. The areas to be grassed shall receive one of the following treatments as described in Appendix 6/8:

Treatment 1: topsoiled, fertilized and seeded Fertilizer and seed may, unless otherwise stated in Appendix 6/8 be applied by hydraulic mulch.

Treatment II: Topsoiled, fertilized and turfed

Treatment III: Left untopsolied but fertilized and seeded by hydraulic mulch.

6. Cutting slopes which are to receive Treatment I or II shall:

be benched when required in Appendix 6/3 to retain topsoil

unless otherwise stated in appendix 6/8 or directed by the Engineer, be harrowed to a depth of 50mm. Such harrowing shall be carried out, immediately prior to topsoiling, diagonally, at an angle

between 5° to 45° to the line of the to, measured on the plane of the slope.

7. Topsoil in treatment I and II shall:

(i) be deposited and spread to the thicknesses described in Appendix 6/8, which thickness shall be reduced where necessary to allow for any subsequent turfing required in Appendix 6/8 or permitted by the Engineer it shall not be spread using a tracked vehicle, when so stipulated in Appendix 6/8):

(ii) have stone and other debris removed and disposed off site which have:

a) dimensions greater than 100mm equivalent diameter, unless otherwise permitted by the Engineer, and

b) dimensions greater than 50mm equivalent diameter which lie within 50mm of the surface.

(iii) not have stone or other debris protruding above the saurface by moe than 30min and

(iv) immediately prior to sowing of seed, including that applied by hydraulic mulch and before laying of turf have:

a) its upper 50mm thickness reduced to a fine tilth by use of a chain harrow or other plant producing a similar fine tilth; and

b) fertilizer complying with sub clause 13 of this clause evenly distributed and raked in, at a rate not less than 75g per m² or other rate required in Appendix 6/8 or agreed with the Engineer. If hydraulic mulch seeding is used such fertilizer may be incorporated in the mulch and no raking in is necessary.

8. Seeding in Treatment 1 shall:

(i) employ a mixture of seed complying with sub-clause 14 of this clause and

(ii) be carried out by evenly distributing such seed at a rate of not less than 20g/m² for side slopes of both embankments and cuttings and not less than 10g/m² elsewhere or other rate required in Appendix 6/8 or agreed by the Engineer; and

(iii) by immediately followed by lightly ranking, by use of a chain horrow or other plant approved by the Engineer, the surface of the topsoil to cover the seeds except that no ranking is required following hydraulic mulch seeding.

9.Turf in Treatment II shall:

(i) be laid in the areas described in Appendix 6/8 or in other area as permitted by the Engineer or

(ii) consist of class 5C imported turf complying with table 6/1 or when permitted by the Engineer; turf arising on Site and required to be excavated as Class 5 A material; and

(iii) be laid well bonded and lightly tamped and when on slope be laid diagonally; and

(iv) where required in Appendix 6/8 be retained in position by methods described therein; and

(v) be regularly watered as necessary during prolonged dry weather

10 Hydraulic mulch seeding shall:

(i) be applied by a process and consist of a mulch approved by the Engineer; and

(ii) where required in Appendix 6/8 have as part of those mulch, glass fiber or other material to form a retaining agent during establishment of swarm growth; and

(iii) for treatment III have as part of the mulch additional additives for promotion of grass growth on the material to be grassed.

11 Except on areas not required to be mown or to be mown three times all as described in Appendix 6/8, areas of grass resulting from treatment I to III shall be mown twice to leave a nominal 75mm height. The first mowing shall be carried out ounce the grass has reached f height of between 100mm and 150mm, the second when it has regrown to between 150mm and 200mm. The plant used for mowing shall comply with any requirements in Appendix 6/8. All areas shall unless permitted otherwise by he Engineer, be left clear of glass cutting following each mowing, by raking or other method approved by the Engineer and arising disposed of site.

12. At the times (Which may include times within the period of maintenance) and within the area instructed by the Engineer, a selective herbicide, approved by the engineer, especially formulated for the prediction of docks, thistles, ragwort and other pernicious agricultural weeds shall be applied by spot treatment spray to such plants individually; the use of spray boom will not be permitted.

13 Fertilizer, including where approved by the Engineer that incorporated in hydraulic mulch, shall consist of a compound containing not less than 10% Nitrogen, 15% Phosphoric Acid and 10& Potash and samples shall be submitted to the Engineer for approval prior to its use in the Permanent works.

14. Grass seed, including where approved by the Engineer, that incorporated in a hydraulic mulch, shall be tested mixture and certificates of germination and purity shall be provided before sowing, together with the names of the varieties used in the mixture. Unless otherwise required in Appendix 6/8 or agreed by the Engineer, this shall contain the seeds listed in Table 6/6 to the proportions therein.

Table 6/5: records and Reports – Information Required

Ground Treatment	In situ Testing
For each column/area treated: Date Contract title Area identification Unique Grid location Ground Level at Commencement Material used Approximate column diameter Depth of penetration of each compaction point Vibrator power compaction during operation Jetting pressure (where applicable) Duration of penetration Duration of compaction Obstructions and delays Number of tests carried out	For each area tested: Date Contract Title Area identification Test position, co-ordinates and level Method of test used All information required by appropriate British Standard test procedure

Table 6/6: Grass Seed Mixture per 50kg

	Kg	%
Perennial Rye Grass	12.5	25
Strong Creeping Red Fescue	10.0	20
Hard Fescue	15.0	30
Smooth-stalked Meadow Grass	5.0	10
Highland Brown top Bent	5.0	10
Huia White Clover	2.5	5

619 Earthwork Environmental Bunds

1 Earthwork environmental bunds shall be constructed in the locations described in Appendix 6/9 with fill materials complying with the requirements therein and Clause 601 and Table 6/1. Deposition shall be in accordance with Clause 608 and compaction with the requirements of Table 6/1 unless otherwise described in Appendix 6/9 or the requirements of sub- Clauses 2 or 3 of this Clause apply.

2 Earthwork environmental bunds formed of reinforced or anchored earth shall be constructed in compliance with Clauses 2502 and 622.

3 Earthwork environmental bunds formed of strengthened embankments shall be constructed in accordance with Clause 621.

4 Where required in Appendix 6/9 earthwork environmental bunds shall be top soiled and seeded, or topsoiled and turfed, all in accordance with Clause 618.

620 Landscape Areas and Screening Mounds

1 Landscape areas and screening mounds shall be constructed in the locations shown in Appendix 6/9 with Class 4 material as described therein and complying with Table 6/1.

2 Unless method compaction to Clause 612 is required in Appendix 6/9 the degree of compaction of Class 4 material shall be sufficient to remove large voids and to produce a coherent mass whilst preventing over-compaction and any build up of excess pore pressures.

3 Following completion of filling of landscape areas, and screening mounds Class 4 material shall where required in Appendix 6/9, be shaped as described therein.

4 Class 4 material shall be deposited in landscape areas or screening mounds after any adjoining embankment or other area of fill has been completed. Where permitted in Appendix 6/9 and provided the adjoining embankment or other area of fill is always kept at least 1 m higher than the landscape area fill, construction of such landscape area may proceed until completion.

5 Landscape areas and screening mounds shall be topsoiled and seeded or turfed in accordance with Clause 618 to the requirements of Appendix 6/9.

621 Strengthened Embankments

1 Strengthened embankments shall be constructed in the locations and to the details described in Appendix 6/9 with fill materials and strengthening materials described therein.

622 Earthworks for Reinforced Earth and Anchored Earth Structures

1 The construction of earthworks for reinforced soil and anchored earth structures together with assembly and erection of reinforcing and anchor elements and associated components shall be in compliance with this Clause and Clause 2502.

2 Excavation shall be carried out in compliance with Clause 604.

3 Fill for reinforced soil structures shall, except for their associated drainage layers, be of Class 6I, 6J, 7C or 7D selected material complying with Table 6/1 as permitted in Appendix 6/1 together with any other additional requirements therein.

4 Fill for anchored earth structures shall, except for their associated drainage layers, be of 6I or 6J selected material complying with Table 6/1 as permitted in Appendix 6/1 together with any other additional requirements therein.

5 Drainage layers to reinforced soil and anchored earth structures shall be one of the following as appropriate:

(i) Class 6H material complying with Table 6/1 and Appendix 6/1.

(ii) Type B filter drain material complying with Clause 505 for use only in horizontal drainage layers. Vertical layers of drainage layer material shall be brought up at the same rate as the adjoining fill material without mixing or contamination.

6 In addition to the requirements of sub-Clauses 7 and 8 of this Clause, fill for reinforced earth and anchored earth

structures shall be deposited and compacted in compliance with Clauses 608 and 612 and Table 6/1. Drainage layer material other than Class 6H shall be deposited in accordance with Clause 608 and compacted as described in Appendix 6/3.

7 Reinforced earth and anchored earth structures shall have:

(i) the deposition and compaction carried out so that all layers of reinforcing and anchor elements are fixed at the required levels on top of compacted fill;

(ii) the deposition, spreading, leveling and compaction of the fill carried out generally in a direction parallel to the facing and executed in stages to alternate with the placing and fixing of the reinforcing and anchor elements and the facing elements;

(iii) the reinforcing and anchor elements kept as free as possible from damage or displacement during deposition, spreading, leveling and compaction of the fill (also the programme of filling shall be arranged so that no machines or vehicles run on the reinforcing or anchor elements);

(iv) all construction plant, and all other vehicles, having a mass exceeding 1,000 kg, kept at least 2 m away from the back of the facing;

(v) within 2 m of the back of the facing, the plant used for compacting the fill restricted to the following items as described in sub- Clause 612.10 and listed in Table 6/4:

a. vibratory roller having a mass per metre width of roll not exceeding 1,300 kg with a total mass not exceeding 1,000 kg;

b. vibrating plate compactor having a mass not exceeding 1,000 kg;

c. vibro tamper having a mass not exceeding 75 kg;

(vi) at the Contractor's option, the reinforced earth and anchored earth fill beyond the 2 m zone referred to in (v) above, raised in thicker layers than within the 2 m zone, providing this is compatible with the arrangement of the reinforcing and anchor elements and the difference in compacted level does not exceed 300 mm;

(vii) during construction of the reinforced earth or anchored earth structure the retained fill at the rear of the structure, as defined in sub-Clause 8 of this Clause, maintained at the same level as the adjoining reinforced earth or anchored earth fill;

(viii) if the retained material at the rear of the reinforced soil or anchored earth structure, as defined in sub-Clause 8 of this Clause, is an existing earthwork or natural slope which requires supporting by temporary shoring, this shoring shall be removed progressively as the work proceeds to prevent the formation of voids.

8 The rear of the reinforced soil or anchored earth structure is the position coinciding with the ends of the reinforcing or anchor elements furthest from the facing units.

623 Earthworks for Corrugated Steel Buried Structures

1 The construction of earthworks for corrugated steel buried structures together with assembly and erection of their components shall be in compliance with this Clause and Clause 2501.

2 Excavation shall be carried out in compliance with Clause 604 and any additional requirements given in Appendix 6/3.

3 Fill for corrugated steel buried structures shall be of the following selected granular materials complying with Table 6/1:

(i) Lower bedding material Class 6K.

(ii) Upper bedding material Class 6L.

(iii) Surround material Class 6M and the overlying fill shall be one of the following:

(iv) Well graded, uniformly graded or coarse, granular material Class 6Q.

(v) Wet, dry, stony or silty cohesive material.

4 In addition to the requirements of sub-Clauses 5 to 14 of this Clause, Class 6K, 6L and 6M materials shall be deposited in compliance with Clause 608 and shall (except for Class 6L upper bedding material which shall be uncompacted) be end-product compacted in compliance with Clause 612 and Table 6/1, except that the compacted layers shall not exceed 150 mm thickness. The compaction and testing requirements for Class 6K lower bedding and Class 6M surround materials shall also comply with any additional requirements given in Appendix 6/3.

5 Class 6K lower bedding material shall have its top surfaced shaped during compaction to match the steel structure profile. A uniform layer of uncompacted Class 6L upper bedding material, shall be deposited, before the placing of any part of the steel structure, over the whole width of the shaped lower bedding material and shall be of sufficient depth to fill the corrugations of the underside of the structure.

6 Class 6M surround material shall be used for filling all excavations above the bedding, except those in hard material for which Class 6K lower bedding material shall be used throughout. Additional requirements for making good are given in Clause 604.

7 Class 6M surround material shall be deposited and compacted uniformly on either side of the structure. The maximum difference in fill level on opposite sides of the structure shall be no more than 250mm at all times unless otherwise permitted in Appendix 6/3.

8 Class 6M surround material shall be deposited and compacted in accordance with sub-Clause 4 of this Clause, above the concrete foundations of arch-profile corrugated steel buried structures.

9 Class 6M surround material under the structure shall be well compacted by hand using a suitably sized pole or length of rectangular timber between the corrugations, or by another suitable method.

10 Plant for compaction of Class 6M surround material within 1 m of either side of the structure and up to a height of 1 m, or one fifth of the span if greater, above the crown, shall be restricted to the following items, as described in sub-Clause 612.10 and listed in Table 6/4:

(i) vibratory rollers having a mass per metre width of roll not exceeding 750 kg;

(ii) vibrating plate compactors having mass not exceeding 750 kg;

(iii) vibro-tampers.

11 Fill placed above the level of the crown of the structure, including Class 6M surround material, shall be deposited, spread and compacted in such a manner that any out of balance forces transmitted to the culvert are kept to a minimum. This will require that trafficking by construction plant is not all in one direction and that the compacted surface of the fill is kept as near horizontal as practicable.

12 During all operations of filling, compaction, road pavement construction and of any other traffic movements which affect the shape of the structure, the changes in the horizontal and vertical diameters of the structure shall not exceed ± 5% for circular structures and ± 2% for structures of other cross-sections. The longitudinal straightness over any 10 m length of the structure shall not deviate by more than 25 mm, and the rotational displacement in any 10 m length of structure shall not be greater than 25 mm.

13 Only that compaction plant described in sub-Clause 10 of this Clause, shall be used in the vicinity of the structure unless the depth of compacted Class 6M surround material placed above the crown of the structure is more than 1 m, or one fifth of the span, whichever is the greater. The structure shall not be subjected to a surcharge greater than the depth of fill required in the Contract and permitted depth of any protection layer given in Appendix 6/3.

14 No material shall be placed by tipping either onto the structure or within a distance on either side of the structure of 2 m or half the span of the structure, whichever is the greater.

15 Method compaction shall be used for the overlying fill (Classes 6Q and 7H) according to Clause 612; the method used being that for the corresponding generalfill in Table 6/1.

624 Ground Anchorages

1 The Contractor shall design the ground anchorages required as part of the Permanent Works and listed in Appendix 1/11, in accordance with the design requirements described in Appendix 6/10. The ground anchorages shall be installed and where required in Appendix 6/10 proof loaded, in accordance with the requirements therein.

2 Ground anchorages not forming part of the Permanent Works will only be

permitted where such anchorage will not affect the Permanent Works.

625 Crib Walling

1 The Contractor shall design the crib walling listed in Appendix 1/10 in accordance with the design specification and procedures in Appendix 6/10 and Standard BD 68.

626 Gabions

1 Gabions shall be constructed in compliance with this Clause and with any additional requirements in Appendix 6/10.

2 Gabion units shall be assembled in accordance with the manufacturer's instructions and shall be sufficiently filled with Class 6G material complying with Table 6/1 and any other requirements in Appendix 6/1, with an allowance for consolidation of fill, so as to minimize distortion during construction. Gabion units shall, where appropriate, be maintained square and with vertical sides during filling. Internal tie wires shall be inserted and units shall be tensioned in accordance with the manufacturer's instructions. Gabion units shall be constructed so as to maintain tightness of mesh and shall be laced securely with wire, complying with sub-Clause 3(i) of this Clause.

3 The gabion mesh shall be one of the following unless otherwise described in Appendix 6/10:

(i) A mesh manufactured from wire complying with BS 1052 having a minimum core diameter of 2.0 mm, unless otherwise described in Appendix 6/10.

(ii) A geomesh, being a grid of plastic material suitable for use in earthworks, having the properties described in Appendix 6/10.

4 All wire shall be galvanized in compliance with BS 443 and be coated with a minimum thickness of 0.55 mm of PVC for extruded coatings and 0.25 mm of PVC for bonded coatings. The PVC shall be capable of resisting the effects of immersion in sea water, exposure to ultra violet light and abrasion, when tested for a period not less than 3000 hours in accordance with BS 2782 : Part 5 : Method 540B (ISO 4892).

5 The size of mesh openings and grading of fill shall be as described in Appendix 6/10, but the maximum size of fill material shall not exceed two thirds of the minimum dimension of the gabion compartment or 200 mm whichever is smaller and the minimum size of the fill, unless otherwise stated in Appendix 6/10, shall be not less than the size of the mesh opening.

6 Mechanical equipment may only be used for filling gabion units provided that the results are equivalent to filling by hand.

627 Swallow Holes and Other Naturally Occurring Cavities

1 Infilled swallow holes and other naturally occurring cavities shall where required in Appendix 6/11 be excavated, filled and capped as described in Appendix 6/11.

2 Open swallow holes and other shallow cavities shall where required in Appendix 6/11 be flushed, cleared of rubbish where to do so would not endanger operatives, and filled and capped as described in Appendix 6/11.

628 Disused Mine Workings

1 Disused mine workings shall, where required in Appendix 6/11 be investigated, inspected, monitored, cleared, flushed, filled, capped or have any other treatment carried out, all as described in Appendix 6/11.

629 Instrumentation and Monitoring

1 Instrumentation, other than that required in compliance with Clause 607, shall be as described in Appendix 6/12 and shall be installed in the locations shown therein.

2 Monitoring of instrumentation shall be carried out as required in Appendix 6/12 and the results supplied to the Overseeing Organisation as required therein.

630 Ground Improvement

Dynamic Compaction

1 Dynamic compaction, carried out to either method or end-product as required in Appendix 6/13 and achieved by dropping a free-falling heavy mass (pounder) a number of times at pre-determined spacing on the surface of the ground or fill, shall be applied to the areas described in Appendix 6/13.

2 Dynamic compaction shall be completed before the commencement of construction of any Permanent Works, or work on the placement or diversion of Statutory Undertaker's equipment, within that part of the Site defined in Appendix 6/13 which contains the area to be dynamically compacted.

3 The Contractor shall ensure that no damage or injury is caused to persons or property on or off the Site as a result of the dynamic compaction.

Vibrated Stone Columns

4 Vibrated stone columns in existing natural soils or fill by vibro replacement or vibro displacement shall be formed in the manner and in the areas described in Appendix 6/13.

5 Unless otherwise described in Appendix 6/13, materials shall comply with the Series 600 and the Series 800 as appropriate.

6 The Contractor shall report immediately to the Overseeing Organisation any circumstance which indicates that in the Contractor's opinion the ground conditions differ from those expected from his interpretation of the ground investigation reports.

7 Columns shall be installed as shown on the Drawings and within the permitted tolerances stated in Appendix 6/13.

Materials

8 The material used to form the columns shall be clean, hard, inert material and shall be sand, crushed rock, crushed hardcore or crushed concrete. The material shall be appropriate to the ground conditions in which the stone columns are formed and its use shall not be detrimental to any other work on site. The material shall be nominally single sized within the range 20 mm to 75 mm or a graded material complying with Clause 804 (granular sub-base type 2) except the material passing the BS 425ìm sieve shall be non-plastic when tested in accordance with BS1377: Part 2.

Testing of Ground Treatment

9 Testing of treated ground shall be undertaken for control purposes during the treatment and on completion of the ground treatment. The performance criteria for treated ground are given in Appendix 6/13.

10 Improvement in treated ground shall be measured in accordance with the criteria stated in Appendix 6/13.

Types of Test

11 The following tests or alternatives permitted in Appendix 6/13 shall be carried out at the positions and frequency given in Appendix 6/13.

Plate tests

12 Plate bearing tests are loading tests carried out using a plate on treated ground. The test is described in BS 1377 : Part 9 : 1990 Method 4.1.

Zone Tests

13 Zone tests are loading tests carried out with a slab, intended to test bearing pressure over a wider and deeper zone than in the plate tests. The test is described in BS 1377: Part 9: 1990 Method 4.2.

Penetration Tests

14 In granular soils the static cone (Dutch cone) penetration test, the standard penetration test (SPT) or dynamic cone penetration tests shall be employed as described in Appendix 6/13.

Trial Areas

15 Trial areas are to be treated and tested where required in Appendix 6/13. Trial areas, which meet the performance requirements, may form part of the Permanent Works.

16 Equipment and materials used in trial areas shall be identical to those proposed for the Permanent Works.

17 Testing in trial areas shall be carried out as given in Appendix 6/13.

18 Detailed reports shall be prepared for all testing as defined in Table 6/6.

Records and Reports

19 Complete records of plant, equipment and materials shall be maintained during all ground treatment operations.

20 Records shall be made available to the Overseeing Organisation including all information identified in Table 6/6 and any other information required by Appendix 6/13. All records pertaining to a particular day's operations shall be made available to the Overseeing Organisation at the start of the following day's operations.

Other Methods

21 Other methods of ground improvement shall be carried out where required in Appendix 6/13 and as described therein.

631 Earthworks Materials Tests

1 Unless otherwise described in the Contract sampling and testing of earthworks materials shall be carried out in accordance with BS 1377: Part 1 to Part 9 inclusive.

632 Determination of Moisture Condition Value (MCV) of Earthworks Materials

1 Where the Moisture Condition Value (MCV) is to be determined, the determination shall be carried out in accordance with BS 1377: Part 4.

2 The determination of the MCV/moisture content relation in accordance with BS 1377: Part 4 shall be carried out when required in Appendix 6/1.

3 Where permitted in Appendix 6/1 the rapid assessment procedure for material acceptability also given in BS 1377 : Part 4 may be used.

633 Determination of Undrained Shear Strength of Remolded Cohesive Material

1 Where required in Appendix 6/1, the undrained shear strength of cohesive soil under total stress conditions shall be determined from triaxial compression tests performed on remolded specimens and tested under conditions where the lateral pressure is maintained constant and there is no change in total water content of the specimens. Unless otherwise required in Appendix 6/1, the tests shall be in accordance with BS 1377 : Part 7 and the additional requirements of sub-Clauses 2 to 4 of this Clause.

2 The specimens shall be prepared in accordance with BS 1377 : Part 7 using remoulded material compacted into a split mould of nominal diameter 100 mm and nominal height 200 mm. The soil shall be at its natural moisture content and compacted in accordance with BS 1377: Part 1 using the 2.5 kg rammer method described in BS 1377 : Part 4.

3 The specimens shall be tested at an operating cell pressure of 200 ± 10 kN/m² and an axial strain rate of 1% per minute. Where Appendix 6/1 requires c and $\tilde{\varphi}$ to be determined, the test shall be

modified to enable Mohr circles to be plotted and φ reported.

4 Where stated and described in Appendix 6/1, other tests may be used during construction to supplement the test described above, provided the results have been correlated to ensure compatibility.

634 Not Used

635 10% Fines Value and Other Tests for Particle Soundness

10% Fines Value (TFV)

1 The 10% fines value shall be the value determined in accordance with BS 812: Part 111 with samples tested in a soaked condition.

Other Tests for Particle Soundness

2 Where Appendix 6/1 requires magnesium sulfate soundness tests to be carried out, they shall be carried out in accordance with BS 812 : Part 121. Where Appendix 6/1 requires slake durability, point load or other tests for soundness to be carried out, they shall be carried out in accordance with the procedures given therein.

636 Determination of Effective Angle of Internal Friction ($\tilde{\varphi}$) and Effective Cohesion ($\tilde{c}$) of Earthworks Materials

1 The effective angle of internal friction φ effective cohesion shall be determined by shear box or triaxial tests as required in Table 6/1 and Appendix 6/1. Unless otherwise required in Appendix 6/1, the tests shall be in accordance with the requirements in sub-Clauses 2 to 6 of this Clause.

Shear Box Tests

2 For Classes 6N, 6P, 6I and 6J granular materials, the tests shall be carried out in accordance with BS 1377 : Part 7 and the following:

(iii) The plan size of the shear box shall be nominally 300 mm square.

(iv) Three samples shall be tested, each sample occupying the full depth of the shear box and shall be compacted at the optimum moisture. content to a dry density of 92% ± 2% of the maximum dry density determined in accordance with BS 1377 : Part 4 using the vibrating hammer method. The samples shall not be immersed in water.

(v) Each of the samples shall be subjected to a different normal stress equal to the maximum vertical pressure in the fill at the base, quarter height and mid-height of the structure respectively. Each of the samples shall be sheared in a single stage test within one hour of compaction and the rate of shearing shall be such that no pore water pressure is generated.

(vi) The values of $\tilde{\varphi}$ reported shall be those corresponding to the maximum strength envelope.

3 For Classes 7A, 7C and 7D cohesive materials, the tests shall be carried out in

accordance with BS 1377 : Part 7 and the following:

(i) The shear boxes shall be nominally 300 mm square and nominally 60 mm square.

(ii) For the initial determination of fill properties three samples shall be tested in each size of shear box. The samples shall occupy the full depth of the shear box and shall be compacted at the optimum moisture content to a dry density of 92% ± 2% of the maximum dry density determined in accordance with BS 1377 : Part 4 using the 4.5 kg rammer method. To allow the samples to soften, the shear box assembly shall then be immersed in water for a minimum period of 24 hours.

(iii) Each of the three samples in a set shall be subjected to a different effective normal stress equal to the maximum vertical pressure in the fill at the base, quarter height and mid-height of the structure respectively. Normal stresses shall be applied to the softened sample for a minimum period of 24 hours prior to shearing in a single stage test. The rate of shearing shall be such that no pore water pressure is generated.

(iv) The values of $\tilde{c}$ and $\tilde{\phi}$ reported shall be those corresponding to the maximum strength envelope.

(v) The test results obtained using the 300 mm square box shall be taken as the properties of the fill. The initial test results obtained using the 60 mm square box shall be used for the subsequent quality control of the fill.

Triaxial Tests

4 Where Class 7A cohesive fill to structures is to be tested by a consolidated drained triaxial test, the test shall be in accordance with BS 1377 : Part 8 using the sample size and preparation procedure in Clause 633 and the requirements of Appendix 6/1.

637 Determination of Resistivity (r_s) to Assess Corrosivity of Soil, Rock or Earthworks Materials

Method of Test

1 Where the resistivity of the ground or of material to be used in the Permanent Works is required to be determined, this shall be obtained by in situ tests as described in sub-Clause 2 of this Clause or, when required in Appendix 6/1, by laboratory tests on samples in accordance with BS 1377 : Part 3.

In Situ Resistivity Tests

2 In situ resistivity shall be determined at the site of the structure or the cutting or the proposed borrow pit or on stockpiles in accordance with BS 1377 : Part 9 and the requirements of Appendix 6/1.

3 Details of the area and volume of material to be tested shall be made available to the Overseeing Organisation together with the arrangement of electrodes in each test. The Overseeing Organisation shall be given notice of the date, time and location of each test.

4 At any test location, at each selected depth, two measurements shall be made such that the electrode alignment for the second measurement is approximately at right angles to the electrode alignment for the first measurement.

5 At any test location, the first selected depth shall be no more than 1.5 m below the ground surface or no more than 1.5 m below the upper surface of the material to be tested, whichever is appropriate. Following the measurements at the first selected depth, further measurements shall be made at selected depths increasing by approximately 2 m each time until measurements have been carried out on the full depth of ground or material to be tested.

6 Where the depth of material to be tested is too great to be tested from the surface within the confines of the Site, the Contractor shall undertake all necessary arrangements for testing such material, including subsequent tests which may be required at a lower level following excavation. Details of his arrangements shall be made available to the Overseeing Organisation.

638 Determination of Redox Potential (E_h) to Assess Corrosivity of Earthworks Materials for Reinforced Soil and Anchored Earth

Structures Method of Test

1 Where the redox potential of material to be incorporated into reinforced earth or anchored earth structures is required to be determined, this shall be obtained by in situ tests as described in sub-Clauses 2 to 6 of this Clause or, when required in Appendix 6/1, by laboratory tests on samples in accordance with BS 1377: Part 3.

In Situ Redox Potential Tests

2 In situ redox potential shall be determined in undisturbed ground at the site of the cutting or the proposed borrow pit or on stockpiles in accordance with BS 1377 : Part 9 and the requirements of Appendix 6/1.

3 Details of the area and volume of material to be tested shall be made available to the Overseeing Organisation together with the locations of the test pits.

4 The Overseeing Organisation shall be given notice of the date, time and location of each test.

5 At each test location the tests shall be carried out in a test pit not less than 600 mm square in plan excavated to a depth given in Appendix 6/1.

6 At each test location, a sample shall be taken from the base of the excavation and kept in a hermetically sealed container for determining the pH value of the fill which shall be obtained in accordance with BS 1377 : Part 3.

639 Determination of Coefficient of Friction and Adhesion Between Fill and Reinforcing Elements or Anchor Elements for Reinforced Soil and Anchored Earth Structures

Reinforcing Elements

1 The coefficient of friction and the adhesion shall be determined by tests carried out in a 300 mm size shear box with the element material fixed at the top of the lower half of the box and the fill sample occupying the top half only.

2 The test shall be carried out following the procedure given in Clause 636 for the determination of the effective angle of internal friction and effective cohesion of earthworks materials except that:

(i) The apparatus shall in addition include a steel block fitting closely inside the lower half of the shear box and equal in height to it less the thickness of the reinforcing element material. (The flat toothed grid fitting the bottom of the shear box is not required).

(ii) The preparation of test specimens shall be as follows:

Element material shall be cut to fit the interior plan shape of the shear box using a sufficient number of strips of such material abutting to completely fill the interior plan area without overlap. They shall be firmly fixed to the top of the steel block so that the top face of the material is flush with the top edge of the lower half of the box and aligned so that shearing occurs in a direction parallel to the longitudinal axis of a reinforcing element.

A sample of the fill material to be used in the Permanent Works, of sufficient size to carry out the tests, and within the range of moisture contents permitted in Table 6/1 for such material, shall be sieved to obtain a test sample passing the 20 mm BS sieve, of sufficient quantity after compaction to fill the top half of the shear box. The top and bottom of the shear box shall be fixed together and the test sample of the sieved fill materials immediately placed and compacted in the top half of the box as described in Clause 636.

3 The value of the coefficient of friction between the fill and the reinforcing element shall be obtained by plotting the values of peak shear stress, obtained in the tests, against applied normal stress and by measuring the slope of the resulting straight line graph. The adhesion between the fill and the reinforcement shall be obtained by taking the shear stress corresponding with zero normal stress.

4 The following additional information shall be recorded for each test:

(i) Normal stress applied (kN/m²).

(ii) Peak shear stress (kN/m²).

(iii) Strain at peak shear stress (%).

(iv) Moisture content of fill after test (Classes 7C and 7D).

Anchor Elements

5 Where required in Appendix 6/1, tests shall be carried out as described therein to assess the interaction between the fill and the element.

640 Determination of Permeability of Earthworks Materials

1 Where required in Table 6/1 or Appendix 6/1 the permeability of earthworks materials shall be determined as described in Appendix 6/1.

641 Determination of Available Lime Content of Lime for Lime Stabilised Capping

1 The available lime content of lime for lime or lime and cement stabilised capping to be determined on Site shall be carried out as described in BS 6463: Part 1 except that the sample increments shall be taken from the collecting tray used to check the rate of spread at intervals of one increment per 500 m.

2 The available lime content shall be determined as calcium oxide in accordance with BS 6463: Part 2, Method 20, and the results reported as: Available lime (as CaO) = ...% by mass.

642 Determination of the Constrained Soil Modulus (M*) of Earthworks Materials for Corrugated Steel Buried structures General

1 When required in Appendix 6/1, the constrained soil modulus M* shall be determined by one of the following methods:

(i) From plate loading tests in accordance with BS 1377: Part 9.

(ii) From the results of Standard Penetration resistance tests (SPT) on non-cohesive materials in accordance with BS 1377: Part 9.

(iii) From the values of the coefficient of volume compressibility (Mv) from one-dimensional consolidation tests on undisturbed soil specimens of cohesive materials, in accordance with BS 1377: Part 5.

Plate Loading Tests

2 When testing compacted granular fill materials the test surface shall be prepared by either:

(i) removing the surface layer carefully using hand tools to perform the test at a depth of 100 mm below the surface; or

(ii) compacting the surface, after the required compaction has been applied, with two additional passes with no vibration to remove the overstressing in the surface layer. If necessary, the plate shall be bedded onto the fill using a small quantity of dry sand to remove any slight unevenness of the surface of the fill. The field dry density and moisture content shall be determined at the position of each plate loading test in accordance with Clause 612 and BS 1377 : Part 2 or equivalent, respectively.

3 When using the plate loading test to determine M* of the material existing on site a smooth surface shall be prepared by careful hand excavation and the plate bedded onto the soil using either sand or quick setting gypsum plaster depending

on whether the soil is granular or cohesive.

4 The loading test shall be carried out under a series of maintained loads. The maximum load should be such that the average pressure applied to the plate is in excess of 350 kN/m². The elastic modulus Es shall be determined as the secant modulus between average pressures applied to the plate of 150 and 350 kN/m² in the first load cycle. A value of Poisson's ratio of 0.3 shall be assumed. A second load cycle testing shall also be conducted and the results of this test compared with the first load cycle.

Generally a maximum load of 500KN/m² will be applied and the elastic modulus determined between pressures of 0.3 x maximum load and 0.7 x maximum load:

$$E = \frac{1.5 \times 0.3m \times \Delta T}{\Delta S}$$

It is preferred to determine E_v by a polynom.

5 The constrained soil modulus M* shall be determined from the elastic modulus E_v using the equation:

$$M^* = \frac{(1 - \nu)E_v}{(1 + \nu)(1 - 2\nu)} \text{ (N/mm²)}$$

where ν = Poisson's ratio to be taken as 0.3 and Es = Elastic modulus of the soil (N/mm²)

Standard Penetration resistance Tests

6 The constrained soil modulus M* of non-cohesive materials existing on site shall be determined from the relationship:

$$M^* = \frac{0.39N^{1.4}}{\gamma_m} \text{ (N/mm²)}$$

Where N = uncorrected SPT value and m = 1.3

One-dimensional Consolidation Tests

7 The constrained soil modulus M* of undrained cohesive materials existing on site shall be determined from the formula:

$$M^* = \frac{1}{m_v} \text{ (N/mm²)}$$

where m_v (mm²/N) is the coefficient of volume compressibility The value of mv to be used in the formula is that calculated from the test results for the loading increment in the consolidation test corresponding to the in situ effective overburden pressure at the level of the crown of the structure.

Number of Tests

8 Three tests for M* shall be carried out on the soil occurring on each side of the structure, one of which is to be at the level of the maximum span, unless otherwise described in Appendix 6/1.

643 Lime and Cement Stabilization to Form Capping

1 Where capping is to consist of, either wholly or in part, lime and cement stabilized material Class 9E or 9F, this Clause shall apply to the construction of

those parts which are stabilized with lime and cement.

2 Material to be stabilized with lime and cement shall be Class 6R or 7I material all complying with Clause 601 and Table 6/1.

3 Lime for lime and cement stabilization shall, as required in Appendix 6/7, be either quicklime or hydrated lime complying with BS890. Quicklime shall when sieved have 100% passing a BS 10 mm sieve and at least 95% by mass passing a BS 5 mm sieve.

4 The Contractor shall make available to the Overseeing Organisation for each source of lime a report of a chemical analysis for 'available lime' made in accordance with sub-Clause 641.2. Such reports shall be submitted to the Overseeing Organisation prior to the incorporation of lime in the Permanent Works at weekly or other intervals defined in Appendix 6/7 during periods when lime and cement stabilization is carried out.

5 Cement for lime and cement stabilization shall be Portland cement complying with Clause 1001, unless otherwise described in Appendix 6/7.

6 Classes 6R and 7I material to be stabilized shall have added to it, at any point, the percentage of its dry weight of lime and cement as determined on the demonstration area, to meet the required bearing ratio in Appendix 6/1, subject to a minimum of 1% by weight of 'available lime' and 2% cement as a percentage of the dry weight of the 6R and 7I materials.

7 The Contractor shall not carry out lime and cement stabilization when the shade temperature is below 3°C unless on a rising thermometer above 0°C. Lime and cement stabilization shall not be carried out during periods of rain or when rain is imminent. When cement is spread on material likely to cause premature hydration, processing in accordance with sub-Clause 16 of this Clause shall follow immediately.

8 Lime of quantity complying with sub-Clause 6 of this Clause shall be uniformly spread by an approved spreading machine on top of the layer to be stabilized. Using a collecting tray and balance the Contractor shall check the rate of spread by weight, once for every 500 m² of lime spread or a different rate of testing for the rate of spread as described in Appendix 6/7. At the same time the Contractor shall collect samples of lime deposited on the tray and test them for available lime content in accordance with Clause 641.

9 Unless indicated otherwise in Appendix 6/7, the material shall be stabilized in a single layer if its compacted thickness is 250 mm or less. If its compacted thickness is greater, the material shall be stabilized in layers not less than 130 mm and not more than 250 mm thick, including any cutting-in required by sub-Clause 13 of this Clause.

10 Unless indicated otherwise in Appendix 6/7, the material forming the layer to be stabilized shall be processed by pulverising and mixing in the lime by means of sufficient number of passes of an approved mobile stabilizing machine until 95% of the Class 9E or 95% of the silt and clay fraction of Class 9F

processed material passes a BS 28 mm sieve after dry sieving and the pulverisation complies with Table 6/1.

11 During processing only sufficient water shall be available in the material to slake the quicklime (if used) and to enable satisfactory mixing and compaction to be achieved. Any added water shall be through an integral spray-bar on the stabilizing machine.

12 The layer shall receive at least two passes of the stabilizing machine to pulverise and mix the lime and soil, after which the processing shall be interrupted by a period of not less than 24 hours and not greater than 72 hours to enable the lime to react with the soil. Before this period commences the surface of the layer shall be sealed with one pass of a smooth wheeled roller having a mass per metre width of roll of not less than 2700 kg or a pneumatic tyred roller of not less than 1000 kg per wheel. At the end of this period the layer shall receive one further pass of the stabilizing machine or more if required to enable the material to comply with sub-Clauses 10 of this Clause.

13 The stabilizing machine shall be equipped with a device for controlling the depth of processing which shall be maintained at the correct setting at all times. An overlap of 150 mm shall be made between adjacent passes of the stabilizing machine. Where a subsequent layer of material is placed on a layer previously stabilized the tines or blades of the stabilizing machine shall be set so that they cut into the previously stabilized layer below by at least 20 mm.

14 The appropriate quantity of cement shall be uniformly spread, by a suitable spreading machine, on top of the layer previously processed with lime. Using a collecting tray and balance the Contractor shall check the rate of spread of the machine once for every 500 m² of cement spread.

15 Unless indicated otherwise in Appendix 6/7, the material previously mixed with lime shall be stabilized with cement in a single layer or in layers of the same compacted thickness as for the lime mixed material layers, including any cutting-in required by sub-Clause 13 of this Clause.

16 Unless indicated otherwise in Appendix 6/7, the material forming the layer to be stabilized shall be processed by pulverising and mixing in the cement by means of a sufficient number of passes of an approved mobile stabilizing machine until 95% of the silt and clay fraction is reduced to particles or lumps passing a BS 28 mm sieve after dry sieving and the pulverization complies with Table 6/1.

17 During processing, only sufficient water shall be available in the material to hydrate the cement and enable satisfactory mixing and compaction to be achieved. Any added water shall be through an integral spray-bar on the stabilizing machine.

18 The stabilizing machine shall be equipped with a device for controlling the depth of processing which shall be maintained at the correct setting at all times. An overlap of 150 mm shall be made between adjacent passes of the stabilizing machine. Where a subsequent layer of material is placed on a layer previously stabilized the tines or blades of the stabilizing machine shall be set so

that they cut into the previously stabilized layer below by at least 20 mm.

19 Each layer of Class 9E or 9F processed material shall be compacted as soon as possible after the final pass of the stabilizing machine. Compaction shall be completed within 2 hours following the mixing of the cement into the material to be stabilized. Immediately before compaction Class 9E processed material shall have a Moisture Condition Value (MCV) of not greater than 12 nor less than the figure stated in Appendix 6/1 both as determined in accordance with Clause 632. Water shall be added if necessary in a uniform manner to enable this MCV requirement to be met.

20 The compaction of each layer of Class 9E or 9F material shall comply with Clause 612, Table 6/4 Method 7, except that if layers of Class 9E or 9F greater than 250 mm thickness are to be constructed, the number of passes of the compaction plant shall be determined from the results of a demonstration area as detailed in Appendix 6/7.

21 Class 9E and 9F materials shall be cured in accordance with Clause 1035. During periods when the air temperature is forecast to drop below 3°C or when ground frost is forecast Class 9E and 9F material shall be protected, to prevent freezing, for a period of 7 days from the time of completion of compaction. Such protection shall be sealed to prevent the ingress of moisture.

22 Class 9E and 9F materials shall not have other material deposited or compacted above them until such time as the required bearing ratio in Appendix 6/1 has been achieved. The relaxation allowed in sub-Clause 617.2 shall not apply before this time.

TABLE 6/1: A[illegible] Earthworks Materials: Classification Requirements (See footnotes)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability (In Addition to Requirements on Use Of Fill Materials In Clause 601 and Testing in Clause 631)				Compaction Requirements in Clause 612	Class		
							Property (See Exceptions in Previous Columns	Defined and Tested in Accordance with:	Acceptable Limits Within: Lower	Acceptable Limits Within: Upper				
GENERAL GRANULAR FILL	1	A	-	Well graded granular material	General Fill	Any material, or combination of materials, other than material designated as Class 3 in the Contract. (Properties (i), (ii) and (iv) in next column, shall not apply to chalk) Recycled aggregate Plasticity index: <6%	(i) grading	BS 1377: Part 2	Tab 6/2	Tab 6/2	Tab 6/4 Method 2	1	A	-
							(ii) uniformity coefficient	See Note 5	10	-				
							(iii) me	BS 1377: Part 2	App 6/1	App 6/1				
							(iv) MCV	Clause 632	App 6/1	App 6/1				
							(v) SMC of chalk	Clause 634	-	20%				
	1	B	-	Uniformly graded granular material	General Fill	Any material, or combination of materials, other than chalk and material designated as Class 3 in the Contract. Recycled aggregate	(i) grading	BS 1377: Part 2	Tab 6/2	Tab 6/2	Tab 6/4 Method 3	1	B	-
							(ii) uniformity coefficient	See Note 5	-	10				
							(iii) me	BS 1377: Part 2	App 6/1	App 6/1				
							(iv) MCV	Clause 632	App 6/1	App 6/1				
	1	C	-	Coarse granular material	General Fill	Any material, or combination of materials, other than material designated as Class 3 in the Contract. (Properties (i) and (ii) in next column, shall not apply to chalk). Recycled aggregate.	(i) grading	BS 1377: Part 2	Tab 6/2	Tab 6/2	Tab 6/4 Method 5	1	C	-
							(ii) uniformity coefficient	See Note 5	5	-				
							(iii) 10% fines value	Clause 635	50kN	-				
	1	D	-	Well graded Granular Material	General Fill	See type 1a	(i) to (v): See type 1a				Tab 6/4	1	D	-

TABLE 6/1: Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631)			Compaction Requirements in Clause 612	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable Limits Within: Lower	Upper			
GENERAL COHESIVE FILL	2	A	-	Wet cohesive material	General Fill	Any material, or combination of materials, other than material designated as Class 3 in the Contract. (Properties (i), (ii), (iii) lower limit and (iv) in the next column, shall not apply to chalk)	(i) grading	BS 1377 : part 2	Tab 6/2	Tab 6/2	Tab 6/4 Method 1 except; (i) for materials with liquid limit greater than 50, determined by BS1377 : Part 2, only deadweight tamping or vibratory tamping rollers or grid rollers shall be used. (ii) for chalk all types of vibratory rollers of Categories over 1800 kg shall not be used	2	A	-
							(ii) plastic limit (PL)	BS 1377 : part 2	-	-			
							(iii) mc	BS 1377 : Part 2	PL -4%	App 6/1			
							(iv) MCV	Clause 632	App 6/1	App 6/1			
							(v) Undrained shear strength of remoulded material	Clause 633	App 6/1	App 6/1			
							(vi) SMC of chalk	Clause 634	20%	App 6/1			
	2	B	-	Dry cohesive material	General Fill	Any material, or combination of materials, other than chalk	(i) grading	BS 1377 : Part 2	Tab 6/2	Tab 6/2	Tab 6/4 Method 2	2	B	-
							(ii) plastic limit (PL)	BS 1377 : Part 2	-	-			
							(iii) mc	BS 1377 : Part 2	App 6/1	PL -4%			
							(iv) MCV	Clause 632	App 6/1	App 6/1			
							(v) undrained shear strength of remoulded material	Clause 633	App 6/1	App 6/1			

TABLE 6/1: Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631)				Compaction Requirements in Clause 612	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable Limits Within:					
									Lower	Upper				
GENERAL COHESIVE FILL	2	C	-	Stony cohesive material	General Fill	Any material, or combination of materials, other than chalk	(i) grading	BS 1377 : part 2	Tab 6/2	Tab 6/2	Tab 6/4 Method 2	2	C	-
							(ii) plastic limit (PL)	BS 1377 : part 2	-	-				
							(iii) mc	BS 1377 : Part 2	App 6/1	App 6/1				
							(iv) MCV	Clause 632	App 6/1	-				
							(v) Undrained shear strength of remoulded material	Clause 633	App 6/1	-				
	2	D	-	Silty cohesive material	General Fill	Any material, or combination of materials, other than chalk	(i) grading	BS 1377 : Part 2	Tab 6/2	Tab 6/2	Tab 6/4 Method 3	2	D	-
							(ii) mc	BS 1377 : Part 2	App 6/1	App 6/1				
							(iii) MCV	Clause 632	App 6/1	App 6/1				
							(iv) undrained shear strength of remoulded material	Clause 633	App 6/1	App 6/1				
	2	E	-	Reclaimed pulverized fuel ash cohesive material Not available in Malta	General Fill	Reclaimed material from lagoon or stockpile containing not more than 20% furnace bottom ash	(i) mc	BS 1377 : Part 2	To enable compaction to Clause 612		End product 95% of maximum dry density of BS 1377 : Part 4 (2.5 kg rammer method)	2	E	-
							(ii) bulk density	BS 1377 : Part 9	App 6/1	App 6/1				

TABLE 6/1: Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631)				Compaction Requirements in Clause 612	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable Limits Within:					
									Lower	Upper				
GENERAL CHALK	FILL	3	-	-	Chalk Not available in Malta	General Fill	Chalk and associated materials all designated as Class 3 in the Contract	(i) mc	BS 1377 : Part 2	-	App 6/1	Tab 6/4 Method 4, or Method 1 or 2 if required in App 6/1. All types of vibratory rollers of Categories over 1800 kg shall not be used	3	-	-
								(ii) SMC	Clause 634	App 6/1	App 6/1				
LANDSCAPE	FILL	4	-	-	Various	Fill to landscape areas	See App 6/1	(i) grading	BS 1377 : Part 2	App 6/1	App 6/1	See Clause 620 and App 6/1	4	-	-
								(ii) mc	BS 1377 : Part 2	-	App 6/1				
								(iii) MCV	Clause 632	App 6/1	App 6/1				
TOPSOIL		5	A	-	Topsoil, or turf, existing on site	Topsoiling	Topsoil or turf designated as Class 5A in the Contract	(i) grading	Clause 618	-	Clause 618	-	5	A	-
		5	B	-	Imported topsoil	Topsoiling	General purpose grade complying with BS 3882	-	-	-	-	-	5	B	-
		5	C	-	Imported turf	Turfing	Material Complying with BS 3969	-	-	-	-	-	5	C	-

TABLE 6/1: Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631)				Compaction Requirements in Clause 612	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable Limits Within:					
									Lower	Upper				
SELECTED GRANULAR FILL	6	A	-	Selected well graded granular material	Below water	Natural gravel, natural sand, crushed gravel, crushed rock other than argillaceous rock, crushed concrete, chalk, well burnt colliery spoil or any combination thereof. (Properties (i) and (ii) in next column, shall not apply to chalk.) Recycled aggregate	(i) grading	BS 1377 : Part 2	Tab 6/2	Tab 6/2	No compaction	6	A	-
							(ii) uniformity	See Note 5	10	-				
							(iii) SMC of chalk index	Clause 634	-	20%				
							(iv) plasticity index	BS 1377 : Part 2	Non-plastic					
	6	B	-	Selected coarse granular material	Starter layer	Natural gravel, natural sand, crushed gravel, crushed rock, crushed concrete, chalk, well burnt colliery spoil, slag or any combination thereof. (Properties (ii) and (iii) in next column, shall not apply to chalk.) Recycled aggregate	(i) grading	BS 1377 : Part 2	Tab 6/2	Tab 6/2	Tab 6/4 Method 5	6	B	-
							(ii) plasticity index	BS 1377 : Part 2	Non-plastic					
							(iii) 10% fines value	Clause 635	50kN	-				
	6	C	-	Selected uniformly graded granular material	Starter layer	Natural gravel, natural sand, crushed gravel, crushed rock other than argillaceous rock, crushed concrete, chalk, well burnt colliery spoil, slag or any combination thereof. (Property (iii) in next column, shall not apply to chalk.) Recycled aggregate	(i) grading	BS 1377 : Part 2	Tab 6/2	Tab 6/2	Tab 6/4 Method 3	6	C	-
							(ii) uniformity coefficient	See Note 5	-	10				
							(iii) plasticity index	BS 1377 : Part 2	Non-plastic					
							(iv) 10% fines value	Clause 635	50kN	-				
							(v) mc	BS 1377 : Part 2	App 6/1	App 6/1				

TABLE 6/1: Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631)			Compaction Requirements in Clause 612	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable Limits Within: Lower	Upper			
SELECTED GRANULAR FILL	6	D	-	Selected uniformly graded granular material	Starter layer below pulverised fuel ash	Natural gravel, natural sand, crushed gravel, crushed rock other than argillaceous rock, crushed concrete, chalk, well burnt colliery spoil, slag or any combination thereof. Recycled aggregate	(i) grading	BS 812 : Part 103	Tab 6/2	Tab 6/2	Tab 6/4 Method 4	6	D	-
							(ii) uniformity coefficient	See Note 5	-	10			
							(iii) plasticity index	BS 1377 : Part 2	Non-plastic				
							(iv) mc	BS 1377 : Part 2	App 6/1	App 6/1			
							(v) MCV	Clause 632	App 6/1	App 6/1			
	6	E	-	Selected granular material (Class 9A)	For stabilisation with cement to form capping	Any material, or combination of materials, other than unburnt colliery spoil and argillaceous rock. (Properties (i), (ii) and (iii) in next column, shall not apply to chalk.) Recycled aggregate	(i) grading	BS 1377 : Part 2	Tab 6/2	Tab 6/2	Not applicable	6	E	-
							(ii) mc	BS 1377 : Part 2	-	App 6/1			
							(iii) liquid limit	BS 1377 : Part 2	-	45			
							(iv) plasticity index	BS 1377 : Part 2	-	20			
							(v) organic matter	BS 1377 : Part 3	-	App 6/1			
							(vi) total sulfate content	BS 1377 : Part 3	-	App 6/1			
							(vii) total sulfur content	BS 1047	-	App 6/1			
							(viii) SMC of chalk	Clause 634	-	20%			

TABLE 6/1: Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631)				Compaction Requirements in Clause 612	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable Limits Within:					
									Lower	Upper				
SELECTED GRANULAR FILL	6	F	1	Selected granular material (fine grading)	Capping	Any material, or combination of materials, other than unburnt colliery spoil argillaceous rock and chalk. Recycled aggregate	(i) grading	BS 1377 : Part 2	Tab 6/2	Tab 6/2	Tab 6/4 Method 6	6	F	1
							(ii) optimum mc	BS 1377 : Part 4 (vibrating hammer method)	-	-				
							(iii) mc	BS 1377 : Part 2	Optimum mc - 2%	Optimum mc				
							(iv) 10% fines value	Clause 635	30kN	-				
	6	F	2	Selected granular material (coarse grading)	Capping	Any material, or combination of materials, other than unburnt colliery spoil and argillaceous rock. (Property (i) in next column shall not apply to chalk.) Recycled aggregate	(i) grading	BS 1377 : Part 2	Tab 6/2	Tab 6/2	Tab 6/4 Method 6	6	F	2
							(ii) optimum mc	BS 1377 : Part 4 (vibrating hammer method)	-	-				
							(iii) mc	BS 1377 : Part 2	Optimum mc - 2%	Optimum mc				
							(iv) 10% fines value	Clause 635	App 6/1					
	6	F	3	Selected granular material	Capping	Recycled bituminous planings and granulated asphalt, but excluding materials containing tar or tar-bitumen binders. Recycled aggregate	(i) grading	BS 1377 : Part 2	Tab 6/2	Tab 6/2	Tab 6/4 Method 6 Maximum Compacted layer thickness shall be 200 mm	6	F	3
							(ii) optimum mc	Clause 613	-	-				
							(iii) mc	Clause 613	Optimum mc -2%	Optimum mc				
							(iv) bitumen content	BS 598 : Part 102	-	10%				

TABLE 6/1: Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631)				Compaction Requirements in Clause 612	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable Limits Within:					
									Lower	Upper				
SELECTED GRANULAR FILL	6	G	-	Selected granular material	Gabion filling	Natural gravel, crushed rock, crushed concrete or any combination thereof. None of these constituents shall include any argillaceous rock	(i) grading	BS 812 : Part 103	Clause 626	Clause 626	None	6	G	-
							(ii) 10% fines value	Clause 635	50kN	-				
	6	H	-	Selected granular material	Drainage layer to reinforced soil and anchorded earth structures	Natural gravel, natural sand, crushed gravel, crushed rock, crushed concrete, chalk, well burnt colliery spoil or any combination thereof. None of these constituents shall include any argillaceous rock. (Properties (vi), (vii), (viii), (ix), (x), (xi) and (xii) in next column only apply when metallic reinforcing or anchor elements, facing units or fastenings are used.) (Properties (ii) and (v) in next column shall not apply to chalk.) Recycled aggregate except recycled asphalt	(i) grading	BS 1377 : Part 2	Tab 6/2	Tab 6/2	Tab 6/4 Method 3	6	H	-
							(ii) plasticity index	BS 1377 : Part 2	Non-plastic					
							(iii) 100% fines value	Clause 635	50kN	-				
							(iv) mc	BS 1377 : Part 2	App 6/1	App 6/1				
							(v) MCV	Clause 632	App 6/1	App 6/1				
							(vi) pH value	BS 1377 : Part 3	Tab 6/3	Tab 6/3				
							(vii) chloride ion content	BS 812 : Part 117	-	Tab 6/3				
							(viii) water soluble sulfate content	BS 1377 : Part 3	-	Tab 6/3				
							(ix) resistivity	Clause 637	Tab 6/3	-				
							(x) redox potential	Clause 638	Tab 6/3	-				
							(xi) organic content	BS 1377 : Part 3	-	Tab 6/3				
							(xii) microbial activity index	Table 6/3	-	Tab 6/3				

TABLE 6/1: Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631)				Compaction Requirements in Clause 612	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable Limits Within:					
									Lower	Upper				
SELECTED GRANULAR FILL	6	1	-	Selected well graded granular material	Fill to reinforced soil and anchored earth structures	Natural gravel, natural sand, crushed gravel, crushed rock, crushed concrete, slag, chalk, well burnt colliery spoil or any combination thereof except that chalk shall not be combined with any other constituent. None of these constituents shall include any argillaceous rock. (Properties (i), (ii) and (v) in next column shall not apply to chalk.) (Properties (viii), (ix), (x), (xi), (xii), (xiii) and (xiv) only apply when metallic reinforcing or anchor elements, facing units or fastenings are used.) Recycled aggregate except recycled asphalt	(i) grading	BS 1377 : Part 2	Tab 6/2	Tab 6/2	Tab 6/4 Method 2	6	1	-
							(ii) uniformity coefficient	See Note 5	10	-				
							(iii) SMC of chalk	Clause 634	-	20%				
							(iv) mc	BS 1377 : Part 2	App 6/1	App 6/1				
							(v) MCV	Clause 632	App 6/1	App 6/1				
							(vi) effective angle of friction (φ') and effective cohesion (c')	Clause 636	App 6/1	-				
							(vii) coefficient of friction and adhesion (fill/elements)	Clause 639	App 6/1	-				
							(viii) pH value	BS 1377 : Part 3	Tab 6/3	Tab 6/3				
							(ix) chloride ion	BS 812 : Part 117	-	Tab 6/3				
							(x) water soluble sulfate content	BS 1377 : Part 3	-	Tab 6/3				
							(xi) resistivity	Clause 637	Tab 6/3	-				
							(xii) redox potential	Clause 638	Tab 6/3	-				
							(xiii) organic content	BS 1377 : Part 3	-	Tab 6/3				
							(xiv) microbial activity index	Table 6/3	-	Tab 6/3				

TABLE 6/1: Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631)			Compaction Requirements in Clause 612	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable Limits Within:				
									Lower	Upper			
SELECTED GRANULAR FILL	6	J	-	Selected uniformly graded granular material	Fill to reinforced soil and anchored earth	Natural gravel, natural sand, crushed gravel, crushed rock, crushed concrete, slag, chalk, well burnt colliery spoil or any combination thereof, except that chalk shall not be combined with any other constituent. None of these constituents shall include any argillaceous rock. (Properties (viii), (ix), (x), (xi), (xii), (xiii) and (xiv) in next column only apply when metallic reinforcing or anchor elements, facing units or fastenings are used.) (Properties (i), (ii) and (v) in next column shall not apply to chalk.) Recycled aggregate except recycled asphalt	(i) grading	BS 1377 : Part 2	Tab 6/2	Tab 6/2	Tab 6/4 Method 3	6	J	-
							(ii) uniformity coefficient	See Note 5	5	10			
							(iii) SMC of chalk	Clause 634	-	20%			
							(iv) mc	BS 1377 : Part 2	App 6/1	App 6/1			
							(v) MCV	Clause 632	App 6/1	App 6/1			
							(vi) effective angle of friction (ϕ') and effective cohesion (c')	Clause 636	App 6/1	-			
							(vii) coefficient of friction and adhesion (fill/elements)	Clause 639	App 6/1	-			
							(viii) pH value	BS 1377 : Part 3	Tab 6/3	Tab 6/3			
							(ix) chloride ion content	BS 812 : Part 117	-	Tab 6/3			
							(x) water soluble sulfate content	BS 1377 : Part 3	-	Tab 6/3			
							(xi) resistivity	Clause 637	Tab 6/3	-			
							(xii) redox potential	Clause 638	Tab 6/3	-			
							(xiii) organic content	BS 1377 : Part 3	-	Tab 6/3			
							(xiv) microbial activity index	Table 6/3	-	Tab 6/3			

TABLE 6/1: Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631)				Compaction Requirements in Clause 612	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable Limits Within:					
									Lower	Upper				
SELECTED GRANULAR FILL	6	K	-	Selected granular material	Lower bedding for corrugated steel buried structures	Natural gravel, natural sand, crushed gravel, crushed rock, crushed concrete, well burnt colliery spoil or any combination thereof. None of these constituents shall include any argillaceous rock. Recycled aggregate except recycled asphalt	(i) grading	BS 1377 : Part 2	Tab 6/2	Tab 6/2	End product 90% of maximum dry density of BS 1377 : Part 4 (Vibrating hammer method)	6	K	-
							(ii) uniformity coefficient	See Note 5	5	-				
							(iii) plasticity index	BS 1377 : Part 2	-	6				
							(iv) optimum mc	BS 1377 : Part 4 (vibrating hammer method)	-	-				
							(v) mc	BS 1377 : Part 2	Optimum mc -2%	Optimum mc +1%				
							(vi) MCV	Clause 632	App 6/1	App 6/1				
							(vii) 10% fines value	Clause 635	100kN	-				
							(viii) resistivity	Clause 637	2000 ohm cm	-				
							(ix) water soluble sulfate content	BS 1377 : Part 3	-	0.25 gms/ litre				
							(x) chloride ion content	BS 812 : Part 117	-	0.025%				
							(xi) pH value	BS 1377 : Part 3	6	9				
							(xii) sulfide and hydrogen sulfide	Standard textbook of qualitative inorganic analysis BS 812 : Part 103	-	Rapid blackening of lead acetate paper				

TABLE 6/1: Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631)			Compaction Requirements in Clause 612	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable Limits Within: Lower	Upper			
SELECTED GRANULAR	FILL	6	L	-	Selected uniformly graded granular material	Upper bedding for corrugated steel buried structures	Natural gravel, natural sand, crushed gravel, crushed rock, crushed concrete, well burnt colliery spoil or any combination thereof. None of these constituents shall include any argillaceous rock. Recycled aggregate except recycled asphalt	(i) grading	BS 812 : Part 103	Tab 6/2 (BS 882 Tab 5)	Tab 6/2	None	6	L	-
								(ii) resistivity	Clause 637	2000 ohm cm	-				
								(iii) water soluble sulfate content	BS 1377 : Part 3	-	0.25 gms/ litre				
								(iv) chloride ion content	BS 812 : Part 117	-	0.025%				
								(v) pH value	BS 1377 : Part 3	6	9				
								(vi) sulfide and hydrogen sulfide	Standard textbook of qualitative inorganic analysis	-	Rapid blackening of lead acetate paper				

TABLE 6/1: Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631)				Compaction Requirements in Clause 612	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable Limits Within:					
									Lower	Upper				
SELECTED GRANULAR FILL	6	M	-	Selected granular material	Surround to corrugated steel buried structures	Natural gravel, natural sand, crushed gravel, crushed rock, crushed concrete, well burnt colliery spoil or any combination thereof. None of these constituents shall include any argillaceous rock. Recycled aggregate except recycled asphalt	(i) grading	BS 1377 : Part 2	Tab 6/2	Tab 6/2	End product 90% of maximum dry density of BS 1377 : Part 4 (Vibrating hammer method) unless otherwise stated in App 6/1	6	M	-
							(ii) uniformity coefficient	See Note 5	5	-				
							(iii) plasticity index	BS 1377 : Part 2	-	6				
							(iv) optimum mc	BS 1377 : Part 4 (vibrating hammer method)	-	-				
							(v) mc	BS 1377 : Part 2	Optimum mc -2%	Optimum mc +1%				
							(vi) MCV	Clause 632	App 6/1	App 6/1				
							(vii) 100% fines value	Clause 635	100kN	-				
							(viii) resistivity	Clause 637	2000 ohm cm	-				
							(ix) water soluble sulfate content	BS 1377 : Part 3	-	0.25 gms/ litre				
							(x) chloride ion content	BS 812 : Part 117	-	0.025%				
							(xi) pH value	BS 1377 : Part 3	6	9				
							(xii) sulfide and hydrogen sulfide	Standard textbook of qualitative inorganic analysis	-	Rapid blackening of lead acetate paper				

TABLE 6/1: Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631)			Compaction Requirements in Clause 612	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable Limits Within: Lower	Acceptable Limits Within: Upper				
SELECTED GRANULAR	FILL	6	N	-	Selected well graded granular material	Fill to structures	Natural gravel, natural sand, crushed gravel, crushed rock, crushed concrete, slag, well burnt colliery spoil or any combination thereof. None of these constituents shall include any argillaceous rock. Recycled aggregate except recycled asphalt	(i) grading	BS 1377 : Part 2	Tab 6/2	Tab 6/2	End product 95% of maximum dry density of BS 1377 : Part 4 (vibrating hammer method)	6	N	-
								(ii) uniformity coefficient	See Note 5	10	-				
								(iii) 10% fines value	Clause 635	100kN	-				
								(iv) undrained shear parameters (c and φ)	Clause 633	App 6/1	-				
								(v) effective angle of internal friction (φ') and effective cohesion (c')	Clause 636	App 6/1	-				
								(vi) permeability	Clause 640	App 6/1	-				
								(vii) mc	BS 1377 : Part 2	App 6/1	App 6/1				
								(viii) MCV	Clause 632	App 6/1	App 6/1				
								(ix) slope stability test (where required in App 6/6)	Clause 610	App 6/6					

TABLE 6/1: Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631)			Compaction Requirements in Clause 612	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable Limits Within:				
									Lower	Upper			
SELECTED GRANULAR FILL	6	P	-	Selected granular material	Fill to structures	Natural gravel, natural sand, crushed gravel, crushed rock, crushed concrete, slag, chalk, well burnt colliery spoil or any combination thereof. None of these constituents shall include any argillaceous rock. (Properties (i), (ii) and (ix) in next column shall not apply to chalk.) Recycled aggregate except recycled asphalt	(i) grading	BS 1377 : Part 2	Tab 6/2	Tab 6/2	End product 95% of maximum dry density of BS 1377 : Part 4 (vibrating hammer method)	6	P	-
							(ii) uniformity coefficient	See Note 5	5	-			
							(iii) SMC of chalk	Clause 634	-	20%			
							(iv) 10% fines value	Clause 635	30kN	-			
							(v) undrained shear parameters (c and φ)	Clause 633	App 6/1	-			
							(vi) effective angle of internal friction (φ') and effective cohesion (c')	Clause 636	App 6/1	-			
							(vii) permeability	Clause 640	App 6/1	-			
							(viii) mc	BS 1377 : Part 2	App 6/1	App 6/1			
							(ix) MCV	Clause 632	App 6/1	App 6/1			
							(x) slope stability test (where required in App 6/6)	Clause 610	App 6/6				

TABLE 6/1: Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631)				Compaction Requirements in Clause 612	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable Limits Within:					
									Lower	Upper				
SELECTED GRANULAR FILL	6	Q	-	Well graded uniformly graded or coarse granular material	Overlying fill for corrugated steel buried structures	As Class 1A, 1B or 1C granular fill materials, but not to include argillaceous rock, slag or PFA in any proportions. Recycled aggregate except recycled asphhalt	As for Class 1A, 1B or 1C with the addition of the following:					6	Q	-
							(i) water soluble sulfate content	BS 1377 : Part 3	-	0.25 gms/ litre				
							(ii) chloride ion content	BS 812 : Part 117	-	0.025%				
							(iii) pH value	BS 1377 : Part 3	6	9				
							(iv) sulfide and hydrogen sulfide	Standard textbook of qualitative inorganic analysis	-	Rapid blackening of lead acetate paper				
	6	R	-	Selected granular material	For stabilisation with lime and cement to form capping (Class 9F)	Any material, or combination of materials, other than unburnt colliery spoil and argillaceous rock. (Properties (i), (ii) and (iii) in next column, shall not apply to chalk.)	(i) grading	BS 1377 : Part 2	Tab 6/2	Tab 6/2	Not applicable	6	R	-
							(ii) mc	BS 1377 : Part 2	App 6/1	-				
							(iii) liquid limit	BS 1377 : Part 2	-	45				
							(iv) plasticity index	BS 1377 : Part 2	-	20				
							(v) organic matter	BS 1377 : Part 3	-	App 6/1				
							(vi) total sulfate content	BS 1377 : Part 3	-	App 6/1				
							(vii) total sulfur content	BS 1047	-	App 6/1				
							(viii) SMC of chalk	Clause 634	-	20%				

TABLE 6/1: Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631)			Compaction Requirements in Clause 612	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable Limits Within:				
									Lower	Upper			
SELECTED COHESIVE	FILL	7	A	-	Selected cohesive material	Fill to structures	Any material or combination of materials, other than argillaceous rock and materials designated as Class 3 in the Contract. If chalk is used it shall form 100% of constituents. (Properties (i) and (iii) shall not apply to chalk.) (Properties (vii) and (viii) may be increased to 54% and 31% respectively for Lias Clay only and subject to the requirements of Appendix 6/6)	(i) grading	BS 1377 : Part 2	Tab 6/2	Tab 6/2	End product: 100% of maximum dry density of BS 1377 : Part 4 (2.5 kg rammer method) or a dry density corresponding to 5% air voids at field mc whichever is lower	7	A	-
							(ii) mc	BS 1377 : Part 2	App 6/1	App 6/1			
							(iii) MCV	Clause 632	App 6/1	App 6/1			
							(iv) undrained shear parameters (c and φ)	Clause 633	App 6/1	App 6/1			
							(v) effective angle of internal friction (φ') and effective cohesion (c')	Clause 636	App 6/1	App 6/1			
							(vi) SMC of chalk	Clause 634	App 6/1	App 6/1			
							(vii) liquid limit	BS 1377 : Part 2	-	45			
							(viii) plasticity index	BS 1377 : Part 2	-	25			

TABLE 6/1: Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631)			Compaction Requirements in Clause 612	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable Limits Within: Lower / Upper				
SELECTED COHESIVE	FILL	7	B	-	Selected conditioned pulverised fuel ash cohesive material Not available in Malta	Fill to structures and to reinforced soil	Conditioned material direct from power station dust collection system and to which a controlled quantity of water has been added	(i) mc	BS 1377 : Part 2	To enable compaction to Clause 612		End product: 95% of maximum dry density of BS 1377 : Part 4 (2.5 kg rammer method)	7	B	-
								(ii) bulk density	BS 1377 : Part 9	App 6/1	App 6/1				
								(iii) undrained shear parameters (c and φ)	Clause 633	App 6/1	-				
								(iv) effective angle of internal friction (φ') and effective cohesion (c')	Clause 636	App 6/1	-				
								(v) coefficient of friction and adhesion (fill/elements)	Clause 639	App 6/1	-				
								(vi) permeability	Clause 640	App 6/1	-				
								(vii) slope stability test (where required in App 6/6)	Clause 610	App 6/6					

TABLE 6/1: Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631)				Compaction Requirements in Clause 612	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable Limits Within:					
									Lower	Upper				
SELECTED COHESIVE FILL	7	C	-	Selected wet cohesive material	Fill to reinforced soil	Any material, or combination of materials, other than unburnt colliery spoil, argillaceous rock and chalk. (Properties (viii), (ix), (x), (xi) and (xii) in next column only apply when metallic reinforcing elements, facing units or fastenings are used)	(i) grading	BS 1377 : Part 2	Tab 6/2	Tab 6/2	Tab 6/4 Method 1	7	C	-
							(ii) mc	BS 1377 : Part 2	App 6/1	App 6/1				
							(iii) MCV	Clause 632	App 6/1	App 6/1				
							(iv) effective angle of internal friction (φ') and effective cohesion (c')	Clause 636	App 6/1	-				
							(v) coefficient of friction and adhesion (fill/elements)	Clause 639	App 6/1	-				
							(vi) liquid limit	BS 1377 : Part 2	-	45				
							(vii) plasticity index	BS 1377 : Part 2	-	25				
							(viii) pH value	BS 1377 : Part 3	Tab 6/3	Tab 6/3				
							(ix) chloride ion content	BS 812 : Part 117	-	Tab 6/3				
							(x) water soluble sulfate content	BS 1377 : Part 3	-	Tab 6/3				
							(xi) resistivity	Clause 637	Tab 6/3	-				
							(xii) redox potential	Clause 638	Tab 6/3	-				

TABLE 6/1: Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631)			Compaction Requirements in Clause 612	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable Limits Within:				
									Lower	Upper			
SELECTED COHESIVE FILL	7	D	-	Selected stony cohesive material	Fill to reinforced soil	Any material, or combination of materials, other than unburnt colliery spoil, argillaceous rock and chalk. (Properties (vi), (vii), (viii), (ix), (x), (xi) and (xii) in next column only apply when metallic reinforcing elements, facing units or fastenings are used)	(i) grading	BS 1377 : Part 2	Tab 6/2	Tab 6/2	Tab 6/4 Method 2	7	D	-
							(ii) mc	BS 1377 : Part 2	App 6/1	App 6/1				
							(iii) MCV	Clause 632	App 6/1	App 6/1				
							(iv) effective angle of internal friction (φ') and effective cohesion (c')	Clause 636	App 6/1	-				
							(v) coefficient of friction and adhesion (fill/elements)	Clause 639	App 6/1	-				
							(vi) liquid limit	BS 1377 : Part 2	-	45				
							(vii) plasticity index	BS 1377 : Part 2	-	25				
							(viii) pH value	BS 1377 : Part 3	Tab 6/3	Tab 6/3				
							(ix) chloride ion content	BS 812 : Part 117	-	Tab 6/3				
							(x) water soluble sulfate content	BS 1377 : Part 3	-	Tab 6/3				
							(xi) resistivity	Clause 637	Tab 6/3	-				
							(xii) redox potential	Clause 638	Tab 6/3	-				

TABLE 6/1: Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631)			Compaction Requirements in Clause 612	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable Limits Within: Lower	Acceptable Limits Within: Upper				
SELECTED COHESIVE FILL	7	E	-	Selected cohesive material	For stabilisation with lime to form capping (Class 9D)	Any material, or combination of materials, other than unburnt colliery spoil	(i) grading	BS 1377 : Part 2	Tab 6/2	Tab 6/2	Not applicable	7	D	-
							(ii) mc	BS 1377 : Part 2	-	App 6/1				
							(iii) MCV	Clause 632	App 6/1	-				
							(iv) plasticity index	BS 1377 : Part 2	10	-				
							(v) organic matter	BS 1377 : Part 3	-	App 6/1				
							(vi) total sulfate content	BS 1377 : Part 3	-	App 6/1				
							(vii) total sulfur content	BS 1047	-	App 6/1				
	7	F	-	Selected silty cohesive material	For stabilisation with cement to form capping (Class 9B)	Any material, or combination of materials, other than chalk, unburnt colliery spoil and argillaceous rock	(i) grading	BS 1377 : Part 2	Tab 6/2	Tab 6/2	Not applicable	7	F	-
							(ii) uniformity coefficient	See Note 5	5	-				
							(iii) mc	BS 1377 : Part 2	App 6/1	App 6/1				
							(iv) MCV	Clause 632	App 6/1	App 6/1				
							(v) liquid limit	BS 1377 : Part 2	-	45				
							(vi) plasticity index	BS 1377 : Part 2	-	20				
							(vii) organic matter	BS 1377 : Part 3	-	App 6/1				
							(viii) total sulfate content	BS 1377 : Part 3	-	App 6/1				
							(ix) total sulfur content	BS 1047	-	App 6/1				

TABLE 6/1: Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631)			Compaction Requirements in Clause 612	Class		
							Property (See exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable Limits Within: Lower	Acceptable Limits Within: Upper				
SELECTED COHESIVE FILL	7	G	-	Selected conditioned PFA cohesive material (Not available in Matla	For stabilisation with cement to form capping (Class 9C)	Conditioned material direct from power station dust collection system and to which a controlled quantity of water has been added	(i) mc	BS 1377 : Part 2	App 6/1	App 6/1	Not applicable	7	G	-
							(ii) total sulfate content	BS 1377 : Part 3	-	1%				
	7	H	-	Wet, dry, stony or silty cohesive material and chalk	Overlying fill for corrugated steel buried structures	As Class 2A, 2B, 2C, 2D general cohesive fill material or Class 3 chalk fill material, except that argillaceous rock, slag, PFA or any combination thereof shall not be used	As for Class 2A, 2B, 2C, 2D or 3 with the addition of the following					7	H	-
							(i) water soluble sulfate content	BS 1377 : Part 3	-	0.25 gms/litre				
							(ii) chloride ion content	BS 812 : Part 117	-	0.025%				
							(iii) pH value	BS 1377 : Part 3	6	9				
	7	I	-	Selected cohesive material	For stabilisation with lime and cement to form capping (Class 9E)	Any material, or combination of materials, other than unburnt colliery spoil	(i) grading	BS 1377 : Part 2	Tab 6/2	Tab 6/2	Not applicable	7	I	
							(ii) mc	BS 1377 : Part 2	-	App 6/1				
							(iii) MCV	Clause 632	App 6/1	-				
							(iv) plasticity index	BS 1377 : Part 2	10	-				
							(v) organic matter	BS 1377 : Part 3	-	App 6/1				
							(vi) total sulfate content	BS 1377 : Part 3	-	App 6/1				
							(vii) total sulfur content	BS 1047	-	App 6/1				

TABLE 6/1: Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631)				Compaction Requirements in Clause 612	Class		
							Property (See exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable Limits Within:					
									Lower	Upper				
MISC FILL	8	-	-	Class 1, Class 2 or Class 3 material	Lower trench fill	Any; except there shall not be any stones or lumps of clay >40 mm nominal diameter. Recycled aggregate	(i) mc	BS 1377 : Part 2	App 6/1	App 6/1	Tab 6/4	8	-	-
							(ii) MCV	Clause 632	App 6/1	App 6/1				
STABILISED MATERIALS	9	A	-	Cement stabilised well graded granular material	Capping	Class 6E with addition of cement according to Clause 614	(i) pulverisation	BS 1924 : Part 2	60%	-	Tab 6/4 Method 6	9	A	-
							(ii) bearing ratio	BS 1924 : Part 2	App 6/1	-				
							(iii) mc	BS 1924 : Part 2	App 6/1	App 6/1				
	9	B	-	Cement stabilised silty cohesive material Not available in Malta	Capping	Class 7F with addition of cement according to Clause 614	(i) pulverisation	BS 1924 : Part 2	App 6/1	-	Tab 6/4 Method 7	9	B	-
							(ii) MCV immediately before compaction	Clause 632	App 6/1	12				
							(iii) bearing ratio	BS 1924 : Part 2	App 6/1	-				
							(iv) mc	BS 1924 : Part 2	App 6/1	App 6/1				
	9	C	-	Cement stabilised conditioned pulverised fuel ash cohesive material	Capping	Class 7G with addition of cement according to Clause 614	(i) pulverisation	BS 1924 : Part 2	60%	-	End product 95% of maximum dry density of BS 1924 : Part 2 (2.5 kg rammer method)	9	C	-
							(ii) bearing ratio	BS 1924 : Part 2	App 6/1	-				
							(iii) mc	BS 1924 : Part 2	To enable compaction to Clause 612					
	9	D	-	Lime stabilised cohesive material	Capping	Class 7E with addition of lime according to Clause 615	(i) pulverisation	BS 1924 : Part 2	30%	-	Tab 6/4 Method 7	9	D	-
							(ii) MCV immediately before compaction	Clause 632	App 6/1	App 6/1				
							(iii) bearing ratio	BS 1924 : Part 2	App 6/1	-				
							(iv) mc	BS 1924: Part 2	App 6/1	App 6/1				

TABLE 6/1: Acceptable Earthworks Materials: Classification and Compaction Requirements (See footnotes) (continued)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability (In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631)			Compaction Requirements in Clause 612	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable Limits Within:				
									Lower	Upper			
STABILISED MATERIALS	9	E	-	Lime and cement stabilised cohesive material	Capping	Class 7I with addition of lime and cement according to Clause 643	(i) pulverisation	BS 1924 : Part 2	30%	-	Tab 6/4 Method 7	9	E	-
							(ii) MCV immediately before completion	Clause 632	App 6/1	App 6/1				
							(iii) bearing ratio	BS 1924 : Part 2	App 6/1	-				
							(iv) mc	BS 1924 : Part 2	App 6/1	App 6/1				
	9	F	-	Lime and cement stabilised well graded granular material	Capping	Class 6R with addition of lime and cement according to Clause 643	(i) pulverisation	BS 1924 : Part 2	60%	-	Tab 6/4 Method 6	9	F	-
							(ii) bearing ratio	BS 1924 : Part 2	App 6/1	-				
							(iii) mc	BS 1924 : Part 2	App 6/1	App 6/1				

Footnotes to Table 6/1

1. App = Appendix
2. Tab = Table
3. Where in the Acceptable Limits column reference is made to App 6/1, only those properties having limits ascribed to them in Appendix 6/1 shall apply. Where Appendix 6/1 gives limits for other properties not listed in this Table such limits shall also apply.
4. Where BS 1377 : Part 2 is specified for mc, this shall mean BS 1377 : Part 2 or BS 812 : Part 3 as appropriate.
5. Uniformity coefficient is defined as the ratio of the particle diameters D_{60} to D_{10} on the particle-size distribution curve, where:
   D_{60} = particle diameter at which 60% of the soil by weight is finer
   D_{10} = particle diameter at which 10% of the soil by weight is finer

Table 6/2: Grading Requirements for Acceptable Earthwork Materials

Percentage By Mass Passing the Size Shown																					
Class	**Size (mm)**		**Size (mm) BS Series**													**Size (microns) BS Series**				**Size (microns)**	**Class**
	500	300	125	90	75	37.5	28	20	14	10	6.3	5	3.35	2	1.18	600	300	150	63	2	
1A		100	95-100											<55		<35			<15		1A
1B			100																<15		1B
1C	100		10-95													0-.25			<15		1C
1D					100				<75					<50			<30		<15		1D
2A &2B			100											80-100					15-100		2A &2B
2C			100											15-80					15-100		2C
2D			100																15-80	0-20	2D
6A	100									0-100		0-85				0-45			80-100		6A
6B	100		0-10																0-5		6B
6C			100			0-100					0-100		0-35	0-10		0-2					6C
6D										100		89-100		60-100	30-100	15-80	5-48	0-15 except 0-20 for crushed rock			6D
6E & 6R			100	85-100						25-100						10-100					6E & 6R
6F1					100	75-100				40-95		30-85				10-50			<15		6F1
6F2			100	80-100	65-100	45-100				15-60		10-45				0-25			<15		6F2
6F3			100	80-100	65-100	45-100				15-60		10-45				0-25			0-12		6F3
6H								100				60-100			15-45	0-25		0-5	0-12		6H
6I & 6J			100		85-100				25-100					15-100		9-100					6I & 6J
6K								100											<15		6K
6L										100		89-100		60-100	30-100	15-100	5-70	0-15 except 0-20 for crushed rock	0-10		6L

TABLE 6/2: Grading Requirements for Acceptable Earthworks Materials (continued)

Percentage by Mass Passing the Size Shown																					
Class	Size (mm)		Size(mm) BS Series													Size (microns) BS Series				Size (micr-ons)	Class
	500	300	125	90	75	37.5	28	20	14	10	6.3	5	3.35	2	1.18	600	300	150	63	2	
6M					100														0-10		6M
6N & 6P					100														<15		6N & 6P
7A					100														15-100		7A
7C			100		85-100				83-100					80-100		60-100			15-45	0-20	7C
7D			100		85-100				40-90					15-79		15-75			15-45	0-20	7D
7E					100		95-100												15-100		7E
7F			100																15-100		7F
7I					100		95-100												15-100		7I

TABLE 6/3: Limits of Material Properties of Fill for Use With Metal Components in Reinforced Soil and Anchored Earth Structures for Class 6H, 6I, 6J, 7C and 7D Materials

Reinforcing Element Material	Properties of Fill							
	PhValue		Max Chloride Ion Content	Max Organic Content	Max Water Soluble Sulfate Content	Minimum Resistivity	Minimum Redox Potential	Microbial Activity Index
	Min	Max	%	%	grams/litre	ohms.cm	volts	
Galvanised Steel	6	9	0.025	0.2	0.25	5000	0.43	) Less than 5
Stainless Steel	5	10	0.025	0.2	0.5	3000	0.35	) Less than 5

NOTES:

1 A method of calculating the Microbial Activity Index may be obtained by reference to TRRL Contractor Report 54 'Soil Corrosivity Assessment'.

2 The corrosion potential of frictional fill shall be assessed from resistivity, pH, chloride and soluble sulfate tests. For cohesive soil it will be necessary to test additionally for organic content. Should either organic content or sulfate be in excess of the specified levels, then tests shall also be included for Redox Potential and Microbial Activity Index. Further information may be obtained by reference to TRRL Contractor Report 54.

3 Methods of test (except for Microbial Activity Index) are given in BS 1377 : Part 3.

TABLE 6/4: Method Compaction for Earthworks Materials: Plant and Methods (Method 1 to Method 6)
(This Table is to be read in conjunction with sub-Clause 612.10)

Type of Compaction Plant	Ref No.	Category	Method 1		Method 2		Method 3		Method 4		Method 5		Method 6		
			D	N#	D	N#	D	N#	D	N	D	N	N for D = 110 mm	N for D = 150 mm	N for D = 250 mm
Smoothed wheeled roller (or vibratory roller operating without vibration)		Mass per metre width of roll:													
	1	over 2100 kg up to 2700 kg	125	8	125	10	125	10*	175	4	unsuitable		unsuitable	unsuitable	unsuitable
	2	over 2700 kg up to 5400 kg	125	6	125	8	125	8*	200	4	unsuitable		16	unsuitable	unsuitable
	3	over 5400 kg	150	4	150	8	unsuitable		300	4	unsuitable		8	16	unsuitable
Grid roller		Mass per metre width of roll:													
	1	over 2700 kg up to 5400 kg	150	10	unsuitable		150	10	250	4	unsuitable		unsuitable	unsuitable	unsuitable
	2	over 5400 kg up to 8000 kg	150	8	125	12	unsuitable		325	4	unsuitable		20	unsuitable	unsuitable
	3	over 8000 kg	150	4	150	12	unsuitable		400	4	unsuitable		12	20	unsuitable
Deadweight tamping roller		Mass per metre width of roll:													
	1	over 4000 kg up to 6000 kg	225	4	150	12	250	4	350	4	unsuitable		12	20	unsuitable
	2	over 6000 kg	300	5	200	12	300	3	400	4	unsuitable		8	12	20
Pneumatic-tyred roller		Mass per wheel:													
	1	over 1000 kg up to 1500 kg	125	6	unsuitable		150	10*	240	4	unsuitable		unsuitable	unsuitable	unsuitable
	2	over 1500 kg up to 2000 kg	150	5	unsuitable		unsuitable		300	4	unsuitable		unsuitable	unsuitable	unsuitable
	3	over 2000 kg up to 2500 kg	175	4	125	12	unsuitable		350	4	unsuitable		unsuitable	unsuitable	unsuitable
	4	over 2500 kg up to 4000 kg	225	4	125	10	unsuitable		400	4	unsuitable		unsuitable	unsuitable	unsuitable
	5	over 4000 kg up to 6000 kg	300	4	125	10	unsuitable		unsuitable		unsuitable		12	unsuitable	unsuitable
	6	over 6000 kg up to 8000 kg	350	4	150	8	unsuitable		unsuitable		unsuitable		12	unsuitable	unsuitable
	7	over 8000 kg up to 12000 kg	400	4	150	8	unsuitable		unsuitable		unsuitable		10	16	unsuitable
	8	over 12000 kg	450	4	175	6	unsuitable		unsuitable		unsuitable		8	12	unsuitable
Vibratory tamping roller		Mass per metre width of a vibrating roll:													
	1	over 700 kg up to 1300 kg	100	12	100	12	150	12	100	10	unsuitable		unsuitable	unsuitable	unsuitable
	2	over 1300 kg up to 1800 kg	125	12	125	12	175	12*	175	8	unsuitable		12	unsuitable	unsuitable
	3	over 1800 kg up to 2300 kg	150	12	150	12	200	12*	unsuitable		unsuitable		8	12	unsuitable
	4	over 2300 kg up to 2900 kg	150	9	150	9	250	12*	unsuitable		400	5	6	10	unsuitable
	5	over 2900 kg up to 3600 kg	200	9	200	9	275	12*	unsuitable		500	6	6	10	unsuitable
	6	over 3600 kg up to 4300 kg	225	9	225	9	300	12*	unsuitable		600	6	4	8	unsuitable
	7	over 4300 kg up to 5000 kg	250	9	250	9	300	9*	unsuitable		700	6	3	7	12
	8	over 5000 kg	275	9	275	9	300	7*	unsuitable		800	6	3	6	10

TABLE 6/4: Method Compaction for Earthworks Materials: plant and Methods (Method 1 to Method 6)
(This Table is to be read in conjunction with sub-Clause 612.10)

Type of Compaction Plant	Ref No.	Category	Method 1		Method 2		Method 3		Method 4		Method 5		Method 6		
			D	N#	D	N#	D	N#	D	N	D	N	N for D = 110 mm	N for D = 150 mm	N for D = 250 mm
Vibratory roller		Mass per metre width of a vibratory roll:													
	1	over 270 kg up to 450 kg	unsuitable		75	16	150	16	unsuitable		unsuitable		unsuitable	unsuitable	unsuitable
	2	over 450 kg up to 700 kg	unsuitable		75	12	150	12	unsuitable		unsuitable		unsuitable	unsuitable	unsuitable
	3	over 700 kg up to 1300 kg	100	12	125	10	150	6	125	10	unsuitable		16	unsuitable	unsuitable
	4	over 1300 kg up to 1800 kg	125	8	150	8	200	10*	175	4	unsuitable		6	16	unsuitable
	5	over 1800 kg up to 2300 kg	150	4	150	4	225	12*	unsuitable		unsuitable		4	6	12
	6	over 2300 kg up to 2900 kg	175	4	175	4	250	10*	unsuitable		400	5	3	5	11
	7	over 2900 kg up to 3600 kg	200	4	200	4	275	8*	unsuitable		500	5	3	5	10
	8	over 3600 kg up to 4300 kg	225	4	225	4	300	8*	unsuitable		600	5	2	4	8
	9	over 4300 kg up to 5000 kg	250	4	250	4	300	6*	unsuitable		700	5	2	4	7
	10	over 5000 kg	275	4	275	4	300	4*	unsuitable		800	5	2	3	6
Vibrating plate compactor		Mass per m^2 of base plate:													
	1	over 880 kg up to 1100 kg	unsuitable		unsuitable		75	6	unsuitable		unsuitable		unsuitable	unsuitable	unsuitable
	2	over 1100 kg up to 1200 kg	unsuitable		75	10	100	6	75	10	unsuitable		unsuitable	unsuitable	unsuitable
	3	over 1200 kg up to 1400 kg	unsuitable		75	6	150	6	150	8	unsuitable		unsuitable	unsuitable	unsuitable
	4	over 1400 kg up to 1800 kg	100	6	125	6	150	4	unsuitable		unsuitable		8	unsuitable	unsuitable
	5	over 1800 kg up to 2100 kg	150	6	150	5	200	4	unsuitable		unsuitable		5	8	unsuitable
	6	over 2100 kg	200	6	200	5	250	4	unsuitable		unsuitable		3	6	12
Vibro-tamper		Mass:													
	1	over 50 kg up to 65 kg	100	3	100	3	150	3	125	3	unsuitable		4	8	unsuitable
	2	over 65 kg up to 75 kg	125	3	125	3	200	3	150	3	unsuitable		3	6	12
	3	over 75 kg up to 100 kg	150	3	150	3	225	3	175	3	unsuitable		2	4	10
	4	over 100 kg	225	3	200	3	225	3	250	3	unsuitable		2	4	10
Power rammer		Mass:													
	1	100 kg up to 500 kg	150	4	150	6	unsuitable		200	4	unsuitable		5	8	unsuitable
	2	over 500 kg	275	8	275	12	unsuitable		400	4	unsuitable		5	8	14
Dropping-weight compactor		Mass of rammer over 500 kg weight drop:													
	1	over 1 m up to 2 m	600	4	600	8	450	8	unsuitable		unsuitable		unsuitable	unsuitable	unsuitable
	2	over 2 m	600	2	600	8	unsuitable		unsuitable		unsuitable		unsuitable	unsuitable	unsuitable

TABLE 6/4: Method Compaction for Earthworks Materials: Plant and Methods (Method 7)
(This Table is to be read in conjunction with sub-Clause 612.10)

Type of Compaction Plant	Ref No.	Category	Method 7	
			N for D = 150 mm	N for D = 250 mm
Smooth wheeled roller (or vibratory roller operating without vibration)		Mass per metre width of roll:		
	1	over 2100 kg up to 2700 kg	unsuitable	unsuitable
	2	over 2700 kg up to 5400 kg	unsuitable	unsuitable
	3	over 5400 kg	12	unsuitable
Grid roller		Mass per metre width of roll:		
	1	over 2700 kg up to 5400 kg	unsuitable	unsuitable
	2	over 5400 kg up to 8000 kg	16	unsuitable
	3	over 8000 kg	8	unsuitable
Deadweight tamping roller		Mass per metre width of roll:		
	1	over 4000 kg up to 6000 kg	4	8
	2	over 6000 kg	3	6
Pneumatic-tyred roller		Mass per wheel:		
	1	over 1000 kg up to 1500 kg	unsuitable	unsuitable
	2	over 1500 kg up to 2000 kg	12	unsuitable
	3	over 2000 kg up to 2500 kg	6	unsuitable
	4	over 2500 kg up to 4000 kg	5	unsuitable
	5	over 4000 kg up to 6000 kg	4	16
	6	over 6000 kg up to 8000 kg	unsuitable	8
	7	over 8000 kg up to 12000 kg	unsuitable	4
	8	over 12000 kg	unsuitable	4
Vibratory tamping roller		Mass per metre width of vibrating roll:		
	1	over 700 kg up to 1300 kg	unsuitable	unsuitable
	2	over 1300 kg up to 1800 kg	unsuitable	unsuitable
	3	over 1800 kg up to 2300 kg	16	unsuitable
	4	over 2300 kg up to 2900 kg	12	unsuitable
	5	over 2900 kg up to 3600 kg	10	unsuitable
	6	over 3600 kg up to 4300 kg	8	16
	7	over 4300 kg up to 5000 kg	7	14
	8	over 5000 kg	6	12
Vibratory roller		Mass per metre width of vibrating roll:		
	1	over 270 kg up to 450 kg	unsuitable	unsuitable
	2	over 450 kg up to 700 kg	unsuitable	unsuitable
	3	over 700 kg up to 1300 kg	unsuitable	unsuitable
	4	over 1300 kg up to 1800 kg	unsuitable	unsuitable
	5	over 1800 kg up to 2300 kg	12	unsuitable
	6	over 2300 kg up to 2900 kg	10	unsuitable
	7	over 2900 kg up to 3600 kg	10	unsuitable
	8	over 3600 kg up to 4300 kg	8	unsuitable
	9	over 4300 kg up to 5000 kg	8	unsuitable
	10	over 5000 kg	6	12
Vibratory plate compactor		Mass per m^2 of base plate:		
	1	over 880 kg up to 1100 kg	unsuitable	unsuitable
	2	over 1100 kg up to 1200 kg	unsuitable	unsuitable
	3	over 1200 kg up to 1400 kg	unsuitable	unsuitable
	4	over 1400 kg up to 1800 kg	10	unsuitable
	5	over 1800 kg up to 2100 kg	8	unsuitable
	6	over 2100 kg	6	unsuitable
Vibro-tamper		Mass:		
	1	over 50 kg up to 65 kg	unsuitable	unsuitable
	2	over 65 kg up to 75 kg	unsuitable	unsuitable
	3	over 75 kg up to 100 kg	unsuitable	unsuitable
	4	over 100 kg	8	unsuitable
Power rammer		Mass:		
	1	100 kg up to 500 kg	8	unsuitable
	2	over 500 kg	6	10
Dropping weight compactor		Mass of rammer over 500 kg height drop:		
	1	over 1 m up to 2 m	unsuitable	unsuitable
	2	over 2 m	unsuitable	unsuitable

TABLE 6/5 : (05/01) Records and Reports - Information Required

Ground Treatment	In situ Testing
For each column/area treated: Date Contract title Area identification Unique grid location Ground level at commencement Material used Approximate column diameter Depth of penetration of each compaction point Vibrator power consumption during operation Jetting pressure (where applicable) Duration of penetration Duration of compaction Obstructions and delays Number and type of tests carried out	For each area tested: Date Contract Title Area identification Test position, co-ordinates and level Method of test used All information required by appropriate British Standard test procedure

ROAD PAVEMENTS - GENERAL

Contents

ROAD PAVEMENTS – GENERAL

701 Pavement Construction

1 Road pavements shall be constructed from one of the permitted options described in Appendix 7/1 and in compliance with this Series and the appropriate Clauses of Series 800, 900 and 1000.

The naming of the various pavement layers according to BS will be subject to change over the next few years to reflect European harmonisation: Wearing Course will become Surfacing, Basecourse will become Binder Course and Roadbase will become Base Course. Cement Stabilisation as described in the 'Directives for The Standardization of Pavements for Traffic Areas' will become Cement Bound Material (CBM). Specification uses the new namings.

2 The Contractor shall, in his choice of permitted materials for sub-bases (foundation course or Cement bound material) and base courses, have regard to the nature of those materials and of the subgrade or any capping and the need to protect them from deterioration due to the ingress of water, the adverse effects of weather and the use of construction plant. The Contractor shall programme the laying and compaction of the sub-base and the subsequent pavement courses and take such other steps as may be considered necessary, to provide protection to the base course, sub-base and subgrade.

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

Horizontal Alignments

1 Horizontal alignments shall be determined from one edge of the pavement surface as described in Appendix 1/12. The edge of the pavement as constructed and all other parallel alignments shall be correct within a tolerance of 25mm therefrom, except for kerbs, channel blocks and edge lines which shall be laid with a smooth alignment within a tolerance of ±13 mm.

Surface Levels and Thickness of Pavement Courses

2 The design levels of pavement courses shall be calculated from the vertical profile, crossfalls and the pavement course thicknesses described in Appendix 7/1. The level of any point on the constructed surface of the pavement courses shall be the design level subject to the appropriate tolerances stated in Table 7/1.

TABLE 7/1: Tolerances in Surface Levels of Pavement Courses

Road surfaces	
-Wearing course on binder course	± 4mm
-Wearing course on base course	± 6mm
-Adjacent to a surface water channel*	+ 5 to +10mm
-Combined base / wearing course	± 10mm
Binder course*	± 6mm
Asphalt base course*	± 10mm
Unbound base course*	± 20mm
Foundation course	± 20mm
Cement bound material	
-Below asphalt course	± 15mm
-Below unbound course	± 20mm
Formation level	
-Below course with binder	± 20mm
-Below unbound course	± 25mm

Where a surface water channel is laid before the adjacent road pavement layer the top of that layer, measured from the top of the adjacent edge of the surface water channel, shall be to the tolerances given in Table 7/1.

3 Notwithstanding the tolerances permitted in surface levels of pavement courses, the cumulative tolerance shall not result in a reduction in thickness of the pavement,. The layer thickness will be calculated as the mean value over the whole construction area. A minimum of 20 values are necessary for the calculation of the mean value. The layer thickness may be determined for partial sections. The partial section should correspond at least to one day of construction work.

Higher thicknesses than specified are used to compensate lower thicknesses of courses below the

course in question. Clause 925, sub-clause 8 is applied for the payment.

a) Cement bound material, foundation course, and base courses:

The layer thickness after compaction shall not be less than 10% from the specified thickness.

Independently of the mean value, single values of the layer thickness shall not fall below the specified thickness as follows:

-Cement bound material	30mm
-Foundation course	30mm
-Unbound base course	30mm
-Asphalt base course	25mm

Single values which exceed the specified thickness by more than 30mm are not considered for the calculation of the mean value.

b) Surfacing (binder course and/or wearing course):

The limit values for mean values and single values (percentage from the specified thickness) of Table 7/2 shall not be exceeded.

4 For checking compliance with sub-Clause 2 and sub-Clause 3 of this Clause, measurements of the surface levels of all courses will be taken on a grid of points located as described in Appendix 7/1. Measurements may be taken at a longitudinal distance of 10m and at three points in the transversal direction of a carriageway actually in the axle and the two exterior third points of half of the carriageway width (for a 7.5m carriageway at a distance of 2.5 m from the axle). In any length of pavement, compliance shall be deemed to be met for all surfaces, other than the final road surface, when not more than one of ten consecutive measurements taken longitudinally or one in any transverse line, exceeds the tolerances permitted in Table 7/1, provided that this one measurement shall not exceed by more than 5 mm the tolerance for the course concerned. For the final road surface the tolerance given in Table 7/1 shall apply to any point on that surface.

Surface Regularity

5 The longitudinal regularity of the surfaces of wearing courses, binder courses, base courses, and sub-bases in pavements and concrete slabs shall be such that the number of surface irregularities is within the relevant limits stated in Table 7/3.
An irregularity is a variation of not less than the permissible value specified of the profile of the load surface or the course in question as measured by a 4m long straight edge or by a rolling straight-edge capable of measuring irregularities over a 4m length.

TABLE 7/3: Maximum Permitted Number of Surface Irregularities

	Surfaces of carriage-ways, hard strips and hard shoulders				Surfaces of all other courses			
Irregularity					Tol. (mm)		Tol.+3mm (mm)	
Case a	4mm		7mm					
Case b	6mm		9mm					
≤10mm	10mm		13mm					
Length (m)	300	75	300	75	300	75	300	75
A: Arterial and Distributor roads*	20	9	2	1	40	18	4	2
B: Other traffic areas*	40	18	4	2	60	27	6	3

** The Category of each section of road is described in Appendix 7/1.*

No irregularity exceeding 10mm shall be permitted for case (a) and case (b) and no irregularity exceeding 14mm shall be permitted for areas with slow traffic, mechanically laid combined base wearing course and hand laid wearing course. No irregularity exceeding the tolerance by more than 4mm shall be permitted for all other courses (e.g. foundation course: 24mm)

a) Tolerances for irregularities of base courses and sub-bases:

Asphalt base course:	10mm
Unbound base course:	20mm
Foundation course:	20mm

Cement bound material:

Below asphalt	15mm
Below unbound base course	20mm

b) Tolerances for surface irregularities of surfacings:

Surface irregularities must not exceed the permissible tolerances of Table 7/4.

TABLE 7/2: Limiting Values for Layer Thicknesses lower than Specified

	Wearing course [1], binder course and asphalt base course together	Wearing course [1] and asphalt base course together	Wearing course[1] and binder course together	Wearing course[1]	Combined Base/Wearing course
a) Mean Value					
1. Construction areas greater 3000m² or urban roads over 500m² and wearing courses with more than 50kg/m²	-	-	≤10%	≤10%	≤10%
2. Small construction areas and wearing courses up to 50kg/m²	-	-	≤15%	≤15%	≤15%
b) Single values	≤10%	≤15%	≤15%	≤25%	≤25%

1) The values of line b) are applied analogously in case of stage construction, that means if the final surfacing (binder course and wearing course) will be laid later: therefore a value of 25% is allowed for the upper layer of the provisional surfacing of the first stage, for the provisional surfacing and the asphalt base course together a value of 15%.

TABLE 7/4: Tolerances for Surface Irregularities after mechanical laying (4m length).

	Combined base/wearing courses	Binder courses	Wearing courses
On base which is not bound by binder	≤10mm	≤10mm	-
On base which is bound by binder and the permissible irregularity of the base is higher than 6mm	≤10mm	≤6mm	≤6mm (case b)
On asphalt base with permissible irregularity of less than 6mm	-	-	≤4mm (case a)

Higher tolerances than those of Table 7/4 may be allowed for areas with slow traffic but not more than 10mm. The permissible irregularities of the surface must only arrive in gradual transition and not in shorter regular distances. In cases of hand laid areas the permissible tolerances are 15mm for combined base/wearing courses and 10mm for binder courses and wearing courses.

Deviations of the required cross slope of the road surface must not be more than ± 0.4% and for combined base/wearing courses not more than ± 0.5%. If the cross slope is below 1.5% and the longitudinal slope below 0.5% for transition curves of carriageways for rapid traffic, the difference between the specified cross slope and the achieved cross slope must not be more than 0.2%

6 Prior to checking any final road surface or course it shall be cleaned of loose or extraneous materials. These operations shall be carried out without damaging the surface, as soon as possible and within 3 days of construction of the pavement.

7 Compliance with the required tolerances and the permitted number of surface irregularities shall be checked by the rolling straight-edge along any line or lines parallel to the edge of pavement on sections of 300 m at regular intervals as stated in Appendix 7/1, whether or not it is constructed in shorter lengths. Sections shorter than 300 m forming part of a longer pavement shall be assessed using the number of irregularities for a 300 m length pro-rata to the nearest whole number.

Where the total length of pavement is less than 300 m, the measurements shall be taken on 75 m lengths.

8 Pavements shall be measured transversely for irregularities at regular intervals as stated in Appendix 7/1, by a 4 m long straight-edge placed at right angles to the centre line of the road. The maximum allowable difference between the course surface and the straight-edge is the same like for the longitudinal direction.

9 Testing of the longitudinal surface regularity is generally carried out in the middle of the lane.

Rectification

10 Where any pavement area does not comply with the Specification for regularity, surface tolerance, thickness, material properties or compaction, the full extent of the area which does not comply with the Specification shall be made good and the surface of the pavement course shall be rectified in the manner described below:

(i) Unbound materials

The top 75 mm shall be scarified, reshaped with material added or removed as necessary, and re-compacted. The area treated shall be not less than 20 m long and 2 m wide.

(ii) Cement bound sub-bases

The method of correction will depend on the period which has elapsed between detection of the error and the time of mixing of the material. If this is less than 4 hours, the surface shall be scarified to a depth of not less than 50 mm, surplus material removed or freshly mixed material added as necessary, and re-compacted in accordance with the Specification. If the period is 4 hours or more the full depth of the layer shall be removed from the pavement and replaced with material in accordance with the Specification. In either case the area treated shall be at least 5 m long and the full width of the paving laid in one operation. If the Contractor proposes rectification within 7 days of laying he shall comply with sub-Clause 1048.4. Alternatively, for sub-bases under concrete pavements the Contractor may make up low areas to a level within the tolerances of this Clause with a 1:4 cement and sand mortar or with 3 mm size fine graded wearing course complying with BS 4987 : Part 1.

(iii) Bituminous base courses

With asphalt base courses, the full depth of the top layer as laid shall be removed and be replaced with fresh material laid and compacted in accordance with the Specification. Any area so treated shall be at least 5 m long and the full width of the paving laid in one operation. Alternatively for low areas in bituminous base courses to be overlaid with a binder course, the Contractor may make up the level with additional binder course material.

(iv) Wearing courses, base/wearing courses, binder courses and top surface of base courses in pavements without binder course.

These shall have the full depth of the course removed, or in the case of base courses in pavements without binder course, the topmost layer, and replaced with fresh material laid and compacted in accordance with the Specification.

The area rectified shall be the full width of the paving laid in one operation, and at least 5 m long if binder course or base course on pavements without binder course, or 15 m if wearing course or base/wearing course.

Where the number of surface irregularities exceeds the limits in Table 7/3, the area to be rectified shall be 300 m or 75 m long as appropriate and the full width of the lanes affected, or such lesser length as necessary to make the number of surface irregularities conform with the limits and shall be the full width of the lanes affected.

Checking of the wearing course for compliance with this Clause shall be carried out as soon as possible after completion of the surfacing and remedial works completed before the road is opened to traffic.

Areas to be removed shall be delineated both longitudinally and transversely by saw cutting prior to the material being removed. Joints shall be formed by coating the exposed sawn face with hot bitumen.

(v) Concrete slabs

Concrete slabs shall be rectified by planing, grinding or bump cutting. Large depressions, which cannot be dealt with in this way, shall be rectified by cutting out the surface and replacing by a thin bonded surface repair complying with Clause 1032.

Retexturing of hardened concrete shall be carried out by sawing grooves in accordance

with the Specification. Texturing of replaced surfaces shall be by brushing in accordance with the Specification. Where the slab cannot be rectified as above, the full depth of slab shall be removed and replaced with a slab constructed in compliance with Clause 1033 to the extent required to obtain compliance to the Specification. Remedial works involving the placing of fresh concrete shall be completed in sufficient time for the concrete strength to have developed as required in Clause 1048, before that section of pavement is opened to traffic.

703 Weather Conditions for Laying of Unbound Granular and Cementitious Materials

1 Road Pavement materials in a frozen condition shall not be incorporated in the Works but may be used, if acceptable, when thawed.

2 Road Pavement materials shall not be laid on any surface which is frozen or covered with ice.

3 The temperature of concrete or cement-bound material in any pavement layer shall not be less than 5^{o}C at the point of delivery. These materials shall not be laid when the air temperature fall below 3^{o}C and laying shall not be resumed until the rising air temperature reaches 3^{o}C unless, with the agreement of the Engineer, all surfaces of the concrete slabs are protected by thermal insulation blankets laid immediately after placing and finishing the concrete. The insulation shall be placed before the temperature of the concrete surface has dropped below 2^{o}C and shall be retained for a minimum of 3 days or until the concrete is assessed to have reached 50% of the specified characteristic compressive strength provided that the air temperature is above 0^{o}C and rising at that time. Thermal insulation blankets shall be closed cell polyethylene foam sheets, minimum 10mm thick with a "U" value of 4 watts/mC (or K value of 0.04 watts/m Kelvin) or suitable material with an equivalent or lower thermal conductivity. They shall be sufficiently robust and capable of being held in place for the necessary curing time.

704 Use of Surfaces by Traffic and Construction Plant

1 Construction plant and traffic used on pavements under construction shall be suitable in relation to the material, condition and thickness of the courses it traverses so that damage is not caused to the subgrade or the pavement courses already constructed.

2 The wheels or tracks of plant moving over the various pavement courses shall be kept free from deleterious materials.

3 Where the Contractor proposes to use the sub-base for construction plant he shall improve the sub-base where necessary, to accommodate the method of construction and the type of plant and vehicles which he proposes to use, in order to avoid damage to the sub-base, any capping and the subgrade. Any permanent thickening shall be across the whole width of the pavement, unless otherwise agreed by the Engineer. Temporary thickening shall not impede drainage of the sub-base or the subgrade.

4 Concrete slabs may be used by traffic when the characteristic compressive strength is assessed to have reached 25 N/mm^2 for pavement surface slabs, or 20 N/mm^2 for base courses with asphalt surfacing. The method of assessing the time when this strength is reached shall be as described in Clause 1004, or as otherwise agreed with the Engineer.

5 In the absence of test data establishing compliance with sub-Clause 4 of this Clause, no vehicle with an axle loading greater than 2 tonnes shall run on concrete slabs within a period of 14 days after placing the concrete. Vehicles with rubber tyres with an axle loading less than 2 tonnes, or wheels or tracks of concreting plant, shall not use any part of a newly constructed pavement within 7 days. The above periods shall be increased at the discretion of the Engineer if the 7-day cube strength is below that required. These periods shall be extended by one day per each night for which the temperature of the layer falls to 0^{o}C or below.

6 Cement bound material (sub-base) has to be kept moist for at least 3 days or to be protected against drying by other measures according to Clause 1035, sub-Clause 16. Further layers may be applied earlier if during laying no deformations of the sub-base arrive and if curing is not endangered by water content reduction (e.g. application of tack coat before laying of an asphalt base courses). Opening to traffic of the Cement bound material or the

pavement including the Cement bound material is only allowed if 70% of the required compressive strength is achieved. Otherwise no vehicle shall run on cement bound material within 7 days of construction. This period shall be extended by one day for each night on which the temperature of the layer falls to 0^{o}C or below.

705 General Requirements for Sub-bases and Base Courses

1 The Contractor shall, in his choice of materials for base courses have regard to the nature of those materials and of the sub-base, subgrade or any capping and the need to protect them from deterioration due to the ingress of water, the adverse effects of weather and the use of construction plant. The Contractor shall programme the laying and compaction of the sub-base and the subsequent pavement courses and take such other steps as may be considered necessary, to provide protection to the base course, sub-base and subgrade.

Transporting

2 Unbound and cement bound plant-mixed material shall when mixed be removed at once from the mixer, transported directly to the point where it is to be laid and protected from the weather both during transit from the mixer to the laying site and whilst awaiting tipping.

Laying

3 All material shall be placed and spread evenly. Spreading shall be undertaken either concurrently with placing or without delay. Unbound and cement bound material shall be spread using a paving machine and operated with a mechanism which levels off the material to an even depth.

706 Excavation, Trimming and Reinstatement of Existing Surfaces

General

1 The Contractor shall not excavate pits, trenches or other openings in paved areas which have been constructed as part of the Permanent Works in order to construct other parts of the Works, including Statutory Undertakers and other service works, except with the prior approval of the Overseeing Organisation.

2 Where excavation and trimming of existing paved areas and roads not constructed as part of the Permanent Works are required in Appendix 7/2, they shall be carried out and reinstated in compliance with this Clause and with any additional requirements described in Appendix 7/2. Excavations shall be carried out to the dimensions described in Appendix 7/2, or, if not so described, to the minimum dimensions, subject to sub-Clause 3 of this Clause, necessary to carry out the work.

Excavations

3 Excavations in asphalt layer of existing pavements and other paved areas, except those described in sub-Clause 4 of this Clause, shall be cut to neat lines to dimensions at least greater on each side than the dimensions of any further excavation below formation level as follows: 15cm for excavation depths up to 2m and 20cm for excavation depths equal or greater than 2m. Planing shall be carried out in accordance with Clause 917. Concrete surfacing and concrete roadbases, shall be cut back by sawing by at least 300 mm on each side to the level of any reinforcement in reinforced slabs and to the full depth of the slab in unreinforced slabs.

If excavations are required to inspect the condition of lower layers, each layer shall be excavated separately and cleaned of debris to permit inspection.

4 Concrete blocks, precast concrete flags, kerbs and channels shall be lifted without cutting, to the nearest joint satisfying sub-Clause 3 of this Clause and carefully stored for re-use or dealt with as described in Appendix 2/3. In situ kerbs and channels shall be broken out to at least 150mm beyond the excavation.

Reinstatement of Paved Areas

5 Immediately before bituminous layers are reinstated, the edges of the existing material shall be cleaned of all loose material and be coated with an appropriate hot bituminous binder, or equivalent treatment. Where joints in concrete slabs are affected by the excavation they shall be reinstated by cutting back to at least 0.5 m on each side of a transverse joint and forming an expansion joint on one side of the excavation and a contraction joint on the other and provide longitudinal joints where necessary in the same line before reinstatement in

compliance with Series 1000 to match the existing construction.

Reinstatement of Other Areas

6 Where the excavation affects grassed areas, unpaved footpaths, footways, verges and bridleways they shall be reinstated to match the existing surface, after backfilling with acceptable material described in Appendix 7/2 to a depth of not less than 150 mm below the finished surface.

Junctions Between New Pavement Construction and Existing Pavement or Other Paved Areas

7 Where new pavement construction abuts an existing bituminous pavement which has to be reduced in level or overlaid to match alignment and levels, the existing surface shall be trimmed by the minimum amount of cold-milling (planning) to a depth which will allow the specified thickness of new construction to be laid, the edge being trimmed and treated in compliance with this Clause. Where the difference in level makes it necessary, a regulating course as described in Appendix 7/1 and specified in Clause 907 shall be provided. The locations of areas to be trimmed are given in Appendix 7/2.

8 Junctions between concrete pavements and between concrete and bituminous pavements shall be constructed as described in Appendix 7/2.

Compressed Air

9 When compressed air is used to clean dust, dirt and debris from prepared faces of existing concrete or bituminous pavements which are otherwise ready for reinstatement, only oil-free compressed air shall be used and this shall be at a pressure of not less than 0.5 N/mm².

707 Breaking Up or Perforation of Redundant Pavement

1 Where redundant pavement construction is to be perforated or broken up, the pavement shall be treated as described in Appendix 7/6.

708 Weather Conditions for Laying of Asphalt Wearing Course and Other Bituminous Pavement Layers

1 Laying of road pavement materials containing bituminous binders may proceed during light precipitation (receiving layer not covered by the water film) provided the temperature of the surface to be covered is 2°C or more and the air temperature is above 3°C for wearing courses, and above 0°C for binder and base courses. Responsibility for working methods shall remain with the Contractor including all necessary adjustments to suit fluctuations in weather conditions.

2 Laying of road pavement materials containing bitumen binders may proceed provided the temperature of the surface to be covered is 2°C or more, the air temperature is at or above -1°C and rising and the surface to be covered is dry, unfrozen and free from ice, snow, salt and grit

709 Cold Milling (Planing) of Bituminous Bound Flexible Pavement. (Cold Milling is described in Clause 917)

710 Testing for Constituent Materials in Recycled Coarse Aggregate and Recycled, Concrete Aggregate

Constituent materials shall be tested analogous to prEN13108-8.

711 Not Used

712 Not Used

713 Not Used

714 Not Used

715 Not Used

716 Not Used

ROAD PAVEMENTS - UNBOUND, HYDRAULICALLY BOUND AND OTHER MATERIALS.

Contents

ROAD PAVEMENTS - UNBOUND, HYDRAULICALLY BOUND AND OTHER MATERIALS.

801 General Requirements for Unbound, Hydraulically Bound and Other Materials

1 Sub-bases (foundation course) and unbound base courses shall be made and constructed using materials described in the following Clauses. The permitted alternatives for each part of the Works shall be as described in Appendix 7/1.

2 Where recycled coarse aggregate or recycled concrete aggregate is used in accordance with this Series, it shall have been tested in accordance with Clause 710.

Transporting

3 Plant-mixed material shall, when mixed, be removed at once from the mixer, transported to the point where it is to be laid and protected from weather both during transit from the mixer to the laying site and whilst awaiting tipping.

Laying

4 Materials shall not be laid on any surface that is frozen or covered with ice.

5 All material shall be placed and spread evenly. Spreading shall be undertaken either concurrently with placing or without delay. Unbound and hydraulically bound base course material shall be spread using a paving machine or a suitable spreader box and operated with a mechanism that levels off the material to an even depth. Mixtures are to be laid at a water content which is favourable for compaction.

6 Except where otherwise stated in Appendix 7/1, material shall be spread so that after compaction the total thickness is at least as follows:

- Aggregate mixture 0/37.5mm: 15cm
- Aggregate mixture 0/50mm: 18cm

Laying of several layers is possible if the minimum laying thickness is observed. Where the layers of unbound material are of unequal thickness the lowest layer shall be the thickest layer.

Compaction

7 Compaction should be completed as soon as possible after the material has been spread and in accordance with the requirements for the individual materials.

8 Full compaction shall be obtained over the full area including in the vicinity of both longitudinal and transverse joints.

9 Compaction of unbound materials may be carried out by a method specified in Table 8/1. Independently of these recommendations the following requirements have to be achieved:

(i) Compaction degree based on the Standard Proctor Test according to BS 1377: Part 4 shall not fall below D_{pr} = 103%. In residential areas where laying is hindered by manholes etc., a compaction degree of D_{pr} = 100% may be required to be included in the tender documents.

(ii) The reaction modulus E_{v2} according to ASTM-D-1194 and Clause 642, Sub-Clause 4 required in chart 1, chart 2, chart 3 and chart 5 of the "Directives for the Standardization of Pavements for Traffic Areas" has to be achieved. The relation E_{v2}/E_{v1} shall not exceed 2.2. Higher relations than 2.2 are permissible if the value E_{v1} is at least 60% of the required E_{v2} value.

The following tolerances are permissible in production control and control testing:

- Less than five test values: all values have to be above the minimum value.
- Five or more test values: one value may fall below the required value by 10%.

The Site Engineer of the Overseeing Organization decides to which extent the compaction control will be carried out based only on the relation E_{v2}/E_{v1}.

10 The surface of any layer of material shall on completion of compaction and immediately before overlaying, be well closed, free from movement

under construction plant and from ridges, cracks, loose material, pot holes, ruts or other defects. All loose, segregated or otherwise defective areas shall be removed to the full thickness of the layer, and new material laid and compacted.

11 For the purposes of Table 8/1 the following shall apply:

(i) The number of passes is the number of times that each point on the surface of the layer being compacted shall be traversed by the item of compaction plant in its operating mode (or struck, in the case of power rammers).

(ii) The compaction plant in Table 8/1 is categorised in terms of static mass. The mass per metre width of roll is the total mass on the roll divided by the total roll width. Where a smooth-wheeled roller has more than one axle, the category of the machine shall be determined on the basis of the axle giving the highest value of mass per metre width.

(iii) For pneumatic-tyred rollers, the mass per wheel is the total mass of the roller divided by the number of wheels. In assessing the number of passes of pneumatic-tyred rollers the effective width shall be the sum of the widths of the individual wheel tracks together with the sum of the spacing between the wheel tracks provided that each spacing does not exceed 230mm. Where the spacing exceed 230mm, the effective width shall be the sum of the widths of the individual wheel tracks only.

(iv) Vibratory rollers are self-propelled or towed smooth-wheeled rollers having means of applying mechanical vibration to one or more rolls:

(a) The requirements for vibratory rollers are based on the use of the lowest gear on a self-propelled machine with mechanical transmission and a speed of 1.5-2.5 km/h for a towed machine or a self-propelled machine with hydrostatic transmission. If higher gears or speeds are used an increased number of passes shall be provided in proportion to the increase in speed of travel.

(b) Where the mechanical vibration is applied to two rolls in tandem, the minimum number of passes shall be half the number given in Table 8/1 for the appropriate mass per metre width of one vibrating roll but if one roll differs in mass per metre width from the other, the number of passes shall be calculated as for the roll with the smaller value. Alternatively the minimum number of passes may be determined by treating the machine as having a single vibrating roll with a mass per metre width equal to that of the roll with the higher value.

(c) Vibratory rollers operating without vibration shall be classified as smooth wheeled rollers.

(d) Vibratory rollers shall be operated with their vibratory mechanism operating at the frequency of vibration recommended by the manufacturer. All such rollers shall be equipped, or provided with devices indicating the frequency at which the mechanism is operating and the speed of travel. Both devices shall be capable of being read by an inspector alongside the machine.

(v) Vibrating-plate compactors are machines having a base-plate to which a source of vibration consisting of one or two eccentrically weighted shafts is attached:

(a) The mass per square metre of base-plate of a vibrating-plate compactor is calculated by dividing the total mass of the machine in its working condition by its area in contact with compacted material.

(b) Vibrating-plate compactors shall be operated at the frequency of vibration recommended by the manufacturer. They shall normally be operated at travelling speeds of less than 1 km/h but if higher speeds are necessary, the number of passes shall be increased in proportion to the increase in speed of travel.

(vi) Vibro-tampers are machines in which an engine driven reciprocating mechanism acts on a spring system, through which oscillations are set up in a base-plate.

(vii) Power rammers are machines, which are actuated by explosions in an internal combustion cylinder. The operator controls

each of these explosions manually. One pass of a power rammer is considered as the instance when the compacting shoe has made one strike on the area in question.

(viii) Combinations of different types of plant or different categories of the same plant will be permitted; in which case the number of passes for each shall be such proportion of the appropriate number in Table 8/1 as will together produce the same total compactive effort as any one operated singly, in accordance with Table 8/1.

TABLE 8/1: Compaction Requirements for Granular Sub-base Material Types 1 and 2

Type of compaction plant	Category	Number of passes for layers not exceeding the following compacted thickness		
		110 mm	150 mm	225 mm
Smooth-wheeled roller (or vibratory roller operating without vibration)	Mass per metre width of roll:			
	over 2700 kg up to 5400 kg	16	unsuitable	unsuitable
	over 5400 kg	8	16	unsuitable
Pneumatic-tyred roller	Mass per wheel:			
	over 4000 kg up to 6000 kg	12	unsuitable	unsuitable
	over 6000 kg up to 8000 kg	12	unsuitable	unsuitable
	over 8000 kg up to 12000 kg	10	16	unsuitable
	over 12000 kg	8	12	unsuitable
Vibratory roller	Mass per metre width of vibrating roll:			
	over 700 kg up to 1300 kg	16	unsuitable	unsuitable
	over 1300 kg up to 1800 kg	6	16	unsuitable
	over 1800 kg up to 2300 kg	4	6	10
	over 2300 kg up to 2900 kg	3	5	9
	over 2900 kg up to 3600 kg	3	5	8
	over 3600 kg up to 4300 kg	2	4	7
	over 4300 kg up to 5000 kg	2	4	6
	over 5000 kg	2	3	5
Vibrating-plate compactor	Mass per square metre of base plate:			
	over 1400 kg/m² up to 1800 kg/m²	8	unsuitable	unsuitable
	over 1800 kg/m² up to 2100 kg/m²	5	8	unsuitable
	over 2100 kg/m²	3	6	10
Vibro-tamper	Mass:			
	over 50 kg up to 65 kg	4	8	unsuitable
	over 65 kg up to 75 kg	3	6	10
	over 75 kg	2	4	8
Power rammer	Mass:			
	100 kg-500 kg	5	8	unsuitable
	over 500 kg	5	8	12

Use of Surfaces by Traffic and Construction Plant

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

13 Where the Contractor proposes to use the sub-base or base course layers for construction plant he shall improve the sub-base or roadbase layers where necessary, to accommodate the method of construction and the type of plant and vehicles which he proposes to use, in order to avoid damage

to the base course, sub-base, any capping and the subgrade. Any permanent thickening shall be across the whole width of the pavement. Temporary thickening shall not impede drainage of the sub-base or the subgrade.

802 Not used

803 Granular Material Type 1

1 Type 1 granular material (e.g. for base courses) shall be crushed rock or crushed concrete. The material shall lie within the grading envelope of Table 8/2, and not be gap graded.

2 The material passing the 425 micron BS sieve shall be non-plastic as defined by BS 1377: Part 2 and tested in compliance therewith.

3 The material shall be transported, laid and compacted without drying out or segregation.

4 The material shall have a ten per cent fines value of 50kN or more when tested in compliance with BS 812: Part 111. The test sample shall be in a soaked condition at the time of test.

5 The aggregate will be considered suitable if:

(i) aggregate from the source, when tested in accordance with BS 812 : Part 121, has a soundness value greater than 65;

or

(ii) evidence can be provided to the Overseeing Organisation of satisfactory use of aggregate from the source.

The water absorption of the coarse aggregate from the source determined in accordance with BS 812: Part 2 shall also be declared.

TABLE 8/2: Granular Material Type 1 Range of Grading

ASTM sieve size	Percentage by mass passing
50.0 mm	100
37.5 mm	70 – 100
25.0 mm	60 – 80
12.5 mm	40 – 65
4.75 mm	22 – 47
2.36 mm	15 – 40
0.30 mm	5 - 20
0.075 mm	0 – 5
The particle size shall be determined by the washing and sieving method of BS 812: Part 103	

804 Granular Material Type 2

1 Type 2 granular material (e.g. for foundation courses) shall be natural sands, gravels, and crushed rock, crushed concrete, or recycled aggregate. The material shall lie within the grading envelope of Table 8/3 and not be gap graded. The other materials content of recycled coarse aggregate and recycled concrete aggregate shall be determined in accordance with Clause 710. Foreign materials including wood, glass, plastic and metal shall not exceed 1%.

2 The material passing the 425 micron BS sieve when tested in compliance with BS 1377: Part 2 shall have a plasticity index of less than 6.

3 The material shall satisfy the minimum CBR requirement in Appendix 7/1 when tested in accordance with BS 1377: Part 4, with surcharge discs. The material shall be tested at the density and moisture content likely to develop in equilibrium pavement conditions, which shall be taken as being the density relating to a uniform air voids content of 5% and the optimum moisture content determined in compliance with BS 5835.

4 The material shall be transported, laid and compacted at a moisture content within the range 1% above to 2% below the optimum moisture content determined in compliance with BS 5835 and without drying out or segregation.

5 The material shall have a ten per cent fines value of 50 kN or more when tested in compliance with BS 812: Part 111. The test sample shall be in a soaked condition at the time of test.

6 The aggregate will be considered suitable if:

(i) aggregate from the source, when tested in accordance with BS 812: Part 121, has a soundness value greater than 65;

or

(ii) evidence can be provided to the Overseeing Organisation of satisfactory use of aggregate from the source.

The water absorption of the coarse aggregate from the source determined in accordance with BS 812: Part 2 shall also be declared.

TABLE 8/3: Granular Material Type 2 Range of Grading

ASTM sieve size	Percentage by mass passing
50.0 mm	100
37.5 mm	70 – 100
25.0 mm	60 – 100
12.5 mm	40 – 80
4.75mm	22 – 62
2.36 mm	15 – 50
0.30 mm	5 – 25
0.075 mm	0 – 10
The particle size shall be determined by the washing and sieving method of BS 812: Part 103	

805 Not used

806 Granular Material Type 4

1 Type 4 granular sub-base material (e.g. for foundation courses) shall be derived from asphalt arisings. The asphalt arisings shall be either asphalt road planings or granulated asphalt, but excluding materials containing tar or tar-bitumen binders.

Asphalt planings are defined as materials derived from the asphalt layers of the pavement using a mobile machine fitted with milling cutters.

Granulated asphalt is defined as asphalt bound material recycled from roads under reconstruction or surplus asphalt material destined for bound pavement layers, but unused, which has been granulated. It may be used up to an amount of 30%.

2 Type 4 granular sub-base material shall have an upper limit on recovered bitumen content of 10% when tested in accordance with BS 598: Part 102.

3 Type 4 granular sub-base material shall, at the time of placing, lie within the lump size-grading envelope of Table 8/4 and not be gap graded.

4 The material shall be transported, laid and compacted at a moisture content within the range optimum moisture content to 2% below the optimum moisture content determined in compliance with BS 5835 and without drying out or segregation.

Measurement of moisture content both for control purposes and for OMC determination shall be according to BS 812: Part 109 using a conventional oven on a reduced temperature setting of 45 to 50°C.

TABLE 8/4: Type 4 Granular Sub-base Material Range of Lump-size Grading

ASTM sieve size	Percentage by mass passing
50.0 mm	100
37.5 mm	70 – 100
25.0 mm	60 – 100
12.5 mm	40 – 80
4.75mm	22 – 62
2.36 mm	15 – 50
0.30 mm	5 – 25
0.075 mm	0 – 10
The lump size distribution shall be determined either by the washing and sieving method or by the dry sieving method of BS 812: Part 103:1985 (see Note 1). Note 1: The planings should be oven dried (prior to sieving) at a temperature of 45 to 50°C. Sieving shall be carried out at 20 ± 5°C to reduce the tendency of the bitumen to soften and particles to adhere to each other.	

5 When required by Appendix 7/1, the Contractor shall undertake a Trafficking Trial incorporating the Type 4 granular sub-base material proposed for use in the Works. A trial area shall be constructed, trafficked and assessed in accordance with the procedure described in sub-Clauses 6 to 11 of this Clause. The mean vertical deformation after 1000 equivalent standard axles shall be less than 30 mm when measured in accordance with the procedure stated in sub-clause 10 of this clause.

Proposals for sub-base trials shall be submitted to the Overseeing Organisation 5 days in advance of construction.

Trial Procedure

6 The trial area shall be located on a formation prepared in accordance with the Specification. The trial area may be located so that it can be incorporated within the Permanent Works if the resistance to wheel track rutting is demonstrated to comply with sub-Clause 5 of this Clause.

7 The trial area shall be at least 60 m long, and of sufficient width that when trafficked, the wheel

paths of the test vehicle shall be at least 1 m from either edge of the top of the sub-base layer. The sub-base shall be compacted to the thickness specified in Appendix 7/1. The formation shall extend for a further 1 m either side of the sub-base layer.

8 A sufficient run off/run on area shall be constructed at each end of the trial area, the same width, and compacted to the same level, as the trial area, to ensure correct tracking by the test vehicle and minimise dynamic effects of the vehicle bouncing on its springs. Suitable guidance shall be given to assist the driver in maintaining the same track on each pass and to achieve channelled trafficking. Examples of suitable guides would be a string or painted line.

Materials

9 The sub-base used in the trial shall be transported, laid and compacted using the equipment proposed for use in the Works.

10 Maximum vertical deformation shall be measured in both wheel tracks using optical or laser levels at predetermined monitoring points on five transverse lines spaced equally along the length of the trial bay. The transverse lines at the ends of the trial area shall be at least 5 m from the run off/run on areas. The average vertical deformation of the two wheel tracks after 1000 standard axles shall be recorded.

Reporting

11 The Contractor shall provide the Overseeing Organisation with a report on the Trafficking Trial. For Type 4 sub-base to be approved for use in the Works the report shall set out the results of the trial, stating how they validate the use of the material.

ROAD PAVEMENTS – BITUMINOUS BOUND MATERIALS

Contents

ROAD PAVEMENTS – BITUMINOUS BOUND MATERIALS

901 Bituminous Courses

General

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

Aggregates for Bituminous Materials

2 Natural, recovered unbound and artificial aggregates shall be clean, hard and durable. Aggregates must not contain organic and swelling material of damaging quantity. They have to be of angular shape and have to be resistant to wear, to weathering and to heat. The type of rock decay 'Sonnenbrand' must not be present in basalt.

Where recycled coarse aggregate or recycled concrete aggregate is used in this Series it shall have been tested in accordance with Clause 710 and the content of all foreign materials (including wood, plastic and metal) shall not exceed 1% by mass.

Hardness

Unless otherwise stated in Appendix 7/1, coarse aggregates for bituminous materials shall have the following properties:

(i) A Los Angeles coefficient not greater than 35 per cent for crushed aggregate when tested in a dry condition in accordance with ASTM C131. A Los Angeles coefficient not greater than 20 per cent when tested in accordance with MSA-EN 1097-2 for crushed aggregate of wearing courses.
(ii) Recovered unbound aggregates shall be natural and artificial aggregates recovered from a previous use in an unbound form and which meet the requirements of this Clause.

Durability

When required in Appendix 1/5, the aggregate source shall be tested in accordance with BS812: Part 121 and shall have a soundness value greater than 75, or such lower value as may be required in Appendix 7/1.

For routine testing, the water absorption value of the course aggregate shall be determined as in BS 812: Part 2. The water absorption value of the coarse aggregate shall be less than 4%.

Cleanness

Unless otherwise stated in Appendix 7/1, the fraction of material passing 75 micron, for coarse and fine aggregates for bituminous materials, shall not exceed the limits stated in BS 594: Part 1 and BS 4987: Part 1, when tested in accordance with the washing and sieving method of BS 812: Part 103.

Polishing

Polished stone value according to BS 812: Part 3 is required for wearing courses only.

- Construction classes IV to VI :PSV $\geq$ 45
- Construction classes HD and I to III :PSV $\geq$ 53
- Open porous asphalt :PSV $\geq$ 55

Transporting

3 Hot bituminous materials shall be transported continuously according to the progress of construction works in clean insulated vehicles, unless otherwise agreed by the Overseeing Organization, and shall be covered while in transit or a waiting tipping. To facilitate discharge of the mixed materials, dust, coated dust, water or the minimum of liquid soap, vegetable oil, or other non-solvent solutions may be used on the interior of the vehicles. When a fluid coating is used then, prior to loading, the body shall be tipped to its fillets extent with the tailboard open to ensure drainage of any excess. The floor of the vehicle shall be free from adherent bituminous materials or other contaminants.

Laying

4 Wherever practicable, bituminous materials shall be spread, levelled and tamped by a self-propelled paving machine, which may be equipped with an averaging beam. As soon as possible after arrival at site the materials shall be supplied continuously to the paver and laid without delay. The rate of delivery of material to the paver shall be regulated to enable the paver to operate continuously and it shall be so operated whenever practicable.

5 The travel rate of the paver, and its method of operation, shall be adjusted to ensure an even and uniform flow of bituminous material across the screed, so that the material is free from dragging, tearing and segregation of the material.

6 Hot bituminous materials shall be laid in accordance with the requirements and recommendations for laying in BS 4987: Part 2 or BS 594: Part 2, as appropriate. Where there is no British Standard for the particular material it shall be laid in accordance with the requirements and recommendations of BS 594: Part 2, subject also to the requirements of sub-Clauses 7 to 29 of this Clause.
The minimum thickness of material laid in each paver pass shall be in accordance with BS 4987: Part 2 or BS 594: Part 2, as appropriate, or the full course thickness, where this is less than the specified minimum in BS 4987: Part 2 or BS 594: Part 2. The ratio layer thickness/maximum grain size of 3 to 4 (maximum 5) may be assumed to be a general rule.

7 When laying bituminous courses the paver shall be taken out of use when approaching an expansion joint of a structure. In laying the remainder of the pavement up to the joint, and the corresponding area beyond it by hand, the joint or joint cavity shall be kept clear of surfacing material.

8 With the exception of sand asphalt carpet, bituminous materials with a temperature greater than 125^0C shall not be deposited on a bridge deck waterproofing system unless adequate precautions are taken to avoid heat damage in accordance with a good industrial practice. A maximum temperature of 145^0C is permitted for sand asphalt carpet.

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

(i) For laying regulating courses of irregular shape and varying thickness.
(ii) In confined spaces where it is impracticable for a paver to operate.
(iii) For footways although laying by paver is preferred.
(iv) At the approaches to expansion joints at bridges, viaducts or other structures.
(v) For laying mastic asphalt in accordance with BS 1447

10 Hand-raking of wearing course material or the addition of such material by hand spreading to the paved area, for adjustment of level, shall only be permitted in the following circumstances:

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

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

11 Hand laid work shall conform to the requirements of this Clause.

12 Bituminous materials shall be laid and compacted in layers, which enable the specified thickness, surface level, regularity requirements and compaction to be achieved.

13 Compaction of bituminous materials shall commence as soon as the uncompacted material will bear the effects of the rollers without undue displacement or surface cracking. Compaction shall be substantially completed before the temperature falls below the minimum rolling temperatures stated in BS 594: Part 2 or BS 4987: Part 2. Rolling shall continue until all roller marks have been removed from the surface.

14 Except where otherwise specified, compaction may be carried out preferably using 8-10 tonnes deadweight smooth wheeled rollers having a width of roll not less than 450 mm, or by multi-wheeled pneumatic-tyred rollers of equivalent mass, or by vibratory rollers or a combination of these rollers. All courses shall be surface finished with a smooth-wheeled roller, which may be a deadweight roller or a vibratory roller in non-vibrating mode. Vibratory rollers shall not be used in vibrating mode on bridge decks nor are they to be used at mixture temperatures below 100°C.

15 Vibratory rollers may be used if they are capable of achieving at least the standard of compaction of an 8-tounes deadweight roller. They shall be equipped or provided with devices, indicating the frequency at which the mechanism is operating and the travel speed, which can be read from the ground. The performance of vibratory rollers proposed for use may be assessed as follows:

(i) by means of site trials in accordance with BS 598: Part 109; or

(ii) by the Contractor producing evidence of independent trials.

Where compaction is to be determined in accordance with Clause 927, the requirements to prove the performance of rollers shall not apply. In such cases the Contractor may use any plant to achieve the specified level of compaction and finish at temperatures above the minimum specified rolling temperature.

16 Bituminous materials shall be rolled in a longitudinal direction, with the driven rolls nearest the paver. The roller shall first compact material adjacent to joints and then work from the lower to the upper side of the layer, overlapping on successive passes by at least half the width of the rear roll or, in the case of a pneumatic tyred roller at least the nominal width of one tyre.

17 Rollers shall not be permitted to park or stand on warm compacted materials.

18 Unless otherwise specified in Appendix 7/1, the design, compaction assessment and compliance requirements for bituminous courses shall be in accordance with Clause 927. For the compaction degree determined in accordance with clause 927, a value of $\geq$ 96% is required for base/wearing courses and of $\geq$ 97%for all other courses

Chippings

19 In order to increase skid resistance, it may be necessary to apply uncoated or slightly coated chippings or sand to wearing courses mechanically. Addition of chippings by hand operation shall only be permitted in the following circumstances:

(i) In confined spaces, where it is impracticable for a chipping spreader to operate.

(ii) As a temporary expedient, when adjustments have to be made to the spreader distribution mechanism.

(iii) When hand laying of the wearing course is permitted.

(iv) To correct uneven distribution of chippings.

20 Chippings shall be applied uniformly at time and rolled into the hot wearing course surface so they are effectively held and provide the necessary skid resistance. Recommended amount are as follows:

(i) Crushed sand/chippings 1/3mm:
0.5 to 1.0 kg/m²

(ii) Chippings 2/5mm:
1.0 to 2.0 kg/m^2

Loose material has to be removed after application:

Joints

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

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

(ii) By cutting back (e.g. with edge roller, blade, joint cutter) the exposed joint for a distance equal to the specified layer thickness to a vertical face, discarding all loosened material and coating the vertical face completely with a suitable hot bitumen (200g/m per 4 cm thickness), before the adjacent width is laid. A polymer modified adhesive bitumen strip with a minimum thickness of 2 mm may also be used. Bitumen emulsion is not suitable.

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

General

23 If necessary the application of a bituminous tack coat spray, complying with Clause 920, to the surface on which laying is to take place will be required in order to achieve sufficient layer bond.

24 Bituminous material shall be kept clean and uncontaminated. The only traffic permitted to run

on bituminous material to be overlaid shall be that engaged in laying and compacting the next course. Should any bituminous material become contaminated the Contractor shall make it good by cleaning it and, if this proves impracticable, by rectification in compliance with Clause 702.

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

Regulating Course

26 Regulating course materials shall be made and laid in accordance with the requirements of Clause 907.

Use of Surfaces by Traffic and Construction Plant

27 All temporary running surfaces shall be thoroughly cleaned and a tack or bond coat applied prior to laying the succeeding course. Where trafficking has been of a very short duration, the tack coat may be omitted when so directed by the Overseeing Organization (e.g. sufficient bitumen film on the lower layer surface).

28 Tack coat shall be bitumen emulsion as described in Appendix 7/4 and shall be applied at a uniform rate of spread. The bitumen emulsion shall not be permitted to collect in any hollows and shall be allowed to break before the next layer is placed.

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

902 Reclaimed Bituminous Materials

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

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

Reclaimed Feedstock

3 All reclaimed material shall be pre-treated before use such that it is homogeneously mixed and the maximum particle size does not exceed 37.5mm

Properties of Recovered Binder

4 The binder shall be recovered from the reclaimed asphalt in accordance with the requirements of BS 2000: Part 397 and tested in accordance with BS 2000: Part 49. The penetration value and the softening point of the binder recovered shall comply with the requirements of EN13108.

Suitability has to be demonstrated it these requirements are not met (e.g. compactability, void content).

Softening point of the Bitumen recovered from the resulting mixture: $\leq$ 70° C.

Compliance and Frequency of Testing

5 Compliance shall be monitored either:

(i) by sampling and testing from the permanent works at a frequency approved by the Overseeing Organization or

(ii) by periodic trials at a frequency approved by the Overseeing Organization.

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

903 Asphalt Concrete for Base Courses

1 Unless otherwise specified in Appendix 7/1, base course mixtures shall comply with sub-Clauses 2 and 3 of this Clause. Tolerances from Mix-Design are those of ASTM D 3515.

Aggregate

2 Grading of total aggregate complies with table 1, dense mixtures and nominal maximum size of aggregate 25mm of ASTM D 3515. The content of aggregate 19mm to 25mm is at least 10%.

Binder

3 The binder shall be petroleum bitumen complying with EN 12591. The penetration of the bitumen shall be 50/70 penetration as described in Appendix 7/1. The maximum temperature of the bitumen at any stage shall be 180ºC when penetration bitumen is used.

The bitumen content by weight of total mixture shall be within the limits of 4.8% to 6.3%. It is recommended that the percentage voids filled with bitumen (VFB) is within the range of 65% to 78%.

Technological Properties

4 The technological properties of the Marshall specimen compacted at a temperature of 150 ± 5°C by 50 blows from each side are as follows:

- Stability: ≥ 6.7 KN
- Flow: 2mm to 4mm
- Void content: 4 % to 7 %

904 Asphalt Concrete for Binder Courses

1 Unless otherwise specified in Appendix 7/1, binder course mixtures comply with sub-Clauses 2 and 3 of this clause. Tolerances from Mix-Design are those of ASTM D3515.

Aggregate

2 Grading of total aggregate complies with table 1, dense mixtures and nominal maximum size of aggregate 19mm of ASTM D3515. The content of aggregate greater 12.5 mm is at least 20%.

Binder

2. Binder shall comply with EN 12591 and have the penetration grade 50/70. Maximum temperature of Bitumen: Clause 903 sub-Clause 3.

The bitumen content by weight of total mixture shall be within the limits of 5.0% to 6.9%. It is recommended that the percentage voids filled with bitumen (VFB) is within the range of 65% to 78%.

Technological Properties

3 The technological properties of the Marshall Specimen compacted at a temperature of 150 ± 5°C by 50 blows from each side are according to Clause 903, Sub-Clause 4 except void content; 4% to 6%.

905 Asphalt Concrete for combined Base-Wearing Courses

1. Unless otherwise specified in Appendix 7/1, combined base-wearing course mixtures comply with sub-clauses 2 and 3 of this clause. Tolerances from Mix-Design are those of ASTM D3515

Aggregate

2 Grading of total aggregate complies with table 9/1.

Table 9/1: Aggregate Grading

Sieve Size (mm)	Percentage Passing (%)
25.00	100
19.00	95-100
12.50	82-92
9.50	73-86
4.75	49-67
2.36	33-53
0.60	14-36
0.30	11-28
0.075	6-11

Binder

3. Binder shall comply with EN12591 and have the penetration grade 50/70. Maximum temperature of bitumen: Clause 903, sub Clause 3.

The bitumen content by weight of total mixture shall be within the limits of 7.1% to 7.8%. It is recommended that the percentage voids filled with bitumen (VFB) is within the range of 82% to 90%.

Technological Properties

4 The technological properties of Marshall-Specimen compacted at a temperature of 135±5°C by 50 blows from each side are as follows:

- Stability: ≥8KN
- Flow: 2mm to 5mm
- Void content: 1% to 3%

Void content of laid materials after compaction shall be below 7%

906 Asphalt Concrete for Wearing Courses

1 Unless otherwise specified in Appendix 7/1, wearing course mixtures shall comply with sub-clauses 2 and 3 of this clause. Tolerances from Mix-Design are those of ASTM D3515.

Aggregate

2. Grading of total aggregate complies to table 1, dense mixture and nominal maximum size of aggregate 12.5mm of ASTM D3515.

Binder

3. The binder shall be petroleum bitumen complying with EN12591. The penetration of the Bitumen shall be the grade as specified in Appendix 7/1. The maximum temperature of bitumen at any stage shall be 180 °C when 50/70 penetration bitumen is used.

The bitumen content by weight of total mixture shall be within the limits of 5.8% to 7.2%. It is recommended that the percentage voids filled with bitumen (VFB) is within the range of 65% to 78%.

Technological Properties

4 The technological properties of the Marshall specimen compacted at a temperature of 150±5°C by 50 blows from each side are according to Clauses 903, sub-Clause 4 except void content: 3% to 5%.

907 Regulating Courses

1 Regulating courses shall be in accordance with sub-Clauses 2 and 3 of this Clause and the requirements of Appendix 7/1. Bituminous materials for regulating courses shall meet the requirements for the appropriate material as specified in Clause 903 to Clause 906. The regulating course shall have at least the same technological properties of the asphalt layer which is being adjusted by the regulating layer.

2 Regulating courses, which may consist of one or more layers of a bituminous material, shall have their finished surfaces laid to achieve the appropriate tolerances for horizontal alignments, surface levels and surface regularity, for pavement layers, in accordance with Clause 702.

3. Minimum and maximum layer thicknesses acc. to Clause 901, sub-Clause 6 have to be respected. Minimum layer thickness for regulating courses has to be at least 2.5 x maximum grain size (e.g. for binder course 0/19mm at least 4.8cm). If the minimum thickness cannot be achieved, scarifying will be necessary. Binder course material 0/12.5mm allows minimum thickness of 3.0cm.

Table 9/2: Aggregate grading for regulating courses 0/12.5mm

Sieve Size (mm)	Percentage Passing (%)
16.00	100
12.50	90-100
9.50	65-85
4.75	45-65
2.36	30-50
0.60	15-40
0.30	9-30
0.075	3-9

4 Compaction degree of ≥96% may be accepted for regulating courses.

908 Not used

909 Not Used

910 Not Used

911 Mix Design for Asphalt Concrete

1 Asphalt concrete shall be designed in accordance with the Marshall method of Mix Design according to the Asphalt Institute Manual Series No.2 (MS-2).

The design mixture selected by the Contractor must be approved by the Roads Directorate prior to its use in any Works.

Constituent Material

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

Grading of Total Aggregate

3 Grain size distribution has to be chosen within the limits of Clauses 903 to Clause 906 so that the required technological properties are achieved. It must not be necessarily in the middle of the grading envelope.

Verification

4 Verification of the design proposal shall be carried out using materials obtained from the plant before manufacture of the courses commences. Technological properties shall be determined at the proposed target binder content recommended by the Roads Directorate.

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

Composition

5 When determined in accordance with the procedures, of ASTM D2172, C136, D1559, D2041 and D2726, the composition and technological properties of the plant mixture shall comply with the requirements for the course design mix. The nature and source of the coarse and fine aggregate may be changed only if the mix is redesigned and agreed by the Roads Directorate prior to its use in the works. With the agreement of the Roads Directorate the source of the filler may be varied provided its characteristics remain essentially the same.

913 Not Used

914 Not Used

915 Not Used

916 Not Used

917 Cold-milling (Planing) of Bituminous Bound Flexible Pavement

1 Where milling of bituminous bound flexible pavement is required, the area of carriageway to be milled shall be removed to the specified depth by a milling machine approved by the Engineer. The process shall be carried out so as not to produce excessive quantities of either fumes of smoke. Damping with water sprays will minimise dust. The use of machines which employ direct flame heating, shall not be permitted.

2 The cut edges shall be left neat, vertical and in straight lines. The contractor shall brush and sweep the milled surface by mechanical means, to produce a clean and regular running surface with a groove depth not greater than 10mm, with a uniform texture, to the satisfaction of the Engineer.

3 Carriageways shall be milled to the tolerance of surface levels specified in clause 702 namely, a milling of a wearing course $\leq$6mm and milling of binder and wearing course together $\leq$10mm. In awkward spaces (e.g. Kerbs, junctions, manholes) tolerances $\leq$10mm are allowed. If the tolerance in this Clause is exceeded, the full extent of the area which does not comply, shall be rectified by further milling or by regulating with materials in accordance with Clause 907.

4 Existing ironwork shall not be disturbed by the milling action. When necessary, surfacing in the vicinity of ironwork shall be removed by pneumatic tools or other suitable methods.

5 Where milling is carried out on a carriageway open to traffic, temporary ramping to ensure the safe passage of vehicles shall be provided to the approval of the Engineer.

6 If the milled surface profile varies by more than the permissible tolerance when measured transversely or longitudinally by a 4-metre straight edge, adjustments or replacements shall be made to

the cutting teeth on the milling drum before work continues. Any discontinuity between adjacent milling passes exceeding 6 or 10mm, when measured transversely by a 4-metre straight edge, shall be rectified by further milling or regulating before placing bituminous materials.

7 Where milling is required over extensive areas, the contractor shall programme the work to allow removal of full length widths. If this is impracticable, the proposed programme of milling shall be submitted to the Engineer for approval.

8 Immediately after milling, surplus material shall be removed by a machine of suitable and efficient design and the milled surface swept to remove all dust and lose debris.

9 No stockpiling shall be allowed on Site unless permitted by the Engineer.

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

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

918 Slurry Sealing

1 Slurry sealing shall comply with BS434: Part 1 and Part 2, and with Sub-Clauses 2 to 17 of this Clause. It is preferred that slurry seals re delivered as finished product to the site.

Aggregate

2 Occurring sand free from silt, clay or other fine material. The aggregate, whether a mixture or not, shall have a smooth grading within the limits of Table 9/3

Table 9/3: Aggregate Grading

BS Sieve Size	Percentage by mass of total aggregate and additive passing	
	3mm Finished thickness	1.5mm Finished thickness
5mm	100	100
3.35mm	80-100	100
2.36mm	75-100	95-100
1.18mm	55-90	70-95
600µm	35-70	55-75
300µm	20-45	30-50
150µm	10-25	10-30
75µm	5-15	5-15

Additive

3 The additive shall be Portland cement complying with MSA EN 197-1, or hydrated lime complying with BS 890. At least 75% shall pass the 75µm BS sieve.

Bitumen Emulsion

4 The slurry seal bitumen emulsion shall comply with BS434: Part 1 and shall be either:

(i) Class A4 Rapid Setting or Class K3 capable of producing a slurry which on laying develops early resistance to traffic and rain and is sufficiently stable to permit mixing with the specified aggregate, without breaking during the mixing and laying processes, or

(ii) Class A4 Slow Setting

Tack Coat

5 Where required, or described in Appendix 7/3, tack coat shall be cationic bitumen emulsion complying with BS 434: Part 1.

Composition of Mixed Material

6 The mixed material shall comprise aggregate, bitumen emulsion and, where necessary, additive complying with sub-Clause 3 of this Clause. The amount of emulsion used shall be between 180 litres/ tonne and 250 litres/ tonne of dry aggregate; the precise proportions of each constituent being selected after laboratory tests and trials using the same plant intended to be used in the Works. When additive complying with sub-Clause 3 of this Clause is used, the proportion shall not. normally exceed 2% by mass of aggregate.

The following requirements are in general to be met:

- Bitumen Content: >14%
- Water content: >20%

- Aggregate and Additive: >55%

Mixings

7 The materials shall be measured into a mechanical mixer and mixed such that the aggregate is completely and uniformly coated with bitumen emulsion and a slurry is produced of consistency that can be satisfactorily laid as described in sub-Clauses 12 to 14 of tins Clause. When required, an additive complying with sub-Clause 3 of this Clause, shall be used to control consistency, mix, segregation and setting rate.

Preparation of Site

8 Before applying tack coat, or spreading slurry, any necessary patching of the road surface shall be completed. Immediately before application of bituminous materials, loose material, dust and vegetation shall be cleaned from the existing surface by sweeping, supplemented if necessary by air jet (Water pressure 80 to 150 bar) and removed from the site. All ironwork, road studs and where directed by the Engineer, road markings, shall be masked. At junctions with surfaces not to be treated, clean lines shall be defined by masking, or other suitable means.

Laying

9 If required, a tack coat shall be applied in accordance with BS 434: Part 2 before spreading the slurry seal.

10 The rate of spread of tack coat shall depend on the surface to be treated. For bituminous surfaces the rate shall be 0.15-0.30 l/m² and for concrete surfaces it shall be 0.4-0.6 l/m²

11 Slurry shall be spread evenly by mechanical means such that the aggregate cover (dry mass equivalent) is 4-6 kg/m² for 3mm finished thickness and 2-4 kg/m² for 1.5 mm finished thickness.

12 All voids, cracks and surface irregularities shall be completely filled. Spreading shall not be undertaken when the ground temperature falls below 5°C or when standing water is present on the surface. In warm dry weather the surfacing, immediately ahead of the spreading, shall be slightly damped by mist water spray applied mechanically unless the Engineer agrees otherwise.

13 The slurry may be rolled by a self-propelled or towed multi-wheeled smooth tread rubber-tyred roller, having an individual wheel load between 0.75 and 1.5 tonnes, making at least six passes, unless the Contractor demonstrates to the satisfaction of the Engineer that rolling is unnecessary or that a fewer passes are sufficient for a particular process. Rolling shall commence as soon as the slurry has set sufficiently to ensure rutting or excessive movement will not occur

14 The finished slurry shall have uniform surface texture and colour throughout the work., without variations of texture within the lane width, or from lane to lane, due to segregation of aggregates or colour, due to variations in the emulsion/water content of the mixture. It must be possible to open the carriageway to traffic 30 minutes after laying.

15 The finished surface shall be free from blowholes and surface irregularities which may be due to scraping, scabbing, dragging, droppings, excess overlapping or badly aligned longitudinal or transverse Joints, damage by rain or other defects. Slurry sealing which does not comply with this Clause or is non-uniform in surface texture or colour 24 hours after laying, shall be rectified by removal and replacement with fresh material rolled in compliance with the Specification. If this is impracticable, fresh material superimposed and rolled in compliance with the Specification. Areas so treated shall lie not less than 5 m long and not less than one lane wide. All areas being worked on shall be kept free of traffic until permitted by the Engineer.

Preliminary Slurry Mixture Design and Trial Areas

16 Using the same plant proposed for the works the Contractor may make trial mixes of the slurry, varying the bitumen emulsion/aggregate ratio to produce a slurry or creamy consistency which, whilst the screed box is travelling at the laying speed, will flow ahead of the screeding blade across the whole width of the spread at all times. At least three trial mixes should be made, each sufficient to spread a trial area of 40 square meters, to the specified finished thickness. The preparation o f the existing surface for the trials, the tack coat spreading and the rolling methods shall comply in all respects with this Clause. Trial Areas which achieve the required spreading consistency will be examined after 24 hours, for surface texture and

adhesion.

17 Mix design will be carried out according to MS-2 at a compaction temperature of 135±5°C. The mixture will be produced in three steps:

(i) Mixing of aggregates and additives,
(ii) Mixing after addition of water,
(iii) Mixing after addition of emulsion.

The mixture has to be tried for four hours at a temperature of 150°C before producing the Marshall Specimen. Stability and flow are not determined.

18 When a produced mix has been approved variations shall not be made in mixing time, mix proportion or in the type, size, grading or source of any of the constituents without the agreement of the Engineer who may require further tests to be made.

919 Surface Dressing – SD

General

1 Surface dressing consists of a bitumen containing binder applied directly to the base or to a base which had chippings previously applied to it and of the spreading of coated or uncoated chippings in one or two layers. The three types of application and the amount of binder and aggregate are to be found in table 9/5.

Use

2 Surface dressings are mainly used for roads of construction classes IV to VI as well as unclassified roads and other traffic areas. They are used primarily to improve the skid resistance and for the substance preservation.

Surface dressings protect the traffic areas essentially from destruction by water ingress and other climatic influences (e.g. ageing of bitumen). Depending on the aggregate used they may also improve the visibility at night and during wet road surface conditions.

Type and condition of base, traffic loading, speed and also climatic and local conditions have to be considered when they are applied.

Type of surface dressing should be chosen in accordance with table 9/4.

Table 9/4: Type of surface dressing according to the condition of base.

Condition of Base	SD with single chippings spreading	SD with double chippings spreading	SD to previously applied chippings
Bleeding	-	-	+
Polished grains	+	+	+
Mortar loss	+	+	-
Crocodiling	+	+	-

Explanation:
+ Suitable
- Not suitable

Irregularities of the surface cannot be eliminated by surface dressing.

Repeated use of surface dressing may have disadvantages e.g. bitumen increase in the wheel passes or increase of irregularities.

Materials, type of surface dressing

3 Type of surface dressing and the materials to be used have to be indicated in the bill of quantities. Table 9/5 has to be observed.

Table 9/5:Type of application and materials for Surface Dressing

Type of Binder	Layer respectively course	Amount of binder (Kg/m²)	Amount of chippings (Kg/m²) for grain range 8/11 | 5/8 | 2/5		
1. Surface dressings with single chippings spreading					
Unstable bitumen emulsion K1-70 ,		1.5 to 2.0	-	11 to 17	-
Polymermodified unstable bitumen		1.2 to 1.6	-	-	9 to 14

emulsion					
Polymermodified hot bitumen		1.0 to 1.4	-	9 to 15	-
		0.9 to 1.1	-	-	8 to 12
2. Surface dressing with double chippings spreading					
Unstable bitumen emulsion K1-70,	1.layer	1.6 to 2.2	10 to13	-	-
	2.layer	-	-	-	3 to 6
Polymermodified unstable bitumen emulsion	1.layer	1.4 to 1.8	-	10 to 12	-
	2.layer	-	-	-	3 to 6
Polymermodified hot bitumen	1.layer	1.2 to 1.3	10 to 13	-	-
	2.layer	-	-	-	2 to 5
	1.layer	1.1 to 1.2	-	9 to 12	-
	2.layer	-	-	-	2 to 5
3. Surface dressing to previously applied chippings.					
Polymermodified unstable bitumen emulsion	1.course	-	10 to 13	-	-
	2.course	1.8 to 2.3	-	(10 to 15)*)	10 to 13
	1.course	-	-	9 to 12	-
	2.course	1.7 to 2.1	-	-	10 to 13
Polymermodified hot bitumen	1.course	-	10 to 13	-	-
	2.course	1.3 to 1.6	-	(10 to 12)*)	10 to 13
	1.course	-	-	9 to 12	-
	2.course	1.2 to 1.5	-	-	10 to 13

Explanation:
- Not suitable
*) Alternatively possible

Bitumen emulsions comply with BS 434: Part 1, type K1-70. For polymermodified bitumen the Contractor provides a Binder Data Sheet giving details of the properties of the binder proposed

Chippings shall have a Los Angeles coefficient of below 20. A PSV-value of at least 53 is recommended if surface dressing is applied o improve the skid resistance. Aggregates which are not coated must not have a fines content of greater 0.3% for the sieve size 0.075 mm. Coated chippings are not to be used with bitumen emulsion as setting would be hindered.

The amount of chippings and binder has to be established for each project, as well as for partial sections of the road. Binder amount as well as grain size and amount of chippings are to be chosen according to the base, traffic loading and climate conditions. The amount of binder has to be chosen such that the chippings are sufficiently embedded (up to the shoulder) but no bitumen exceeds the grain tips. Trial areas might be necessary to establish the final mix composition.

Advice for the consideration of the various influence factors to the necessary bitumen content is to be found in table 9/6.

Table 9/6: Influence factors for binder determination based on bitumen content.

Amount of Bitumen	Influence factors
Higher	Base with high void content and rough surface (e.g. mortar loss)
	Rigid surface (e.g. concrete)
	Low traffic volume
	Shady and/or moist situation of the road
	Rough grain surface of chippings
Lower	Low void content of base
	Soft surface (e.g. too high Bitumen content)

	Fine-grained and/or closed surface of base
	High traffic loading
	Sunny situation of road

Execution

4. Surface dressing should be carried out in the dry season, i.e. middle of April to middle of September so that a sufficient period is available where the road is under traffic at favourable climate conditions.

Temperature of the binders has to be chosen in such a way that would ensure easy spraying, overheating has to be excluded. Application temperature of K1-70 for example is generally between 30°C and 75°C and must be controllable. The truck binder sprayer shall be capable of uniform application at the designed rate of spread over a variable or fixed width to allow a full lane width to be dressed in a single pass. Only in awkward spaces should hand spraying be allowed.

The chipping spreader shall have controlled metering and be capable of variable or fixed width application to match the binder sprayer. For surface dressing with single and double chippings spreading, the chippings have to be applied immediately after spraying of the binder and to be pressed on by rolling; local chippings decrease or increase has to be eliminated before rolling. For surface dressing to previously applied chippings, the chippings are regularly to be spread onto the cleaned base; afterwards the binder is sprayed and immediately hereafter the second chipping layer is spread and pressed on by rolling.
Surface dressings produced with bitumen emulsion have to be closed to traffic until setting has been fully attained. Traffic speed has to be limited to 40Km/h until the surface dressing is stable and loosened grains have been removed. Surplus chippings have to be removed before opening the road to restricted traffic.

5 Any defects arising from deficiencies in the materials, workmanship and aftercare which are apparent during or at the end of the maintenance period shall be rectified by the Contractor at his own expense.

As Built Manual

6 Not more than 30 days after completion of the work, the Contractor shall provide a record of the progress of the work in the form of an As Built Manual incorporating all relevant information, including all test results; variations to the design and those necessitated by localized site conditions; weather information; unforeseen problems and a list of complaints, if any, from the general public or road users, and any such other information that the Overseeing Organization may reasonably require should also to be included.

920 Tack Coats and other Bituminous Sprays

1 This Clause shall not apply to bond and tack coats for proprietary thin surface course systems

Tack Coats

2 Tack coats shall be bitumen emulsions complying with BS 434: Part 1. Tack coats for hot rolled asphalt and coated macadam shall be in accordance with BS 594: Part 2 and BS 4987: Part 2, respectively.

Modified Bituminous products may also be used, a certificate has to be presented to the Overseeing Organization.

Bituminous Sprays

3 Bituminous sprays used to facilitate sealing and curing shall consist of either bitumen emulsion to BS 434: Part 1; cutback bitumen or bitumen to BS 3690; or modified bituminous products with a Certificate.

Manufacture and Product Data

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

Preparation

5 Any limitations on area availability and timing or other constraints relating to the execution of works shall be as specified in Appendix 1/13. Before spraying is commenced, the surface shall be free of all loose material and standing water. Surface

preparation shall be carried out in accordance with BS 594: Part 2, or BS 4987: Part 2 as appropriate, and shall comply with any requirements specified in Appendix 7/4. When specified in Appendix 7/4, street furniture, ironwork and drop-kerbs shall be masked using self-adhesive masking material before application starts and removed prior to the completion of the works.

Application

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

Rate of Spread

7 Unmodified bituminous emulsions shall be sprayed at the rate of spread specified in BS 434: Part 2 or as otherwise specified in Appendix 7/4. The rate of spread of bitumen and cutback bitumen shall be as specified in Appendix 7/4.

Accuracy of Application

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

Overlaying Concrete Surfaces

9 The Contractor shall submit evidence of the suitability of tack coat he intends to use when overlaying concrete surfaces to the Overseeing Organization prior to the commencement of the work.

Blinding Material

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

Bond Testing

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

(a) Wearing coarse to binder course or base course:
minimum load ≥ 14KN,
shear way : 2-5mm;
(b) Binder course to base course:
minimum load: ≥10KN,
shear way: 1-4.5mm.

921 Surface Texture of Asphalt Concrete Wearing Courses

1 The surface of the finished wearing course must have sufficient roughness. The Skid Resistance of the road surface for the construction classes HD and I to VI measured by the measuring proceedings SCRIM must not fall by more than 0.03 below the following limit values for the single value of a 100m section:

- Acceptance of construction works

  - at 80 km/h μ_{SCRIM} = 0.46
  - at 60 km/h μ_{SCRIM} = 0.53
  - at 40 km/h μ_{SCRIM} = 0.60

- Up to the end of a service time of four years

  - at 80 km/h μ_{SCRIM} = 0.43
  - at 60 km/h μ_{SCRIM} = 0.50
  - at 40 km/h μ_{SCRIM} = 0.56

2 Correlations between SCRIM and the Skid Resistance Value measured by the Skid Resistance Tester according to RRL Road Note No 27,1969 (See also MSA-EN 1436) may be found in the specification 'Arbeitsanweisung für kombinierte Griffigkeits-und Rauheitsmessungen mit dem Pendelgerät und dem Ausflussmesser' of the Road and Transportation Research Association (FGSV). According to this specification the relations for a speed of 40km/h are as follows:

  - μ_{SCRIM} = 0.60 : SRT-Value = 64
  - μ_{SCRIM} = 0.56 : SRT-Value = 60

These relations are taken from the lower confidence limit of Fig.10 of the specification mentioned above.

3. The requirement to Skid Resistance is not applied for residential areas, or parking areas or pedestrian areas.

922 Not Used

923 Not Used

924 High Friction Surfaces

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

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

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

Aggregate

4 Aggregate used in high friction surfacing systems shall have the minimum polished stone value, determined in accordance with BS 812: Part 114, as specified in Appendix 7/1.

Installation and Quality Control Procedures

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

System Coverage

6 For each location where high friction surfacing is applied, the total quantities of each system component used, the measured area of the surface treated and the calculated coverage rate in kg/m^2 shall be reported to the Overseeing Organization within three days of completion at that location. For systems in which aggregate is broadcast over a film of binder applied to the surface, the calculated coverage rate shall be that of the binder film and shall not include the mass of the aggregate.

After care

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

Guarantee

8 The Contractor shall guarantee the high friction surfacing materials and workmanship for a period of two years from the date of opening the surfacing to traffic. This guarantee shall exclude defects arising from damage caused by settlement, subsidence or failure of the carriageway on which the surfacing has been applied, but shall cover failure to meet the minimum requirements set out in

Table 4 of the BBA/HAPAS 'Guidelines Document for the Assessment and Certification of High Friction Surfaces for Highways', or a comparable international document.

925 Testing of Bituminous Mixtures and Their Component Materials

1 The sampling, testing and analysis of bituminous mixtures shall comply with BS 598: Parts 100 to 103 except where specified otherwise in this Series.

2 Production control is carried out by the contractor to ensure that the completed construction works are according to the requirements of the contract. The frequency shown in table 9/7 is only a minimum requirement. The test results have to be presented to the Overseeing Organization on request. Deviations from the contractual requirements have to be reported to the Overseeing Organization and any shortcomings are to be rectified without delay.

Table 9/7: Type and Frequency of testing

Construction Materials / Type of Test	Specification	Asphalt Concrete	Gussasphalt	Cold Asphalt	Slurry Sealing	Surface Dressing
1. Aggregate[1)]		-	-	-	-	x
2. Mixture [2) 5)]						
2.1 Grain size distribution	ASTM C136	x	x	x	x	-
2.2 Bitumen content	ASTM D2172	x	x	x	x	-
2.3 Softening point of recovered bitumen	EN 1427	x	x	x	-	-
2.4 Density and void content of specimen	ASTM D2041, ASTM D2726	x	x[3)]	x	-	-
2.5 Stability and flow (Marshall)	ASTM D1559	x	-	x	-	-
2.6 Penetration depth after 30min and 60min	DIN-1996 Part 3	-	x	-	-	-
3. Layer properties						
3.1 Compaction degree [2)]	ASTM D1559, ASTM D2726	x	-	x	-	-
3.2 Layer bond [2)]	ALPA StB: Part 4	x	-	-	-	-
3.3 Levels (transversal slope)	String method	x	x	x	-	-
3.4 Regularity	4m straight edge	x	x	x	-	-

3.5 Thickness respectively mass/m²		x	x	x	x	x
3.6 Void content [4]		x	-	-	-	-

1) See also Clause 925,- Sub Clause 7
2) Each layer and per each started 3000m² or per day one sample; number of samples may be increased according to necessity (e.g. urban roads, bridge courses)
3) Only density for cubes
4) Only for wearing course and base/wearing course
5) Eventually also additives

3 Control testing is to be carried out by the Overseeing Organization. Type and frequency of testing is described in table 9/7. The results are the base for the acceptance of the construction works. Sampling, and testing at site is carried out by the Overseeing Organization in the presence of the contractor. They may also be carried out in the absence of the contractor if he has been informed in good time and is absent.

4 The contractor may require additional control testing if there is contended that the result of sub-Clause 3 is not characteristic for the area in question. Sampling places and their assigned partial areas are determined in presence of the contractor. The partial area assigned to the initial test result shall not be less than 20% of the initial area.

The Overseeing Organization may carry out additional control testing at it's own discretion. The results of the initial and the additional control tests assigned to the partial areas are decisive for the acceptance of the construction works. Costs of additional tests required by the contractor are to be met by the contractor.

5 Arbitrary testing may be carried out if there are doubts of the Overseeing Organization or the contractor that the control testing has not been carried out correctly. It will be carried out by a laboratory which has not carried out the control testing and will be chosen by the Overseeing Organization and the contractor. Both parties may be present when the tests are carried out.

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

6 Interpretation of the test results is based on the tolerances of ASTM D3515 and the reproducibility and repeatability of the specification in question (e.g. ASTM D2726, paragraph 12).

For the void content of the Marshall specimen the following tolerances are applied to the minimum and maximum values according to the specification (clause 903 to clause 906):

- Wearing course: 1.5%
- Binder course, base course, and base wearing course: 2.0%

7 Within the framework of control testing also samples of aggregate and bitumen are to be taken if there are doubts that the requirements are met.

8 The softening point ring and ball of the recovered bitumen must no exceed the upper limit of the bitumen used by more than 8°C, i.e. for grade 50/70 bitumen the softening point ring and ball must not exceed 62°C.

Price Reduction Formulas

9 The Overseeing Organization may carry out price reductions in 20% of all cases per contractor per year for the thickness, the bitumen content, the compaction degree and the regularity according to established formulas. If there are several defects in one project, the reductions are added.

10 Thickness - If the required thickness is not achieved the unit price (Lm/m²) will be corrected accordingly. An additional price reduction will be calculated according to the following formula:

$$A = p/100 \times 3.75 \times UP \times Area$$
$$= A' \times UP \times Area$$

A = *price reduction*
P = *percentage exceeding the tolerance*
UP = *corrected unit price*
Area = *area concerned*

Higher thickness of an upper layer is used to

compensate the thickness of the layer below.

11 Bitumen content - If the bitumen content does not fall into the tolerance of ±0.5% compared with the mix design a price reduction is carried out according to the formulas (1) to (3):

(1) Out of the tolerance for a single value or for the mean value of 2 to 4 samples and p≤0.3%

A = P/100 x 30 x UP x Area
= A' x UP x Area

(2) Out of the tolerance for a single value or for the mean value of 2 to 4 samples and p>0.3%:

A = 1/100 x (p x 130-30) x UP x Area
= A' x UP x Area

(3) Out of the tolerance for the mean value of 5 and more samples:

A = P/100 x 100 x UP x Area
= A' x UP x Area

12 Compaction degree - If the compaction degree falls below the required value a price reduction is carried out according to the following formula:

A = p^2/100 x 3 x UP x Area
= A' x UP x Area

13 Regularity of the wearing course - If the regularity exceeds the required value, a price reduction is carried out according to the following formula:

$$A = 0.6 \times UP \times B \times \sum .p_i^2$$

B: road width at measuring point
P_i: regularity above required value

926 Not Used

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

The compaction degree K of asphalt concrete is the quotient of the sample density of the compacted material δ_A and the density δ'_A of the specimen prepared according to ASTM D1559:

$$K = \delta_A/\delta'_A \times 100\ (\%).$$

928 Not Used

929 Not Used

930 Not Used

931 Not Used

932 Not Used

933Not Used

934 Not Used

935 Not Used

936 Not Used

937 Not Used

938 Not Used

939 Not Used

940 Gussasphalt

General

1 Gussasphalt is a dense mixture consisting of chippings, sand, filler and bitumen whose aggregate mixture has a low void content. The bitumen content is designed in that way that the voids of the aggregate mixture are completely filled with bitumen or that there is a small bitumen surplus so that durable and safe wearing courses can be produced. Gussasphalt is in hot condition pourable and easy to spread and doesn't need compaction after laying. The surface has to be roughened immediately after laying.

Application

2 Gussasphalt can be used on wearing course for all kind of traffic areas. Gussasphalt of 0/4.75mm will only be used be exception for carriageways. It is suitable for bicycle lanes and footpaths.

Construction materials

3 The requirements of table 9/8 are applied.

In special cases Trinidad Epure or polymer modified bitumen may be used. Natural asphalt improves the workability. Polymermodified bitumen is sensitive to overheating and may need special laying equipment.

Table 9/8 Gussasphalt

Gussasphalt	**0/12.5**	**0/9.5**	**0/4.75**
1. Aggregate sieve			
Sieve Size (mm)			
12.50	90-100	100	
9.50	75-90	90-100	100
4.75	60-70	70-85	90-100
2.36	45-55	50-60	55-65
1.18	35-50	40-55	45-60
0.60	30-48	35-50	38-55
0.30	25-40	30-45	30-50
0.075	20-30	22-32	24-34
2. Bitumen			
Type of bitumen	30/45 (50/70)[1)]		
Bitumen content (%)	6.5 to 8.0	6.8 to 8.0	7.0 to 8.5
Softening point after extraction (°C)	≤ 71 [2)]	≤ 71	≤ 71
3. Mixture			
Penetration 5cm² at 40°C for cubes (70mm x 70mm)			
- after 30 min (mm)	1.0 to 3.5	1.0 to 5.0	1.0 to 5.0 [3)]
- increase after a further 30 min (mm)	≤ 0.4	≤0.6	≤0.6
4. Layer			
Thickness (including spreaded material) (cm)	3.5 to 4.0	2.5 to 3.5	2.0 to 3.0
or			
Material by weight (including spreaded material) (kg/m²)	80 to 100	65 to 85	45 to 75
5. Spreaded Material	Chippings 2.36/4.75 mm :		5 to 8 kg/m²
	Chippings 2.36mm and/or 4.75/9.5mm:		15 to 18 kg/m²
	Sand:		2 to 3 kg/m²

1) Only in special cases
2) For Bitumen grade 20/30: ≤ 75°C
3) Bicycle lanes and footpaths: ≤ 10mm

Execution

4 Laying speed has to be regular during laying, i.e. the gussasphalt finisher should never come to standstill. The temperature of the gussasphalt should be constant for the laying cross section. These influence factors determine the regularity of the surface because of the spreading of chippings.

Special measures are necessary if the diagonal cross slope is greater than 7%, for example: reduced laying temperature, stiffer mixture or reduced amount of material before the screed.
Connections have to be constructed on joints and to be filled with sealing compound. Edge are to be vertical.

Shaping of surface

5 Surface has to be roughened in carriageways by chippings. In other areas sand may be used. Surplus material has to be taken up. It may be necessary to loosen by steel-wheel rollers material, which doesn't completely adhere.

Roughening is carried out by slightly coated chippings 2.36/4.75mm in an amount of 5to8 kg/m² mechanically applied to the hot surface and pressed to the gussasphalt by rolling. Application by hand can be carried out in small areas. Rolling can be carried out by smooth or profiled rollers.

Roughening can also be carried out with slightly coated chippings 2.36/4.75 or/and 4.75/9.5mm in an amount of 15 to 18Kg/m² mechanically. Chippings have to be pressed into the hot surface by rubber-tyred rollers or steel-wheel rollers.

Heated or slightly coated sand is spread and rubbed into the hot surface.

941 Not Used

942 Not Used

943 Not Used

944 Not Used

945 Not Used

946 Not Used

947 Not Used

948 Not Used

949 Repairs to Potholes – Cold asphalt

1 Temporary repairs to small areas of surface courses including holes for road stud sockets shall be carried out in accordance with Appendix 7/22

Cold Asphalt

2 Cold Asphalt for repair works is designed according the Manual Series No. 14 (MS-14) of the Asphalt Institute. Requirements are as follows:

- Grading:
  dense mixture 0/12.5 mm according to MS-14 Appendix C.06, Gradation 2 for mineral aggregate.

- Binder:
  medium setting anionic emulsion HFMS-2 according to ASTM D977

- Void content of Marshall specimen: 8% to 12%

- As an indication:
  bitumen content after curing may be between 6% to 8% with a tendency to the lower limit.

950 Depressions

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

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

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

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

951 Patching

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

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

3 Joint edges shall be formed as specified in sub-Clause 901.21

4 All loose material shall be removed off Site.

5 Replacement material shall be specified in Appendix 7/1

6 A tack or bond coat shall be applied in accordance with Clause 920.

7 All construction layers shall be laid and compacted such that on completion each layer shall be at the same level as the adjacent course.

ROAD PAVEMENTS - CONCRETE AND CEMENT BOUND MATERIALS

Contents

ROAD PAVEMENTS - CONCRETE AND CEMENT BOUND MATERIALS

1001 Grades of Concrete and Constituent Materials for Pavement Layers

1 Concrete in rigid or composite pavements shall be one of the grades given in Table 10/1, in accordance with the pavement design alternatives permitted in Appendix 7/1.

2 All concrete for use in pavements shall be designed mixes or equivalent standard mixes in accordance with the relevant clauses of BS 5328 : Parts 1, 2, 3 and 4, except where otherwise specified in this Series. Prescribed mixes may be selected for rapid construction if permitted in Appendix 7/1 or agreed with the Overseeing Organisation.

Cement

3 The general term 'cement' in this Series means any of the materials in (i) or the combinations in (ii) below:

(i) Cements — Complying with:

(a) Portland cement CEM I	MSA EN 197-1
(b) Portland slag cement CEM II/B-S and Portland blastfurnace cement (PBC)	MSA EN 197-1
(c) Blastfurnace cement CEM III/A	MSA EN 197-1
(d) Portland pulverised-fuel ash cements CEM II/ B-V	MSA EN 197-1
(e) Pozzolanic cement CEM IV/A	MSA EN 197-1

(ii) Combinations

(a) Portland cement CEM I MSA EN 197-1 with ground granulated blastfurnace slag (ggbs) (BS 6699) for use with Portland cement CEM I

(b) Portland cement CEM I MSA EN 197-1 with pulverised-fuel ash (pfa) (BS 3892 Part 1) for use as a cementitious component in structural concrete Alternatively, in concrete Grades C20 and below and in Cement-bound materials specified in Clause 1035, the pfa may be in accordance with BS 3892 : Part 2

(c) Portland cement CEM I with pozzolanic additive having a current BBA Certificate MSA EN 197-1

Generally a portland cement CEM I type 32.5R is used for the manufacturing of concrete pavement

(iii) Cement Contents

In each cubic metre of fully compacted concrete, the cement content shall be in accordance with the following:

Grade **Cement**	**C40**	**C40 In at least the top 50mm of surface slabs**	**C30**	**C20**	**C15**	**10**	**C7.5**
Min. Portland Cement CEM 1 BS EN 197-1 (Kg/m³)	320	320	280	(a) or 180	(a) or 160	(b) or 130	(b) or 120
Min. Other cements or combinations pennitted in Sub-clauses 3(i) and 3 (ii) (kg/m³)	340	340	340	(a) or 180	(a) or 160	(b) or 130	(b) or 120
For mixtures pre-blended or mixed on site							
Maximum proportion of ggbx (%)	50	35	65	65	65	65	65
Maximum propotion of pfa (%)F	35/15	25/15	35/15	35/15	50/-	50/-	50/-
Min. CEM 1 content (Kg/m³)	220	255	200	160	-	-	-

Note

(a) denotes maximum aggregate/cement ratio of 14:1 by mass.

(b) denotes maximum aggregate/cement ratio of 18:1 y mass.

TABLE 10/1: Pavement Layers - Grades of Concrete

Pavement Layer	**BS 5328: Part 2**		**Clauses**
	Designed Mix Grade	**Standard Mix**	
(i) Surface slabs: Unreinforced concrete (URC) Jointed reinforced concrete (JRC) Continuously reinforced concrete pavement (CRCP) (ii) Continuously reinforced concrete base course (CRCR) (iii) CRCP and CRCR ground beam anchorages	C40 C40 C30		) 1001 to 1034 and 1044
(iv) Wet lean concrete 4) For bases courses or (v) Wet lean concrete 3) sub-bases (vi) Wet lean concrete 2) (vii) Wet lean concrete 1)	C20 C15 C10 C7.5	ST4 ST3 ST2 ST1	) 1030
(viii) Cement Bound Material Category 2 (CBM2) (ix) Cement Bound Material Category 4 (CBM4)	) For) sub-bases as required in) Appendix 7/1		) 1030 to 1042

(iv) When used, the proportion of microsilica to CEM I shall be 10 ± 1%.

(v) In cement bound materials the maximum proportion of:

(a) ggbs to the total cement shall not exceed 65% by mass;

(b) pfa to the total cement shall not exceed 50% by mass.

Water

4 Water from a water company supply may be used without testing. Water from other sources may be used if it conforms with BS 3148. The water content shall be the minimum required to provide the specified workability for full compaction of the concrete to the required density, as determined by trial mixes or other means, and the maximum free water/cement ratio shall be 0.45 for Grades C40 and C30 and 0.60 for Grades C20 and C15. The requirements for standard mixes shall be in accordance with BS 5328.

(i)for surface slabs of pavements which are to be overlaid by a 30 mm minimum thickness thin surface course system complying with Clause 942, air entraining shall not be required.

5 Plasticisers or water reducing admixtures shall comply with BS 5075 : Part 1 or Part 3. Admixtures containing calcium chloride shall not be used.

Aggregate

6 Aggregates for all pavement concrete shall be natural material complying with Clause 1701, Sub-Clause 2. Crushed concrete, which complies with the quality and grading requirements of BS 882 and Table 10/2, may also be used in all pavement concrete mixes but excluding exposed aggregate concrete surface complying with Clause 1044. Aggregates for wet lean concrete or cement bound materials shall be natural material complying with Clause 1701 Sub Clause 2, or recycled coarse aggregate or recycled concrete aggregate complying with the quality and grading requirements of Clause 1701 Sub-Clause and Table 10/2. Once the appropriate gradings have been determined they shall not be varied without the approval of the Overseeing Organisation. Irrespective of source, the aggregate will be considered suitable if:

(i) aggregate from the source, when tested in accordance with BS 812 : Part 121, has a soundness value greater than 75;

or

(ii) evidence can be provided to the Overseeing Organisation of satisfactory use of aggregate from the source. The water absorption of the coarse aggregate from the source determined in accordance with BS 812 : Part 2 shall also be declared. Where recycled coarse aggregate or recycled concrete aggregate is used in this Series, it shall have been tested in accordance with Clause 710.

TABLE 10/2: Limits for 'Other Materials' and Limiting Concrete Mixes for Recycled Coarse Aggregate and Recycled Concrete Aggregate

Aggregate Type	Recycled Concrete	Recycled Course Aggregate and

	Aggregate	**Recycled Concrete Aggregate**
Maximum Permitted concrete grade	C30 or greater	C20 or less
Permitted standard mixes	All	ST1 – ST3
Other Materials	**Maximum % by Mass**	**Maximum % by Mass**
Fines content	5	3
Masonry	5	100
Ultra lightweight material (<1000 kg/m³)	0.4	1
Asphalt	5	10
Foreign materials	1	1

7 The nominal size of coarse aggregate shall not exceed 40 mm. When the spacing between longitudinal reinforcement is less than 90 mm, the nominal size of coarse aggregate shall not exceed 20 mm.

8 Sand (i.e. fine aggregate) containing more than 25% by mass of acid-soluble material as determined in accordance with BS 812 : Part 119, in either the fraction retained on, or the fraction passing the 600 micron BS sieve, shall not be used in the top 50 mm of surface slabs. This requirement will not apply for pavements with an exposed aggregate concrete surface constructed to Clause 1044 or if it can be shown that the sand (ie fine aggregate) retained on, or the fraction passing the 600 micron BS sieve, contains less than 25 per cent by weight of calcium carbonate.

9 The water absorption of flint coarse aggregate containing white flints for use in concrete surface slabs, when determined in accordance with BS 812 : Part 2 shall not exceed:

3.5% for any separate nominal size fraction;

2.0% for the total combination of coarse aggregates in the proportions to be used in the concrete.

Tests shall be carried out on three samples taken at random from the source prior to use. Tests shall also be carried out during stockpiling or paving, once a week, or at a lesser rate when authorised by the Overseeing Organisation.

Source of Recycled Aggregates

10 Where recycled coarse aggregate or recycled concrete aggregate is used, only crushed concrete resulting from reclamation or processing of concrete previously used in construction which originates from appropriate identified structures with a known history of use shall be used.

11 In order to detect substances and chemicals harmful to the durability of concrete, appropriate tests based on current relevant advice shall be carried out on recycled coarse aggregate and recycled concrete aggregate, and the results reported to the Overseeing Organisation.

Chloride Content

12 The chloride ion content of the aggregate to be used in concrete with embedded metal shall be determined in accordance with BS 812 : Part 117, or in the case of recycled coarse aggregate or recycled concrete aggregate in accordance with BS 1881: Part 124, and shall be as stated in BS 5328 : Part 1.

Control of Alkali-Silica Reaction (ASR)

13 The requirements of sub-Clause 1704.6 shall apply to road pavement concrete specified in this Series.

1002 Not Used

1003 Density

1 The density of concrete Grades C40 and C30 shall be such that without air-entrainment the total air voids are not more than 3%. With air-entrainment, the total air voids shall be not more than 9.5% for 20 mm aggregate or 8.5% for 40 mm aggregate. The density of concrete Grades C20, mix ST4 or below shall be at least 95% of the theoretical maximum dry density.

2 The air voids shall be derived from the difference between the theoretical maximum dry density of the concrete calculated from the relative densities of the constituents of the mix and the average value of three direct density measurements made in accordance with BS 1881 : Part 114 on cores taken in accordance with BS 6089. Cores shall be at least 100 mm diameter and shall be 150 mm diameter for 40 mm size aggregate. Where different concrete mixes are used in separate layers, the density of each layer shall be separately determined by splitting or cutting the cores between the layers.

3 Cores shall be taken at the rate given in Clause 1028 for trial bays and at the rate of at least three per 600 m² length of pavement layer being constructed in any single width during normal working or per day. If the density of 30 consecutive cores meets the requirements of the Specification the rate of sampling may be reduced to at least three per 2000 m length. If the density of any core is below the minimum required, the concrete across the whole width of the slab constructed at the time relating to that core shall be removed. In unreinforced concrete the whole slab length between joints shall be removed. For reinforced slabs additional cores shall be taken at 5 m intervals on each side of any defective core until concrete of satisfactory density is found in order to determine the limit of the defective area of concrete which shall be removed. Defective areas shall be made good with new material in accordance with the Specification.

4 In calculating the density, allowance shall be made for any steel in the cores.

5 Core holes shall be reinstated with compacted concrete with mix proportions of 1 part of Portland cement CEM I: 2 parts of sand: 2 parts of 10 mm nominal single sized coarse aggregate by mass.

1004 Quality Control of Concrete Strength

1 Sampling and testing for, and compliance with the specified characteristic strength of designed mixes shall be in accordance with BS 5328 : Part 4, except that it shall be at the following rates of sampling and testing and meet the following requirements:

2 Concrete cubes of the appropriate size shall be made, cured and tested in accordance with BS 1881 : Part 108, 111 and 116 respectively from concrete delivered to the paving plant, each set being from a different delivery of concrete. At least 4 cubes (Factory Production Control) and 3 cores (Control Testing) shall be tested per set for each 600 m² of concrete slab or per day for each type of mix. If the strength of 12 consecutive cubes meets the requirements of the Specification the rate of sampling may be reduced to 4 for each 1000 m² of concrete slab and not less than 4 sets of cubes shall be made each day for each type of mix satisfying the reduction. This rate of sampling and testing may be modified at the Engineer discretion.

3 For areas of 600m^2 or more, one cube shall be tested in compression at 7 days and the other three at 28 days after mixing. Groups of four consecutive results at 28 days

shall be used for assessing the strength for compliance with BS 5328: Part 4. For areas less than 600m^2, two cubes shall be tested at 7 days and two tested at 28 days and assessed as in BS 5328: Part 4.

4 The ratio R between 7 and 28 day strengths shall be established for the mix to be used in the slab by testing pairs of cubes at each age on at least six batches of the proposed mix or it shall be quoted by the supplier of the concrete. The average strength of the 7-day pair of cubes shall be divided by the average strength of the 28-day pair of cubes for each batch and the ratio R shall be the average of these six values. The ratio R shall be expressed to three decimal places.

5 If during the construction of the trial length or during normal working, the average value of any 4 consecutive 7-day test results falls below the strengths given in Table 10/3 then the cement content of the concrete shall be increased by 5% by mass. The increased cement content shall be maintained at least until the four corresponding 28-day tests have been assessed. If the cement content is increased, the concrete mix shall be adjusted to maintain the required workability.

TABLE 10/3: 7 Day Cube Strengths

Grade of Concrete	PC mixes, R not available N/mm²	All mixes R available	Pfa o ggbs mixes, R not available N/mm²
C40	35	43 R	29
C30	27	33 R	22
C20	18	22 R	14
C15	13	17 R	11
C10	8	10 R	7
C7.5	5.5	7 R	4.5

6 The values in columns 2 and 4 of Table 10/3 may only be used when sufficient test results on trial mixes for calculating the ratio R are not available. Once sufficient results are available from normal working the ratio R shall be calculated from the results available on Site.

7 To assess the time for use of a concrete slab by traffic, the strength development rate may be predetermined by trial mixes. Alternatively pairs of cubes shall be made for each 600 m² or less and stored alongside the pavement in containers or in such a way
that their sides are well insulated. If thermal insulation is used for accelerated curing the cubes shall be similarly insulated. Pairs of cubes shall be tested at the intervals specified in Appendix 7/1. Tests for compliance with the specified strength shall be made in the normal way.

1005 Workability

1 The workability of the concrete at the point of placing shall enable the concrete to be fully compacted and finished without undue flow. The optimum workability for the mix to suit the paving plant being used shall be determined by the Contractor and approved by the Engineer.

2 The workability shall be determined by the Compacting Factor test in accordance with BS 1881 : Part 103, or the Vebe test in accordance with BS EN 12350-3 or alternatively for concrete grade C20 or below, by the slump test in accordance with BS EN 12350-1, at the minimum rate of one determination per 300 m² of slab laid or 6 times per day, whichever is the greater. For areas less than 300 m² the rate shall be at least one determination to each 20 m length

of slab or at least 3 times per day. Tests for workability shall also be carried out in accordance with BS EN 12350-4 for degree of compactability. Within 7 days, copies of the test sheets and results for compaction factor and degree of compactability shall be supplied to the Overseeing Organisation, presented so that correlation of the results of both tests can be examined. No limits are specified for degree of compactability. Tests for workability shall be carried out at the point of placing, in conjunction with tests for strength and any tests for air content. The workability shall be maintained at the optimum within the following tolerances:

Compacting Factor (CF)	±0.03
Slump	±20 mm
Vebe	±3 seconds or as found satisfactory as a result of trial mixes.

3 If any determination of workability gives a result outside the tolerance, a further test shall be made immediately on the next available load of concrete. The average of the two consecutive results and the difference between them shall be calculated. If the average is not within the tolerance or the difference is greater than 0.06 for CF or 20 mm for slump, or 6 seconds for Vebe, subsequent samples shall be taken from the delivery vehicles, which shall not be allowed to discharge into the Works until compliance with the Specification has been established.

1006 Trial Mixes

1 For concrete grades C15 and above the Contractor shall carry out laboratory trials of designed mixes with the materials from all sources to be used in the Works, in accordance with BS 5328 : Part 3, unless recent data relating entirely to the proposed mix satisfies the requirements of the Specification. The trial mixes shall be repeated if necessary until the proportions of ingredients are determined which will produce a concrete which complies in all respects with the Specification.

2 Apart from minor adjustments to the mix as permitted by BS 5328 : Part 3 any changes in sources of materials or mix proportions that are proposed by the Contractor during the course of the Works shall be assessed by making laboratory trial mixes and the construction of a further trial length, unless approved by the Overseeing Organisation.

1007 Separation and Waterproof Membranes

1 A separation membrane shall be used between jointed reinforced concrete surface slabs or unreinforced concrete surface slabs and the sub-base.

2 Separation membranes shall be impermeable plastic sheeting 125 microns thick laid flat without creases. Where an overlap of plastic sheets is necessary, this shall be at least 300 mm. There shall be no standing water on or under the membrane when the concrete is placed upon it.

3 Under CRCP and CRCR a waterproof membrane shall be provided, which shall be a bituminous spray in accordance with Clause 920 before concreting. Where a bituminous spray has been used to cure cement-bound material or wet lean concrete then only those areas, which have been damaged, shall be resprayed after making good.

1008 Steel Reinforcement General

1 Reinforcement is normally installed only in the end slabs or in special cases e.g. if the slab length is greater than 25 times the slab thickness respectively 30 times for square slabs or if irregular settlements of the subgrade may arrive. Amount of steel: 3kg/m² for the construction classes HD to III and 2kg/m² for the other construction classes. The distance of the longitudinal steel bars must not exceed 150mm and of the transversal steel bars must not exceed 300mm.

Reinforcement shall comply with any of the following standards and be in prefabricated sheets or cages, or bars assembled on site and shall be free from oil, dirt, loose rust and scale:

(i) (Carbon steel bars for the reinforcement of concrete) BS 4449.

(ii) (Cold-reduced steel wire for the reinforcement of concrete) BS 4482.

(iii) (Steel fabric for the reinforcement of concrete) BS 4483.

2 When deformed bars are used they shall conform to Type 2 bond classification of BS 4449.

3 Spacing of bars shall not be less than twice the maximum size of aggregate used. Laps in longitudinal bars shall be not less than 35 bar diameters or 450 mm whichever is greater. In continuously reinforced concrete slabs (CRCP or CRCR), only one third of the laps may be in any one transverse section, except in single bay width construction where half the laps may be in any one transverse section. There shall be a minimum of 1.2 m longitudinally between groups of transverse laps or laps in prefabricated reinforcement sheets. Alternatively the reinforcement may be butt welded in accordance with Clause 1717.

4 Laps in any transverse reinforcement shall be a minimum of 300 mm. Where prefabricated reinforcement sheets are used and longitudinal and transverse laps would coincide, no lap is required in the transverse bars within the lap of the longitudinal reinforcement. These transverse bars may be cropped or fabricated shorter so that the requirements for cover are met. Alternatively, prefabricated sheets incorporating splices (i.e. flying ends) may be used to provide nesting of reinforcement in both directions at lap positions. The lengths of the laps shall be the minimum values previously stated.

5 If the reinforcement is positioned prior to concreting, it shall be fixed on metal supports and retained in position at the required depth below the finished surface and distance from the edge of the slab so as to ensure that the required cover is achieved. Reinforcement assembled on site shall be tied, or firmly fixed, at sufficient intersections to provide sufficient rigidity to ensure that the reinforcement remains in the correct position during construction of the slab.

6 Alternatively, when a reinforced concrete slab (JRC, CRCP or CRCR) is constructed in two layers, the reinforcement in the form of prefabricated sheets may be placed on or into the bottom layer which shall be spread and compacted to such a level that it will support the reinforcement without distortion at the required position in the slab. The sheets shall be tied together at overlaps and after the second layer has been spread and compacted, the reinforcement shall have the required cover.

7 When a reinforced concrete slab is constructed at maximum width as in Clause 1010 the transverse reinforcement in the centre of each slab width shall be a minimum of 12 mm nominal diameter bars at 600 mm centres. This reinforcement shall be at least 600 mm longer than one third of the width of the slab and be lapped to other transverse reinforcement bars or sheets, or be continuous across the whole width of each slab.

Jointed Reinforced Concrete Slabs

8 The reinforcement shall be so placed that after compaction of the concrete, the cover below the finished surface of the slab is 50 ± 10 mm for slabs less than 200 mm thick, 60 ± 10 mm for slabs 200 mm or more but less than 270 mm thick, 70 ± 20 mm for slabs 270 mm thick or more. The negative vertical tolerance shall not be permitted beneath road stud recesses. Where traffic signal detector loops are to be installed, the minimum cover to the reinforcement from the surface shall be 100 mm. The vertical cover between any longitudinal joint groove forming strip and any reinforcement or tie bars shall be a minimum of 30 mm. Any transverse bars shall be at right angles to the longitudinal axis of the carriageway. Any transverse reinforcement shall terminate at 125 ± 25 mm from the edges of the slab and longitudinal joints, where tie bars as in Clause 1012 are used. No longitudinal bars shall lie within 100 mm of a longitudinal joint. The reinforcement shall terminate 300 mm ± 50 mm from any transverse joint, excluding emergency construction joints.

Anchoring

9 See Clause NG 1008 Sub-Clause 4

Continuously Reinforced Concrete Slabs (CRCP or CRCR)

10 The reinforcement shall be Grade 460 deformed steel bars with the diameters and spacings as described in Appendix 7/1.

11 The reinforcement shall consist of bars assembled on site, or of prefabricated sheets. Except where otherwise shown on the Drawings the longitudinal bars shall be parallel to the centre-line of the road.

12 The reinforcement shall be positioned so that, after compaction of the concrete, it shall be at the mid depth of the specified thickness of the slab ±25 mm. No longitudinal bar shall lie within 100 mm of a longitudinal joint. In reinforcement assembled on site, longitudinal bars shall be placed immediately above any transverse bars, which shall be at right angles to the longitudinal axis of the carriageway. Any transverse reinforcement shall terminate 125 ± 25 mm from the edges of the slab and longitudinal joints where tie bars as in Clause 1012 are used.

1009 Transverse Joints General

1 Transverse joints shall be provided in unreinforced and jointed reinforced concrete slabs and shall be contraction, expansion or warping joints at the spacings described in Appendix 7/1, such that for unreinforced concrete slabs the length/width ratio shall be not greater than 2.0. The spacings may be increased by 20% if limestone coarse aggregate is used throughout the depth of the slab.

2 Joints in the surface slab and sub-base shall be staggered so that they are not coincident vertically and are at least 1 m apart.

3 Transverse joints shall be straight within the following tolerances along the intended line of the joint, which is the straight line transverse to the longitudinal axis of the carriageway, except at road junctions or roundabouts where the positions shall be as shown on the Drawings.

(i) deviations of the filler board or bottom crack inducer from the intended line of the joint shall be not greater than ± 10 mm;

(ii) the best fit straight line through the joint groove as constructed shall be not more than 25 mm from the intended line of the joint;

(iii) deviations of the joint groove from the best fit straight line of the joint shall be not greater than 10 mm.

4 Transverse joints on each side of a longitudinal joint shall be in line with each other and of the same type and width. The position of the joints relative to manholes and gullies shall be in accordance with Clause 1018.

5 Concrete pavement layers shall be isolated from fixed structures by expansion joints, or earthworks or a granular layer over the structure, or by bridge-type expansion joints, or by lengths of fully flexible pavement construction. End of pavement surface slabs shall have a transition bay as shown on the Drawings, leading into the fully flexible construction.

6 Transverse joints shall have a sealing groove which shall be sealed in compliance with Clause 1016.

Contraction Joints

7 Contraction joints shall consist of:

(i) a sawn joint groove complying with Clause 1013;

(ii) dowel bars complying with Clause 1011;

(iii) a sealing groove complying with Clause 1016.

Expansion Joints

8 Expansion joints shall consist of:

(i) a joint filler board complying with Clause 1015;

(ii) dowel bars complying with Clause 1011;

(iii) a sealing groove complying with Clause 1016.

9 The filler board shall be positioned vertically within the prefabricated joint assemblies along the line of the joint within the tolerances given in sub-Clause 3 of this Clause, and at such depth below the surface as will not impede the passage of the finishing beams on the paving machines. The joint filler board together with the sealing groove shall provide a complete separation of adjacent slabs and any spaces around dowel bars and between the sub-base and the filler board shall be packed with a suitable compressible material after fixing the joint assembly.

Warping Joints

10 Warping joints shall consist of:

(i) a sawn joint groove complying with Clause 1013;

(ii) tie bars complying with Clause 1012;

(iii) a sealing groove complying with Clause 1016.

Construction Joints

11 Construction joints made at the end of a working day in unreinforced concrete slabs and jointed reinforced concrete slabs shall be contraction joints. In the event of mechanical breakdown of the concreting machinery, or at the onset of adverse weather, emergency joints may be formed.

12 Emergency joints in unreinforced concrete slabs shall be contraction joints not less than 2.5 m from the preceding or succeeding joint position. If possible they should coincide with contaction or expansion joints.

13 Emergency joints in jointed reinforced concrete slabs shall be not less than 2.5 m from the preceding or succeeding joint position. The stop end formwork shall be sufficiently rigid to ensure that dowel bars, tie bars or reinforcement will be held in position in compliance with the specification, and placed in such a position that it permits the longitudinal reinforcement to project through the joint for a distance of at least 750 mm.

14 Construction joints in continuously reinforced concrete slabs (CRCP and CRCR) at end of day or in an emergency shall not be constructed within 1.5 m of any lap in the longitudinal reinforcement. The stop end formwork shall be sufficiently rigid to ensure that the longitudinal reinforcement and the tie bars as required in sub-Clause 1012.7 which project through the joint are held in the correct position.

1010 Longitudinal Joints General

1 Sawn or wet-formed longitudinal joints shall be provided in surface slabs between or at the centre of traffic lanes within the allowable positions as shown on the Drawings, so that bay widths are not greater than 4.2 m (or 5.0 m with limestone aggregate) for unreinforced slabs, or 6 m (or 7.6 m with limestone aggregate) for reinforced concrete surface slabs with transverse reinforcement as in sub-Clause 1008.7. Longitudinal joints shall be provided in CRCR between lanes or at the centre of lanes, within a tolerance of ± 150 mm so that bay widths are not greater than 6 m (or 7.6 m with limestone aggregate). Joints in the surface slab, roadbase or sub-base shall be staggered so that they are not coincident vertically and are at least 300 mm apart.

2 Wet-formed longitudinal joints shall consist of wetformed joint grooves complying with Clause 1013, a bottom crack inducer complying with Clause 1014 and tie bars complying with Clause 1012, except where transverse reinforcement is permitted in lieu.

3 Longitudinal joints shall be constructed within the following tolerances:

(i) deviations of the bottom crack inducer from the intended line of the joint, parallel to the axis of the road shall be not greater than ± 13 mm;

(ii) the joint groove shall be located vertically above the bottom crack inducers within a horizontal tolerance of ± 25 mm;

(iii) the best fit line along the constructed joint groove, shall be not more than 25 mm from the intended line of the joint;

(iv) deviations of the joint groove from the best fit line of the joint shall be not greater than 10 mm.

4 Sawn longitudinal joints shall consist of joint grooves complying with Clause 1013.

5 Tie bars may be replaced by continuous transverse reinforcement across the joints in continuously reinforced concrete slabs which are constructed in more than one lane width in one operation, provided that the transverse reinforcement is a minimum of 12 mm diameter bars at 600 mm centres. The transverse reinforcement in these circumstances shall be protected by suitable bituminous paint or equivalent coating for a distance of at least 75 mm either side of the joint.

Longitudinal Construction Joints

6 Longitudinal construction joints between separate slabs shall have tie bars as in Clause 1012 with a joint groove as in Clause 1013. Alternatively, if split forms are used, the transverse reinforcement, if 12 mm diameter or more, may be continued across the joint for a minimum of 500 mm or 30 times the diameter of the transverse reinforcement bars, whichever is the greater. The transverse reinforcement in these circumstances shall be protected by suitable bituminous paint or equivalent coating for a distance of at least 75 mm either side of the joint. A joint sealing groove is not required in construction joints in continuously reinforced concrete base courses. Where the edge of the concrete slab is damaged it shall be made good before the adjacent slab is constructed.

1011 Dowel Bars

1 Dowel bars shall be Grade 250 steel complying with BS 4449 and shall be free from oil, dirt, loose rust and scale. They shall be straight, free of burrs and other irregularities and the sliding ends sawn or cropped cleanly with no protrusions outside the normal diameter of the bar. For expansion joints, dowel bars shall be 25 mm diameter at 300 mm spacing, 600 mm long for slabs up to 239 mm thick and 32 mm diameter for slabs 240 mm thick or more. For contraction joints, dowels shall be 20 mm diameter at 300 mm spacing 400 mm long for slabs up to 239 mm thick and 25 mm diameter for slabs 240 mm thick or more.

2 Dowel bars shall be supported on cradles in prefabricated joint assemblies positioned prior to construction of the slab. For contraction joints, as an alternative to prefabricated assemblies, dowel bars may be mechanically inserted with vibration into the concrete by a method which ensures full recompaction of the concrete around the dowel bars and the surface finished by a diagonal finishing beam, or a longitudinal oscillating float travelling across the slab.

3 Dowel bars shall be positioned at mid-depth from the surface level of the slab ± 20 mm. They shall be aligned parallel to the finished surface of the slab, to the centre line of the carriageway and to each other within the following tolerances:

(i) for bars supported on cradles prior to construction of the slab and for inserted bars in two layer construction prior to placing the top layer:

(a) all bars in a joint shall be within ± 3 mm per 300 mm length of bar;

(b) two thirds of the bars shall be within ± 2 mm per 300 mm length of bar;

(c) no bar shall differ in alignment from an adjoining bar by more than 3 mm per 300 mm length of bar in either the horizontal or vertical plane;

(ii) for all bars, after construction of the slab:

(a) twice the tolerances for alignment as in

(iii) above;

(b) equally positioned about the intended line of the joint within a tolerance of 25 mm.

4 Cradles supporting dowel bars shall not extend across the line of the joint.

5 Dowel bars, supported on cradles in assemblies, when subjected to a load of 110 N applied at either end and in either the vertical or horizontal direction (upwards and downwards and both directions horizontally) shall not deflect more than the following limits:

(i) two thirds of the number of bars of any assembly tested shall not deflect more than 2 mm per 300 mm length of bar;

(ii) the remainder of the bars in that assembly shall not deflect more than 3 mm per 300 mm length of bar.

6 The assembly of dowel bars and supporting cradles, including the joint filler board in the case of expansion joints shall have the following degree of rigidity when fixed in position:

(i) For expansion joints the deflection of the top edge of the filler board shall be not greater than 13 mm, when a load of 1.3 kN is applied perpendicular to the vertical face of the joint filler board and distributed over a length of 600 mm by means of a bar or timber packing, at mid depth and midway between individual fixings, or 300 mm from either end of any length of filler board, if a continuous fixing is used. The residual deflection after removal of the load shall be not more than 3 mm.

(ii) The joint assembly fixings to the sub-base shall not fail under the 1.3 kN load applied for testing the rigidity of the assembly but shall fail before the load reaches 2.6 kN.

(iii) The fixings for contraction joints shall not fail under a 1.3 kN load and shall fail before the load reaches 2.6 kN when applied over a length of 600 mm by means of a bar or timber packing placed as near to the level of the line of fixings as practicable.

(iv) Failure of the fixings shall be deemed to be when there is displacement of the assemblies by more than 3 mm with any form of fixing, under the test load. The displacement shall be measured at

the nearest part of the assembly to the centre of the bar or timber packing.

7 Dowel bars shall be covered by a flexible polymeric corrosion resistant coating, bonded onto the previously cleaned bar. The coating shall be smooth and free of indentations. During coating, the bar shall be supported at each end. Minimum thickness shall be 0.3 mm. The coating shall also be able to withstand 250 hours immersion in a fog cabinet complying with BS 3900 : Part F12, without showing any visible crazing or corrosion of the protected bar. The coated bar shall comply with the following pull out test:

(i) Four bars shall be taken at random from stock and without any special preparation shall be coated as required in this Clause. The dowel bars which have been coated shall be cast centrally into concrete specimens 150 x 150 x 450 mm, made of the same mix proportions to be used in the pavement, but with a maximum nominal aggregate size of 20 mm and cured in accordance with BS 1881 : Part 111. At 7 days a tensile load shall be applied to achieve a movement of the bar of at least 0.25 mm. The average bond stress to achieve this movement shall be not greater than 0.14 N/mm².

8 For expansion joints, a closely fitting cap 100 mm long consisting of waterproofed cardboard or suitable synthetic material shall be placed over one end of each dowel bar. An expansion space 10 mm greater than the the construction of the slab. thickness of the joint filler board shall be formed between the end of the cap and the end of the dowel bar.

1012 Tie Bars

1 Tie bars in transverse and especially longitudinal joints shall be Grade 250 steel or Grade 460 deformed steel bars complying with BS 4449, in accordance with the requirements given below and Table 10/4. Deformed bars shall have Type 2 bond classification. Tie bars shall be free from oil, dirt, loose rust and scale. Tie bars which are to be cranked and later straightened shall be Grade 250.

2 Tie bars for use across joints shall have corrosion protection in the form of a flexible polymeric corrosion resistant coating, bonded centrally onto 150 mm of the previously cleaned centre section of the bars. Where tie bars are to be cranked for construction joints and later straightened, the coating shall be shown to be capable of being straightened through 90 degrees without cracking.

The coating for both straight and cranked bars after straightening shall be able to withstand 250 hours immersion in a fog cabinet complying with BS 3900 : Part F12, without showing any visible crazing or cracking, or corrosion of the protected part of the bar.

3 Tie bars in warping joints and wet-formed longitudinal joints shall be made up into rigid assemblies with adequate supports and fixings to remain firmly in position during

TABLE 10/4: Tie Bar Details

Joints	Diameter mm	Grade of Steel	Length mm	Spacing mm
Transverse construction joints in continuously reinforced concrete	As for main reinforcement	460	1500	Twice the spacing of main reinforcement
Emergency construction joints in jointed reinforced concrete slabs other than at contraction or expansion joints	12	250 or 460 deformed	1000	600
Warping joints	12	250 or 460 deformed	1000	300
			750	600
Longitudinal				
All joints, except where Transverse reinforcement is permitted in lieu	12	250 or 460 deformed	1000	600
			750	600
	or 16	460 deformed	600	600
	or 20	460 deformed	500	600
Transition from rigid to flexible construction	20	460 deformed	1000	300

NOTE: The transverse reinforcement may be continued across the joint in reinforced concrete if the bars are of a minimum nominal diameter of 12 mm and the bars are protected from corrosion and the cover is as required in this Clause.

4 Alternatively, tie bars at longitudinal joints may be mechanically inserted by vibration from above using a method which ensures recompaction of the concrete around the tie bars.

5 At longitudinal construction joints, tie bars may be adequately fixed to side forms or inserted into the side of the slab by a method which ensures recompaction of the concrete around the tie bars and adequate bond.

6 Tie bars in warping joints shall be positioned from the top surface of the slab within +20, -10 mm of the mid depth of the slab. Tie bars in other joints shall be positioned and remain within the middle third of the slab depth, approximately parallel to the surface and approximately perpendicular to the line of the joint, with the centre of each bar on the intended line of the joints within a tolerance of ± 50 mm, and with a minimum cover of 30 mm below any top crack inducer of joint groove for slabs 200 mm thick or more, or 20 mm for slabs up to 200 mm thick.

7 At transverse construction joints in continuously reinforced concrete, tie bars shall be 1.5 m long and of the same grade and size as the longitudinal reinforcement, and shall be fixed at twice the normal spacing midway between the longitudinal reinforcement bars so that 750 mm ± 50 mm extends each side of the joint at the same level as the longitudinal reinforcement and be tied to the transverse reinforcement. Where paving from a construction joint is not resumed within 5 days, an extra longitudinal reinforcement bar 8 m long shall be lapped and tied to each tie bar. These extra bars may be combined with the tie bars. Where the spacing between longitudinal reinforcement and the extra 8 m long bars is less than 90 mm, the nominal size of aggregate shall be 20 mm for a sufficient number of concrete batches to complete that section of pavement.

8 Where tie bars are used in longitudinal joints in continuously reinforced concrete they shall be placed at the same level as the transverse reinforcement and tied to the longitudinal reinforcement.

1013 Joint Grooves General

1 Transverse contraction or warping joint grooves shall be sawn in the hardened concrete.

2 Transverse joint grooves which are initially constructed less than the full width of the slab shall be completed by sawing through to the edge of the slab and across longitudinal joints as soon as any forms have been removed and before an induced crack develops at the joint.

Sawn Transverse and Longitudinal Joint Grooves

3 Sawing shall be undertaken as soon as possible after the concrete has hardened sufficiently to enable a sharp edged groove to be produced without disrupting the concrete and before random cracks develop in the slab. The grooves shall be between 1/4 and 1/3 of the specified depth of the slab and of any convenient width not less than 3 mm. The sealing groove may be sawn to the required width later. Expansion joint sealing grooves shall be sealed as soon as practical after sawing.

Wet-formed Longitudinal Joint Grooves

4 When slabs are constructed in more than one lane width in one operation a joint groove shall be formed by inserting a groove former ahead of the finishing beams from dispenser. The concrete so displaced shall be recompacted by a vibrating compactor or similar device, at least 300 mm wide operating symmetrically along the line of the joint. After finishing the concrete, the groove forming strip shall be in the correct position and alignment, within 10° of the vertical, and to sufficient depth below the surface to allow for the passage of the finishing beam within the range 0-3 mm below the finished level of the slab. Groove forming strips in wet-formed longitudinal joint grooves shall be left in place.

Construction Joint Grooves in Surface Slabs

5 The grooves shall be formed by fixing a groove-former or strip or cork seal along the top edge of the slab already constructed, before concreting the adjacent slab. Where the edge of the concrete is damaged it shall be ground or made good before fixing the groove forming strip. Alternatively the subsequent slab may be placed adjacent to the first and a sealing groove sawn later in the hardened concrete to the minimum depth required in Table 10/5 or to the manufacturer's instructions if greater, and to sufficient width to eliminate minor spalling of the joint arris, up to a maximum of 25 mm for longitudinal joints and 40 mm for transverse joints. The joint shall be sealed in compliance with Clause 1016.

1014 Groove Formers and Bottom Crack Inducers

General

1 Except where joint grooves are sawn, which is the normal construction procedure, a bottom crack inducer shall be provided at each longitudinal joint position.

2 The bottom crack inducer shall be triangular or inverted Y-shaped fillet, with a

base width not less than the height, made of timber or rigid synthetic material. It shall be firmly fixed to the sub-base so as to remain in position during the whole process of constructing the slab.

3 The combined depth of groove formers and bottom crack inducers shall be between 1/4 and 1/3 of the depth of the slab and the difference between the depth of the groove former and the height of the bottom crack inducer shall not be greater than 20 mm.

Longitudinal Joints

4 Groove forming sealing strips for wet-formed longitudinal joints shall be of firm compressible strips of ethylene vinyl acetate foam of minimum density 90 kg/m3, or synthetic rubber, or equivalent material. They shall have a minimum thickness of 5 mm and shall be sufficiently rigid to remain vertical and straight in the concrete without curving or stretching. They shall be inserted continuously along the joint.

1015 Joint Filler Board

1 Joint filler board for expansion joints and manhole and gully slab joints shall be 25 mm thick unless otherwise shown in the Drawings, within a tolerance of ± 1.5 mm. It shall be a self-expanding cork seal or a firm compressible material or a bonded combination of compressible and rigid materials of sufficient rigidity to resist deformation during the passage of the concrete paving plant. The depth of the joint filler board for manhole and gully slabs shall be the full depth of the slab less the depth of the sealing groove. In expansion joints, the filler board shall have a ridged top as shown on the Drawings, except where a sealing groove former is indicated on the Drawings.

Holes for dowel bars shall be accurately bored or punched out to form a sliding fit for the sheathed dowel bar.

2 The joint filler board shall meet the requirements given when tested in accordance with the procedures in the following clauses:

(i) Weathering Test

(a) Three specimens, each 115 mm square ± 2.5 mm, shall be placed in a ventilated drying oven maintained at a temperature of 55°C ± 5°C for 7 days, after which they shall immediately be immersed in water at room temperature of between 16°C and 21°C for 24 hours. They shall then be subjected to five cycles of freezing and thawing in the following manner.

(b) The specimens shall be placed in a watertight weathering test pan having a ribbed bottom and a fitted slotted lid designed to hold the three specimens vertically on edge. The pan shall be filled with water to half the depth of the specimens and then frozen to 0°C, for at least four hours after the initial freezing of the water. The pan shall then be placed in a water bath maintained at 18°C to 38°C without disturbing the specimens and shall remain there for one hour after thawing has completed. The pan and specimens shall then be returned to the refrigerator and freezing and thawing shall be repeated in precisely the same manner until five cycles of the process have been completed.

The specimens shall be removed from the pan and air dried at room temperature for 48 hours before examination.

(c) The Material shall be deemed to have passed the weathering test if the specimen show no signs of disintegration or shrinkage

(ii) Compression and Recovery Test

(a) Two of the specimens which pass the weathering test, and two new specimens, each trimmed to 100 mm square ± 0.5 mm, maintained at room temperature and humidity for 24 hours, shall be subjected to three applications of load at 24 hour intervals in a compression test machine complying with BS 1610, with auxiliary platens 100 mm², minimum 13 mm thick. During each application of load each specimen shall be compressed to 50% of its original thickness at a rate of strain of 1.3 mm per minute. The load required to achieve this amount of compression shall be not less than 0.07 N/mm² nor more than 10 N/mm² for material to be used in pavements and not less than 0.07 N/mm² and not more than 0.4 N/mm² for material to be used in bridge joints. The load shall be released immediately the required degree of compression is reached and after the third applicable recovery period of 30 minutes shall be allowed after which the thickness of the specimen shall measured.

(b) This thickness, expressed as a percentage of the original thickness, is the 'recovery' value of the specimen. The thicknesses shall be measured to an accuracy of 25 micron. The two new specimens shall be weighed before and after testing. The difference in mass shall be determined with an accuracy of 0.1% and shall be expressed as a percentage of the original mass of the specimen.

(c) The material shall be deemed to have passed the test if all four specimens have recovery values of at least 70% and the two new specimens have not suffered a reduction of mass in excess of 1%.

(iii) Extrusion Test

(a) The third sample which passes the weathering test shall be trimmed to 100 mm square ± 0.5 mm and be subjected to the following extrusion test.

(b) The extrusion mould shall be 100 mm x 100 mm (+ 0.5 mm, - 0) internally, of sufficient depth to test the sample as received, open on one side only and fixed rigidly to a base plate. The mould shall be provided with a closely fitting pressure plate which shall fit without binding, and with an accurate horizontal measuring dial gauge or measuring device accurate to 25 microns. The specimen shall be mounted in the extrusion mould and loaded once as described in the compression and recovery test. The extrusion at the open side of the mould shall be measured with the gauge when the specimen is compressed to 50% of its original thickness and before release of the load.

(c) The material shall be deemed to have passed the test if the extrusion of the free edge does not exceed 6 mm.

(iv) Immersion Test for Cork Filler Board

(a) Two specimens each 115 mm x 115 mm ± 2.5 mm shall be prepared and the thickness of each specimen shall be determined to the nearest 25 microns before the specimens are immersed in boiling water for one hour. After removal from the water the specimens shall be allowed to cool to room temperature and after 15 minutes at this temperature their thickness shall be remeasured to the nearest 25 microns.

(b) The material shall be deemed to have passed the test if both specimens have a thickness of not less than 140% of their thickness before immersion.

(v) Acid Test for Cork Filler Board

(a) Two specimens each 115 mm x 115 mm ± 2.5 mm shall be immersed in hydrochloric acid of a specific gravity of 1.18 at room temperature which is then brought to the boil and maintained thus for one hour when the specimens shall be removed and rinsed in water.

(b) The material shall be deemed to have passed the test when, after examination, the specimens show no evidence of serious disintegration, friability or lack of resilience. Discolouration or minor swelling shall not be considered as failure.

1016 Preparation and Sealing of Joint Grooves

General

1 All transverse joints in surface slabs, except for construction joints in CRCP shall be sealed using one of the joint seals described in Clause 1017. Additionally longitudinal joints which are sawn or widened, shall be sealed.

Preparation of Joint Grooves for Sealing

2 Joint grooves shall be prepared in accordance with BS 5212 : Part 2 and sub-Clauses 3 to 8 of this Clause.

3 That part of the groove former used to form the sealing groove or any temporary seal shall be removed cleanly without damaging the joint arrises to a minimum depth of 25 mm where compression seals are used or otherwise to such depth as will provide an applied seal to the dimensions shown in Table 10/5, after allowing for any necessary caulking material described in sub-Clause 6 of this Clause. If joint grooves are not initially constructed to provide the minimum dimensions for the joint seals as given in Table 10/5, they shall be widened by sawing. Joint grooves formed by tapered formers need not be widened. The sealing grooves shall be cleaned out immediately after sawing using high pressure water jets, to remove all slurry from the joint, before the slurry hardens.

4 If rough arrises develop when grooves are made they shall be ground to provide a chamfer approximately 5 mm wide. If the groove is at an angle up to 10° from the perpendicular to the surface, the overhanging edge of the sealing groove shall be sawn or ground perpendicular. If spalling occurs or the angle of the former is greater than 10° the joint sealing groove shall be sawn wider and perpendicular to the surface to encompass the defects up to a maximum width, including any chamfer, of 40 mm for transverse joints and 25 mm for longitudinal joints. If the spalling cannot be so eliminated then the arris shall be repaired by suitable thin bonded arris repair using cementitious materials as specified in Clause 1032.

5 For applied sealants the sides of the joint sealing groove shall be scoured by dry abrasive blasting. This shall not be carried out before the characteristic compressive strength of the concrete is expected to reach 15 N/mm². When compression seals are used, the sides of the groove may be ground or wire brushed.

6 For hot and cold applied sealants, compressible caulking material, debonding strip or tape or cord compatible with the sealant, of a suitable size to fill the width of the sealing groove, shall be firmly packed or stuck in the bottom of the sealing groove to such a depth so as to provide the correct depth of seal as described in Table 10/5 with the top of the seal at the correct depth below the surface of the concrete.

7 All grooves shall be cleaned of any dirt or loose material by air blasting with filtered, oil-free compressed air. The groove shall be clean and dry at the time of priming and sealing.

8 For applied sealants the joint grooves shall be primed with the relevant primer for the hot or cold applied sealant in accordance with the manufacturer's recommendations and with BS 5212 : Part 2, except that when necessary the joint grooves may be primed and sealed earlier than 14 days after construction, as soon as the grooves have been grit-blasted and cleaned.

TABLE 10/5: Dimensions of Applied Joint Seals

Type and Spacing of Joints (m)	Minimum Width	Minimum Depth of Seal (Note 1)		Impegnated Foam Compression Strips	Depth of Seal Below the Concrete Surface
		Cold Applied	Hot Applied		
	mm	mm	mm	mm	mm
Contraction					
15 and under	13 (Note 2)	13	15	30	5 + 2
Over 15 to 20	20	15	30	30	5 + 2
Over 20 to 25	30	20	25	40	5 + 2
Expansion	30	20	25	40	7 + 2
Transverrse Waping	10	10	13	30	5 + 2
Longitudinal Joints (If Sealed)	10	10	13	30	0 to 5
(Gully and Manhole Slabs	20	15	20	30	0 to 3

NOTE (1): The depth of seal is that part in contact with the vertical face of the joint groove. The depth of seal below the surface shall be taken at the centre of an applied seal relative to a short straight edge, 150 mm long, placed centrally across the joint within 7 days of sealing.

NOTE (2): For cork seals other than in construction joints, grooves shall be 20 mm width, 50 mm depth.

Sealing with Applied Sealants

9 Sealing shall be carried out continuously along the full length of joint in any one rip, except for remedial areas. When hot or cold applied sealants are used the sealant shall be applied within the minimum and maximum drying times of the primer recommended by the manufacturer. Priming and sealing with applied sealants shall not be carried out when the naturally occurring temperature in the joint groove to be sealed is below 10°C except between 8°C and 10°C it may be carried out when the temperature is rising.

10 Hot-applied sealants shall be heated in and applied from a thermostatically controlled, indirectly heated dispenser with a recirculating pump. The sealant shall
not be heated to a temperature higher than the safe heating temperature nor for a period longer than the safe heating period, both as specified by the manufacturer. The

dispenser shall be cleaned out at the end of each day and reheated material shall not be used.

11 The components of cold-applied sealants shall be thoroughly mixed in the correct proportions in accordance with the manufacturer's instructions using an automatic metering and mixing dispenser or, for hand application, using a power operated paddle mixer for sufficient time to produce a homogenous mix without entrapped air. As soon as possible after mixing and within the worklife of the sealant, the material shall be dispensed into the joint, or applied using a caulking gun, to the correct level below the concrete surface. The tack-free time shall be achieved within 3 hours for machine dispensed material, or within 12 hours for hand applied material.

Testing of Applied Sealants

12 Test certificates shall be supplied from a testing laboratory stating that the sealant complies with the relevant standard in Clause 1017. Site testing of cold-applied sealants shall be in accordance with BS 5212 : Part 2. Site testing of hot applied sealants shall be in accordance with BS 2499 : Part 2. Samples of hot applied sealants shall be taken and tested for initial penetration and resilience in accordance with clauses 8 and 23 respectively of BS 2499 :

Part 3 : 1993 and shall comply with the requirements of BS 2499 : Part 1.

Sealing with Compression Seals

13 When compression seals are used, the widths of the seal shall be selected in relation to the width of the sealing groove, the bay lengths and manufacturer's recommendations so that the estimated maximum width of the joint opening shall be not more than 70% of the original width of the seal, the estimated maximum width being calculated on the basis of a movement of 4 mm per 10 m run of slab. The maximum calculated width of sealing groove shall be 30 mm. The depth of groove shall be such that the contact face of the seal with the side of the groove shall be not less than 20 mm and that the top of the seal shall be a minimum of 3 mm below the surface of the concrete.

14 Compression seals shall be inserted into the grooves without prior extension or rotation and, where recommended by the manufacturer, with a lubricant adhesive which is compatible with the seal and the
concrete. The adhesive shall be applied to both sides of the sealing groove or the seal, or to both. The seal shall be positioned with its axis perpendicular to the concrete surface. Excess adhesive on top of the seal shall be removed to prevent adhesion of the top faces of the seal under compression. Except when compression seals are used in longitudinal joints the transverse joint seal shall be continuous across the slab and the longitudinal joint groove forming strips shall be cut to the required depth after the concrete has hardened for the transverse seal to be inserted. If compression seals are used in longitudinal joints where the grooves have been sawn after construction of the slab they shall be continuous across transverse joints, with the transverse seals butted and fixed to the longitudinal seals with adhesive.

1017 Joint Seals

1 Joint seals shall consist of hot or cold applied sealants or compression seals or self expanding cork seals complying with this Clause. The colour of the joint seal material shall comply with the requirements of Appendix 7/2.

Hot-applied Sealants

2 Hot-applied sealants shall be Type N1 or Type F1 complying with BS 2499.

3 For joints between concrete surface slabs and bituminous surfacing, hot applied Type N1 sealants complying with BS 2499 shall be used. Alternatively polymer modified bitumen sealing strips may be used and shall be applied in accordance with the manufacturer's instructions. Hot-applied Type N1 sealants may be used in joints in asphalt kerbs laid on concrete pavements.

Cold-applied Sealants

4 Cold-applied sealants shall be Type N complying with BS 5212 : Part 1 except that Type F shall be used for lay-bys and hardstandings.

5 For joints in kerbs and joints other than in pavements, seals may be any of the pavement sealants if they have the suitable characteristics for the application, or gunning grade cold applied plasticised bituminous rubber sealant or gunning grades of two part polysulphide-based sealants complying with BS 4254 may be used. Alternatively, polyurethane-based sealing compounds may be used provided their performance is not inferior to BS 4254 material.

Compression Seals

6 Compression seals shall be pre-compressed neoprene impregnated expanding foam sealing strip having a current BBA certificate or rubber seals made
of polychloroprene elastomers complying with BS 2752 and conforming with the requirements of ASTM Standard D2628-81. Seals of butadiene-acrylonitrile or other synthetic rubbers may be used if certificates are produced to show that they conform to the performance requirements of ASTM Standard D2628-81 for oven ageing, oil and ozone resistance, low

temperature stiffening and recovery. Seals made of ethylene vinyl
acetate in microcellular form and other synthetic materials may be used in longitudinal joints and in structures if test certificates are produced to show adequate resistance to fuels and heat ageing when tested in accordance with BS 4443 : Part 4, Method 10 and Method 12 respectively. The compression set of any seal shall not be greater than 15% when the specimen is subjected to a 25% compression in accordance with BS 4443 : Part 1, Method 6. When immersed in standard oils for 48 hours at 25°C in accordance with BS 903 : Part A16, the volume change shall not be
greater than 5%.

7 Compression seals shall be shaped so that they will remain compressed at all times in accordance with Clause 1016 and shall have a minimum of 20 mm contact face with the sides of the sealing groove. If lubricant-adhesive is used, it shall be compatible with
the seal and the concrete and shall be resistant to abrasion, oxidization, fuels and salt.

1018 Joints at Manhole and Gully Slabs

1 Manhole covers, gullies and their frames shall be isolated from the pavement slabs and be contained in separate small slabs, which shall be larger than the exterior of the manhole and gully shafts, including any concrete surround less than 150 mm below the underside of the sub-base layer. The joint around the manhole or gully slab shall be vertical and incorporate joint filler board as in Clause 1015 but without dowel bars and tie bars.

2 Gully slabs in unreinforced concrete slabs shall be adjacent to or straddle a transverse joint, extending the gully slab as necessary to a maximum of 2 m. Where this is impractical, an extra tied warping joint shall be provided adjacent to or within the gully slab and at least 2 m from the next transverse joint. If the edge of an isolator slab is within 1 m of any longitudinal joint the isolator slab shall be extended to that joint.

3 Manhole slabs in unreinforced concrete slabs shall be adjacent to or straddle transverse or longitudinal joints. If the manhole is within the middle third of the bay length a warping joint shall be constructed on one side of the manhole slab across the whole width of the bay to the nearest longitudinal joint.

4 Reinforcement as shown on the Drawings shall be placed in the main concrete slabs in the corners between the manhole and gully slabs and the transverse or longitudinal joints. Extra reinforcement as described in the Contract shall be placed in reinforced concrete slabs around the manhole or gully slabs.

5 Manhole and gully slabs shall have square corners, at all corners which are not adjacent to a transverse or longitudinal joint in the main slab.

6 Reinforcement as shown on the Drawings shall be placed in the gully or manhole slab and concrete grade C40 shall be placed by hand in the space between the main slab and the manhole frame. The concrete shall be fully compacted and finished in compliance with Clause 1025.

7 A sealing groove shall be made directly above the joint filler board and sealed in compliance with Clause 1016.

1019 Inspection of Dowel Bars

1 Compliance with Clause 1011 for the position and alignment of dowel bars at contraction and expansion joints shall be checked by measurement relative to the side form or guide wires.

2 When the slab has been constructed, the position and alignment of dowel bars and any filler board shall be measured after carefully exposing them across the whole width of the slab. When the joint is an expansion joint the top of the filler board shall first be exposed sufficiently in the plastic concrete to permit measurement of any lateral or vertical displacement of the board. During the course of normal working these measurements shall be

carried out at a rate of one joint per 1500 m length of slab or one per 5 days whichever occurs the sooner. For small areas the rate shall be one joint for up to each 100 joints or decided by the Engineer.

3 If the position or alignment of the bars in a single joint in the slab is unsatisfactory then the next two joints shall be inspected. If only the one joint of the three is defective, the rate of checking shall be increased to one joint per day until compliance is being achieved. In the event of non-compliance in two or more successive joints, the Contractor shall revert to the construction of trial lengths and make any necessary alterations to the concrete mix, paving plant or methods until the dowel bar position and alignment is satisfactory.

4 After the dowel bars have been examined, the remainder of the concrete shall be removed 500 mm on each side of the line of the joint, and reinstated to the requirements of the Specification. Alternatively if the dowels are examined in the penultimate joint of a day's work that joint shall be made a construction joint for the next day's work and the remainder of the concrete in the last slab may be discarded.

1020 Side Forms, Rails and Guide Wires

Side Forms and Rails

1 All side forms and rails shall be made of steel and be sufficiently robust and rigid to support the weight and pressure caused by the paving equipment. Side forms for use with wheeled paving machines shall incorporate metal rails firmly fixed at a constant height below the top of the forms.

2 The forms shall be secured by using not less than three pins for each 3 m length having one pin fixed at each side of every joint. Forms shall be tightly joined together by a locked joint, free from play or movement in any direction. Forms shall be cleaned and oiled immediately before each use. The rails or running surface shall be kept clean in front of the wheels of any paving machines. The forms shall be straight within a tolerance of 3 mm in 3 m.

3 The forms shall be bedded on low moisture content cement mortar or concrete grade C7.5 and set to the pavement surface level as shown on the Drawings within a tolerance of ± 3 mm. The bedding shall not extend under the slab. There shall be no vertical step between the ends of adjacent forms greater than 3 mm. The horizontal alignment for forms shall be to the required alignment of the pavement edge as shown on the Drawings within a tolerance of ± 10 mm. The Contractor should ensure that the forms are set to the correct profile immediately prior to concreting. The mortar or concrete bedding shall be broken out after use.

4 Side forms shall not be removed earlier than 6 hours after the completion of the construction of the slab. Care shall be taken to prevent damage to the concrete and any projecting tie bars during the removal of the forms. If the removal of forms results in any
damage to the concrete the period of 6 hours shall be increased to that which is necessary to avoid further damage and the Contractor shall make good the damaged areas.

Guide Wires

5 A guide wire shall be provided along each side of the slab to be constructed by slip form paving plant. Each guide wire shall be at a constant height above and parallel to the required edges of the slab as shown on the Drawings, within a vertical tolerance of ± 3 mm. Additionally one of the wires shall be at a constant horizontal distance from the required edge of the pavement as shown in the Drawings within a lateral tolerance of ± 10 mm.

6 The guide wires shall be supported from stakes not more than 8 m apart by connectors capable of fine horizontal and vertical adjustment. The guide wire shall be tensioned on the stakes so that a 500 gramme weight shall produce a deflection of not more than 20 mm when suspended at the mid-point between any pair of stakes. The ends of the guide wires shall be anchored to fixing points which shall be not

closer to the edge of the slab than the row of stakes and in no circumstances shall a guide wire be anchored to a stake.

7 The stakes shall be positioned and the connectors maintained at their correct height and alignment from 1200 hours on the day before concreting takes place until 36 hours after the concrete has been finished. The guide wire shall be erected and tensioned on the connectors at any section for at least two hours before concreting that section.

1021 Delivery, Storage and Batching of Concreting Materials

1 Cement shall be kept dry and used in the order in which it is delivered to the Site. Different types of cements shall be stored separately. Silos for storing pfa shall be equipped with aerators to ensure free flow within the silo.

2 Aggregate for roadworks shall be delivered to and stored on the Site in one of the following ways:

(i) in separate nominal single sizes of coarse aggregate and sand (ie fine aggregate);

(ii) as graded coarse aggregate of appropriate size and sand (ie fine aggregate);

(iii) as mixes of coarse aggregates from separate sources blended off site and sand (ie fine aggregate);

(iv) as all-in aggregate for grades C20 or below.

3 Aggregate brought on to the Site shall be kept free from contact with deleterious matter. Sand nominally below 5 mm sieve size shall have been deposited at the site for a time sufficient to permit the moisture content to stabilise before use.

4 Batching plant and storage for aggregate shall comply with the following requirements as appropriate to the method of delivery:

(i) If separate gradings of aggregate are stockpiled, separate accommodation shall be provided for each nominal size of coarse aggregate or blend of sand (ie fine aggregate). The bases for stockpiles shall be suitably surfaced to prevent contamination of the aggregate. Drainage of the stockpile bases shall be provided.

(ii) Aggregate shall be measured by mass and provision shall be made for batching each nominal size or blend of aggregate separately, to the tolerances specified in BS 5328 : Part 3.

(iii) All-in aggregate shall be delivered and stockpiled in such a manner and to a height that avoids segregation.

1022 Mixing Concrete

1 Concrete shall be mixed on or near to the Site in a stationary batch type mixer in compliance with BS 5328 : Part 3. Ready mixed concrete may be used for small areas only.

2 The drums or blades of all mixers shall be operated at the speed used for testing, in accordance with BS 3963 for the mix proportions required, within a tolerance of ± 1 revolution per minute. The mixing blades of a pan mixer shall be maintained within the tolerances specified by the manufacturers of the mixer and the blades shall be replaced when it is no longer possible to maintain the tolerances by adjustment. All drums or pans which have been out of use for more than 30 minutes shall be cleaned before any fresh concrete is mixed in them.

3 The rated output of the batching and mixing plant shall exceed by at least a third the amount of concrete that is required at a constant rate to

enable the paving train to move forward continuously, at the planned rate of progress.

4 The temperature of the water for mixing with cement shall not exceed 60°C.

5 Ready mixed concrete shall comply with this Series and the following special requirements. The concrete shall be carried in purpose made agitators, operating continuously, or truck mixers. The concrete shall be compacted and in its final position within 2 hours of the introduction of cement to the aggregate. The time of such introduction shall be recorded on the delivery note together with the weight of the constituents of each mix. When concrete is transported in a truck mixer, water shall be added under supervision either at the site or at the central batching plant, but in no circumstances shall water be added in transit.

1023 Transport and Delivery

1 Freshly mixed concrete may be transported in tipping or ejector trucks, or truck mixers or agitators operating continuously. The mixed material shall be protected during transit and while awaiting discharge to prevent wetting by rain or evaporation of moisture. It shall be transported and delivered so that segregation or loss of the constituent materials is reduced to the minimum.

2 The number of delivery vehicles provided shall be sufficient to ensure a constant supply of concrete to enable the paving plant to proceed continuously.

1024 Construction by Machine

1 The concrete slab shall be constructed in a continuous process by either slip-form or by fixed form paving plant in accordance with this Clause or by small paving machines or hand guided methods as in Clause 1025.

2 The slab may be constructed in either one or two layers. In two layer construction the thickness of the top layer shall be not less than 50 mm or twice the maximum size of the coarse aggregate, whichever is the greater, and shall be at least 15 mm thicker than the depth of the groove former, if used.

Construction by Fixed Form Paving Machines

3 A fixed form paving train shall consist of separate, powered machines which spread, compact and finish the concrete in a continuous operation.

4 Concrete shall be discharged without segregation into a hopper spreader which is equipped with the means of controlling its rate of deposition on to the sub-base or on to the lower layer. The concrete shall be spread in each layer without segregation and to a uniform uncompacted density over the whole area of the slab. The deposited concrete shall be struck off to the necessary level by the underside of the hopper as it is traversed across the spreading machine. The machine shall be capable of being rapidly adjusted for changes in average and differential surcharge necessitated by changes in slab thickness or crossfall. When the slab is constructed in two layers, the spreading of the concrete in the top layer shall follow the completion of the bottom layer within the times given in Table 10/6.

5 Prior to being compacted, the surface level of each loose spread layer shall be adjusted to the correct surcharge by means of rotating strike-off blades or a screw device.

6 The concrete shall be compacted by vibration or by a combination of vibration and mechanical tamping so as to comply with Clause 1003 throughout the full depth of the slab. Poker vibrators shall be used in each layer adjacent to the side forms and the edge of a previously constructed slab.

7 The initial regulation and finish to the surface of the slab shall be effected by means of a beam oscillating transversely or obliquely to the longitudinal axis of the pavement. This beam

shall be readily adjustable for both height and tilt.

8 Joint grooves shall be constructed in compliance with Clause 1013. When grooves are wet-formed, the concrete shall be re-compacted around the former by a hand held vibrating plate compactor drawn along or on each side of the joint, prior to the final regulation of the surface by a longitudinal oscillating float.

9 The regulation and finishing of the surface of the slab shall be carried out by a machine which incorporates twin oblique oscillating finishing beams which shall be readily adjustable for both height and tilt. The beams shall weigh not less than 170 kg/m, be of rectangular section and span the full width of the slab. The leading beam shall be vibrated. The beams shall be supported on a carriage, the level of which shall be controlled by the average level of not less than four points evenly spaced over at least 3.5 m of the supporting rail, beam, or slab, on each side of the slab that is being constructed. Except for CRCR slabs, the final regulation of the surface of the slab shall be provided by a longitudinal oscillating float, traveling across the slab. After the final regulation and before the texture is applied, any excess concrete on top of the joint groove former, where present, shall be removed. Additionally the longitudinal oscillating float shall complete the traverse of the slab in both directions within the length of the float and shall have a total longitudinal stroke of 200 mm to 300 mm.

10 The longitudinal oscillating float shall have a minimum length of 3 m and a minimum constant width of 250 mm with a maximum weight of 10 kg/m. The edges of the float shall be curved or chamfered.

11 A minimum length of 500 mm of longitudinal oscillating float shall be within the length of the machine tracks or wheels.

12 When a concrete slab is constructed in more than one width, flanged wheels on the paving machines shall not be run directly on the surface of any completed part of the slab. The second or subsequent slabs shall be constructed either by supporting machines with flanged wheels on flat-bottom section rails weighing not less than 15 kg/m laid on the surface of the completed slab, or by replacing the flanged wheels on that side of the machines by smooth flangeless wheels. Before flangeless wheels or rails are used, the surface regularity of the slab over which they are to pass shall comply with Clause 702 (table 7/3, case a) and its surface shall be thoroughly cleaned and brushed to remove all extraneous matter. Flangeless wheels or rails shall be positioned sufficiently far from the edge of the slab to avoid damage to that edge.

Construction by Slip-form Paving Machine

13 A slip-form paving train shall consist of powered machines which spread, compact and finish the concrete in a continuous operation.

14 The slip-form paving machine shall compact the concrete by internal vibration and shape it between sliding side forms or over fixed side forms by means of either a conforming plate or by vibrating and oscillating finishing beams.

15 The concrete shall be deposited without segregation in front of the slip-form paver across its whole width and to a height which at all times is in excess of the required surcharge. The deposited concrete shall be struck off to the necessary average and differential surcharge by means of a strike-off plate or a screw auger device extending across the whole width of the slab. The equipment for striking off the concrete shall be capable of being rapidly adjusted for changes of the average and differential surcharge necessitated by changes in slab thickness or crossfall.

16 The level of the conforming plate and finishing beams shall be controlled automatically from the guide wires by sensors attached at the four corners of the slip form paving machine. The alignment of the paver shall be controlled automatically from the guide wire by at least one sensor attached to the paver. The alignment and level of ancillary machines for finishing, texturing and curing of the concrete shall be automatically controlled relative to the guide wire or to the surface and edge of the slab.

17 Slipform paving machines shall have vibration of variable output, with a maximum energy output of not less than 2.5 kW per metre width of slab per 300 mm depth of slab for a laying speed of up to 1.5 m per minute or pro rata for higher speeds. The machines shall be of sufficient mass to provide adequate reaction on the traction units to maintain forward movements during the placing of concrete in all situations.

18 Except for CRCR slabs, the final regulation of the surface slab shall be provided by a longitudinal oscillating float travelling across the slab. The longitudinal float shall comply with the requirements of sub-Clauses 9, 10 and 11 of this Clause. Additionally, the longitudinal float shall either be a separate machine closely following a slipform paver or alternatively it shall be attached to a slipform paver in such a manner that it functions effectively and does not adversely affect the performance of the paver or the surface of the slab.

19 Joint grooves shall be constructed in compliance with Clause 1013. Where grooves are wet-formed the concrete shall be compacted around the former by a separate vibrating plate compactor with twin plates. The groove former shall be compacted to the correct level by a vibrating pan which may be included with the transverse joint finishing beam. Final finishing shall be carried out in accordance with sub-Clause 18 of this Clause. Any excess concrete on top of the groove former shall be removed before the surface is textured.

20 Where a concrete slab is constructed in more than one width or where the edge needs to be matched for one level to another section of surface slab, and the surface levels at the edges are not achieved, the slab shall be supported by separate side forms placed before or after the paver to ensure that edge levels meet the required tolerances.

TABLE 10/6: Maximum Working Times

General

21 While the concrete is still plastic its surface shall be brush-textured in compliance with Clause 1026 and the surface and edges of surface slabs and CRC roadbases shall be cured in compliance with Clause 1027. Other roadbase or sub-base slabs shall be cured as in sub-Clause 1035.16.

22 The spreading, compacting and finishing of the concrete shall be carried out as rapidly as possible and the paving operation shall be so arranged as to ensure that the time between the mixing of the first batch of concrete in any transverse section of the slab and the application of the sprayed curing membrane to the surface of that section shall not exceed those given in Table 10/6.

23 Each bay in jointed concrete surface slabs shall be consecutively numbered near the verge, next to a transverse joint while the concrete is plastic. In continuously reinforced concrete pavement the slab shall be marked with the chainage at intervals not greater than 50 m apart.

1025 Construction by Small Paving Machines or Hand Guided Methods

1 As an alternative to fixed form or slip-form paving trains, the concrete slab may be constructed using parts of trains, small paving machines, truss type finishing beams or hand guided methods. Hand tamping beams may only be used for short lengths or infill bays or tapers. Reinforcement, dowel bars and tie bars shall be supported in position in accordance with Clauses 1008, 1011 and 1012 respectively, except where two layer construction is used and reinforcement is placed on the bottom layer.

Temperature of concrete at discharge from the delivery vehicle	Reinforced concrete slabs constructed in two layers, without retarding admixtures		All other concrete slabs	
	Mixing first layer to finishing concrete	Between layers	Mixing first layer to finishing concrete	Between layers in two layers work
Not more than 25 °C	3 hours	Half hour	3 hours	1.5 hours
Exceeding 25 °C but not exceeding 30 °C	2 hours	Half hour	2 hours	1 hour
Exceeding 30 °C	Unacceptable for paving	-	Unacceptable for paving	-

2 The concrete shall be spread uniformly without segregation or varying degrees of pre-compaction, by conveyor, chute, blade or auger. The concrete shall be struck off by a screed or auger so that the average and differential surcharge is sufficient for the surface of the slab to be at the correct levels after compaction of the concrete.

3 The concrete shall be compacted by vibrating finishing beams across the slab and with vibrating pokers adjacent to the side forms or the edge of a previously constructed slab. In addition, internal poker vibration shall be used for slabs thicker than 200 mm and may be used for lesser thicknesses. When used, the pokers shall be at points not more than 500 mm apart over the whole area of the slab, or drawn continuously across the slab in front of the finishing beams.

4 The finishing beams shall be metal with a contact face at least 50 mm wide. They shall be rigid or supported by a frame or truss without sag across the width of slab being paved. The beams shall be supported on rails or forms or an adjacent slab and shall be moved forward at a steady speed of 0.5 m to 2 m per minute whilst vibrating, to compact the concrete and to produce a smooth surface finished to the correct crossfalls, crowns and levels relative to the top of the forms or adjacent slab.

5 Joint grooves shall be constructed in compliance with Clause 1013. Any irregularities at wet-formed joint grooves shall be rectified by means of a vibrating float at least 1.0 m wide drawn along the line of the joint. The whole area of the slab shall be regulated by two passes of a scraping straight edge not less than 1.8 m wide or by a further application of a twin vibrating finishing beam. Any excess concrete on top of the groove former shall be removed before the surface is textured.

6 The surface shall be brush-textured as described in Clause 1026.

7 The surface shall be cured in compliance with Clause 1027, within the time to completion given in Table 10/6.

1026 Finished Surface Requirements

Texture of Running Surfaces

1 The finished surface of the pavement shall comply with the requirements of Clause 702. Instead of irregularities of 4mm for construction classes HD I to III, irregularities up to 6mm are permitted for construction classes IV to VI and for hand guided methods. Where a pavement area does not comply with the Specification in any respect the full extent of the surface which does not comply shall be rectified in accordance with Clause 702.

2 After the final regulation of the surface of the slab and before the application of the

curing membrane, the surface of concrete slabs to be used as running surfaces shall be brush-textured in a direction at right angles to the longitudinal axis of the carriageway. The texture shall be applied evenly across the slab in one direction by a brush not less than 450 mm wide. The texture shall be uniform both along and across the slab.

3 The texture depth shall be determined by the sand patch test as described in Clause 1031. Tests shall be taken within 100 m of commencement of paving and thereafter at least once for each day's paving at the times after construction as given below and in the following manner: 10 individual measurements of the texture depth shall be taken at least 2 m apart anywhere along a diagonal line across a lane width between points 50 m apart along the pavement. No measurement shall be taken within 300 mm of the longitudinal edges of a concrete slab constructed in one pass.

4Texture depths shall be as required in Table 10/7.

5 Where the required texture depth is found to be deficient the Contractor shall make good the texture across the full lane width over lengths necessary to comply with the requirements of Table 10/7, by retexturing the hardened concrete surface as described in Clause 1029. Failure to achieve a satisfactory minimum texture depth by random grooving shall result in the removal of the full thickness of the slab to the extent required to permit reconstruction of the slab in accordance with the Specification. If the texture depth is excessive the surface shall be planed or ground or otherwise treated over lengths necessary to comply with the requirements of Table 10/7. The treatment shall not affect the requirements of Clause 702 in respect of surface levels or surface regularity.

TABLE 10/7: Texture Depths

Time of Test	Required Texture Depth (mm)		
		Specified Value	Tolerance
(i) Between 24 hours and 7 days after the construction of the slabs or until the slab is first used by vehicles	An Average of 10 measurements	1.00	+ 0.25
(ii) Not later than 6 weeks before the road is opened to public transport	An average of 10 measurements	1.00	+ 0.25 - 0.25

Texture of Concrete Roadbases

6 The surface of wet-laid concrete roadbases shall be roughened before the application of any curing compound by brushing with a wire brush or stiff broom.

1027 Curing

1 Immediately after the surface treatment described in Clause 1026, the surface and exposed edges of surface slabs shall be cured for a minimum period of 7 days, (unless the Engineer agrees to a shorter period but not less than 3 days) by the application of an approved resin based aluminised curing compound, or polythene sheeting or an approved sprayed plastic film which hardens into a peelable plastic sheet and which shall be removed before road marking and opening to traffic. Curing by keeping the surface and the vertical faces continuously moist is also possible if the required strength will be achieved.

2 Resin based aluminised curing compound shall contain sufficient flake aluminium in finely divided dispersion to produce a complete coverage of the sprayed surface

with a metallic finish. The compound shall become stable and impervious to evaporation of water from the concrete surface within 60 minutes of application and shall have an efficiency index of 90% when tested as described in BS 7542.

3 The curing compound shall not react chemically with the concrete to be cured and shall not crack, peel or disintegrate within three weeks after application.

4 Prior to application, the contents of any containers shall be thoroughly agitated. The curing compound shall be mechanically applied using a fine spray on to the surface at a rate of at least 0.22 1/m². For the sides of slip-formed slabs or when the side forms are removed within 24 hours and for small areas where mechanical application cannot be used, the compound shall be sprayed by hand lance at a rate of at least 0.27 1/m². The rate of spread shall be checked during construction of each trial length and for each 1000 m² of treated slab or per day.

5 The mechanical sprayer shall incorporate an efficient mechanical device for continuous agitation and mixing of the compound in its container during spraying.

6 Continuously reinforced concrete base courses shall be cured in accordance with this Clause. Wet lean concrete base courses and sub-bases shall be cured in accordance with sub-Clause 1035.16.

7 To achieve high early strength for early use by vehicles, insulation blankets as described in Clause 1045 and clause 703 shall be used for accelerated curing.

8 During laying and for a period of 2 hours after laying the surface shall be protected from rain damage by the use of tentage.

1028 Trial Length General

1 Except in rapid construction projects and unless otherwise described in Appendix 7/1, at least three months prior to the construction of the trial length of surface slabs or CRCR the Contractor shall submit a detailed description of the proposed materials, mix proportions, plant, equipment and construction methods. No trials of new materials, plant, equipment or construction methods; nor any development of them shall be permitted either during the construction of the trial length or in any subsequent paving work, unless they form part of further satisfactory trials.

2 Unless otherwise described in Appendix 7/1, the Contractor shall demonstrate the materials, mix proportions, plant, equipment and methods of construction that are proposed for concrete paving, by first constructing a trial length of slab, at least 150 m but not more than 300 m long for 23 mechanised construction, and at least 30 m long for hand guided methods. The mix proportions decided by trial mixes may be adjusted during the trial but shall not be changed once the trial length has been satisfactorily completed unless the Contractor lays a further trial area to assess the suitability of the proposed changes.

3 The trial length shall be constructed in two parts over a period comprising at least part of two separate working days, with a minimum of 75 m constructed each day when mechanised paving plant is used and a minimum of 15 m on each day for hand guided methods. The trial length shall be constructed at a similar rate to that which is proposed for the main construction in the Permanent Works.

4 At least two transverse joints and one longitudinal joint of each type that are proposed for unreinforced concrete slabs and jointed reinforced concrete slabs in the main construction in the Permanent Works shall be constructed and assessed in the trial length. If in the trial length expansion joints are not demonstrated, the first 2 expansion joints and at least the first 150 m of longitudinal construction joint for mechanised paving, or 30 m for hand guided method of construction laid in the main construction in the Permanent Works, shall be considered the trial length for these joints. One construction joint shall be demonstrated in each trial length of CRCP or CRCR.

Assessment

5 The trial length shall comply with the Specification in all respects, with the following additions and exceptions:

Surface Levels and Irregularity

(i) In checking for compliance with Table 7/1 the levels shall be taken at intervals of not more than 2.5 m along any line or lines parallel to the longitudinal centre line of the trial length.

(ii) The maximum number of permitted irregularities of pavement surfaces shall comply with the requirements o0f Table 7/3 for 300 m lengths. Shorter trial lengths shall be assessed pro-rata based on values for a 300 m length.

Joints

(iii) At least 3 cores of minimum diameter 100 mm shall be taken from the slab at joints to check the lateral and vertical location of joint grooves and bottom crack inducers.

(iv) After a minimum of 24 hours after construction the removable part of the joint groove former shall be taken out of at least three joints and the sides of the groove shall be inspected for compaction. If there are voids the size and number should be compared with a similar size section of the photograph for 3% excess voidage in BS 1881 : Part 120. If there is excess voidage, additional compaction shall be provided and further joints inspected. The joints so exposed shall be temporarily or permanently sealed.

(v) Alignment of dowel bars shall be inspected as described in Clause 1019 in any two consecutive transverse joints. If the position or alignment of the dowel bars at one of these joints does not comply with Clause 1011 but if that joint remains the only one that does not comply after the next 3 consecutive joints of the same type have been inspected then the method of placing dowels shall be deemed to be satisfactory. In order to check sufficient joints for dowel bar alignment without extending the trial length unduly, the Contractor may construct joints at more frequent joint intervals than the normal spacing required in Appendix 7/1.

(vi) If there are deficiencies in the first expansion joint that is constructed as a trial the next expansion joint shall be a trial joint. Should this also be deficient further trial expansion joints shall be made as part of a trial length. Deficient expansion joints shall not form part of the Permanent Works.

Density

(vii) Density shall be assessed as described in Clause 1003 from at least 3 cores drilled from each part of the trial length.

Position of Reinforcement and Tie Bars

(viii) Compliance with Clause 1008 for the position of steel reinforcement and Clause 1012 for the position and alignment of tie bars shall be checked by drilling additional cores from the slab unless they can be determined from cores taken for density assessment.

Completion of Trial

6 The Contractor shall not proceed with normal working unless the trial length complies with the Specification and any earlier defective trial lengths have been removed, unless they can be remedied to comply with the Specification.

7 After satisfactory completion of the trial length, the materials, mix proportions, plant, equipment and construction methods shall not thereafter be changed, except for normal adjustments and maintenance of plant, unless the Contractor lays a further trial length as described in this Clause to demonstrate that the changes will not adversely affect the Permanent Works or agrees the changes with the Overseeing Organisation.

Rejection and Further Trials

8 Trial lengths which do not comply with the Specification, with the exception of areas within the pavement surface which can be remedied in accordance with Clause 1029, shall be removed and the Contractor shall construct a further trial length.

1029 Texturing of Hardened Concrete

1 Worn, rain damaged or inadequately textured surface slabs shall be textured by sawing grooves in the hardened concrete surface at right angles to the longitudinal axis of the pavement with machines using diamond or other abrasive cutting discs.

2 Grooves shall be irregularly spaced and shall be not less than 2 mm and not more than 5 mm wide. The sequence of distances between groove centres in mm shall be:- 40, 45, 35, 45, 35, 50, 30, 55, 35, 30, 50, 30, 45, 50, 30, 55, 50, 40, 35, 45, 50, 40, 55, 30, 40, 55, 35, 55. A tolerance of ± 3 mm shall be allowed on each of the spacings. The minimum width of grooving head shall be 500 mm and a head not providing a complete sequence of spacings shall use the number of spacings appropriate to its width commencing at the start of the sequence.

3 Groove depths shall be measured using a tyre tread depth gauge and measurements shall be taken as follows:

(i) At 10 locations at least 2 m apart along a diagonal line across a lane width between points 50 m apart longitudinally. No measurement shall be taken within 300 mm of the longitudinal edge of a slab.

(ii) At each of the 10 locations the depth of 10 adjacent grooves shall be measured.

(iii) Where a grooved area is less than 50 m in length the locations where measurements are taken shall be as (i)

but the number shall be proportional to the requirements for 50 m.

(iv) The average of each set of 10 measurements shall be not less than 3 mm, nor greater than 7 mm.

4 Slurry from the sawing process shall be prevented from flowing into joints, drains or into lanes being used by traffic, and all resultant debris from the grooving shall be removed.

1030 Wet Lean Concrete

Wet Lean Concrete is the term describing lower strength concretes which are suitable only for sub-bases if the pavement Design method takes so called sub-bases into consideration. The Directives for the standardization of pavements for Traffic Areas doesn't provide these types of pavement constructions

1031 Measurement of Texture Depth-Sand Patch Method

1 The following apparatus shall be used:

(i) a cylindrical container 25 ml internal capacity for concrete surfaces;

(ii) a flat wooden disc 64 mm diameter with a hard rubber disc, 1.5 mm thick, stuck to one face, the reverse face being provided with a handle;

(iii) dry natural sand with a rounded particle shape passing a 300 micron BS sieve and retained on a 150 micron BS sieve.

Method

2 The surface to be measured shall be dried, any extraneous mortar and loose material removed and the surface swept clean using a wire brush both at right angles and parallel to the carriageway. The cylinder shall be filled with the sand, tapping the base 3 times on the surface to ensure compaction, and striking off the sand level with the top of the cylinder. The sand shall be poured into a heap on the surface to be tested. The sand shall be spread over the surface, working the disc with its face kept flat, in a circular motion so that the sand is spread into a circular patch with the surface depressions filled with sand to the level of the peaks.

3 The diameter of the patch shall be measured to the nearest 5 mm. The texture depth of concrete surfaces shall be calculated from:

$$\frac{31000 \text{ mm}}{D^2}$$

where D is the diameter of the patch in mm.

1032 Thin Bonded Repairs Materials

1 Cement mortar shall be used for depths less than 20 mm and fine concrete for greater depths. Resin mortar may only be used for small patch repairs less than 1 metre long and less than 30 mm in depth and where insufficient time for adequate curing of a cementitious cement mortar exists.

2 The cements, aggregates, admixtures and water shall comply with Clause 1001. The sand (ie fine aggregate) for mortars or fine concrete shall be within the limits of Grades C or M of BS 882. Coarse aggregate for fine concrete shall be 10 mm single sized aggregate complying with BS 882. All aggregates shall have the same thermal properties as the aggregate in the original concrete, and match other properties as closely as possible. Filler and aggregate for resin mortars shall be prepacked in the

correct proportions and mixed with the resin all in accordance with the manufacturer's instructions.

3 The proportions of cement, admixtures, additives to water and aggregates shall be sufficient to provide high early strength mortar or fine concrete or concrete complying with Clauses 1001, 1003 and 1004. For cement mortar the sand (ie fine aggregate) to cement ratio shall not be greater than 3. For resin mortar the sand content shall be in accordance with the manufacturer's requirements in the range between 7 and 11 to 1 of resin. High early strength concrete shall be able to achieve 25 N/mm² in less than 48 hours. For thin bonded repairs using high early strength concrete less than 30 mm depth, air entrainment is not required.

Procedure

4 Mark out the area to be rectified parallel and perpendicular to the axis of the road. Cut a groove around the perimeter at least 10 mm deep without overcutting into the adjacent slab. Carefully cut out the concrete to the required depth, with a vertical face without undercutting the adjacent slab.

5 If a joint is included in the area to be rectified, fix a groove former along the line of the joint by chasing out a groove. For joints on the perimeter fix the groove former by adhesive to the adjacent slab.

6 For cementitious repairs, wet the area of the patch. Keep it wet until the repair material is ready to be placed. Remove excess water, prime the surfaces with cement grout or bonding agent, spread the repair material immediately before the primed surface is dry, with sufficient surcharge. Thoroughly compact it by vibration ensuring full compaction at the edges and corners.

7 Retexture the surface to match the surrounding concrete and cure in accordance with Clause 1027.

8 For resin mortar repairs, ensure the area is dry before application of the primer. Place the repair material within the time allowed by the manufacturer for the primer, and compact it well into the edges to the patch. Apply a brush texture to match the original.

1033 Full Depth Repairs and Reinstatements General

1 Full depth repairs shall be repairs which will require full depth reinstatement of the concrete slab in accordance with this Clause to the extent instructed by the Overseeing Organisation, which repairs may also require reinstatement of sub-base. Full width repairs shall be repairs over the full width of a bay or bays. Part width repairs shall be repairs over part of the width of a bay or bays. A bay shall be that portion of the concrete pavement bounded by adjacent longitudinal and transverse joints.

2 The area of concrete to be removed shall be marked out perpendicular to and parallel to the axis of the road.

For continuously reinforced concrete slabs (CRCP or CRCR) the edge of the repair shall be not less than 0.5 m from the nearest crack and not less than 3 m from a transverse construction joint at ground beam anchorages. Where this and the provisions of sub- Clause 3 of this Clause would otherwise require a longitudinal repair joint within 1 m of the existing longitudinal joint or edge, the

repair shall be extended to align with that longitudinal joint or edge.

Part Width Repairs

3 Providing all the following criteria are met, part width repairs may be carried out in accordance with sub-Clause 4 of this Clause:

(i) the transverse width of the repair shall not exceed 45% of the width of the slab under repair; and

(ii) the longitudinal joint which would be formed by the repair shall not occur within the wheeltrack; and

(iii) the minimum transverse width of the repair shall not be less than 1.0 m.

If these criteria and those in sub-Clause 2 of this Clause cannot be met, a full-width repair shall be made in accordance with this Clause.

Full Width Repairs

4 For full width repairs the following criteria shall apply unless otherwise specified in Appendix 7/2:

(i) Repair lengths which do not replace an existing transverse joint shall be constructed with two transverse contraction joints and the longitudinal joint shall have tie bars in repair lengths which are greater than 1 metre.

(ii) Repair lengths which replace a single existing transverse joint shall be constructed with two transverse joints: one expansion and one contraction. The new expansion joint shall be formed at the end which will have the shortest longitudinal distance between this joint and the joint in the adjacent lane(s). The longitudinal joint(s) between the existing joint(s) and the new expansion joint shall be constructed without tie bars and shall have 5 mm thick compressible foam within the joint for the full depth of the concrete slab. The longitudinal joint between the new contraction joint and the joint in the adjacent bay(s) shall be constructed with tie bars where the exposed length so permits.

(iii) Repair lengths which replace more than one existing transverse joint shall be constructed with transverse joints to match expansion and contraction joints in the adjacent bay(s). Where the repair length does not replace an existing expansion joint, one end joint shall be formed as an expansion joint. Except for the end joints all transverse joints shall be formed to coincide with the existing transverse joints. Where one end joint is an expansion joint, the longitudinal joint(s) between the existing joint(s) and the new expansion joint shall be constructed without tie bars and shall have 5 mm thick compressible foam within the joint for the full depth of the concrete slab. All other longitudinal joints shall be constructed with tie bars.

Repair Work

5 A groove of 40 mm nominal depth but less than the depth of any reinforcement shall be sawn around the perimeter. For jointed slabs, the saw-cut shall be full depth to provide the face for a new joint. There shall be no over-cutting into the adjacent slab. Additional cuts within the repair area may be made to ease removal of the redundant portion of the slab. At internal corners full depth holes

across the corners at the limits of the saw cuts shall be drilled prior to breaking out.

The line of cut shall not vary by more than ±25 mm throughout its length from the set out line. All sawn edges shall be perpendicular or parallel to the sides and surfaces of the slab.

When sawing operations have been completed, and before any other operations are commenced, the surface of the carriageway shall be thoroughly cleaned of the slurry produced by sawing and of any other detritus.

6 The concrete shall be carefully broken out without undercutting the slab or damaging adjoining slabs. If reinforcement has to be removed sufficient shall be left for a lap length, except where a dowelled joint is being made. Reinforcement shall not be bent and subsequently straightened. Slurry from sawing, slab breaking, repair materials and other debris shall be prevented from entering joints and grooves in adjacent areas.

7 When a new joint is required holes shall be drilled of the appropriate size and depth for dowels or tie bars according to the type of joint. These holes shall be thoroughly cleaned of debris and dust. This shall include but not be limited to the use of oil-free compressed air at a pressure of not less than 0.5 N/mm2.

Dowels and tie bars shall comply with the requirements of Clauses 1011 and 1012 respectively. Epoxy mortar shall be to the manufacturer's recommendation for this specific application.

The holes shall be filled with epoxy mortar, the mortar being injected to the rear of the hole to avoid air entrapment. The dowel bars shall be inserted into the holes before the initial set of the mortar. If cartridges of epoxy mortar are used they shall be inserted into each hole, the dowel bar inserted through the cartridges and rotated for 1 minute to ensure that the epoxy mortar is well mixed. After insertion the dowels and tie bars shall be within the specified tolerances for alignment.

Where repairs straddle a movement joint with an adjacent slab, tie bars shall be omitted and the joint between the slabs debonded to ensure that movement patterns are not restricted.

Where Appendix 7/1 or the drawings so require, full bay replacement shall be made and this may require an expansion joint or a contraction joint to be provided at the ends of the replaced bay.

8 Expansion joint filler shall be fixed to one of the transverse joints. In the other transverse joint, contraction joint groove forming strip seals shall be fixed to the edges of the adjacent concrete. If the repair is adjacent to another slab, bond between the two slabs shall be prevented by providing full depth 5 mm thick compressible foam strips to Clause 1014 along the longitudinal joint between them.

9 The sub-base layer and any separation membrane shall be reinstated as necessary to comply with Series 800 and Clause 1007 respectively.

Defective sub-base material shall be removed and the sub-base reinstated to the correct level with the material described in Appendix 7/2. Reinstatement of the subbase shall be completed before new dowel and tie bars are fixed at the joints.

10 New reinforcement shall be lapped and welded or tied. The length of tied laps shall

be 35 bar diameters or 450 mm whichever is the greater for longitudinal bars and 300 mm for transverse bars. Welded laps shall be 150 mm minimum length unless a butt-weld process has been permitted in Appendix 7/1.

11 The reinstated concrete shall be placed, spread, compacted and finished as specified in Clause 1025. Particular care shall be taken to ensure full compaction at the edges. The concrete shall be normal or high early strength pavement concrete, complying with Clauses 1001 to 1005 and shall achieve the required characteristic strength prior to opening to traffic.

Crack Repairs

12 Stitched crack repairs shall be either

Type 1 - Staple Tie Bar Repair
Type 2 - Diagonal Tie Bar Repair

as described in Appendix 7/2 and compliant with sub- Clauses 13 and 14 of this Clause.

The extent of crack repairs shall be determined by inspection after the surface has been cleaned.

13 For Type 1 crack repairs, slots 25 - 30 mm wide by 470 mm long at 600 mm centres and at right angles to the line of the crack shall be chased out to a depth such that, when bedded, the tie bars lie between 1/3 and ½ of the depth of the slab below the surface.

Holes of 25 mm - 30 mm diameter by 50 mm deep shall be drilled at each end of the slot and the slots cleaned out using oil free compressed air.

When in a dry state the slots shall be primed and the staple tie bars placed into beds of epoxy mortar and covered to a minimum depth of 30 mm with the same material.

The sides of the slots shall be cleaned of loose material and the slots filled with thoroughly compacted epoxy or cementitious mortar as described in Appendix 7/2.

After curing a groove shall be sawn along the line of the crack and sealed in accordance with Clause 1016.

14 For Type 2 crack repairs drilling points shall be marked out at a distance from the crack equivalent to the depth of the slab, at 600 mm intervals along the crack with alternate points on opposite sides of the crack.

Holes of 16 mm minimum diameter shall be drilled at right angles to the crack and at approximately 26^{o} to the surface of the slab to a depth which allows 50 mm cover at the bottom of the slab. These holes shall be thoroughly cleaned of debris and dust.

12 mm diameter grade 460 deformed steel tie bars shall be notched at a point which will ultimately be 50 mm below the slab surface when the bars are fully inserted into the hole.

Each hole shall be filled with epoxy mortar and its quantity adjusted to ensure that when the tie bar is fully inserted the level of the mortar is up to a point which is 25 mm below the notch on the tie bar. Such adjustment of the epoxy mortar and the final insertion of the tie bar shall be done rapidly to ensure its completion before the initial set of the mortar. After the epoxy mortar has set, the length of tie bar above the notch shall be broken off. Once all these bars have been broken off, the tops of all these holes shall be filled with epoxy mortar.

If cartridges of epoxy mortar are used the bars shall be inserted through the cartridges and rotated for 1 minute to ensure that the adhesive is well mixed.

Joint Grooves and Seals

15 Longitudinal joint grooves shall be recut where directed in Appendix 7/2 using the following procedure.

The longitudinal joint shall be saw cut to a nominal width of 10 mm to encompass the existing joint and to sufficient depth to remove the existing sealant approximately 25 mm deep. Where existing sealant or traces thereof cannot be removed within the 10 mm saw cuts the groove shall be widened to enable all existing sealant to be removed. The groove sides shall be vertical, and the horizontal alignment of the groove shall be straight and parallel to the edge of the slab.

The concrete and sealant shall be removed between the saw cuts without damaging the sides of the groove.

The base of the groove shall be formed to a uniform profile suitable for the application of debonding tape or caulking material.

Any residual traces of sealant or detritus shall be removed from the groove and the groove prepared for sealing in accordance with Clause 1016.

16 Transverse joint grooves shall be recut where directed in Appendix 7/2 using the following procedure.

The transverse joint shall be saw cut to form a groove to satisfy the dimension of applied joint seals as specified in Table 10/5 allowing for debonding tape or any necessary caulking material of at least 5 mm uncompacted depth and to encompass the existing joint.

The groove sides shall be vertical, and the horizontal alignment of the groove shall be straight and parallel to the line of the joint.

The concrete and sealant shall be removed between the saw cuts without damaging the sides of the groove.

The base of the groove shall be formed in accordance with Clause 1017.

Any residual traces of sealant or detritus shall be removed from the groove and the groove prepared for sealing in accordance with Clause 1016.

17 The joints shall be sealed in accordance with Clause 1016.

1034 Summary of Rates for Sampling and Testing Concrete for Pavement Layers

1 Table 10/8 summarises the minimum rates of sampling and testing of specimens for ensuring compliance with the Specification.
2 Samples for testing shall be taken at the point of placing or from the relevant pavement layer.

TABLE 10/8: Rates for Sampling and Testing Concrete for Pavement Layers

Clause	Test	Rate (the greater number shall be used)	
1003	Density	a) Main slab	3 Cores per 600m² or per day
		b) Trial length	3 Cores per trial length
1004	(A) Strength of cubes	a) Main slab	1 set of 4 cubes per 600 m² or per day One of each set tested at 7 days Three of each set tested at 28 days Groups of 4 results assessed as in BS 5328 : Part 4
		b) Slabs less than 600 m²	4 cubes per 100 m² Two cubes tested at 7 days Two cubes tested at 28 days and assessed as in BS 5328 : Part 4
	(B) Strength of cores		Three cores per 600m² or per day
1005	Workability	a) Main Slab	1 per 300 m² or 6 per day
		b) Slabs less than 300 m²	1 per 20 m length or 3 per day
1016	Hot or cold applied joint sealants	Penetration test	One sample per 1000 m joint or at least one per day
1019	Inspection of dowel alignment	a) Main slab	1 joint per 1500m length or 1 joint per 5 days whichever is the sooner
		b) Slabs less than 1500 m in length	At a rate of one joint for up to each 100 joints
		c) Trial lengths	2 consecutive joints If one defective, inspect next 3 consecutive joints
1026	Texture depth	Each lane width	One within 100 m of commencement of paving and thereafter at least one set of 10 measurements per day's work.

1035 General Requirements for Cement Bound Materials

1 Cement-bound materials shall be made and constructed as described in the following Clauses. The permitted alternatives for each part of the Works shall be as described in Appendix 7/1.

2 Cement-bound materials shall comply with Table 10/9 and be tested in accordance with Clause 1040.

Constituents

3 Cement shall comply with Clause 1001 sub- Clauses 3(i), 3(ii), and 3(iv). Water shall comply with sub-Clause 1001.4.

4 Granular material for use in CBM shall comply with Clause 1037 or 1038 as appropriate.

5 Cement for use in all cement-bound materials and aggregates for use in CBM2, and CBM4 shall be delivered and stored in compliance with Clause 1021.

Batching and Mixing

6 Batching shall be carried out by mass. Mixing shall be carried out by the mix-in-plant method. The materials shall be batched and mixed in compliance with BS 5328 : Part 3. Where continuous mixers are used, batching shall be carried out by mass and the continuous mixers shall comply with Table 5 of BS 1305 : 1974 when tested in accordance with BS 3963.

Transporting

7 Plant-mixed cement-bound material shall when mixed be removed at once from the mixer, transported directly to the point where it is to be laid and protected from the weather both during transit from the mixer to the laying site and whilst awaiting tipping.

Laying

8 All cement-bound material shall be placed and spread evenly in such a manner as to prevent segregation and drying. Spreading shall be undertaken either concurrently with placing or without delay. Cement-bound material shall be spread using a paving machine or a spreader box operated with a mechanism which levels off the cement bound material to an even depth.

9 Cement-bound material shall be spread in one layer so that after compaction the total thickness is as specified.

10 At longitudinal or transverse construction joints, unless vertical forms are used, the edge of compacted cement-bound material shall be cut back to a vertical face where the correct thickness of properly compacted cement-bound material has been obtained.

11 In the case of cement-bound sub-bases under a concrete surface slab or continuously reinforced concrete base course, longitudinal construction joints in the sub-base shall be staggered by at least 300 mm from the position of the longitudinal joints in the concrete surface slab or continuously reinforced concrete roadbase, and by 1 m for transverse joints.

Compacting

12 Compaction shall be carried out immediately after the cement-bound material has been spread and in such a manner as to prevent segregation.

13 Special care shall be taken to obtain full compaction in the vicinity of both longitudinal and transverse construction joints.

14 Compaction shall be carried out in compliance with Table 10/9 and be completed within 2 hours of the addition of the cement. The 2 hour period may be varied if the preliminary trial described in sub-Clause 18 of this Clause indicates that this is necessary or appropriate. After compaction has been completed, compacting equipment shall not bear on cement-bound material for the duration of the curing period.

15 The surface of any layer of cement-bound material shall on completion of compaction and immediately before overlaying, be well closed, free from movement under compaction plant and from ridges, cracks, loose material, pot holes, ruts or other

defects. All loose, segregated or otherwise defective areas shall be removed to the full thickness of the layer, and new cement-bound material laid and compacted.

Curing

16 Immediately on completion of compaction, the surface of cement-bound sub-bases shall be cured for a minimum period of 3 days by one of the following methods:

(i) Covering with an impermeable sheeting with joints overlapping at least 300 mm and set to prohibit egress of moisture. The sheeting shall be removed at the end of the curing period.

(ii) Bituminous spraying in compliance with Clause 920 which shall only be applied when there is no visible water. When the cement bound material is likely to be exposed to high temperatures and solar radiation or shall be opened very early to traffic, the bituminous spray shall be blinded with light coloured material 2/5mm in accordance with sub- Clause 920.5 or with Sub-clause 901.19.

(iii) Spraying with a curing compound in compliance with Clause 1027.

(iv) Spraying with suitable plastic film which, when hardened, shall be removed before applying any other pavement layer.

(v) The Cement Bound Material will be kept moist for at least 3 days.

Induced Cracks

17 Cement bound materials shall have cracks induced during construction as described in Clause 1047 and in Appendix 7/20.

TABLE 10/9: Cement Bound Materials

Field Requirements						Specimen Requirements				
Category	Clause	Mixing Plant	Method of Batching	Moisture Content	Minimum Compaction	Compaction	Curig	Compressive Strength Testing	Minimum 28 days core compressive Strength N/mm²	
CBM2	1037	Mix-in-plant	Mass	To suit requirements for strength surface level, regularity and finish	95% of cube density (Note 1)	Clause 1040	BS 1924: Part 2: 1990 Clause 4.2.6	BS 1924: Part 2: 1990 clause 4.2 or BS 1881: (Part 116)	7 to 12	3.5
CBM4	1038	-	-	-	-	-	BS 1881	BS 1881 (Part 116)	> 15.0	6.0

							(Part 111)			

NOTES:

1 The average in situ wet density of each group of three determinations carried out in accordance with Clause 1040 shall not be less than 95% of the average wet density of the corresponding group of three cubes made in accordance with Clause 1040.

2 The average strength of each group of three cores (diameter D= 150mm, height H= 125mm) within the limits one above the limit indicated.

3 The strength of any individual core (diameter D= 150mm, height H= 125mm) shall not be less than the strength indicated.

Preliminary Trial

18 At least 10 days before the start of the main cement-bound material works a trial area of at least 400 m² may be laid to assess the suitability of the proposed materials, mix proportions, mixing, laying, compaction plant and construction procedures. When applicable the area shall include one longitudinal and one transverse construction joint. The rate of testing for the trial area shall not be less than that required by Clause 1040. The trial area will only be accepted for main construction in the Permanent Works if it complies with the Specification. The main construction in the Permanent Works shall not start until the trial shows that compliance with the Specification is attained. The materials, mix proportions, mixing, laying, compaction plant and construction procedures shall not be changed unless the Contractor lays a further trial area to demonstrate the suitability of the proposed changes or agrees the changes with the Overseeing Organisation.

1036 Not Used

1037 Cement Bound Material Category 2 (CBM2)

1 CBM2 (Cement Stabilization) below asphalt layers shall be made from washed or processed granular material, crushed concrete, recycled aggregate, crushed rock, all-in aggregate, or any combination of these. The material shall fall within the grading limits of Table 10/11. Minimum layer thickness after compaction must be 12 cm for a maximum grain size of 37.5mm and 15cm for a maximum grain size of 50mm.

2 The material shall have a ten per cent fines value of 50 kN or more when tested in accordance with BS 812 : Part 111 except that the specimens shall be in a soaked condition.

TABLE 10/11: Material for CBM2 and CBM4
Range of Grading

BS sieve size	**Percentage by mass passing**	
	0/50	0/37.5mm
50 mm	160	-
37.5 mm	78-95	100
25 mm	62-82	80-95
12.5 mm	40-68	50-75
4.75mm	26-55	30-60
2.36 mm	15-45	18-45
600 micron	8-32	8-32
300 micron	2-22	4-22
75 micron	0-15	0-15

NOTE:
The particle size distribution shall be determined by the washing and sieving method of BS 812 : Part 103

1038 Cement Bound Material Category 4 (CBM4)

1 CBM4 below concrete pavements shall be made from aggregates as in sub-Clause 1001.6. Alternatively recycled coarse aggregates may be used provided they comply with the requirements of sub-Clause 1001.6

2 The grading of the aggregate shall be within the limits in Table 10/11. Minimum layer thickness after compaction must be 13cm for a maximum grain size of 37.5mm and 15cm for a maximum grain size of 50cm.

1039 Coefficient of Thermal Expansion

1 To determine if the coefficient of thermal expansion of CBM4 composed of crushed rock is above or below 10 x 10^{-6} per °C it shall be measured in a laboratory equipped for the test.

The test procedure shall be based on the method outlined in Current Practice Sheet 3PC/06/01 "Thermal Movement of Concrete" by R D Brown, Concrete Journal; November 1972. It shall be carried out in a temperature controlled water bath on three test samples of nominal size 100 x 100 x 500 mm water cured for at least 28 days at 20°C. The change in length of the samples shall be measured as the temperature is raised in 20°C increments over the range 20°C to 60°C and the results plotted to demonstrate that a reasonably linear relationship has been achieved. The coefficient of thermal expansion of each sample shall be calculated from the linear change over the full temperature range and the mean value determined.

1040 Testing of Cement Bound Materials

Frequency of Sampling for Cube Specimens

1 Besides the testing of the compressive strength of cores according to table 10/9, samples may be provided in accordance with BS 1924 : Part 1 : 1990, clause 5 from the laid cement-bound material before compaction. One group of five samples may be provided from five locations equally spaced along a diagonal that bisects each 800 m² or part thereof laid each day. The number of samples and/or groups may be increased or reduced by the Engineer.

Making of Cubes

2 One 150 mm cube shall be made from each sample taken in accordance with sub-Clause 1 of this Clause. The cubes shall be made in accordance with BS 1924 : Part 2 : 1990, clause 4.2.5 without further mixing of the material and within 2 hours of the addition of the cement. Cubes shall be cured and tested in accordance with Table 10/9. Number of cubes must allow to test the compressive strength after 7 days and 28 days according to BS 5328 Part 4.

3 To determine the wet density of cubes the mould shall be weighed prior to making the cube and the mass recorded. Immediately after completion of compaction, the cube and mould shall be weighed and the mass recorded. These masses together with the nominal volume of the mould shall be used to derive the wet density of the cube.

In situ wet density

4 The in situ wet density of a layer of cement-bound material shall be taken as the average of the wet densities at five locations equally spaced along a diagonal that bisects each 800 m² or part thereof laid each day. The wet density at each location shall be the average of two readings obtained in accordance with Clause 1041 using a nuclear density gauge complying with BS 1377 : Part 9. The two readings shall be taken at 180° to each other using the same source rod hole. The source rod shall be lowered to within 25 mm of the bottom surface of the layer. Readings shall be taken within two hours of completing final compaction. If there is no nuclear density gauge available, wet in site density may be determined by standardized methods of soil testing.

Mix Design

5 Single Values of the compressive strength must not fall more than 2N/mm² above or below the mean value.

1041 Use of Nuclear Density Gauges with Cement Bound Materials

Standardisation of Nuclear Density Gauges

1 The operation, warming-up period, if any, and standardisation of the gauge shall be carried out in compliance with the manufacturer's recommendations. The gauge shall be calibrated in accordance with BS 1377 : Part 9.

Mode of Operation

2 The gauge shall be used in the direct transmission mode of operation.

Preliminary Checking

3 Prior to the preliminary trial and whenever the constituents of the mix are altered the cement-bound material shall be checked by the procedure given in BS 1924 : Part 2 : 1990, clause 3.7.4.

Field Density Determination

4 The determination of bulk density by direct transmission shall be in accordance with BS 1924 : Part 2 : 1990, clause 3.7.8.

1042 Special Requirements for Cement Bound Materials

1 Where required in Appendix 7/1, cement-bound roadbase in flexible composite construction shall be laid in individual widths with longitudinal construction joints in locations as detailed below:

Single All purpose	One longitudinal construction joint at the centre line marking
Dual 2 lane All-purpose	One longitudinal construction joint at the lane line marking
Dual 3 lane All-purpose	Two longitudinal construction joints, one at each of the lane line markings
Dual 2 lane Motorway	Two longitudinal construction joints, one at the lane line marking and one at the edge line marking between hard shoulder and left hand lane
Dual 2 lane Motorway	Three longitudinal construction joints, one at the lane line marking and one at edge line

	markings between hard shoulder and left hand lane
Dual 4 lane Motorway	Four longitudinal construction joints, one at each lane line marking and one at the edge line marking between hard shoulder and left hand lane

Longitudinal construction joints shall not be more than 150 mm from the centre of the centre line, lane line, or edge line marking, with individual widths not exceeding 4.75 m. Longitudinal construction joints shall not be located within the left hand lane of dual carriageways. At tapers and other changes in section the construction joint layout shall be as detailed on the Drawings, and where necessary joints shall also be permitted within 150 mm of the mid-point of the traffic lane.

1043 Not Used

1044 Pavements with an Exposed Aggregate Concrete Surface

General

1 Pavements with an exposed aggregate concrete surface shall comply with all the requirements of this Series except where otherwise specified in this Clause.

2 The Contractor shall complete Appendix 10/1 and submit this with his tender documents. If after acceptance the Contractor wishes to change the proposals contained in Appendix 10/1 this change shall only be with the consent of the Overseeing Organisation.

3 The concrete slab shall be laid in either a single layer or in two layers as stated in Appendix 10/1. If laid in two layers the surface layer shall be laid monolithically with the lower layer.

4 The Contractor shall carry out trials, as specified in sub-Clauses 31 to 39 of this Clause, to demonstrate that the materials, mix proportions and methods for exposing the aggregate will meet the requirements of this Clause.

Quality of Concrete in the Slab

5 The surface layer concrete shall comply with the following requirements:-

(i) The surface layer shall be not less than 40 mm thick. The coarse aggregate shall comply with the size requirements of Appendix 7/1.

(ii) For 10-6 mm coarse aggregate or 8-4 mm coarse aggregate as required in Appendix 7/1, the amount of aggregate retained on the 10 mm sieve and 8 mm sieve respectively shall not exceed 3% by mass. The aggregate passing the 6 mm sieve and 4 mm sieve respectively shall not exceed 10% by mass.

(iii) The fine aggregate grading shall comply with Classification F of Table 5 in Clause 5.2 of BS 882, except that not less than 99% of the mass of the material shall pass the 2.36 mm sieve.

(iv) The coarse aggregate shall comprise at least 60% by mass of the oven dry constituents of the concrete.

(v) The polished stone value (PSV) and the aggregate abrasion value (AAV) of the coarse aggregate shall be as specified in Appendix 7/1. The flakiness index of the aggregate shall not exceed 20.

(vi) Hardness and durability of the coarse aggregate shall be as described in sub-Clause 901.2.

(vii) The type of cement used in the concrete may be limited to Class 42.5N/42.5R Portland cement CEM I complying with MSA EN 197-1. The minimum cement content of the concrete may be 375 kg/m³ and the maximum free water/cement ratio shall be 0.40.

(viii) The total quantity of air entrained in the concrete as a percentage of the volume of the fully compacted concrete may be 5 ± 1.5%. It can be supposed however that air entrainment is not necessary for the climate condition of Malta.

(ix) The total air voids in the fully compacted concrete shall not be greater than 8%. It air-entrained concrete should be necessary.

General Construction Requirements

6 The concrete paving equipment shall comply with Appendix 10/1 as completed by the Contractor and submitted at Tender stage for approval by the Overseeing Organisation before the work commences. The general construction requirements shall be in accordance with the requirements of this Series except where otherwise stated in this Clause:

(i) The concrete carriageway paving operation shall be undertaken as not less than a single lane width of construction using either slipform paving machines or fixed form paving machines.

(ii) The concrete surface layer shall be fed, spread, compacted, regulated and finished using equipment with elements to obtain the required uniform distribution and bonded embedment of the selected aggregate in the finished road surface.

(iii) The spread concrete shall be compacted in such a manner that base layer concrete is not drawn into the surfacing and selected aggregate is uniformly present in the finished road surface.

(iv) The surface layer shall be compacted and shaped to line and level by a combination of either internal vibration and fixed conforming plate or vibrating conforming plate.

(v) The final regulation of the surface layer shall be provided by a transverse finishing screed in advance of a longitudinal oscillating float in accordance with Clause 1024, traveling across the slab before the application of retarder.

Finished Surface Requirements

7 The finished surface of the pavement shall comply with the requirements of Clause 702. Where a pavement area does not comply with the Specification for regularity, surface tolerance, thickness, material properties or compaction or contains surface depressions, the full extent of the surface which does not comply with the Specification shall be rectified by cutting out the full depth of the slab. It shall be replaced with a new slab complying with the procedures set out in Clause 1033 to the extent required to obtain compliance with the Specification.

Production of an Exposed Aggregate Surface

8 In order to obtain a suitable exposed aggregate surface the main requirement shall be the removal of the surface mortar from the top of the slab to produce an exposed aggregate finish. This objective may be achieved by the application of a suitable cement set retarder which is sprayed on the surface of the fresh concrete immediately after it has been levelled and finished. Retarded mortar shall be removed by wet or dry brushing as stated in Appendix 10/1, generally no sooner than 24 hours after concreting or after a suitable interval determined by trial, to achieve the requirements of sub-Clause 27 of this Clause.

Retarder

9 The composition and viscosity of the retarder shall be such that it can be spread at an adequate and uniform rate over the surface of the concrete slab in order to ensure adequate aggregate exposure during the subsequent brushing operation.

10 The retarder shall contain a pigment in sufficient quantity to give an even uniform colour after it has been sprayed on to the slab surface. The pigment shall be fully degraded by exposure to ultra-violet light without leaving any residue that is detrimental to the surface of the concrete.

11 The chemical composition of the retarder and of the curing compound shall be such that they do not react adversely following the application of the curing compound to the exposed aggregate surface.

12 The Contractor shall use the retarder which he has nominated in Appendix 10/1. This shall be of a type and composition to satisfy the requirements of this Clause.

Application of the Retarder

13 The retarder shall be spread evenly on to the surface of the wet concrete slab as soon as practicable after the surface layer has been levelled and finished, by a spray bar over the full width of the slab in one pass. To achieve this uniformity of spread, the spraying system shall consist of a spray bar, provided with nozzles, mounted on a machine spanning the slab. Temporary works materials and equipment shall be chosen in order to permit inspection to ensure adequate coverage of retarder immediately after spraying and before protection of the surface.

14 Before commencing work, the level of the spray bar, the rate of delivery of the retarder from the nozzles of the spray bar, and the forward speed of the spraying machine shall be adjusted to achieve the required rate of spread. Means shall be provided and steps shall be taken to avoid excess retarder flowing on the surface of the slab.

15 Back-up spraying equipment shall be available on the Site at all times for use in case of a breakdown of the spraying machine.

Protection of the Surface after the Application of the Retarder

16 The finished surface of the pavement concrete after application of retarder shall be protected against precipitation, moisture loss, contamination and dispersal of the retarder by air movements as stated in Appendix 10/1. This protection shall be

applied immediately after the application of the retarder.

17 Where waterproof sheeting is used it shall be laid onto the surface of the concrete immediately after the retarder has been sprayed. It shall be retained in position until immediately prior to exposing of the aggregate.

18 The protection system shall not adversely affect either the finish, the line or the level of the concrete surface or the even distribution of the retarder in any way. Where sheeting is used, any air bubbling or blistering shall be prevented.

Exposing the Aggregate Surface

19 Brushing equipment shall be used to expose the concrete surface aggregate. Where the brushing equipment runs on the slab the concrete shall have gained sufficient strength to avoid any damage to the concrete.

20 Removal of the protection system shall take place as brushing proceeds. If waterproof sheeting is used as a protection system it shall be maintained in position until immediately in advance of the brushing operation.

21 The Contractor shall complete the process of exposing the aggregate before the retarder becomes ineffective. Failure to do so shall entail the remedial measures specified in sub-Clauses 29 and 30 of this Clause.

Brushing System

22 Sufficient brushing capability shall always be maintained on Site to complete the exposure of the aggregate before the retarder becomes ineffective. An adequate back-up brushing facility shall be available on the Site at all times for use in case of a breakdown of the brushing equipment.

23 The brushing equipment nominated by the Contractor in Appendix 10/1 shall be used to produce an even texture on the surface of the slab. Brushing shall be carried out in the longitudinal direction of the concrete slab.

24 The brushing equipment shall be capable of maintaining an adequate brush rotational speed which in conjunction with the forward working speed is sufficient to remove the surface mortar. Adequate dust suppression and collection measures shall be in operation at all times.

25 When complying with the requirements of sub-Clause 19 of this Clause, the wheels of any brushing equipment which may run on the slab shall be fitted with tyres with a shallow tread pattern and a low inflation pressure and be sufficiently wide to avoid damage to the concrete.

Protection of the Surface Layer After Exposure of the Aggregate

26 Within one hour of completing exposure of the aggregate the surface shall be dampened with water. A curing compound shall be applied to the entire exposed aggregate surface of the slab in accordance with Clause 1027. In wet weather the curing compound shall be applied as soon as practicable after the rain stops. The surface may, alternatively, be covered by hessian provided it is maintained in a wet condition at all times during the curing period of the concrete.

Surface Texture Depth and Remedial Measures

27 The texture depth of the surface of the concrete shall be measured by the sand patch method described in BS 598 : Part 105. The average texture depth of each 500m section of carriageway lane, or each carriageway lane where less than 500m, shall comply with the requirements of Appendix 7/1. Any individual result shall be neither greater than the maximum, nor be less than the minimum value of texture depth stated in Appendix 7/1. The Engineer may reduce the section length.

28 During brushing initial interim spot check measurements of the surface texture depth shall be made as soon as it is considered that the required texture depth has been reached. This shall continue until the specified texture depth has been achieved.

29 In the event that it is not possible to achieve the specified minimum texture depth by further exposure, the Contractor shall treat the surface in accordance with Clause 1029 to achieve the specified texture depth. This treatment shall not be applied until the concrete has reached an age of 28 days and shall not affect the requirements of sub-Clauses 702.2 to 702.4 and 702.5 to 702.9.

30 Failure to achieve a satisfactory minimum texture depth by mechanical means shall result in removal of the full thickness of the slab to the extent required to permit reconstruction of the slab in accordance with the Specification. Where the maximum texture depth is exceeded suitable remedial measures shall be employed.

Preliminary Trials

31 If there is no sufficient experience in concrete pavement construction, the Contractor shall carry out preliminary trials to demonstrate to the Overseeing Organisation, not less than one month prior to the commencement of the trial length referred to in sub-Clauses 37 to 39 of this Clause, the materials, mix proportions and methods for achieving the texture depth requirements defined in Appendix 7/1.

32 Preliminary trial panels shall be constructed offline incorporating a top surface of exposed aggregate concrete similar to that specified for the permanent works. These panels shall be 20 m long and not less than 100 mm deep, and the maximum intended paving width. They shall be used to enable the Contractor to determine the required application rate of the retarder and the amount of brushing required to achieve the specified texture depth.

33 The trial panels may alternatively be constructed on-site, but in this case, they may only form part of the permanent Works if they meet all the requirements of the Specification, otherwise they shall be removed after they have served their purpose.

34 The surface texture depth shall be determined by sand patch tests at approximately 2 m spacings along a diagonal line across each trial panel, and shall follow the procedure in BS 598 : Part 105.

35 The average value of each set of 10 individual measurements shall be taken as the resulting texture depth which shall be assessed against the Specification.

36 The materials including all the aggregates, plant and equipment used in the preliminary trials shall be equivalent to that which will be used in the Trial Length.

Trial Length

37 In addition to the requirements of Clause 1028, the texture depth shall be tested for compliance in accordance with sub-Clauses 38 and 39 of this Clause.

38 Texture depth shall be assessed by the sand patch method for each 50 m length of the trial length and for each lane, and shall follow the procedure in BS 598 : Part 105.

39 During the construction of the Trial Length, spot checks shall be made as soon as it is considered that the required texture depth has been reached. Should the texture depth be found to be inadequate, further exposure of the aggregate shall be undertaken until the specified texture depth has been achieved. Where the texture depth is not achieved, and the trial was intended to form part of the running surface of the permanent works, the remedial measures described in sub-Clauses 29 and 30 of this Clause shall apply.

1045 Weather Conditions for Laying of Cementitious Materials

1 Road pavement materials in a frozen condition shall not be incorporated in the Works but may be used, if acceptable, when thawed.

2 Road pavement materials shall not be laid on any surface which is frozen or covered with ice.

3 The temperature of concrete or cement bound material in any pavement layer shall not be less than 5ºC at the point of delivery. These materials shall not be laid when the air temperature falls below 3ºC and laying shall not be resumed until the rising air temperature reach 3ºC unless all surfaces of the concrete slabs are protected by thermal insulation blankets laid immediately after placing and finishing the concrete. The insulation shall be placed before the temperature of the concrete surface has dropped below 2ºC and shall be retained for a minimum of 3 days or until the concrete is assessed to have reached 50% of the specified characteristic compressive strength provided the air temperature is above 0ºC and rising at that time. Thermal insulation blankets shall be closed cell polyethylene foam sheets, minimum 10 mm thick with a 'U' value of 4 watts/mC (or K value of 0.04 watts/m Kelvin) or suitable material with an equivalent or lower thermal conductivity. They shall be sufficiently robust and capable of being held in place against variations in wind and weather conditions for the necessary curing time.

1046 Cold Recycled Cement Bound Material

Scope

1 Recycled cement bound material shall be designed and produced to form the foundation or main structural layer of a road pavement. The primary aggregate source shall be obtained by cold pulverisation of all or part of the existing road structure. The stabilising agent shall be hydraulic cement with Portland cement CEM I as the main component. The aggregate grading may be adjusted by the addition of a filler. Lime may also be used to modify any cohesive subgrade soil incorporated in the pulverised layer.

2 Prior to commencing the pulverisation and stabilisation works, the Contractor shall demonstrate, to the satisfaction of the

Overseeing Organisation, using the results of the mix design procedures described in sub-Clauses 1046.43-1046.49 of this Clause, that the existing pavement materials in the sections of the works defined in Appendix 7/19, are capable of being recycled by pulverisation to form the primary aggregate component of a recycled cement bound material which can meet the specified end-product performance requirements.

Component Materials

Aggregates and Fillers

3 The pulverised road material when mixed with any supplementary aggregate and/or filler shall normally be granular material with not less than 5% and not more than 20% passing the BS 75 micron sieve (Zone A graded material in accordance with Table 10/13). Approval for use of pulverised granular material containing up to 35% passing the BS 75 micron sieve (Zone B graded material in accordance with Table 10/13) shall require confirmation by the Overseeing Organisation, subject to the results of the mixture design procedures described insub-Clauses 43 to 49 of this Clause.

4 The pulverised granular material shall contain not more than 2% of organic matter as determined in accordance with BS 1377 : Part 3 : Clause 3.

TABLE 10/13: Particle Size Distribution of Granular Material for Recycling

Sieve size	Percentage by mass passing	
	Zone A Graded Material	Zone B Graded Material
50 mm	100	-
37.5 mm	94 - 100	-
20 mm	66 - 100	100
10 mm	48 - 75	75 - 100
5 mm	35 - 57	57 - 95
2.36 mm	25 - 42	42 - 77
600 micron	13 - 28	28 - 52
300 micron	10 - 24	24 - 45
75 micron	5 - 20	20 - 35

Aggregate grading should have a coefficient of uniformity (Cu) exceeding 10.

Cement, Filler and Lime

5 The constituents and required quality standards of hydraulic cement, filler and lime shall be certified by the supplier, whose manufacturing and delivery processes may be implemented using quality management systems in accordance with the ISO 9000 : 1994 series of standards and certified by an accredited body.

6 The primary binder shall be Portland cement CEM I or Portland blast furnace slag cement or Portland pfa cement in accordance with sub-Clause 1001.3.

7 PFA shall be in accordance with BS 3892 : Part 1.

8 Lime for lime stabilisation (or as a modifier for plastic fines) shall be either quicklime or hydrated lime, as stated in Appendix 7/19 , complying with sub-Clause 615.33.

Water

9 Water for moisture content control of the pulverised granular material shall normally be obtained from a water company supply and used without testing. Water from an alternative source shall comply with BS 3148 and be approved by the Overseeing Organisation.

Pulverisation and Stabilisation

10 The Contractor shall satisfy the Overseeing Organisation that the plant used for pulverisation is capable of uniformly pulverising the existing road in a single pass, to a depth specified in Appendix 7/19. The

plant used for stabilisation shall be capable of uniformly mixing controlled amounts of water and cementing agent(s) into the full depth of the pulverized layer. For either operation, the plant shall be equipped with a means of controlling the depth of processing to ±15 mm of the required depth.

11 The plant used for stabilisation shall be equipped with a spraybar system within the mixing chamber capable of uniformly distributing water at a monitored and controlled rate. Evidence confirming the capabilities of the plant and calibration of flow meters, shall be submitted to the Overseeing Organisation prior to the stabilisation works commencing.

12 The material shall be pulverised and stabilised in a single layer if the compacted thickness is 300 mm or less. If the compacted thickness is greater than 300 mm, the material shall be pulverised and stabilised in a minimum number of layers between 150 mm and 300 mm thick. Where more than one layer is required, the Contractor shall satisfy the Overseeing Organisation that the lower layer has achieved adequate stability in accordance with sub-Clause 27 of this Clause before proceeding with the overlying layer.

Pulverisation Process

13 Pulverisation of the existing road structure shall be carried out in a systematic pattern, to the required depth, to ensure that all parts of the existing road designated in Appendix 7/19 are included in the works. An overlap of at least 150mm shall be made between adjacent passes of the machine. Any material missed along hard edges or around obstructions shall be excavated and placed in the path of subsequent passes of the machine until a uniform fully pulverized aggregate is obtained. The pulverised material shall not be contaminated with material drawn in from the verge.

14 All longitudinal and transverse joints shall be clean cut and vertical. Where work continues adjacent to previously recycled material, transverse joints shall be reformed a minimum 0.5 m into the previously treated construction. Where a layer of material for stabilization is placed over a layer previously stabilised, the depth of pulverization / stabilisation of this layer shall be set to cut into the underlying stabilised layer by at least 20 mm.

15 Excess pulverised material shall be removed by the grader and/or excavator for use elsewhere on the site or transported to stockpile at locations given in Appendix 7/19. The surface of the layer shall be graded nominally to the required profile and provisionally compacted.

16 Moisture content of the pulverised aggregate immediately prior to stabilisation shall be measured in accordance with BS 812 : Part 109 using the high temperature method. The moisture content shall be uniform throughout the layer within the range 0% to +4% of the optimum moisture content for the unstabilised aggregate, including any designed proportion of filler, determined in accordance with Clause 2.1 of BS 1924 : Part 2 : 1990, using vibratory compaction.

17 If the moisture content of the unstabilised pulverised aggregate fails to meet the specified moisture content range, corrective action shall be taken either by aeration to reduce the moisture content or by controlled addition of water to increase the moisture content.

18 Aeration of the affected area shall be achieved by full depth passes of the

recycling machine to disturb and loosen the material and assist the evaporation of excess moisture. The material shall be kept in a loose condition until subsequent moisture content tests show that the treated material has reached the required moisture content range. The layer shall be re-graded nominally to the required profile and provisionally compacted in preparation for stabilisation.

19 An increase in the moisture content of the affected area shall be achieved by the controlled addition of water through an adjustable spray bar system in conjunction with full depth passes of the recycling machine to achieve a uniform distribution of the water throughout the layer. Water shall be added in increments and mixed in until subsequent moisture content tests show that the material has reached the required moisture content range. The layer shall be regarded nominally to the required profile and provisionally compacted in preparation for stabilisation.

Stabilisation Process

20 Stabilisation shall not be carried out during or after periods of rainfall where the duration and intensity are likely to cause the stabilised mixture to exceed the specified moisture content criteria and compromise the stability of the layer under compaction as described in Sub-Clause 27 of this Clause.

21 Prior to stabilisation, pulverised materials within 100 mm of restricted hard edges such as kerbs and channels, or around obstructions such as gullies, shall be removed and spread uniformly over the remaining full width of the pulverised material.

22 Cement binder, filler, hydrated lime or quicklime shall be spread full-width on the surface of the layer using a mechanical spreader capable of distributing the material(s) in a uniform manner. The rate of spread of these materials shall be calculated to achieve mixture composition determined in accordance with sub- Clauses 43 to 49 of this Clause and monitored as the spreading operation proceeds in accordance with sub-Clause 31 of this Clause.

23 The stabilisation shall be carried out to the required depth in a systematic pattern similar to that used for the pulverisation process, with an overlap of at least 150 mm between adjacent passes of the machine. Where necessary, additional water shall be introduced and distributed through the spray bar system, directly into the rotor and mixing box of the stabiliser.

24 The layer of stabilised material shall be graded to level and compacted within two hours of the final pass of the stabilising plant, unless a curing or “maturing” period of aeration is required. Any furrow formed by prior excavation of edge materials shall be re-filled by grading the adjacent stabilised material into the space using a minimum amount of re-working.

25 The compaction of each layer shall be carried out until such time as the density complies with the minimum compaction field requirements in Table 10/9 and the stabilised layer provides a stable and dense surface. Any open or segregated surface area shall be re-mixed by machine during stabilisation.

26 Where specified in the Appendix 7/19 a system for inducing transverse cracks shall be installed into the fresh stabilised material in accordance with sub-Clauses 50 to 60 of this Clause. The installation shall be carried out after grading to level and application of

initial compaction, then completed by final compaction.

27 The stability of the layer under compaction shall be deemed adequate if the finished surface does not move, rut or exhibit transverse cracking under the load of subsequent construction traffic.

28 Where required by the Overseeing Organisation, the stability of a layer in any area shall be assessed after a curing period of at least 24 hours by channeled trafficking using a rigid three-axle tipper truck loaded to a gross mass of 24 tonnes (assumed equivalent to three standard axles). The vertical deformation shall be measured in all wheeltracks at monitoring points on each of 5 transverse sections set 1m apart after 5, 15, 30 and 40 passes of the truck. The mean vertical deformations at the above trafficking increments shall be plotted against the respective number of truck passes and the mean vertical deformation corresponding to 100 standard axles shall be interpolated. The layer shall be deemed acceptable if the mean vertical deformation corresponding to 100 standard axles is less than 10 mm.

29 On completion of compaction the surface shall be sealed using a sprayed membrane of Class K1-40 bitumen emulsion complying with Clause 920. The bitumen emulsion shall be sprayed at the rate stated in Appendix 7/19. Where the surface is opened to traffic, the sealing membrane shall be blinded with fine aggregate or sand applied at a rate of 5.5 to 7.0 kg/m2.

Process Control

30 The sampling and testing of the recycled cement stabilised roadbase shall be carried out as required for cement bound materials (CBM) in accordance with Clauses 1040 and 1041.

31 The rate of spread of cement, filler, hydrated lime or quicklime shall be measured by weighing the amount of material retained on each of five trays or mats of known area laid in the path of the spreading machine. The trays shall be positioned approximately at points equally spaced along a diagonal bisecting the area of coverage. The mean rate of spread and percentage addition of the material shall be determined and recorded for each assessment area.

32 As directed by the Overseeing Organisation, where lime has been used to modify a cohesive soil component of the pulverised aggregate, the acceptability of the modified materials shall be tested in accordance with sub-Clause 615.13.

End Product Performance of Recycled Cement Bound Material

33 The end-product performance of the recycled cement bound material shall be assessed on the basis of measurements and tests carried out in areas of 800 m2 or part thereof completed each working day, which shall match the areas defined in sub-Clause 1040.1.

34 Within 24 hours of completion, the as-installed performance of the stabilised layer shall be evaluated using a plate-bearing test equipment dynamic plate loading or penetrometer technique to determine values of elastic modulus at points on a nominal grid pattern, as described in Appendix 7/19. The elastic modulus at each point and the mean elastic modulus for the assessment area shall comply with the minimum standards stated in Appendix 7/19.

Additionally, before proceeding with construction of the overlying pavement, the evaluation process shall be repeated to demonstrate that the elastic modulus value at all points and that of the mean value have increased over the respective as-installed values by not less than the percentage values stated in Appendix 7/19. Where these criteria are not met, the full extent of the non-compliant material shall be determined and appropriate remedial measures implemented. Remedial action shall comprise either a delay in construction to allow further curing and stiffening of the layer to occur or a repeat of all or part of the recycling process, followed by re-evaluation, until a compliant material is achieved.

35 Within 270 days of completion of the surfacing works, a Benkelman Beam Deflection survey shall be carried out and analysed in general accordance with HD 29/94 (DMRB 7.3.2, 1994). In particular, the measurements shall be taken on the finished road surface in the nearside wheelpath, at a uniform and maximum spacing of 10 m. The survey shall be carried out during a period when the pavement temperature at a depth of 50 mm is within the range 15°C to 25ºC. Compliance shall be achieved when the rolling mean of 10 results is not less than the figure specified in Appendix 7/19 and no individual result is less than 85% of the figure specified.

36 In the event that the requirements of sub-Clause 35 of this Clause are not met, the full extent of the non-compliant material shall be determined by further investigation involving coring and laboratory testing. For each area of noncompliance, cores shall be extracted through the full depth of the stabilised layer at locations directed by the Overseeing Organisation, at a minimum rate of one x 150 mm diameter core per 75 m2.

37 The Contractor shall be responsible for extraction of the cores with the minimum of force or disruption. Air flush coring shall be allowed for materials that are disturbed by water flush coring. After extraction, each core shall be labelled and photographed and, prior to testing, shall be stored in sealed polythene bags, in a uniformly supported position, at a temperature of 20ºC ± 5ºC. The thickness of the recycled layer shall be measured and recorded.

38 Reinstatement of all core holes shall be completed before opening the area to traffic. All backfill materials shall comply with Clause 903.

39 If, at any of the prescribed core locations, it is not possible to extract an intact core of suitable size or condition for the end-product performance testing, using a maximum of three attempts in an area of 1.5 m radius, the material in the vicinity shall be deemed not to comply with the end-product performance specification.

40 In the laboratory, each core extracted successfully shall be trimmed to remove surfacing materials and any underlying material prior to the measurement of core density in accordance with the standards listed in Table 10/14.

41 Following the measurement of density each core shall be prepared and tested to determine the compressive strength of the core, in accordance with the procedures and standards given in Table 10/15.

42 The results obtained shall be used to judge the expected performance of the recycled stabilized material in the works in relation to the performance of standard CBM roadbase materials. The recycled stabilised material in the assessment area shall be

deemed acceptable if the compliance criteria described in Table 10/6 are met.

TABLE 10/14: Procedures and Standards to be Used to Determine the Density of Core Samples of Recycled Cement Bound Material

Procedure	Procedure Stage	Standard to be Used
Core preparation for density testing	Measurement of core dimensions and accuracy of measurement Methods of trimming core to length	MSA EN12504-1
	Test specimen type, shape and moisture condition	MSA EN12390-7
Core testing for density	Apparatus specification Measurement of volume dimensions Volume by water displacement Measurement of mass Equations for density Accuracy and units of density	MSA EN 12390-7
	Core density as a proportion of theoretical density	Clause 1003

TABLE 10/15: Procedures and Standards to be Used to Determine the Compressive Strength of Core Samples of Recycled Cement Bound Material

Procedure	Procedure Stage	Standard to be Used
Core preparation for density Testing	Measurement of core dimensions and accuracy of measurement Maximum and minimum dimensions for strength testing	MSA 12504-1
	Methods of capping core	MSA 12390-2 or MSA 12390-4 as appropriate
	Suitability of core for strength testing Storage of cores before capping	BS 1881 : Part 120
Core testing for strength	Type of strength test Minimum period of testing after end-preparation Method of curing core prior to testing Measurement of core test specimen dimensions and accuracy Equation for calculating core strength	MSA 12504
	Testing machine specifications Rate of loading	MSA 12390-2 or MSA 12390-4 as appropriate
	Correction for length/diameter ratio and orientation of coring Equations for deriving equivalent cube strength	BS 1881 : Part 120
	Correction for excess voidage	BS 1881 : Part 120

TABLE 10/16: Compliance Criteria for Recycled Cement Bound Material Based on Results of Tests on Cores Extracted from the Works

Property	Individual cores	Mean from cores in each surveyed area
Core density relative to refusal density	93%	95% minimum
Layer thickness [from core measurement]	+ 25 mm	+ 15 mm of specified
Equivalent cube compressive strength	*CBM equivalence	*CBM equivalence

* Compliance criteria is quoted in relation to the design 7 day cube compressive strength appropriate to the equivalent CBM classification of the recycled material.

Mixture Design and Characterisation

43 Mixture design characterisation of recycled cement bound material for each site, or section of site, including details of the cementing agent and/or stabilising

agent(s) and their quantities, shall be submitted to the Overseeing Organisation at least one week prior to commencement of the recycling works. Where the site investigation has identified significant variation of existing pavement materials between different sections of the site, a mix design shall be submitted for each section of the site. The proposed plan area and depth of the different sections, covered by each mixture design, shall be approved by the Overseeing Organisation.

44 The mixture design for recycled cement bound material shall use the same method of mixture design as that used for plant mixed CBM specified in Clauses 1035 to 1039, except that the aggregate shall be crushed and processed in the laboratory, using a method approved by the Overseeing Organisation, to replicate as closely as possible the aggregate expected from pulverisation in the works. The permitted CBM alternatives and equivalent recycled mixture designs for each part of the Works shall be as described in Appendix 7/19.

45 The laboratory crushed and processed aggregate with a particle (or "lump") sized distribution complying with sub-Clause 3 of this Clause shall be thoroughly mixed with measured proportions of the cement to produce trial mixtures with different cement contents. The type and grade of the cement used in the trial mixtures shall be the same as that used in the finished works.

46 If lime is required for stabilisation and/or modification of clay included from pulverisation of the upper subgrade layer, the same proportion of lime shall be added into the trial mixture.

47 The cement content of the recycled cement bound mixture shall be determined in the same manner as the cement content for plant mixed CBM, to achieve the requirements in Table 10/9. The minimum cement content shall be 3% by weight.

48 The mixture design process shall be repeated until an acceptable mixture design is achieved. To achieve this the target composition of the mixture shall be systematically adjusted and the mixture design tests repeated.

49 In addition to the requirements of Table 10/9 the average compressive strength determined after 7 days immersion in water of five test specimens of the target composition mixture, prepared in accordance with sub- Clause 3 of this Clause, shall be not less than 80% of the average compressive strength of five control specimens when subjected to the test procedure described in BS 1924 : Part 2 : Clause 4.3. After 7 days immersion, the specimens shall not show any signs of cracking or swelling.

Induced Cracks

50 Recycled cement bound material shall have cracks induced during construction as described in Clause 1047 and in Appendix 7/20.

1047 Induced Cracking of Cement and Hydraulically Bound Material General

1 For those sections of the Works defined in Appendix 7/20, the material shall have transverse and longitudinal cracks induced using approved plant and equipment to comply with this Clause prior to laying the surfacing layers.

Scope

2 This Clause describes the methods for inducing cracks in new and recycled materials. Furthermore, this Clause deals with the induced cracking of cement bound material or hydraulically bound material.

Induced Cracking

3 Transverse cracks, at the pre-set spacing and tolerances described in Appendix 7/20, shall be induced by suitable plant and materials. Cracks may be induced either: in fresh material prior to compaction as described in sub-Clause 5 of this Clause; or, for cement bound materials, after 3 to 6 days using suitable plant as described in sub-Clause 6 of this Clause.

4 The spacing of the cracks shall be at the pre-set spacing and tolerances unless any underlying pavement construction comprises cracked cement bound material. In this event, the location of cracks in the existing pavement shall be recorded and the location of the induced cracks in the overlying material adjusted to ensure that these induced cracks align with cracks in the underlying construction.

Notches to achieve a regularity induced cracking are cut as follows for cement bound material:

i) Transverse notches: at a distance of 5m except 2.5m if the total thickness of asphalt layers above is below 14cm.

ii) Longitudinal notches: necessary if the laying width is above 8m. The depth of the transverse and longitudinal notches is at least 35% of the laying thickness of the CBM.

5 Where cracks are induced in fresh material, the transverse cracks shall be induced by grooving the fresh material to a depth which leaves a vertical groove not more than 20 mm wide, between one half and two thirds the layer thickness after compaction, over the full width of the pavement. A crack inducing material shall be inserted into the groove prior to compaction, extending from the bottom of the groove to not less than half the height of the groove. During final compaction of the material, the groove shall be closed at the surface and the crack inducing material shall be fully encased and remain continuous within the closed groove.

6 For the cement bound material or hydraulically bound material, cracks shall be induced after 3 to 6 days. The cracks shall be induced by a cutting device or suitable plant capable of delivering variable preset impact loads to the material surface. In this case cracks shall be induced by one strike of the impacting head of such plant and without producing excess surface indentation or excess surface shatter. The plant and impact head shall be of sufficient mass and geared to prevent head bounce and any associated surface damage arising there from. The impact load shall be adjustable to achieve the cracking specified and the minimum load consistent with no surface shatter.

7 Where cracks cannot be induced over the full width of the pavement with one pass of the crack inducing plant, further parallel passes shall be made as necessary so that all subsequent cracks are aligned with those from the preceding pass.

8 The Contractor shall be responsible for varying the equipment and method of working so that crack inducement occurs and areas of material are rendered suitable for overlaying. The plant used to induce cracks in a fresh material shall be such as not to cause rutting of the provisionally

compacted layer that cannot be rectified by the subsequent compaction process. When cracking is to be induced after compaction of the roadbase, the plant shall be self-propelled with wheels having pneumatic tyres. Pneumatic tyres are also preferred for a cutting device.

Trial Length if necessary

9 The Contractor shall demonstrate that the plant, equipment and methods that are proposed for inducing cracks in the material are capable of producing the required type and pattern of cracks by first executing a trial over a minimum length of 100 m of new pavement. The location of the trial shall be agreed with the Overseeing Organisation. A trial length shall be carried out for each separate material design mix.

Assessment of Trial Length

10 Compliance with the crack inducing requirements when induced in accordance with sub-Clause 5 of this Clause shall be assessed as follows:

(i) The correct depth of cracking shall be determined by either:

(a) Coring through the full depth of the layer positioned symmetrically about an induced crack. A set of 10 No 150 mm diameter cores shall be taken within the trial area at locations selected by the Overseeing Organisation. The trial area shall be deemed acceptable if 8 of the set of 10 cores exhibit crack inducing material that is continuously visible over the depth given in sub-Clause 5 of this Clause.

or

(b) Removal of material to the full depth of the layer. Material shall be removed at 10 induced crack locations to allow visual inspection of the full depth of the layer and crack inducing material. The induced crack shall be inspected at least 300 mm from the edge of the pavement. The trial area shall be deemed acceptable if 8 of the set of 10 excavations exhibit crack inducing material that is continuously visible over the depth given in sub-Clause 5 of this Clause.

(ii) Holes from which samples have been extracted shall be backfilled with fresh material compacted in layers not exceeding 50 mm.

11 Compliance with the crack inducing requirements when induced in accordance with sub-Clause 6 of this Clause shall be assessed as follows:

(i) The amount of surface shatter shall be such that there is no requirement for surface sweeping.

(ii) The maximum amount of surface indention shall be half the maximum aggregate size if a suitable plant is used instead of a cutting device.

(iii) Coring through the full depth of the layer positioned symmetrically about an induced crack. A set of 10 No 150 mm diameter cores shall be taken within the trial area at locations selected by the Overseeing Organisation. The trial area shall be deemed acceptable if all of the set of 10 cores exhibit no shattering at the base of the core and for the required cut depth is achieved.

(iv) Holes from which samples have been extracted shall be backfilled with fresh material compacted in layers not exceeding 50 mm.

Approval to Proceed with Main Works

12 Approval of the cutting device or the plant, equipment and methods shall be given following a successful demonstration in the trial length that the induced cracking complies with the requirements of this Clause. The Contractor shall not proceed with the main works until the plant, equipment and methods used in the trial length have been approved by the Overseeing Organisation.

13 When approval has been given, the plant, equipment, methods and material shall not be changed, except for normal adjustment and maintenance of plant, without the prior approval of the Overseeing Organisation. Should it be necessary for the Contractor to change the plant, equipment, methods or the material the Overseeing Organisation may require the Contractor to carry out a further trial length.

Monitoring of Main Works

14 Monitoring of the induced cracking of the main works when induced in accordance with sub-Clause 5 of this Clause shall be as follows:

(i) Monitoring of the induced cracking of the main works shall be carried out by the Contractor, by extracting 150 mm diameter full-depth cores at a rate of not less than one core for every 300 m2 of material containing the crack inducing system. The core locations shall be selected by the Overseeing Organisation, with each core positioned symmetrically over the line of the inserted crack inducing material. Not more than one core shall be extracted per transverse crack. The induced cracking system shall be deemed acceptable if at least four cores in any adjacent set of five cores reveal a crack inducing material extending to at least a quarter of the depth of the layer. The Contractor and Overseeing Organisation shall inspect the cores. The Overseeing Organisation shall determine the acceptability of each core in accordance with this sub-Clause.

(ii) Holes from which samples have been extracted shall be backfilled with fresh material compacted in layers not exceeding 50 mm.

15 Monitoring of the induced cracking of the main works when induced in accordance with sub-Clause 6 of this Clause shall be as follows:

(i) Monitoring of the induced cracking of the main works shall be carried out by the Contractor and shall be such that there is no requirement for surface sweeping.

(ii) The maximum amount of surface indention shall be checked to ensure that it is not greater than half the maximum aggregate size. If a cutting device is used the depth of the notches shall be determined.

1048 Use of Surfaces by Traffic and Construction Plant

1 Construction plant and traffic used on pavements under construction shall be suitable in relation to the material, condition and thickness of the courses it traverses so

that damage is not caused to the subgrade or the pavement courses already constructed. The wheels or tracks of plant moving over the various pavement courses shall be kept free from deleterious materials.

2 Concrete slabs may be used by traffic when the characteristic compressive strength is assessed to have reached 25 N/mm² for pavement surface slabs, or 20 N/mm² for base courses with asphalt surfacing. The method of assessing the time when this strength is reached shall be as described in Clause 1004.

3 In the absence of test data establishing compliance with sub-Clause 2 of this Clause, no vehicle with an axle loading greater than 2 tonnes shall run on concrete slabs within a period of 14 days after placing the concrete. Vehicles with rubber tyres with an axle loading less than 2 tonnes, or wheels or tracks of concreting plant, shall not use any part of a newly constructed pavement within 7 days. The above periods before traffic may run on the pavement shall be increased if the 7-day cube strength is below that required in the Specification. These periods shall be extended by one day for each night on which the temperature of the layer falls to 0ºC or below.

4 Cement Bound Material has to be kept moist for at least 3 days or to be protected against drying by other measures (Clause 1035, sub-clause 16). Further layers may be applied earlier if during layer no deformation of the sub-base arrive and if curing is not endangered by water-content reduction(e.g. application of tack coat before laying of an asphalt base course) Opening to traffic of the cement stabilization or the pavement including the cement stabilization or the pavement including the cement stabilization is only allowed if 70% of the compressive strength is achieved. Otherwise no vehicle shall run on cement bund material within 7 days of construction. This period shall be extended by one day for each night on which the temperature of the layer falls to 0°C or below.

KERBS, FOOTWAYS AND PAVED AREAS

Contents

KERBS, FOOTWAYS AND PAVED AREAS

1101 Precast Concrete Kerbs, Channels, Edgings and Quadrants

1 Except where otherwise specified in this Clause, precast concrete kerbs, channels, edgings and quadrants shall comply with BS 7263 : Part 1 with the exception that requirements to the water absorption may be omitted. Their dimensions and type designations shall be as described in Appendix 11/1. They shall be laid and bedded in accordance with BS 7263 : Part 2 on a mortar bed on a concrete pavement slab, a base course or a Grade C7.5 or ST1 mix concrete foundation. The mortar bed may be omitted if units are bedded onto a concrete slab or foundation that is still plastic. All precast units laid on a mortar bed or bedded onto plastic concrete shall be backed with a Grade C7.5 or ST1 mix concrete.

2 Precast concrete kerbs, which are to be bonded to the pavement surface, shall comply with BS 7263 : Part 1 except for the dimensional and transverse strength requirements and Type designation. The bonding materials and methods of bonding shall be to the manufacturer's recommendations for this specific application. Bonded kerbs shall not be less than 100 mm in width at the base, their height shall not exceed their width and they shall be bonded over their full width. Kerbs shall be precast to the dimensions described in Appendix 11/1. The clear distance between unsupported pavement edge and back of kerb shall be not less than 100 mm. The transverse strength of units shall be established by testing in accordance with BS 7263 : Part 1 except that the maximum stress in bending shall be calculated from the failing load and shall not be less than 4.0 N/mm2. Units shall be installed in accordance with the manufacturer's instructions. They shall be bonded to the pavement surface with a resilient adhesive compatible with the pavement materials and be capable of withstanding a static push-off load of 10 kN/m applied parallel to the pavement surface at right angles to the kerb.

3 Joints shall be provided in kerbs, channels, edgings and backing, which are laid on or adjacent to a concrete pavement to coincide with the pavement transverse contraction, warping and expansion joints. The joints shall be the same width as the joint sealing grooves of the pavement and shall be caulked and sealed as described in Clauses 1016 and 1017. Concrete foundations to kerbs, channels and edgings laid adjacent to a concrete pavement shall be provided with joint filler board complying with Clause 1015 placed vertically through the full extent of the concrete foundation at positions coinciding with the pavement joints. At expansion joints in bridge decks, the kerb joints shall be as described in Appendix 11/1. Where the details of bridge expansion joints are proposed by the Contractor, such details shall include the intended treatment at kerbs and footways.

4 For curves of radius 12 m or less, kerbs of appropriate radius shall be used.

5 The surface level of units of kerb, channel, edging and quadrant shall not deviate from the design level ± 6 mm, nor shall the longitudinal surface regularity deviate more than 4 mm in 4 m when checked with a 4 m straight edge. Horizontal alignment shall comply with Clause 702.

1102 In Situ Asphalt Kerbs

1 The materials for, and making and placing of in situ asphalt kerbs shall comply with the recommendations of BS 5931. In addition, a tack coat shall be used and they shall be laid by a machine capable of producing a dense, smooth-surfaced kerb to true line and level.

2 Kerbs shall be constructed to the dimensions described in Appendix 11/1.

3 Vertical expansion and contraction joints shall be formed in kerbs laid on unreinforced concrete slabs and jointed reinforced concrete slabs to coincide with the pavement transverse expansion

and contraction joints. All joints shall be sealed in compliance with Clauses 1016 and 1017.

1103 Freestanding In Situ Concrete Kerbs, Channels and Edge Details

1 Freestanding in situ concrete kerbs, channels and edge details shall comply with the recommendations of BS 5931 except where otherwise specified in this Clause. They shall be laid by a machine capable of forming dense kerbs or surface water channels or edge details with regular sides, arises and chamfers, finished to a fine surface free from blow holes and dragging and constructed to the dimensions described in Appendix 11/1.

For kerbs, channels and edge details:

(i) Constructed before the adjacent road pavement surface, the surface level adjacent to the future road surface shall not deviate from the design level by more than ±5 mm.

(ii) Constructed after the adjacent road pavement surface, the surface level shall not deviate from the finished level of the adjacent pavement surface by more than +10 to +5 mm.

The longitudinal surface regularity shall not deviate by more than 6 mm in 4 m when measured with a 4 m straight edge.

2 The concrete shall be a designed mix, Grade C35 to BS 5328, air-entrained in accordance with BS 5931. Coarse aggregate used in kerbs and channels shall be partially crushed or crushed materials.

3 The concrete shall be cured by one of the methods specified in Clause 1027 unless otherwise described in Appendix 11/1.

4 Kerbs, channels and edge details shall be firmly secured to the surface on which they are laid. Vertical expansion and contraction joints shall be formed in kerbs, channels and edge details laid on, integral with or adjacent to unreinforced concrete slabs and jointed reinforced concrete slabs to coincide with the pavement transverse expansion, warping and contraction joints. Joints may be omitted from channels cast integral with a CRCP concrete pavement. Vertical expansion joints at 40 m spacing and intermediate contraction joints at 5 m spacing shall be formed in kerbs, channels and edge details laid on or adjacent to other types of concrete and flexible pavement. Contraction joints may replace expansion joints during the summer period from 21 April until 21 October. All joints in kerbs, channels and edge details shall be sealed in compliance with Clauses 1016 and 1017.

1104 Footways and Paved Areas (Precast Concrete Flags and Natural Stone Slabs)

1 Precast concrete flags shall be hydraulically pressed, complying with BS 7263 : Part 1, and their type designations and thicknesses shall be as described in Appendix 11/1.

2 Precast concrete flags and natural stone slabs shall be laid in accordance with BS 7533 : Part 4, to the required cross falls with a bond as described in Appendix 11/1 and with joints at right angles to the kerb. Flags and natural stone slabs shall be bedded on a layer of mortar not less than 10 mm and not more than 40 mm thick. Where permitted in Appendix 11/1, flags and natural stone slabs 450 mm x 450 mm and smaller may be bedded on a layer of clean sharp sand complying with BS 882 Grading C or M, 30 mm thick.

3 On circular work where the radius is 12 m or less all flags and natural stone slabs shall be radially cut on both edges to the required line.

4 The laying course shall be laid on sub-base composed of one of the materials complying with Clause 803, 804, or 806, laid and compacted to Clause 801. Cement stabilization will be exceptional. Required thicknesses are to be found in chart 5 of the “Directives for the standardization of Pavements for Traffic Areas”.

1105 Footways and Paved Areas (Flexible Surfacing)

1 Flexible surfacing for footways and paved areas shall be made and laid in compliance with Clause 905, 906, 940 or other material described in Appendix 11/1.

2 Surfacing shall be laid to true levels and crossfalls, and be of the thickness described in Appendix 11/1.

3 Surfacing shall be laid on sub-base composed of one of the materials complying with Clause 803, 804, or 806, laid and compacted to Clause 801. Cement stabilization will be exceptional. Required thicknesses are to be found in chart 5 of the "Directives for the Standardization of Pavements for Traffic Areas".

1106 Footways and Paved Areas (In Situ Concrete)

1 In situ concrete for footways and paved areas shall be made, laid and cured as described in Appendix 11/1. The grade of concrete and surface finish shall be as described in Appendix 11/1.

2 In situ concrete shall be laid to true levels and crossfalls, and be of the thickness described in Appendix 11/1.

3 In situ concrete shall be laid on a sub-base composed of one of the materials complying with Clause 803, 804, or 806, laid and compacted in compliance with Clause 801. Cement stabilization will be exceptional. Required thicknesses are to be found in chart 5 of the "Directives for the Standardization of Pavements for Traffic Areas".

1107 Footways and Paved Areas (Concrete Block Paving)

1 Precast concrete paving blocks shall be chamfered and shall comply with BS 6717 : Part 1 and conform to the shapes, dimensions and colours described in Appendix 11/1.

2 Precast paving blocks shall be laid in accordance with BS 7533 : Part 3, except that the sub base shall be one of the materials permitted in sub- Clause 1104.4.

3 The layout of blocks and details at edges, chamber covers, gullies and other openings shall be as described in Appendix 11/1.

1108 Not Used

1109 Not Used

1110 Not Used

Series 1200

TRAFFIC SIGNS

Contents

TRAFFIC SIGNS

1201 Regulations, Sign Classification and Standards Regulations

1 Subject to paragraphs 2 and 3 below, all traffic signs used (including retro-reflecting road studs and road markings), whether permanent or temporary, shall be of the size, shape, colour and type prescribed for that use in The Traffic Signs Regulations and
General Directions 1994 (Statutory Instrument 1994 No. 1519), including Working Drawings for Traffic Sign Design and Manufacture (Volumes 1, 2 and 3), the Zebra, Pelican and Puffin Pedestrian Crossings Regulations and General Directions 1997 (Statutory Instrument 1997 No. 2400) and subsequent amending Regulations. Other relevant requirements are contained in the above Regulations and General Directions.

2 Signs that are not prescribed in Regulations need to be specially authorised by the ADT. Where the Contractor proposes to use non-prescribed temporary traffic signs, he shall obtain the agreement of the Overseeing Organisation to their intended design and location. Where the Contractor proposes to use prescribed temporary traffic signs, he shall obtain the agreement of the police and the highway authority to their intended location. The Contractor shall obtain authorisation and approval from the Overseeing Organisation for the use of the signs at the specific locations proposed.

3 Signs that are changeable by means other than the purely mechanical require statutory type approval for their construction and operating mechanisms by the ADT. This requirement is in addition to the need for the design of the sign to be prescribed or specially authorised. The Contractor's proposal for signs that require statutory type approval shall include the reference numbers of any approval already issued in respect of that equipment. The signs shall not be installed until appropriate approval or confirmation of existing approval, by the Overseeing Organisation has been obtained.

Sign Classification

4 For the purposes of the Contract the following classifications apply:

(i) permanent traffic signs. Any of the traffic signs prescribed in the Regulations, or specially authorised by the ADT, or any part thereof, designed to remain in position at the completion of the Permanent Works or a traffic cone, cylinder or other traffic delineator to be retained by the Employer;

(ii) prescribed temporary traffic signs. Any of the traffic signs defined in the Regulations, or specially authorised by the ADT, or any part thereof, described in Appendix 12/1 which, unless otherwise described in Appendix 12/1, comply with the requirements of a permanent traffic sign but which will not remain in position at the completion of the Permanent Works;

(iii) temporary traffic signs. Any of the traffic signs defined in the Regulations, or specially authorised by the ADT, or any part thereof, designed by the Contractor, in compliance with Clause 1216 which will not remain in position at the completion of the Permanent Works.

1202 General Requirements for Permanent Traffic Signs

1 Materials for permanent traffic signs and their construction, assembly, location and erection shall comply with this Series, Series 1400 and the requirements described in Appendix 12/1. The manufacture and installation of traffic signs shall be in accordance with the quality management scheme described in Appendix A.

2 Each complete traffic sign or part thereof shall be capable of passing the tests in BS 873 : Part 1.

3 Sign panels of internally illuminated signs and luminaire face panels shall, unless otherwise described in Appendix 12/1, comply with impact Category 1 of BS 873 : Part 5.

4 All lit traffic signs shall comply with Category 1 luminance of BS 873 : Part 5 unless otherwise described in Appendix 12/1.

5 Before the commencement of fabrication of any traffic sign, unless otherwise stated in Appendix 12/1, the Contractor shall submit for the Overseeing

Organisation's approval:

(i) fabrication drawings for 'directional informatory' and 'informatory' signs as required in Appendix 1/4;

(ii) the information about 'warning', 'regulatory' and other traffic signs required in Appendix 12/1.

6 All traffic sign housings shall be provided with vandal and weather resistant locks. Keys, in the quantities stated in Appendix 12/1, shall be provided to the Overseeing Organisation. Types of lock shall be kept to a minimum.

7 The backs of traffic signs shall have a location identifying mark as described in Appendix 12/1.

8 Traffic signs shall be carefully handled to prevent damage, transported and stored in accordance with the sign face manufacturer's instructions.

1203 Foundations for Permanent Traffic Signs and Signals

1 The type and size of foundations for permanent traffic signs and signals shall be as described in, and unless otherwise stated therein shall comply with, this Clause.

2 All excavations for foundations shall be carried out in compliance with Clause 604 and shall be cleared of all loose material before placing of concrete and backfilling.

3 Unless otherwise described in Appendix 12/1 traffic signs and signals supported by a single post placed in the ground shall have the post installed centrally in 300 mm diameter or square holes filled in compliance with Clause 2602 with mix ST2 concrete to within 150 mm of the ground surface.

4 Unless otherwise described in Appendix 12/1, posts shall be supported for a minimum of 3 days after placing the concrete and backfilling shall not take place
until at least 48 hours after placing.

5 For traffic signals and illuminated signs provision shall be made for cable entry through the foundation by means of ducting as described in Appendix 12/1.

6 Where pockets are formed in concrete foundations their plan dimensions shall be sufficiently larger than those of the post to

allow for positioning and bedding of the post and backfilling of the pocket.

7 All backfilling of foundations shall comply with Clause 611 except that where pipes or buried cables are installed it shall comply with Clauses 505 and 1421 respectively.

8 Reinstatement of existing surfaces above foundations shall comply with Clause 706.

1204 Posts for Permanent Traffic Signs

1 Posts for permanent traffic signs shall be as described in Appendix 12/1 and shall comply with BS 873 : Part 7, the surface protection requirements of BS 873 : Part 6 and with the following:

(i) steel posts shall be tubular or rectangular hollow section complying with BS EN 10 210, joists, universal beams or columns complying with BS 4, and shall be manufactured from steel complying with grade S275 JO or S275 J2;

(ii) aluminium posts shall be of tubular or rectangular hollow section;

(iii) concrete for reinforced or prestressed concrete posts shall comply with Series 1700 and Appendix 12/1.

2 Posts shall not protrude above the top of the sign unless supporting an external luminaire, in which case the protrusion shall be kept to a minimum.

3 Internally illuminated posts for pedestrian crossing beacons shall comply with this Clause and where appropriate with BS 873 : Part 7.

4 Signs erected on a single post shall be positioned so that the post is in the centre of the sign, unless otherwise described in Appendix 12/1.

5 Compartments for electrical equipment shall be as described in Appendix 12/1 and, wherever practicable, access doors shall be on the side of the compartment furthest from approaching traffic. In the case of signs supported by more than one post, such compartment shall be on the post furthest from the carriageway unless otherwise described in Appendix 12/1.

6 Flange plates shall have holes or slots as described in Appendix 12/1 to accommodate the attachment system.

1205 Sign Plates for Permanent Traffic Signs

1 All permanent sign plates shall comply with BS 873 : Part 6, and with this Clause.

2 Plate signs not exceeding 1.2 m in height and 2.4 m width shall be made of a single sheet. Where more than one sheet is used to make up a sign, the number of sheets shall be kept to a reasonable minimum and the separate sheets shall be rectangular and of comparable size and shape.

3 Extruded plank signs up to 4.8 m wide shall have no vertical joints. Above this size, joints in extruded planks should preferably be positioned at a vertical support; if not, then the vertical joints in adjacent planks should not be less than 1.0 m apart and only one joint per extruded plank is permitted.

4 Fabricated plank signs up to 4.8 m wide shall have no vertical joints, but each plank may be constructed from a maximum of two pieces of sub-strate material, producing one split line. Split lines should be lined up vertically or horizontally. Above 4.8 m wide, joints in the stiffening extrusions of adjacent planks should preferably be positioned at a vertical support; if not, then the vertical joints in the stiffening

extrusions of adjacent planks should not be less than 1.0 m apart and only one such joint per fabricated plank shall then be permitted.

5 Where top and bottom light spill screens are required in Appendix 12/1, these shall extend for the whole width of the sign and be fabricated out of the same material as the sign plate.

6 Top and bottom light spill screens shall be considered as part of the sign plate and any stiffeners and mounting fittings shall be designed to accommodate the combined size.

1206 Faces for Permanent Traffic Signs

1 Faces for permanent traffic signs shall be as described in Appendix 12/1. They shall comply with BS 873 : Part 6 and with this Clause.

2 All plastics sheeting shall be fixed in accordance with the sheeting manufacturer's instructions.

3 Only vertical and horizontal joints shall be permitted and all joints in plastics sheeting shall be overlapped by not less than 6 mm. The overlap in the horizontal joints shall be from the top. Butt joints in plastics sheeting shall not be used, except between individual planks or in electro cutable overlay film, or as recommended by the sheeting manufacturer.

4 All materials comprising the sign face, including the background, border and legends shall be carefully matched for colour at the time of sign fabrication to provide uniform appearance both by day and night. The sheeting manufacturer's recommendations on colour matching methods shall be observed.

5 Letters, numerals, symbols and borders shall be clear cut, sharp edged and without cracks.

6 Any cut-out letters, numerals, symbols and borders shall be of material compatible with the sheeting to which they are applied. They shall be applied in accordance with the sheeting manufacturer's instructions.

7 Screen processed letters, numerals, symbols and borders shall be screen printed with materials in accordance with the sheeting manufacturer's instructions. Any inks, pastes and finishing coats used shall be compatible with the sheeting material or the face panel of internally illuminated signs.

8 Sheeting materials including letters, numerals, symbols and borders shall be fully adhered and there shall be no air bubbles, creases, cracks or other blemishes. Where the sheeting manufacturer requires the assembled materials to be provided with a coat of clear lacquer, it shall be uniform and continuous. All lacquer shall be applied at the time of fabrication of the sign face and shall be of a type specified or supplied by the sheeting manufacturer.

1207 Construction and Assembly of Permanent Traffic Signs

General

1 Construction and assembly of traffic signs shall comply with BS 873 : Part 6 and with this Clause.

2 All sign plates and planks, frames, purlins, posts and other components shall be de-burred prior to assembly.

3 Where framing and stiffening are not an integral part of the sign plate their joints shall be welded or joined with suitable brackets utilising nuts, bolts and washers.

4 Where purlins are adopted they shall be attached to each vertical member of the sign frame and the sign stiffening and framing shall

be continuous in the vertical direction. Purlins shall be spaced equally apart. Connections shall be made at every point where a purlin crosses a post.

5 Where purlins are not adopted the sign stiffening and framing shall be continuous in the horizontal direction.

6 Rivets and other devices used for fixing sheet sign plates to their stiffeners or framework, or in the construction of housings, shall be of a material compatible with the materials being joined. Spacing of rivets or other fixing devices shall be uniform and shall not exceed 150 mm around the outside edge of any sheet or section of sheet, and shall not exceed 300 mm on cross braces. Hollow rivets shall not be used. Where sign plates need to be stiffened this shall be achieved in a manner such that the sign face material is not punctured or otherwise damaged to accommodate the stiffening.

7 An additional washer of neoprene, nylon or other suitable material shall be used between the sign face and any metal nuts, bolts, washers and screws to protect it from corrosive or other damaging effects.

8 Where supports to traffic signs, including external lighting luminaires, are required to have flange plates these shall be secured by anchorages and attachment systems complying with Series 1300. The bolts shall be lightly greased before final installation and they and their anchorages shall be installed so as to achieve the loadings, torque settings and other requirements described in Appendix 12/1.

9 Sheet and plank signs shall be connected to posts by an appropriate method. Banding systems shall be of stainless steel complying with AISI Grade 201.

10 Plank signs shall be assembled in accordance with the manufacturer's instructions.

11 Where ferrous components are permitted any drilling of them shall be completed before the application of any finish.

12 Any hole drilled in plates with plastics sheeting to accommodate a rivet or bolt shall immediately prior to the insertion of the rivet or bolt have a clear lacquer, recommended by the plastics sheeting manufacturer, applied to its edge to prevent the ingress of moisture. The surfaces of rivets or bolts exposed on the sign face shall be covered by a suitable material of a colour to match that part of the face.

13 Prior to fitting any sign to any lighting column, the Contractor shall ensure that the sign is included in the technical approval of the lighting column in accordance with the Technical Approval Scheme adopted by the Overseeing Organisation and with Standard BD 26. No holes shall be drilled in the lighting column except those whose location and size are included in the technical approval.

14 Traffic signs to be erected on road lighting columns shall have fixings compatible with the column cross-section and finish. Wiring shall be contained in external conduit complying with BS 4568. Conduits shall be affixed to concrete lighting columns with stainless steel banding systems complying with AISI Grade 201. Conduits shall be affixed to other lighting columns with stainless steel clamps, which shall be screwed with stainless steel screws into tapped holes in the lighting column. Alternatively permanent cabling shall be placed on the inside of the lighting column and shall exit via a bushed drilled hole.

Variable Message Traffic Signs

15 Variable message traffic signs shall comply with this Clause.

1208 Location and Erection of Permanent

Traffic Signs

1 The approximate location of each traffic sign is described in Appendix 12/1. All traffic signs shall have their exact location determined and recorded in compliance with Clause 1403.

2 All posts shall be erected plumb and where two or more posts are provided for any one sign, the faces of the posts shall be lined up.

3 Signs erected on two posts shall have each post positioned so that the distance from the centre of the post to the edge of the sign plate is 300 mm unless otherwise described in Appendix 12/1.

4 Any pockets formed in concrete foundations to receive the posts shall be cleaned out immediately prior to erection. The posts shall be placed centrally in the pockets and be bedded on mortar designation

(i) complying with Clause 2404 and, unless otherwise described in Appendix 12/1, the pockets shall be filled up to finished foundation level with mix ST5 concrete.

5 Traffic signs mounted on posts, except those on gantries, shall be erected to have their face plumb and be orientated in relation to the carriageway in accordance with Chapter 1 of the Traffic Signs Manual.

6 Traffic signs mounted on gantries shall be erected as described in Appendix 12/6 and all other traffic signs shall be erected as described in Appendix 12/1.

7 The site records required by Clause 1402, shall include daily records for non-lit traffic signs.

8 No traffic sign shall be dismantled, re-sited or removed without the prior approval of the Overseeing Organisation.

1209 Covering of Permanent Traffic Signs

1 Where it is required in Appendix 12/1 that permanent traffic signs be blanked-out or have an alternative message, the method to be adopted shall comply with the following, unless otherwise described in Appendix 12/1:

(i) for plate signs: A cover plate compatible with the plate sign's material, or a covering of a suitable, opaque, non damaging material, or, for covering periods of up to one year, a self adhesive plastic film to support the temporary sign face sheeting;

(ii) for other traffic signs: A covering of a suitable, opaque, non damaging material.

2 Cover plates shall be suitably fixed to give a 10 mm minimum air gap between the sign face and cover plate. The fixing method shall not cause damage or staining to the sign face. Any holes remaining in the finished sign face after removal of the plate shall be filled with a suitable material, of a colour to match that part of the face.

3 Where self-adhesive plastic film is used it shall be compatible with the sign face materials and be applied and removed in compliance with the manufacturer's instructions.

4 Any loose covering used must be sufficiently opaque to prevent reflection from and legibility of the covered sign and be securely fastened to the back of the sign. Under no circumstances shall tape or other adhesive material be applied to the face of the sign. Sufficient space shall be left between the covering and the face to permit air flow over the sign.

5 Traffic signs which are to be covered shall not be erected on trafficked highways without the covering in place.

6 Removal of any covering shall be carried out with the minimum disturbance to traffic.

7 Irrespective of any requirement in Appendix 12/1 to cover signs, any traffic sign erected at such a time that its legend does not relate either wholly or in part to the traffic movement and route in operation, shall have its sign face securely covered with one of the materials in sub-Clause 1 of this Clause until such time as its legend is applicable.

1210 Permanent Bollards

1 Permanent bollards shall be as described in Appendix 12/1 and shall comply with appropriate Clauses of this Series.

2 Internally illuminated bollards and, unless otherwise described in Appendix 12/1 reflective-only bollards, shall be secured by stainless steel holding down bolts, nuts and washers. Holding down bolts and anchorages cast into the foundation shall be capable of complying with the performance requirements of BS 873 : Part 3 when tested as described therein.

3 All bolts shall be lightly greased before final installation and tightening to the bollard manufacturer's torque setting.

1211 Permanent Marker Posts

General

1 Permanent marker posts shall be constructed to the dimensions and be installed in the locations and by methods described in Appendix 12/2 and shall comply with this Series and sub-Clauses 2 and 3 of this Clause.

Distance Marker Posts

2 Distance marker posts shall be made from plastics, timber, or other materials described in Appendix 12/2.

Hazard Marker Posts

3 Hazard marker posts shall comply with BS 873 : Part 2. Post construction and colour and type of reflective marker shall be as described in Appendix 12/2.

1212 Road Markings

General

1 Road markings shall be white or yellow (Classes Y1 and Y2) complying with BS EN 1436 Table 6, as appropriate except where an alternative shade has been specified in Appendix 12/3. The markings shall consist of continuous or intermittent lines, letters, figures, arrows or symbols and comply with sub-Clauses 2 to 12 of this Clause. Statutory requirements controlling road markings are contained in The Traffic Signs Regulations and General Directions 1994 (Statutory Instrument 1994 No. 1519) and subsequent amending Regulations.

Permanent Road Markings

2 Permanent road markings shall be one of the following materials and comply with the colour, location and material type requirements described in Appendix 12/3:

(i) thermoplastic road marking material or paint in accordance with BS EN 1871;

(ii) permanent preformed road markings in accordance with BS EN 1790;

(iii) other materials as described in Appendix 12/3 to BS EN 1871.

They shall be also tested in road trials to the Roll-over class P5 in accordance with the procedure stated in BS EN 1824 to demonstrate compliance with the performance requirements as stated in sub-Clauses 3 to6. The test report shall give particulars of the quality and quantity of the material, including drop on glass beads laid at the test site for future reference and comparison purposes should such a need arise.

3 Road markings shall have the following road performance as defined in BS EN 1436 for the period of the functional life starting from the date of application or when the road is trafficked, whichever is later. The materials to be used shall be to the same mix, material quality, quantity and rate of application as used on the test site.

Property	BS EN 1436 Reference	Requirement*	Value
Colour	Table 6	1. White 2. Yellow Class Y1, Y2	X,y co-ordinates given x,y, co-ordinates given
Luminance Factor	Table 5	1.Class B2 2.Class B1	0.3 0.2
Skid Resistance	Table 7	1. Class S1 2. Class S1	45 45
Retroreflectivity	Table 2 Class of R, For dr markings	1. Class R2 2. Class R1	100 80

* Note: 1 = White, 2 = Yellow

4 The width tolerances and thickness for screed, spray, preformed and extruded white or yellow lines shall be in accordance with The Traffic Signs Regulations and General Direction 1994. With the exception of the road markings listed in Article 29 (2) of The Traffic Signs Regulations and General Directions, in no case shall any materials be laid more than 5 mm thick. Unless specified, all white markings shall be reflectorised with glass beads in accordance with BS EN 1423 and BS EN 1424 by incorporation (apart from preformed markings) into the road marking mixture and to the wet surface of the marking.

Property	BS EN 1436 Reference	Requirements	Value
Retroreflectivity	Table 3	Class RW3	50

5 Where there is requirement for improved visibility in wet conditions at night, products showing the following performance in addition to that stated in sub- Clause 3 shall be used.

6 Where there is a requirement for improved skid resistance as referred to in Appendix 12/3 products showing the following performance in addition to that stated in sub-Clause 3 shall be used.

Property	BS EN 1436 Reference	Requirements	Value
Skid Resistance	Table 7	Class S3	55

7 The pavement shall be prepared in accordance with the following:

(i) Where the marking is to be applied on concrete carriageways, the transverse texturing shall be freed from all traces of curing compound by wire brushing or other approved means. Prior to the application of the thermoplastic material a tack coat compatible with the road surface and the marking material shall be applied in accordance with the manufacturer's instructions.

(ii) On surface dressed carriageways, all loose chippings where the marking is to be applied shall be removed prior to application.

8 The application of permanent road markings shall be in accordance with the Sector Scheme described in Appendix A. Road marking materials shall only be applied to surfaces, which are clean and dry. Markings shall be free from raggedness at their edges and shall be uniform and free from streaks. Longitudinal road markings shall be laid to a regular alignment.

Raised Rib Road Markings

9 Raised Rib Road Markings shall only be used on motorways with full width hardshoulders or all-purpose roads (both single and dual carriageway) with at least 1 metre wide hardstrips. They shall comply with sub-Clauses 1, 2(i), 3, 5, 6, 7 and 8 of this Clause.

10 Raised Rib Road Markings shall be white lines, which are continuous over the sections where they are specified in Appendix 12/3. Where specified in Appendix 12/3 gaps shall be provided for drainage purposes.

11 Raised Rib Road Markings shall be in accordance with The Traffic Signs Regulations and General Directions 1994 (Statutory Instrument 1994 No. 1519), Diagrams 1012.2 and 1012.3, as appropriate. Spacing of the transverse raised ribs shall be 500 mm or 250 mm as specified in Appendix 12/3.

12 Raised Rib Road Markings shall not be used adjacent to hatched areas or central reserve crossings except as prescribed for use with diagrams 1040.3, 1040.5 and 1042.

Temporary Road Markings

13 Temporary road markings shall only be adopted with the prior approval of the Overseeing Organisation. They shall comply with sub-Clauses 1 to 8 of this Clause or if required to be removable, be constructed only from a proprietary preformed road marking material complying with BS EN 1790.

14 When temporary road markings are used on surfaces that will continue to be used by public traffic after their removal, any shadow trace remaining after their removal shall be permanently obliterated. Preformed materials shall not be used for this obliteration.

15 Temporary road markings constructed from a proprietary preformed road marking material shall only be adopted in locations and on types of road surface as described in Appendix 12/3 and shall comply with any other requirement therein. The marking material shall be new and together with any primer shall be stored and installed in accordance with the manufacturer's instructions and within the recommended shelf life.

16 Temporary preformed road markings shall only be applied to surfaces that are clean and dry. Upon removal they shall be disposed of off Site and if any making good is necessary to the road surface it shall be satisfactorily carried out before the road is opened to traffic.

Road Markings on Porous Asphalt Surfacing

17 Spray paint, thermoplastic applied by machine screed, spray or extrusion or preformed road markings shall be used for carriageway markings on porous asphalt surfacing. Manual screeding shall not be permitted except for directional arrows and similar markings.

Removal of Road Markings

18 The removal of road markings on surfaces that will continue to be used by traffic shall be undertaken in a manner that will avoid damage to the surface. The removal of temporary road markings shall comply with sub-Clauses 14 and 15 of this Clause.

The removal of permanent road markings shall be by mechanical means only. The Contractor shall submit details of the system he proposes to use to the Overseeing Organisation for approval.

Masking of Road Markings

19 When black masking materials are required to cover existing permanent road markings, they shall either comply with BS 7962 or have received written type approval from the Overseeing Organisation and if required to be removable, be constructed from a proprietary preformed removable black masking material.

1213 Road Studs

Retro-reflecting Road Studs

1 Statutory requirements controlling retro-reflecting road studs are contained in The Traffic Signs Regulations and General Directions 1994 (Statutory Instrument 1994 No. 1519) Regulations 28, 29 and Direction 50 and subsequent amending Regulations.

2 All retro-reflecting road studs shall comply with BS EN 1463-1 and 1463-2, and shall be installed in accordance with the manufacturer's instructions and the Sector Scheme described in Appendix A.

3 Retro-reflecting road studs and components which do not fall into a category of BS EN 1463, but which have statutory type approval by the ADT for the Overseeing Organisation can be incorporated into the Works. They shall be installed in accordance with the manufacturer's instructions.

4 The Contractor shall submit details of the retro-reflecting road studs he proposes to use in the Works to the Overseeing Organisation for approval.

Retro-reflecting Road Studs

5 Permanent retro-reflecting road studs shall be installed in the locations and to any other requirements as described in Appendix 12/3.

Temporary Retro-reflecting Road Studs

6 Temporary retro-reflecting road studs shall be of the fluorescent green-yellow type to BS EN 1463-1 and shall be appropriate for the situation concerned. They shall not be used for a second application. Adhesive used for the temporary retro-reflecting road studs shall be removed from the carriageway on completion of the Works.

Non retro-reflecting Road Studs

7 All non retro-reflecting road studs shall be installed in accordance with the manufacturer's instructions in locations, and complying with any other requirements, described in Appendix 12/3.

Retro-reflecting Road Studs on Porous Asphalt Surfacing

8 The edges of recesses for inset retro-reflecting road studs in porous asphalt surfacing shall be milled when the material has cooled to ambient temperature. Care shall be exercised when removing porous asphalt to form the recess to prevent damage occurring to the cut edges and to prevent detritus clogging the porous asphalt surfacing. Surface applied road studs should not be applied if there is evidence of moisture present on the surface of porous asphalt, nor should inset road studs be installed if moisture is present in the recess after milling of the asphalt.

1214 Traffic Cones, Traffic Cylinders, Flat Traffic Delineators and Other Traffic Delineators

General

1 Traffic cones and traffic cylinders, hereinafter termed cones and cylinders, shall comply with

Designation 1 or Designation 2 of BS 873 : Part 8. Cones shall be to Category A.

2 Flat Traffic Delineators, hereinafter termed FTDs, shall comply with sub-Clauses 3 to 17 of this Clause.

3 An FTD shall comprise a flat blade fixed to a base. The flat blade may incorporate stiffeners provided that they do not encroach into the white retro-reflective area.

4 FTDs shall be constructed of rubber or plastic materials. It shall be possible to insert and remove blades without requiring a special tool. The height of the FTD shall be 750 mm or 1000 mm as stated in Appendix 12/4. The width of the top of the blade shall be 45 ± 10 mm. Other dimensions shall be in accordance with Diagram 7102 of TSRGD 1994.

5 FTD bases shall be so designed that they will stack without binding and without causing damage to the retro-reflective surfaces. Additionally the blades and their attachment to the base or fixing shall be so designed that the blade's face presents throughout its design life a plane to the approaching traffic no more than 12.5° from the vertical.

6 FTD bases may be coloured red, black, grey or brown. They may have a 100 mm wide white reflective line placed on one edge of the base provided:

(i) the edge of the base where the white line is to be attached comprises a sloping surface which is at an angle to the road surface of no more than 60° and is of such dimensions either to fully accommodate the 100 mm wide white line or, where the angle between the road surface and the sloping surface exceeds 30°, to accommodate at least 80 mm of the width of the white line, the excess (maximum 20 mm) being returned onto the top surface of the base;

(ii) the material from which the base is manufactured allows proper adhesion or attachment of the white reflective line to prevent it becoming detached during normal use;

(iii) the coverage of white reflective material is maintained at more than 70% of the area treated.

7 The white reflective strip material shall comply with BS EN 1436 and BS EN 1871 or BS EN 1790 as appropriate. Additionally when tested using a portable retro-reflectometer the white line shall have a coefficient of retro-reflectance of Class R2 or better to Table 2 of BS EN 1436.

8 FTD blades shall be coloured red and white as indicated in Diagram 7102 of TSRGD 1994.

9 The white portions of the FTD blades shall comply with the chromaticity co-ordinates and luminance factor given in BS 873 : Part 6.

10 The red portions of the FTD shall comply with the chromaticity co-ordinates and luminance factor for traffic cones given in BS 873 : Part 8 when measured in accordance with BS 873 : Part 1.

11 That part of the blade coloured white shall comprise retro-reflective material, complying with the requirements for Class 1 or Class 2 as specified in BS 873 : Part 6, which shall be securely applied or attached to the blade to prevent it becoming detached during normal use.

12 The red portions may also be retro-reflective.

13 The minimum mass of the FTD including any ballast recommended by the manufacturer

shall comply with the mass of a traffic cone as defined in BS 873 : Part 8.

14 FTDs shall be clearly and durably marked with the following information in the following order:

(a) the name, trade mark or other means of identification of the manufacturer or vendor;

(b) the title and date of this document, e. Specification for Road Works, with appropriate date.

The marking shall be in characters legible at a normal reading distance such that the total area of the marking does not exceed 30 cm². Additionally the legend 'DUAL CARRIAGEWAY AND MOTORWAY USE ONLY' shall be applied to the lowermost red portion of the blade, using block capitals of minimum height 15 mm, in such a location that it can be clearly seen when the FTD is in position.

15 All markings shall be sufficiently durable to last the expected life of the FTD to which they are applied and in no case less than 5 years.

16 When checked by inspection and by rubbing lightly, first for 15 seconds with a piece of cloth soaked in water and then for 15 seconds with a piece of cloth soaked in petroleum spirit, followed by 15 seconds with a piece of cloth soaked in diesel oil, the marking shall still be legible.

17 FTDs shall be supplied with the following information:

(a) instructions for ballasting (if required);

(b) instructions for fixing blades to bases.

18 Other traffic delineators hereinafter termed delineators shall be as described in Appendix 12/4.

19 The Contractor shall submit to the Overseeing Organisation a copy of a test certificate confirming that samples of the identical type of cone, cylinder, FTD or delineator as those to be used in the Works and supplied as permanent cones, cylinders, FTDs or delineators under the Contract, have been tested and found to comply with sub-Clauses 1 to 18 of this Clause.

Permanent Cones, Cylinders, FTDs and Other Delineators

20 Where required in Appendix 1/5 the Contractor shall arrange for the tests described in sub- Clauses 22 to 56 of this Clause, for cones, cylinders, FTDs and other delineators, to be carried out at a UKAS approved testing laboratory. The numbers to be tested, as given in Appendix 1/5, are to be selected at random from the batch to be supplied under the Contract. Failure of any test will result in rejection of the batch.

Temporary Cones, Cylinders, FTDs and Other Delineators

21 The Contractor shall submit to the Overseeing Organisation certification substantiating that at least 1 in every 500 of any batch of cones, cylinders, FTDs and delineators to be used in the Temporary Works have passed the tests described in sub-Clauses 22 to 56 of this Clause as appropriate.

Testing

22 Cones and cylinders shall be tested in compliance with BS 873 : Part 8.

23 FTDs shall be tested in compliance with sub- Clauses 24 to 55 of this Clause.

24 Test procedures shall be carried out on each size of FTD and each method of attachment between blade and base.

25 When tested in accordance with sub-Clauses 31 to 38 of this Clause with the exception of the white retro-reflective material, no part of the FTD shall crack,
split or deform.

26 When samples with retro-reflective portions attached are tested in accordance with sub-Clauses 31 to 38 of this Clause the coefficient of luminous intensity, R (as defined in Publication CIE No 54; Retro-reflection, definition and measurement), after testing shall be not less than 80% of the value previous to the test.

27 When tested in accordance with sub-Clauses 39 to 43 of this Clause, no part of the FTD with the exception of white retro-reflective material, shall crack, fracture or split and any ballast or ballast container shall not have become displaced within the base or separated from it. Any ballast container as either an integral part of the base or enclosed within it shall not have been damaged to the extent that ballast is discharged. Caps or bungs to ballast containers shall not have been forced from their sockets or other fixings.

28 When tested in accordance with sub-Clauses 44 to 49 of this Clause, no part of the FTD with the exception of white retro-reflective material shall crack, fracture or split. Bases shall remain in contact with the reference surface.

29 When tested in accordance with sub-Clauses 50 to 55 of this Clause, no part of the FTD with the exception of the white retro-reflective material shall crack, fracture or split. Bases shall remain in contact with the reference surface.

30 Throughout the tests in sub-Clauses 31 to 38, 44 to 49, and 50 to 55 of this Clause, the blade shall remain fixed in position. On completion of the testing in accordance with sub-Clauses 44 to 49 and 50 to 55 of this Clause the residual deflection of the top of the blade in any horizontal direction, measured 30 seconds to 60 seconds after completion of the tests, shall be not more than 12.5% of the height of the FTD. The height of the FTD, H, is as measured from the reference surface.

Low Temperature Impact Test

31 The test shall be conducted using a steel ball swung on a pendulum. The apparatus shall be as shown in RCD Drawing Number K3. The steel ball shall have a mass of 0.9 ± 0.045 kg and be suspended by one or two steel pendulum wires of not more than 1 mm diameter so that the pendulum radius is 1750 ± 10 mm. The point of impact shall be vertically beneath the centre of radius of the pendulum and at a height on the specimen of H/2 ± 10 mm where H is the height of a FTD above the reference surface.

32 FTDs shall be fixed to the reference surface using the base.

33 The test shall be carried out on specimens with and without retro-reflective portions attached.

34 For samples with retro-reflective portions attached, the coefficient of luminous intensity, R, of every such face at an observation angle of 20° and at an entrance
angle normal to the face of the blade prior to the conditioning shall be determined; the definitions of observation angle and entrance angle being those given in BS 873 : Part 1.

35 All test samples shall be conditioned for a period of not less than 2 hours at a temperature of -16 ± 2°C. Impact testing shall be carried out within 60 seconds after conditioning.

36 Impact shall be made in ambient conditions of not greater than 20°C.

37 Within 1 hour of impacting, samples shall be immersed with retro-reflective portions attached, in water at 20 ± 5°C for 10 minutes. After draining for 10 minutes the coefficient of luminous intensity, R, shall be measured in accordance with sub-Clause 34 of this Clause.

38 The sample shall be examined and any damage, percentage change in the coefficient of luminous intensity, or any detachment of a blade from its base shall be reported.

Drop Test

39 FTDs requiring the addition of ballast shall be ballasted as instructed by the manufacturer.

40 The FTD shall be conditioned for a period of not less than 2 hours at a temperature of 32 ± 2°C.

41 Within 1 minute after conditioning the FTD shall be suspended with its normal vertical axis horizontal (any cap or bung to a ballast container forming an integral part of the FTD shall be positioned uppermost) and with its lowest part 1500 ± 5 mm above a solid horizontal surface and dropped once vertically from rest onto the solid surface.

42 The test detailed in sub-Clause 41 shall be repeated after conditioning at a temperature of -16 ± 2°C.

43 Any damage observed shall be reported.

Bending Test

44 The test shall be carried out on specimens with and without retro-reflective portions attached.

45 The blade shall be fixed to the base in accordance with the manufacturer's instructions. The blade and its base shall be conditioned for a period of not less than 2 hours at a temperature of -16 ± 2°C. Within 1 minute after conditioning, the blade shall be bent over about its base line by applying a force to the face of the blade at a point on its vertical centre line H/2 ± 10 mm from the top, so that the top edge touches the reference surface or a surface coplanar with it as indicated in the RCD Drawing Number K3. H is the height of the FTD. When the top edge of the blade touches the reference surface the bending force shall be removed immediately.

46 From 30 seconds to 60 seconds after completion the maximum residual horizontal deflection of the top of the blade shall be measured from the vertical axis passing through the centre of the base of the blade and perpendicular to the reference surface.

47 The test shall be repeated in the opposite direction.

48 The procedure in sub-Clauses 45 to 47 of this Clause shall be repeated at a temperature of 32 ± 2°C.

49 The deflections, any damage observed, any detachment of the blade from its base, and any movement of the base shall be reported.

Fatigue Test

50 The test shall be carried out on specimens with and without retro-reflective portions attached. This test is to be carried out on a different specimen to that or those tested in sub-Clauses 31 to 38 and 44 to 49 of this Clause.

51 The blade shall be fixed to the base in accordance with the manufacturer's instructions. The test shall be carried out after conditioning the blade and its base for a period

of not less than 2 hours at a temperature of -16 ± 2°C.

52 By applying a force to the face of blade at a point on its vertical centre line H/2 ± 10 mm from the top, the top of the blade shall be oscillated as indicated in the RCD Drawing Number K3 at a frequency of 60 oscillations per minute to 90 oscillations per minute at an amplitude of H/4 for 10 minutes with the reference surface held in a horizontal position. H is the height of the FTD. One oscillation is the movement from the upright position to the maximum amplitude in one direction, then to the maximum amplitude in the opposite direction and then the return to the upright position.

53 From 30 seconds to 60 seconds after completion the maximum residual horizontal deflection of the top of the blade shall be measured from the vertical axis passing through the centre of the base of the blade and perpendicular to the reference surface.

54 The procedure in sub-Clauses 51 to 53 of this Clause shall be repeated at a temperature of 32 ± 2°C.

55 The deflection, any damage observed and any detachment of the blade from its base shall be reported.

56 Other traffic delineators shall be tested in compliance with Appendix 12/4.

1215 Road Danger Lamps and High Intensity Flashing Beacons

1 Road danger lamps and high intensity flashing beacons shall be used in accordance with Regulations 43 and 42 respectively of TSRGD 1994, or Regulations 44 and 43 and shall comply with BS 3143.

1216 Temporary Traffic Signs

1 Temporary traffic signs shall be designed by the Contractor, comply with Clause 1201, satisfy Clause 117, have the consent of the Overseeing Organisation prior to installation, and comply with sub- Clauses 2 to 6 of this Clause.

Temporary traffic signs shall comply with The Traffic Signs Regulations and General Directions 1994, or The Traffic Sign (Welsh and English Language Provisions) Regulations and General Directions 1985, and be designed in accordance with Working Drawings for Traffic Sign Design and Manufacture (Volumes 1, 2 and 3) and where appropriate Local Transport Notes.

2 Temporary traffic signs shall be constructed as follows:

(i) plate signs and internally illuminated signs:

(a) the coefficient of retro-reflection of the material for the faces of signs used for Type A or Type B works, as defined in Chapter 8 of the Traffic Signs Manual, and any amendment thereto including the amendments specified in sub-Clause 117.8, shall be as given in BS 873 : Part 6 for Class 1 material;

(b) where the sign is to be erected for less than 6 months, it shall, unless Appendix 12/1 requires it to be constructed to a similar standard as a permanent sign, be either portable sign complying with BS 873: Part 2 or a fixed short life sign complying with sub-Clause 3 of this Clause;

(c) where the sign is to be erected for periods of 6 months or more, or

where Appendix 12/1 requires it to be constructed to the standard for a permanent sign, it shall comply with the requirements for permanent traffic signs;

(d) in addition to either (b) or (c) above, electrical work related to temporary traffic signs shall comply with the Series 1400 except Clauses 1402, 1410 and 1425;

(ii) bollards and marker posts shall comply with Clauses 1210 and 1211;

(iii) road studs:

(a) temporary retro-reflecting road studs shall comply with Clause 1213 and only be installed for periods of up to 3 months and thereupon be replaced;

(b) if permanent retro-reflecting road studs are used for temporary purposes they shall comply with Clause 1213 and have the prior approval of the Overseeing Organisation;

(iv) road markings, cones, cylinders and delineators, road danger lamps and high intensity flashing beacons shall comply with Clauses 1212, 1214 and 1215 as appropriate;

(v) portable traffic signals and haul route crossing signals shall, where relevant, comply with Clause 1217;

(vi) any other signal, lamp, barrier or device shall be suitable for its intended purpose and where relevant shall comply with appropriate British Standards.

3 Fixed short life signs shall be constructed as follows:

(i) materials:

(a) sign plates may be constructed of materials to the standard for a permanent sign, or alternatively shall be constructed of timber, hardboard, plywood or chipboard;

(b) stiffening frames for sign plates constructed of timber, hardboard, plywood or chipboard, shall be constructed of timber, mild steel or aluminium sections;

(c) mounting posts shall be constructed of steel, cast iron, aluminium alloy, reinforced or prestressed concrete or timber;

(d) fittings for signs made of materials to the standard for a permanent sign shall be similar to those used for permanent signs. For signs made of timber, hardboard, plywood or chipboard, fittings shall be of steel, stainless steel, or brass wood screws, or wire nails. Adhesives may be used for fixing provided they are weatherproof and are not affected by variations in temperature;

(e) sign plates constructed of timber, hardboard, plywood or chipboard shall be sealed or otherwise treated to ensure that the final finish will provide a satisfactory appearance and will not deteriorate during the period the sign is expected to be in use;

(ii) construction:

(a) sign plates shall be constructed on similar principles to those required for permanent signs, although stiffening may be omitted provided the sign plate passes the bending test given in BS 873 : Part 1;

(b) stiffening frames constructed of timber members shall be jointed so that they withstand adverse weather conditions;

(c) mounting posts constructed of timber shall have dimensions that are sufficient to withstand the estimated loading on the sign;

(d) fixing of signs to the stiffening frame where required, and to the mounting posts shall be by screwing, nailing or gluing;

(e) timber sign plates, stiffening frames and mounting posts shall be preserved with copper/ chrome/ arsenic (CCA) complying with BS 4072. The sign plate face shall be finished to comply with BS 873 : Part 6.

4 Erection of temporary traffic signs mounted on posts shall comply with Clause 1208.

5 Any temporary covering of temporary traffic signs shall comply with Clause 1209. Any temporary covering of road studs and road markings shall comply with any requirements described in Appendix 12/3.

6 Removal of temporary traffic signs shall be carried out as soon as they become superfluous or a hazard to traffic. Methods of removal shall ensure the minimum disturbance to traffic consistent with safety. Making good shall be carried out immediately after removal of the traffic sign.

7 Posts shall not protrude above the top of the sign unless supporting an external luminaire, in which case the protrusion shall be kept to a minimum.

1217 Traffic Signals

General

1 Traffic signals shall comprise road junction signals, pelican and puffin pedestrian crossing signals, haul route signals and wig-wag signals and shall be of the type described in Appendix 12/5.

2 Traffic signals shall comply with sub-Clauses 3 to 15 of this Clause and the requirements described in Appendix 12/5. The installation and maintenance of traffic signals shall be in accordance with the quality management scheme described in Appendix A.

3 Traffic signal equipment shall comply with BS 505 : 1971 (AMD 1990, 1976) as amended by Specification TR 0102. It shall consist of control equipment including detector loops of a type which has received statutory type approval by the ADT in accordance with the procedure described in Specification TRG 0500. They shall be maintained and serviced as described in Appendix 12/5.

4 All traffic safety and management measures associated with work on traffic signals shall comply with Clause 117, and any work entailing the switching off of existing signals shall not be carried out until the highway authority has been informed and until agreed alternative traffic management measures are in operation to safeguard and control vehicles using the highway.

Controllers

5 Controllers shall be provided and installed as described in Appendix 12/5. The cabinet shall be mounted on a foundation, with or without an adjacent inspection chamber as described in Appendix 12/5. The foundation shall make provision for the entry of the appropriate number of cable ducts.

6 Traffic signal controllers shall, in addition to any testing carried out in compliance with Clause 1424 be tested before delivery to Site and again after installation but before commissioning, to ensure they comply with the specification in Appendix 12/5.

Cabling and Electrical Requirements

7 Traffic signal equipment on each post shall be connected to the controller in accordance with the requirements described in Appendix 12/5.

8 The installation shall comply with BS 7671 Regulations for Electrical Installations (IEE Wiring Regulations) and the rules and regulations of the electricity supplier which provides the supply.

9 Cables shall be PVC insulated and sheathed 600/1000 V grade with steel wire armouring to BS 6346 and shall be installed in ducts in compliance with Clause 1421 and terminated in compliance with Clause 1423. Reinstatement shall be in compliance with Clause # 706.

10 Earthing of all posts, pushbutton boxes and the controller cabinet shall comply with Clause 1420. One conductor in each cable between a post and the equipment cabinet shall be a protective conductor and shall bond the earth terminal at the post to the main earth terminal.

11 Cable testing shall be in accordance with Clause 1424. Tests (a), (b), (c), (e), (f), (g), (h) and (j) as defined in sub-Clause 1424.2 shall be conducted and all measurements recorded.

Telecommunications Carrier Interface

12 Where a connection interface to the plant of a telecommunications carrier is specified in Appendix 12/5 the installation shall comply with th rules and regulations of that carrier.

Posts

13 Posts for traffic signals shall be installed in compliance with Clause 1203 and in the locations specified in Appendix 12/5.

Signal Heads

14 All backing boards shall have a border of Class 1 retro-reflective material (white). Pressure sensitive material shall normally be supplied but vacuum applied material may be used in accordance with the manufacturer's process. Application of pressure sensitive material shall take place only on dry surfaces. An ambient temperature of 15°C minimum is recommended for satisfactory adhesion. The material shall have a 50 mm width throughout. Where the continuous border bridges each backing board/signal head a distinct cut edge shall be made to avoid any subsequent stretching/ shrinkage of dissimilar surfaces. The finished border shall be of a neat appearance and not made up of short lengths of cuttings.

Road Markings

15 Road markings associated with traffic signals shall comply with Clause 1212.

1218 Detector Loops

1 The installation and testing of detector loops shall be in accordance with Specification MCH 1540.

1219 Controlled and Un-controlled Crossings

1 The location of controlled and un-controlled crossings shall be as described in Appendix 12/5. Details shall be as described in Appendix 12/5.

2 Surfacing of Zebra crossing areas shall be laid with materials and to methods specified in Appendix 12/5. The finished surfacing shall have a minimum skid resistance Class of S3 when tested in compliance with BS EN 1436.

3 Non retro-reflecting road studs shall comply with Clause 1213.

4 Road markings shall be white and comply with Clause 1212 for permanent markings and be of the material described in Appendix 12/5.

5 Traffic signals, related control and other equipment where incorporated in controlled crossings together with installation and reinstatement shall comply with Clause 1217 for permanent traffic signals.

1220 Traffic Signs on Gantries

1 Where traffic signs (including signals) are erected on gantries the signs shall comply with the requirements of the relevant Clauses of this Series.

2 Fabricated steel gantries shall be constructed to the requirements described in Appendix 12/6, and to comply with Series 1800. Reinforced or prestressed concrete gantries shall be as described in Appendix 12/6 and shall comply with Series 1700.

1221 Preparation and Finish of Metal and Other Surfaces

General

1 Permanent traffic signs and, where specified in Appendix 12/1 prescribed temporary traffic signs shall be prepared, protected against corrosion and finished in compliance with BS 873 : Part 6 and with sub-Clauses 2 to 9 of this Clause.

Faces

2 Faces of sign plates shall be prepared to receive sign face materials in compliance with BS 873 : Part 6 and to the recommendations of the sign face material manufacturer following completion of any preparation and finish in sub-Clauses 3 and 6 of this Clause.

Steel Sign Plates, Purlins, Frames and Fittings

3 Steel sign plates, frames and fittings and purlins shall be prepared and protected in compliance with BS 873 : Part 6 and be as described in Appendix 12/1. Preparation to clean steel 2nd Quality and painting of surfaces shall comply with Series 1900.

Steel Posts and Post Housings

4 Steel posts and post housings shall be prepared and protected in compliance with BS 873 : Part 7. Painting shall comply with Series 1900 and be as described in Appendix 19/2.

Aluminium or Aluminium Alloy Posts and Post Housings

5 Aluminium or aluminium alloy posts and post housings shall, unless otherwise required in Appendix 19/2, be left unpainted, except for the bituminous coating required by BS 873 : Part 7 below ground level. A matt appearance shall be achieved in accordance with sub-Clause 6(ii) of this Clause.

Aluminium or Aluminium Alloy Sign Plates, Framework and Stiffening and Luminaire Housings

6 Backs of aluminium or aluminium alloy sheet and planks forming plate signs and external parts of luminaire housings and other permanently exposed components shall, to prevent specular reflection, be dulled using a method to be agreed by the Overseeing Organisation or be coated with either paint or plastics as follows:

(i) plastics coating, and pre-treatment before its application, shall be in compliance with BS 873 : Part 6;

(ii) surfaces to be painted shall be lightly abraded in accordance with sub-Clauses 1903.5 and 1903.6 or degreased and etch primed with primer detailed in Standard BD35, Item No. 14. Except for etch primed surfaces, all surfaces shall be immediately cleaned in accordance with sub-Clause 1903.9. All surfaces, including etch primed surfaces, shall be applied with one coat of matt polyurethane paint to Standard BD35, Item No. 168, and colour as described in Appendix19/2. The paint application shall comply with the appropriate recoat time (over etch primer) as detailed in the paint manufacturer's data sheet and Clauses in Series 1900.

Internally Housed Electrical Components and Ancillary Equipment

7 Ferrous steel shall be finished inside and out by galvanizing, electro-plating or zinc or aluminium spray all in accordance with Series 1900, or other equivalent preparation and finish. Aluminium and other metals shall unless otherwise required in Appendix 14/4 be left untreated.

Stainless Steel Components

8 Unless otherwise required in Appendix 19/2 stainless steel shall be left untreated except where the component is visible against the sign face when it shall be covered by a suitable material, of a colour to match that part of the face.

Cast Iron and Cast Steel Components

9 External surfaces shall be prepared and protected as described in Appendix 19/2. Cabinets and feeder pillars shall have final coats of paint applied on Site after final installation including the fitting of any internal apparatus required as part of the Permanent Works. Internal surfaces shall unless otherwise specified in Appendix 19/2 receive the same treatment as for external surfaces except that final paint coats shall be applied before internal components are installed.

Road Markings

Permanent Road markings

1 Road marking shall have the following road performance as defined in BS EN 1436 for the period of the functional life starting from the date of application or when the road is trafficked, whichever is later. The materials to be used shall be to the same mix, material

quality, quantity and rate of application as used on the test site.

Property	BS EN 1436 Reference	Requirement*	Value
Colour	Table 6	1. White 2. Yellow Class Y1, Y2	X,y co-ordinates given x,y, co-ordinates given
Luminance Factor	Table 5	1.Class B2 2.Class B1	0.3 0.2
Skid Resistance	Table 7	1. Class S1 2. Class S1	45 45
Retroreflectivity	Table 2 Class of R, For dr markings	1. Class R2 2. Class R1	100 80

* Note: 1 = White, 2 = Yellow

2 The width tolerances and thickness for screed, spray, preformed and extrusion white or yellow lines shall be in accordance with the Traffic Signs Regulations (Northern Ireland) 1997. With the exception of the road markings listed in Article 29 (2) of The Traffic Signs Regulations (Northern Ireland), in no case shall any materials be laid more than 5 mm thick. Unless otherwise specified, all white markings shall be reflectorised with glass beads in accordance with BS EN 1423 and 1424 by incorporation (apart from preformed markings) into the road marking mixture and to the wet surface of the marking.

3 Where there is requirement for improved visibility in wet conditions at night, products showing the following performance in addition to that stated in sub- Clause 3 shall be used.

Property	BS EN 1436 Reference	Requirements	Value
Retroreflectivity	Table 3	Class RW3	50

4 Where there is a requirement for improved skid resistance as referred to in Appendix 12/3, products showing the following performance in addition to that stated in sub clause 3 shall be used.

Property	BS EN 1436 Reference	Requirements	Value
Skid Resistance	Table 7	Class S3	55

5 The pavement shall be prepared in accordance with the following:

(i) where the marking is to be applied on concrete carriageways, the transverse texturing shall be freed from all traces of curing compound by wire brushing or other approved means. Prior to the application of the thermoplastic material a tack coat compatible with the road surface and the marking material shall be applied in accordance with the manufacturer's instructions;

(ii) on surface dressed carriageways, all loose chippings where the marking is to be applied shall be removed prior to application.

6 The application of permanent road markings shall b in accordance with the Sector Scheme described in Appendix A. Road marking materials shall only be applied to surfaces which are clean and dry. Markings shall be free from raggedness at their edges and shall be uniform and free from streaks. Longitudinal road markings shall be laid to a regular alignment.

Raised Rib Road Markings

7 Raised Rib Road Markings shall only be used on motorways with full width hard shoulders or all-purpose roads (both single and dual carriageway) with at least 1 metre wide hard strips. They shall comply with sub- Clauses 1, 2(i), 3, 5, 6, 7 and 8 of this Clause.

8 Raised Rib Road Markings shall be white lines which are continuous over the sections where they are specified in Appendix 12/3. Where specified in Appendix 12/3 gaps shall be provided for drainage purposes.

9 Raised Rib Road Markings shall be in accordance with The Traffic Signs Regulations (Northern Ireland) 1997, Diagrams 1012.2 and 1012.3, as appropriate. Spacing of the transverse raised ribs shall be 500 mm or 250 mm as specified in Appendix 12/3.

10 Raised Rib Road Markings shall not be used adjacent to hatched areas or central reserve crossings except as prescribed for use with diagrams 1040.3,1040.5 and 1042.

Temporary Road Markings

11 Temporary road markings shall only be adopted with the prior approval of the Overseeing Organisation. They shall comply with sub-Clauses 1 to 8 of this Clause or if required to be removable, be constructed only from a proprietary preformed road marking material complying with BS EN 1790.

12 When temporary road markings are used on surfaces that will continue to be used by public traffic after their removal, any shadow trace remaining after their removal shall be permanently obliterated. Preformed materials shall not be used for this obliteration.

13 Temporary road markings constructed from a proprietary preformed road marking material shall only be adopted in locations and on types of road surface as described in Appendix 12/3 and shall comply with any other requirement therein. The marking material shall be new and together with any primer shall be stored and installed in accordance with the manufacturer's instructions and within the recommended shelf life.

14 Temporary preformed road markings shall only be applied to surfaces that are clean and dry. Upon removal they shall be disposed of off Site and if any making good is necessary to the road surface it shall be satisfactorily carried out before the road is opened to traffic.

Road Markings on Porous Asphalt Surfacing

15 Spray paint, thermoplastic applied by machine screed, spray or extrusion. or preformed road markings shall be used for carriageway markings on porous asphalt surfacing. Manual screeding shall not be permitted except for directional arrows and similar markings.

Removal of Road Markings

16 The removal of road markings on surfaces that will continue to be used by traffic shall be undertaken in a manner that will avoid damage to the surface. The removal of temporary road markings shall comply with sub-Clauses 14 and 15 of this Clause.
The removal of permanent road markings shall be by mechanical means only. The Contractor shall submit details of the system he proposes to use to the Overseeing Organisation for approval.

Masking of Road Markings

17 When black masking materials are required to cover existing permanent road markings, they shall either comply with BS 7962 or have received written type approval from the Overseeing Organisation and if required to be removable, be constructed from a proprietary preformed removable black masking material.

1213 Road Studs

Retro reflecting Road Studs

1 Statutory requirements controlling retro-reflecting road studs are contained in The Traffic Signs Regulations (Northern Ireland) 1997 and subsequent amending Regulations.

2 All retro reflecting road studs shall comply with BS EN 1463-1 and 1463-2, and shall be installed in accordance with the manufacturer's instructions and the Sector Scheme described in Appendix A.

3 Retro reflecting road studs and components which do not fall into a category of BS EN 1463, but which have type approval of the Overseeing Organisation can be incorporated into the Works. They shall be installed in accordance with the manufacturer's instructions.

4 The Contractor shall submit details of the retro reflecting road studs he proposes to use in the Works to the Overseeing Organisation for approval.

Permanent Retro-reflecting Road Studs

5 Permanent retro reflecting road studs shall be installed in the locations and to any other requirements as described in Appendix 12/3.

Temporary Retro-reflecting Road Studs

6 Temporary retro reflecting road studs shall be of the fluorescent green-yellow type to BS EN 1463-1 and shall be appropriate for the situation concerned. They shall not be used for a second application. Adhesive used for the temporary retro reflecting road studs shall be removed from the carriageway on completion of the Works.

Non retro-reflecting Road Studs

7 All non-retro reflecting road studs shall be installed in accordance with the manufacturer's instructions in locations, and complying with any other requirements, described in Appendix 12/3.

Retro-reflecting Road Studs on Porous Asphalt Surfacing

8 The edges of recesses for inset retro reflecting road studs in porous asphalt surfacing shall be milled when the material has cooled to ambient temperature. Care shall be exercised when removing porous asphalt to form the recess to prevent damage occurring to the cut edges and to prevent detritus clogging the porous asphalt surfacing. Surface applied road studs should not be applied if there is evidence of moisture present on the surface of porous asphalt, nor should inset road studs be installed if moisture is present in the recess after milling of the asphalt.

SERIES 1300

ROAD LIGHTING COLUMNS AND BRACKETS AND CCTV MASTS

Contents

ROAD LIGHTING COLUMNS AND BRACKETS AND CCTV MASTS

1301 General

1 This Series shall apply to the design, supply and installation of lighting columns and brackets and CCTV masts within the following dimensional limitations:

(i) For steel, aluminium and concrete lighting columns:

  (a) post top columns not exceeding 20 m nominal height;

  (b) columns with brackets not exceeding 18 m nominal height;

  (c) bracket projections not exceeding 0.25 x nominal height or 3 m whichever is the lesser.

(ii) For glass fibre reinforced plastic lighting columns:

  (a) columns not exceeding 10 m nominal height;

  (b) bracket projections not exceeding 1.5 m.

(iii) For steel CCTV masts:

  (a) post top masts not exceeding 25 m nominal height.

2 The Contractor shall propose lighting columns and brackets and CCTV masts, which have been designed by the manufacturer. The manufacture, supply and verification of lighting columns and bracket arms shall comply with the quality management scheme described in Appendix A. The Contractor shall design foundations for planted lighting columns as described in Appendix 13/1.

The Contractor shall where required design:

(i) anchorages and attachment systems for columns and masts with flange plates to foundation or bridge deck;

(ii) foundations for columns and masts with flange plates; as described in Appendix 13/1 and Appendix 13/4.

3 Lighting columns and brackets and CCTV masts shall be supplied and installed in compliance with BS EN 40 : Part 1 and BS 5649 : Parts 2, 3, 5, 6, 7, 8 and 9 together with the amendments and additions stated in Clauses 1309, 1310 and 1311 and all the other requirements of this Series.

4 Brackets for lighting columns shall include wall mounted brackets and fixtures.

5 Temporary lighting on temporary diversions for traffic, and crossovers, shall comply with this Series.

6 Where lighting columns and CCTV masts are to be in the vicinity of overhead power lines the Contractor shall ensure that the appropriate Electricity Authorities are notified and give written agreement to the specific clearances to be provided and that warning notices as described in Appendix 13/1 and Appendix 13/4 are permanently fixed to the columns affected prior to erection.

1302 Design of Lighting Columns, Brackets, CCTV Masts, Foundations, Anchorages and Attachment Systems

1 Lighting columns, brackets, CCTV masts, the foundations of both planted columns and columns and masts with flange plates, and the anchorages and attachment systems for columns and masts with flange plates shall be designed to comply with the requirements of Standards BD 26, BD 83 and the technical approval scheme adopted by the Overseeing Organisation.

The Contractor shall submit to the Overseeing Organisation a copy of the design and check certificates for lighting columns, brackets, CCTV masts and foundations.

Aesthetic Requirements

2 The aesthetic design of lighting columns, luminaires including those with bracket arms and CCTV masts shall be submitted by the Contractor to the Overseeing Organisation. The design of lighting columns and luminaires including those with bracket arms shall comply with the general advice given in BS 5489 for the appearance of lighting installations by day and by night both from the viewpoint of the road and from the surrounding neighbourhood.

Foundations for Planted Lighting Columns

3 The Contractor shall submit designs appropriate to the soil types encountered on Site, as identified in Appendix 13/1, to the Overseeing Organisation for its acceptance.

1303 Data Sheets

1 The Contractor shall complete the details in Appendix 13/2 Sheet 1 and Sheet 2, and Appendix 13/5 in accordance with the instructions given in Appendices 13/3 and 13/6. He shall provide the Overseeing Organisation with triplicate copies of the completed Data Sheets for each type of column and bracket and CCTV mast not later than the date stated in Appendices 13/1 and 13/4.

2 The columns and brackets and CCTV masts shall not be ordered or erected until the Overseeing Organisation has notified its acceptance of the completed Data Sheet in writing to the Contractor.

1304 Identification and Location Markings

1 All lighting columns and brackets and CCTV masts shall carry unique identification marks which indicate the name of the manufacturer, year of production, and other information, to enable details of the lighting column and bracket, and CCTV masts to be determined by reference to the appropriate Lighting Column and Bracket and CCTV Mast Data Sheets.

2 The column and mast identification marks shall be permanent, legible and clearly visible and be:

(i) on a permanent fixed label; or

(ii) hard stamped; or

(iii) formed in the material of the column/mast on an external face only.

It shall be located either within the base compartment or, except in the case of hard stamping, immediately above or below the door. It shall not be located on the door. All hard stamping shall be made only in a secondary member of the column/mast and shall be done in a
manner, which will not induce any stresses in the material of the main member of the column/mast.

3 The bracket identification mark shall be permanent and legible and be:

(i) hard stamped; or

(ii) formed in the material of the bracket on an external face only. The mark

shall be located either on the luminaire spigot or on the underside of the bracket adjacent to the column shaft or wall or pole mounting plate.

4 Alternatively the bracket identification mark shall be hard stamped or formed in a detachable label supplied fixed to the bracket. This label shall be moved from its temporary position and fixed on erection to a suitably provided hole next to the label on the column.

5 In addition, location marks for inspection and maintenance purposes shall be applied to each column as described in Appendix 13/1 and Appendix 13/4.

1305 Installation of Foundations, Anchorages and Attachment Systems

Planted Lighting Columns

1 A layer of concrete mix ST4, 75 mm thick, complying with Clause 2602 shall be placed and compacted in the bottom of the excavation up to the base of the column.

2 The cable entry slot shall be temporarily plugged as necessary in order to prevent any ingress of concrete or filling material during the concreting and backfilling operations.

3 The hole into which the column is placed shall be backfilled as follows:

(i) in the case of metal and glass fibre reinforced plastic columns with concrete or other material described in Appendix 13/1;

(ii) in the case of concrete columns with concrete or earth fill complying with sub-Clause 5 of this Clause or other material described in Appendix 13/1.

4 Concrete backfill shall be mix ST5 complying with Clause 2602, well compacted by vibration over the full planting depth of the column. A duct equal in size to the width of the cable entry hole, shall be formed through the concrete filling using a suitable preformed lining tube capable of retaining its cross-sectional shape during compaction. The concrete
shall be placed 10 mm above ground level adjacent to the column and taper to ground level 100 mm from the column face.

5 Earth backfill shall be Class 8 material complying with Clause 601, Table 6/1 unless otherwise described in Appendix 13/1. The material shall be placed in 150 mm thick layers and shall be well rammed and compacted in order to provide full lateral support to the planting depth of the column. If the backfilling is disturbed for any reason it shall be reinstated in compliance with this Clause. A duct equal in size to the width of the cable entry hole, shall be made through the backfill material using a suitable preformed lining tube capable of retaining its cross-sectional shape during compaction.

Columns and Masts with Flange Plates

6 Concrete in the foundations shall comply with Series 1700.

7 The bedding mortar between the underside of the column/mast flange plate and the top of the concrete base shall comply with Clause 2601.

8 A cable duct, 75 mm diameter, shall be provided through the foundation or bridge component as described in Appendix 13/1 and Appendix 13/4.

9 Steel anchorages and attachment systems shall be used and the anchorage shall include an internally threaded component to receive the attachment system, i.e. holding down bolt or stud.

10 Where anchorages in drilled holes are to be used, the Contractor shall, unless otherwise described in Appendices 13/1 or 13/4, submit to the Overseeing Organisation at least 4 weeks before installation well attested and documented evidence that the proposed anchorage is:

(i) capable of complying with the test requirements specified in Clause 1306; and

(ii) capable of resisting pulsating loading. Anchorages in drilled holes of an expanding type shall not be used.

11 For anchorages in drilled holes the hole location shall be checked to ensure that the hole will be clear of reinforcement before drilling is carried out.

12 Before installation of anchorages in drilled holes, the hole shall be sound, clean and dry and the tolerance of the hole shall be within the values given by the anchorage manufacturer.

13 The threads of steel anchorages shall be lined with grease having a high resistance to creep and being suitable for hot or cold smearing. The grease shall provide protection to the threads for a minimum of either 18 months under cover or 6 months exposed on Site.

14 Attachment systems shall be tightened to the appropriate torque and have the minimum thread engagement calculated in accordance with the requirements of BS 6779 : Part 1 : 1992 : sub-Clause 12.4.1

1**5** All voids in anchorages, attachment systems and flange plates shall be filled with a non-setting passive filler to prevent the collection of water.

1306 Site Tests on Anchorages in Drilled Holes

1 The Contractor shall carry out site tests on anchorages in drilled holes. For the purpose of this sub-Clause the types of fixing referred to in Clause 1 of BS 5080: Part 1:1993 shall include “anchorages”. Where anchorages are tested they shall be loaded incrementally in tension in accordance with BS 5080: Part 1: 1993 except that they shall be capable of resisting a test load equal to 10 per cent above the nominal tensile load to be resisted by the anchorage in lieu of testing to failure. The tensile load shall be determined in accordance with the criteria given in sub-Clauses 8.15 to 8.18 of Standard BD 26 and Section 7 of Standard BD 83. Incremental loads shall be held for not less than half a minute and the test load for not less than five minutes. Readings shall be taken immediately after applying load and at the end of the time intervals stated above.

2 The total movement of the anchorage shall not exceed 1.0 mm during the test. Any evidence of slip during loading up to the test load, as demonstrated by a significant change in the slope of the load/extension curve, shall constitute failure. A test rig deemed to be equivalent to that shown in Figure 3 of BS 5080 : Part 1 : 1993 is contained in the RCD : Section 2.

3 The Contractor shall test anchorages selected on behalf of the Overseeing Organisation at the testing frequency in accordance with Appendix 1/5.

1307 Materials and Surface Finishes

1 All steel fixings including doors, door hinges, chains and locks shall be stainless steel to BS EN 10029, BS 970:Part 1 or BS EN ISO 3506 Parts 1 and 2 as appropriate or steel to BS EN 10 025, or BS 5649:Part 3: 1982 galvanized in compliance with Series 1900.

2 Where different metals are in contact, consideration shall be given to the necessary measures to avoid galvanic corrosion.

3 The surface preparation and protection of steel lighting columns, brackets and wall mountings and CCTV masts, mountings and housings shall comply with Appendix 19/1 and the relevant Clauses in Series 1900.

4 The exterior and interior surfaces of the intended planted depth of an aluminium alloy column shaft and a length of 250 mm above the ground level shall be coated with a non-porous electrically insulating bitumen with a minimum layer thickness of 250 microns. The coating shall only be applied after degreasing and after an approved preliminary treatment in order to ensure adhesion.

5 The underside of an aluminium alloy flange plate shall be treated before erection with bituminous paint complying with BS 3416 or BS 6949.

6 The finish to concrete lighting columns and brackets shall be Class F3 in compliance with Clause 1708.

1308 Handling, Transport and Erection

1 Lighting columns and brackets and CCTV masts shall be handled, transported and stored in such a way as to avoid any structural damage or damage to the surface protection system. Any damage incurred shall be made good in such a way that the structural performance and durability of the item shall be in no way reduced.

2 Lighting columns and brackets and CCTV masts shall be stored clear of the ground in such a way that contact with cement, groundwater, soil or ash or other deleterious material is prevented and that water does not accumulate on any surfaces or inside sections. Suitable packings shall be placed between the columns to allow a free passage of air and dispersion of water.

3 All rivets, bolts, nuts, washers, screws, small plates and small articles generally shall be suitably packed and identified. All such items shall be stored under cover.

4 Columns and masts shall be installed in accordance with the manufacturer's recommendations. The door shall face the direction described in Appendices 13/1 and 13/4.

5 Wall mounted lighting brackets and fixtures shall be fixed as described in Appendix 13/1.

1309 Amendments and Additions to BS 5649 : Part 2 : 1978 (AMD 3136, 1979) for Lighting Columns

Page 4 - Clause 3

Delete Note "Lantern fixing angle 5° or 15°" and

Insert Note "Lantern fixing angle 3°, 5° or 15°".

In the Table insert additional bracket projections w of "0.5 m, 1.0 m, 1.5 m and 2.5 m".

Page 5 - Clause 4

Delete cable entry slot width dimension "50 mm" and

Insert cable entry slot width dimension "X".

Insert additional note as follows:

"5) Cable entry slot width dimension "X" shall be either 75 mm or 50 mm as described in Appendix 13/1."

Page 7 - Clause 6

Delete existing Tables and replace by the following:

h m	s min	a	d_1 min	d_2 min
≤5	8	200	M12	13
≤12	10	300	M16	17
≤20	15	300 400	M24	26

Delete '1'from Figure 7 and 'c' from Figure 8.

Insert additional notes as follows:

"2 Unless otherwise described in Appendix 13/1 circumferential slotted holes shall be used instead of round holes in the flange plates in order to allow ± 5° of rotational adjustment.

3 Where slotted holes are required in the flange plate to allow for rotational adjustment of the column then the flange plate sizes shall be increased to give a suitable edge distance.

4 The distance from the edge of the hole or slot to the edge of the plate shall be not less than d2.

5 Washers complying with BS 4320 shall be used between the holding down fastener and the flange plate."

Page 8 - Clause 7

Delete existing Table for post top lanterns and replace by the following:

Delete existing Table for side entry lanterns and replace by the following:

Page 9 - Clause 8

8.7 Column cross-section

Insert additional sub-Clause as follows:

"8.7.1.3 Material thickness tolerance

(+ unspecified, - 5%)".

8.7.2.2 Deviation in shape

Delete content of entire sub-Clause and insert the following:

"Cross-section dimensional tolerances ± 5% with a maximum of ± 10 mm."

1310 Amendments and Additions to BS 5649 : Part 3 : 1982 for Lighting Columns and Brackets and CCTV Masts

1310.1 For Lighting Columns and Brackets:

Page 2 - Clause 7

Delete sub-Clause 7.1 and insert the following:

"7.1.Steel and Aluminium Lighting Columns

7.1.1 General. Arc welding of carbon manganese steels shall comply with BS 5135. Arc welding of stainless steels shall comply with BS 4677. Arc welding of aluminium alloys shall comply with BS 3019 or BS 3571 as appropriate.

7.1.2 Procedures. Written welding procedures shall be used with testing to BS EN 288 Parts 1, 2 and 3 for steel and BS EN 288 Parts 1, 2 and 4 for aluminium alloys and shall apply to all production and repair procedures. These shall be subject to reapproval after a period of seven years. When applying BS EN 288 Parts 1, 2 and 3 the welding consumables and procedures used for steel shall be such that the mechanical properties of deposited weld metal will not be less than the respective minimum specified values of the parent metal being welded. Testing shall be by a laboratory appropriately accredited for weld testing. Approval shall be by an Independent Inspecting Authority using Registered Welding Engineers, Registered Welding Quality Engineers or equivalent.

7.1.3 Welder Qualification. All welders shall be approved to BS EN 287 Part 1 for steel and BS EN 287 Part 2 for aluminium alloys. The tests shall include in addition an application test representative of the 'main structural' joints on which the welder is to be approved to work. The main structural joints shall include, where relevant, the flange plate joint, the base compartment to shaft joint, the door reinforcement, any intermediate column joint, the column to bracket joint and the column seam weld. Welders shall be subject to reapproval in accordance with BS EN 287. Testing shall be by a laboratory appropriately accredited for weld testing. Approval shall be by an Independent Inspecting Authority using Registered Welding Engineers, Registered Welding Quality Engineers

7.1.4 Inspection and Non-Destructive Testing

7.1.4.1 Inspection Personnel. The manufacturer shall provide suitable personnel to carry out inspection of production welds as required in 7.1.4.2 to 7.1.4.4. Personnel conducting visual inspection shall have a nationally recognised certificate of competence appropriate to the type of welding being inspected. Personnel conducting non-destructive testing (NDT) shall be certified according to a nationally recognized certification scheme appropriate to the equipment used and the weld groups inspected. Evidence of training and qualification shall be retained and made available for examination when required. The results of all weld inspections shall be recorded.

7.1.4.2 Visual Inspection. All welds shall be subject to visual inspection in accordance with BS EN 970 : 1997 prior to any NDT and galvanizing. Weld surfaces shall be free of slag residues and sharp edges. All surfaces shall be free of traces of weld spatter, arc strikes and contaminants. The apparent throat dimensions of butt welds and the apparent leg length and apparent throat dimensions of fillet welds, as measured by a welding gauge and taking into account any known lack of fit, shall not be less than those specified, except that local shortfalls up to 0.5 mm may be accepted provided the average over any 50 mm length is not less than the specified dimension. The toe angle shall not be less than 110°. The surface of all welds shall be free from cracks, lack of fusion including overlap, and slag. Isolated discontinuous porosity may be accepted provided it is not detrimental to the galvanizing process. Undercut shall not result in a section loss of more than 5% over any 50 mm length of joint, nor shall its depth exceed 0.5 mm or 10% of the thickness, whichever is the less.

7.1.4.3 Magnetic Particle Inspection (MPI) and Liquid Penetrant Inspection. MPI shall be applied in accordance with BS 6072 to joints in steel lighting columns selected in accordance

with 7.1.4.5, where any of the material thickness exceeds 20 mm. Liquid penetrant inspection in accordance with BS EN 571-1 shall be applied to transverse welds in aluminium columns selected in accordance with 7.1.4.5. Notwithstanding the requirements of 7.1.4.5, one of the
above methods shall be applied as appropriate where on visual inspection the presence of cracking or lack of fusion may be suspected. To aid inspection the profile of the weld may be dressed by burr grinding provided that the specified throat size and leg length is still maintained. The surface of the weld shall be free of cracks, lack of fusion and slag.

7.1.4.4 Ultrasonic Testing. All butt joints selected in accordance with 7.1.4.5 shall be ultrasonically tested in accordance with BS EN 1714 where the column shaft is 8 mm thick or greater. For aluminium the principles in BS 3923 shall be applied. The weld shall be free of cracks. The height of buried slag, lack of fusion or lack of penetration shall not exceed 3 mm. Within 6 mm of the outer surface, their individual length shall not exceed 5 mm. The resulting net throat area loss over any 50 mm length of weld shall not exceed 5%.

7.1.4.5 Frequency of Testing. Joints for MPI, liquid penetrant inspection or ultrasonic testing shall be selected as follows:

10% of lighting columns of each type shall be inspected. The sample shall include all variations in joint geometry, material thickness and weld size covered by the basic type, that are within the scope of 7.1.4.3 and 7.1.4.4. If non-conformances are found the scope of MPI, liquid penetrant inspection and ultrasonic testing shall be doubled. If further non-conformances are found, the whole batch shall be tested.

7.1.4.6 Reporting. Inspection records for production welds shall be retained by the manufacturer for seven years and those covering the production periods relating to the lighting columns supplied shall be made available for examination.

7.1.5 Destructive Testing. Copies of certified reports of destructive tests on lighting columns supplied under earlier contracts with the Overseeing Organisation shall be made available for examination.

The Contractor shall supply sample joints cut from complete lighting columns for destructive testing as selected on behalf of the Overseeing Organisation. The sample joints shall be cut from the column, extension piece, bracket and welded anchorage where relevant. The basis of selection shall be as follows:

a) For orders of 1 to 10 lighting columns – one complete lighting column for each type, unless destructive testing has been carried out within the last year on a lighting column of that type. The manufacture, supply and verification of lighting columns and bracket arms shall comply with the quality management scheme described in Appendix A.

b) For orders of 11 to 300 lighting columns - one complete lighting column for each type unless destructive testing has been carried out within the last month on a lighting column of that type where the lighting column to be tested was also selected on behalf of the Overseeing Organisation.

c) For orders exceeding 300 lighting columns - two complete lighting columns for each type.

Acceptance criteria shall be as specified in 7.1.4, except that in 7.1.4.2 the throat and leg

dimension shall apply to the true rather than the apparent dimension.

In the event that there is a non-conformance arising from a serious deviation in materials, preparation, assembly, or welding procedure, the batch concerned shall be rejected and further production of the columns affected stopped until such time as the fault has been corrected. A minor non-conformance shall only be accepted on the basis that further sampling and testing shows that fault is not repetitive and in the view of the Overseeing Organisation will not in that instance impair structural integrity.

If the problem can be traced to a particular manufacturing period, operator, piece of equipment or batch of materials and if proper trace ability to individual batches of components can be assured, only those batches affected may be subject to rejection.
The destructive test reports shall be retained by the manufacturer and recorded in a register for a period of two years. The destructive test specimens shall be retained for a period of 12 months. These shall be made available for examination on future contracts with the Overseeing Organisation.

7.1.6 Remedial Work. Welds which do not comply with the Specification may be repaired to an approved procedure, as described in 7.1.2."

Page 2 - Clause 7

Delete sub-Clause 7.2 in its entirety.

1310.2 For CCTV Masts:

BS 5649 : Part 3 : 1982: Clause 2, Clause 6, sub-clause 7.1 and sub-clauses A1 and A3 shall apply, subject to the following amendments:

Page 2 - Clause 2

Delete the last sentence and replace with: "The steel shall be equivalent to or better than BS EN 10025, Grade S275 JR".

Page 2 - Clause 6

Delete and replace with: "The steel used for foundation bolts shall be equivalent to or better than BS EN 10025, Grade 275 JR".

Page 2 - Clause 7

Delete sub-Clause 7.1 and insert the following:

"7.1.Steel CCTV masts
7.1.1 General. Arc welding of carbon manganese steels shall comply with BS 5135. Arc welding of stainless steels shall comply with BS 4677.

7.1.2 Procedures. Written welding procedures shall be used with testing to BS EN 288 Parts 1, 2 and 3 for steel and shall apply to all production and repair procedures. These shall be subject to reapproval after a period of seven years. When applying BS EN 288 Parts 1, 2 and 3 the welding consumables and procedures used for steel shall be such that the mechanical properties of deposited weld metal will not be less than the respective minimum specified values of the parent metal being welded. Testing shall be by a laboratory appropriately accredited for weld testing. Approval shall be by an Independent Inspecting Authority using Registered Welding Engineers, Registered Welding Quality Engineers or equivalent.

7.1.3 Welder Qualification. The tests shall include in addition an application test representative of the 'main structural' joints on which the welder is to be approved to work. The main structural joints shall include, where relevant, the flange plate joint, the base compartment to shaft joint, the door reinforcement, any intermediate mast joint, the mast to bracket joint and the mast seam weld. Welders shall be subject to reapproval in

accordance with BS EN 287. Testing shall be by a laboratory appropriately accredited for weld testing. Approval shall be by an Independent Inspecting Authority using Registered Welding Engineers, Registered Welding Quality Engineers or Welding Inspectors or equivalent.

7.1.4 Inspection and Non-Destructive Testing

7.1.4.1 Inspection Personnel. The manufacturer shall provide suitable personnel to carry out inspection of production welds as required in 7.1.4.2 to 7.1.4.4. Personnel conducting visual inspection shall have a nationally recognized certificate of competence appropriate to the type of welding being inspected. Personnel conducting non-destructive testing (NDT) shall be certified according to a nationally recognized certification scheme appropriate to the equipment used and the weld groups inspected. Evidence of training and qualification shall be retained and made available for examination when required. The results of all weld inspections shall be recorded.

7.1.4.2 Visual Inspection. All welds shall be subject to visual inspection in accordance with BS EN 970 : 1997 prior to any NDT and galvanizing. Weld surfaces shall be free of slag residues and sharp edges. All surfaces shall be free of traces of weld spatter, arc strikes and contaminants. The apparent throat dimensions of butt welds and the apparent leg length and apparent throat dimensions of fillet welds, as measured by a welding gauge and taking into account any known lack of fit, shall not be less than those specified, except that local shortfalls up to 0.5 mm may be accepted provided the average over any 50 mm length is not less than the specified dimension. The toe angle shall not be less than 110°. The surface of all welds shall be free from cracks, lack of fusion including overlap, and slag. Isolated discontinuous porosity may be accepted provided it is not detrimental to the galvanizing process. Undercut shall not result in a section loss of more than 5% over any 50 mm length of joint, nor shall its depth exceed 0.5 mm or 10% of the thickness, whichever is the less.

7.1.4.3 Magnetic Particle Inspection (MPI). MPI shall be applied in accordance with BS 6072 to joints in steel CCTV masts selected in accordance with 7.1.4.5, where any of the material thickness exceeds 20 mm. Notwithstanding the requirements of 7.1.4.5, one of the above methods shall be applied as appropriate where on visual inspection the presence of cracking or lack of fusion may be suspected. To aid inspection the profile of the weld may be dressed by burr grinding provided that the specified throat size and leg length is still maintained. The surface of the weld shall be free of cracks, lack of fusion and slag.

7.1.4.4 Ultrasonic Testing. All butt joints selected in accordance with 7.1.4.5 shall be ultrasonically tested in accordance with BS EN 1714 where the mast shaft is 8 mm thick or greater. The weld shall be free of cracks. The height of buried slag, lack of fusion or lack of penetration shall not exceed 3 mm. Within 6 mm of the outer surface, their individual length shall not exceed 5 mm. The resulting net throat area loss over any 50 mm length of weld shall not exceed 5%.

7.1.4.5 Frequency of Testing. Joints for MPI or ultrasonic testing shall be selected as follows:

10% of CCTV masts of each type shall be inspected. The sample shall include all variations in joint geometry, material thickness and weld size covered by the basic type, that are within the scope of 7.1.4.3 and 7.1.4.4. If non-conformances are found the scope of MPI and ultrasonic testing shall be doubled. If further non-conformances are found, the whole batch shall be tested.

7.1.4.6 Reporting. Inspection records for production welds shall be retained by the manufacturer for seven years and those covering the production periods relating to the CCTV masts supplied shall be made available for examination.

7.1.5 Destructive Testing. Copies of certified reports of destructive tests on CCTV masts supplied under earlier contracts with the Overseeing Organisation shall be made available for examination.

The Contractor shall supply sample joints cut from complete CCTV masts for destructive testing as selected on behalf of the Overseeing Organisation. The sample joints shall be cut from the mast, extension piece, bracket and welded anchorage where relevant. The basis of selection shall be as follows:

a) For orders of 1 to 10 CCTV masts – one complete CCTV mast for each type, unless destructive testing has been carried out within the last year on a CCTV mast of that type.

b) For orders of 11 to 300 CCTV masts – one complete CCTV mast for each type unless destructive testing has been carried out within the last month on a CCTV mast of that type where the CCTV mast to be tested was also selected on behalf of the Overseeing Organisation.

c) For orders exceeding 300 CCTV masts – two complete CCTV masts for each type.

Acceptance criteria shall be as specified in 7.1.4, except that in 7.1.4.2 the throat and leg dimension shall apply to the true rather than the apparent dimension.

In the event that there is a non-conformance arising from a serious deviation in materials, preparation, assembly, or welding procedure, the batch concerned shall be rejected and further production of the columns affected stopped until such time as the fault has been corrected. A minor non-conformance shall only be accepted on the basis that further sampling and testing shows that fault is not repetitive and in the view of the Overseeing Organisation will not in that instance impair structural integrity.

If the problem can be traced to a particular manufacturing period, operator, piece of equipment or batch of materials and if proper traceability to individual batches of components can be assured, only those batches affected may be subject to rejection.

The destructive test reports shall be retained by the manufacturer and recorded in a register for a period of two years. The destructive test specimens shall be retained for a period of 12 months. These shall be made available for examination on future contracts with the Overseeing Organisation.

7.1.6 Remedial Work. Welds which do not comply with the Specification may be repaired to an approved procedure, as described in 7.1.2."

Page 2 - Clause 7

Delete sub-Clause 7.2 in its entirety.

Page 3, Appendix A1

Delete and replace with: "The following grades of steel are considered to comply with Clause 2 of this standard.

BS EN 10025 :	Grades	S275 JR, S275 JO, S275 J2G3, S275 J2G4, S355 JR, S355 JO, S355 J2G3, S355 J2G4
BS EN 10210 :	Grades	S275 JOH, S275 J2H, S355 JOH, S355 J2H".

Page 3 - Appendix A3

Delete and replace with: “The following grades of steel are considered to comply with Clause 6 of this standard Foundation bolts: BS 4190 Grades 4.6 and 4.8 BS 3692 Grade 8.8”.

1311 Amendments and Additions to BS 5649 : Part 5 : 1982 for Lighting Columns and CCTV Masts

1311.1 For Lighting Columns and CCTV Masts:

Page 3
3.2, after paragraph 2

Insert additional paragraphs as follows:

"The door arrangement shall be such that it can be opened by releasing a single threaded locking fastener. The fastener shall be of stainless steel to BS 6105 or BS 970 : Part 1 with the dimensions given in RCD Drawing Number K1.

When the door is secured the fastener head shall be completely recessed into the door in a circular recess as indicated in RCD Drawing Number K1.

Six door keys as shown on RCD drawing No. K1, or for alternative vandal resistant locks approved by the Overseeing Organisation shall be supplied to the Overseeing Organisation.
The locking fastener shall be suitable for opening with the standard key detailed in RCD Drawing Number K1."

1311.2 For Lighting Columns:

Page 3

3.4, after paragraph 2

Insert additional paragraph as follows:

"Where a cable entry slot width of 75 mm is provided, the minimum size of cableway from the cable entry slot to the base compartment shall be 75 mm"

After Page 3

Insert "RCD Drawing Number K1."

1312 Attachments to Lighting Columns and CCTV Masts

1 Attachments to lighting columns and CCTV masts shall be by means of circumferential clamps of stainless steel complying with AISI Grade 201 or other suitable material which shall not damage the column or its protective coating.

1313 Laminated Glass Fibre Reinforced Plastic (GFRP) Lighting Columns

Manufacture of GFRP Laminates

1 The columns shall be produced either by hand layup for mechanical moulding technique. The mechanical manufacture shall be carried out either by filament winding, centrifugal casting, compression moulding, resin injection or any other appropriate method accepted by the Overseeing Organisation.
2 An exterior resin rich layer of at least 0.25 mm thickness shall be provided to ensure adequate protection of the reinforcing fibres against adverse effects of the weather and possible chemical attack.

3 Columns containing bubbles, cracks, holes, pits or other voids each greater than 7 mm² in area shall be rejected.

4 The dimension and tolerances shall be those given in BS 5649 : Part 2: 1978 for seamless metal columns. The outer surface shall have a smooth uniform taper along its total length.

Materials for GFRP Laminates

5 The fibre reinforced plastic shall be in the form of laminate made of thermosetting resin, fibre reinforcement (mainly glass fibre), catalyst system and filler.

6 The resins used shall conform to the appropriate British Standards. Polyester resins shall be based on isophthalic acid and conform to BS 3532, Type B.

7 Any fillers and pigments incorporated in the resin shall form part of the total resin system and shall be subject to acceptance of the Overseeing Organisation.

8 Fibre reinforcement shall conform to the appropriate British Standards. Where glass fibre is used as the base for mat or chopped fibre it shall conform to BS 3691 and shall be treated with an appropriate finish compatible with the resin system used.

9 All accelerators, catalysts and hardeners shall be used in accordance with the resin manufacturer's instructions.

Testing of GFRP Laminates

10 The properties of the laminates shall be verified by testing as described in sub-Clauses 13 to 18 of this Clause. Any material failing any of the tests listed shall be rejected. Such tests shall, unless otherwise described in Appendix 13/1, be carried out on samples representing the batch of columns to be supplied under the Contract.

11 Two types of samples shall be provided for the tests:

(i) Samples from a specially prepared flat laminate for type tests or where changes in raw materials or manufacturing techniques are proposed. These shall comprise tests for colour fastness, electric strength, water absorption and impact strength.

(ii) Samples cut from complete columns to be used for quality control purposes, to be carried out at a frequency of one in each two hundred-production columns. Each column for tests will be selected on a random basis and will be examined by visual inspection and for loss on ignition.

12 A flat laminate sample 300 mm ± 10 mm square by 3 mm + 0.5 mm/-0.0 mm thick shall be prepared by hand lay-up method using the same curing conditions resin and reinforcement systems as used for production columns. The total glass fibre content shall not exceed 40% by weight.

13 The colour fastness test shall be conducted in accordance with BS 2782 : Part 5 : Method 550A and the results assessed by Method 552A. Material with a colour change assessed greater than moderate will not be accepted.

14 The electric strength test shall be carried out in accordance with BS 2782 : Part 2 : Method 221. The electric strength shall be not less than 10 kV/mm.

15 The water absorption test shall be carried out in accordance with BS 2782 : Part 4 : Method 430A. The absorption of water shall be not greater than 50 milligrammes.

16 The impact strength test shall be carried out in accordance with BS 2782 : Part 3 : Method 359. The impact resistance shall be at least 30 kJ/m².

17 The loss on ignition tests shall be carried out in accordance with BS 2782 : Part 10 : Method 1002. The loss on ignition on samples taken at random throughout the length of a column shall not exceed 60% after subtracting the amount allowed for non-combustible fillers. The percentage of glass fibre remaining following ignition shall be at least 40% by weight.

18 Samples cut randomly throughout the length of a column shall be visually inspected to confirm that there are no delaminations or voids greater than specified in sub-Clause 3 of this

Clause and that the laminate is fully densified and includes the required number of laminations.

1314 Brackets for Laminated GFRP Lighting Columns

General

1 Brackets shall consist of a galvanized steel tube assembly with an external self-skinning rigid polyurethane foam moulding.

Materials

2 The steel tube assembly shall comply with BS EN 40 : Part 1 and BS 5649 and the requirements of this Series.

3 The rigid polyurethane foam shall be moulded in accordance with the manufacturer's instructions to give a bulk density within the range of 500 ±50 kg/m3, when in the form of a test sheet in accordance with sub-Clause 5 of this Clause. The surface shall be free from obvious defects such as voiding, pitting or cracking. It shall have a surface hardness of at least D/30/1 when measured in accordance with BS 2782 : Part 3 : Method 365B.

4 The polyurethane moulding shall be primed with a two part polyurethane primer and finished with a two part polyurethane top coating all in accordance with the manufacturer's instructions.

Testing of Polyurethane Foam

5 Properties of foam shall be verified by testing using specimens cut from moulded test sheets of 10 mm nominal thickness using the same material as in the manufacture of the bracket arms.

6 The apparent bulk density of a specimen shall be determined and be within the range of 500 ± 50 kg/m3. The method of testing shall be in accordance with the polyurethane foam manufacturer's instructions.

7 The impact strength of a specimen shall be determined in accordance with BS 2782 : Part 3 : Method 359 and shall be at least 6.0 kJ/m².

8 The flexural stress at a deflection of 10 mm carried out on a specimen shall be in the range of 24 to 30 MPa. The method of testing shall be in accordance with the polyurethane foam manufacturer's instructions.

9 The tests specified in sub-Clauses 6, 7 and 8 of this Clause shall each be carried out on two specimens and, unless otherwise stated in Appendix 13/1, the results shall be representative of the batch of columns to be supplied.

10 Evidence of quality control including results of tests similar to those required in sub-Clauses 6, 7 and 8 of this Clause shall be made available when required by the Overseeing Organisation.

11 Tests specified in sub-Clauses 6, 7 and 8 of this Clause shall be carried out when changes in raw materials or manufacturing techniques are proposed. For quality control purposes testing shall be carried out in accordance with sub-Clause 3 of this Clause on each production batch of brackets, which are to be fitted to columns.

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WATERPROOFING FOR CONCRETE STRUCTURES

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WATERPROOFING FOR CONCRETE STRUCTURES

2001 General

1 Immediately before the application of the primer or laying of the waterproofing system or protective layer, the concrete surface or primed surface shall be clean, dry and free from laitance, loose aggregate dust and where the adhesion to the concrete would be impaired, free form curing liquids, compound and membranes.

2 The waterproofing membrane, primer and bonding agents including tack coat, shall be compatible with each other.

3 The use of ventilation layers, partial bonding or bond breakers with the waterproofing system is not permitted.

4 The surface finish for new bridge decks between parapet up stands and to top of buried structures to be waterproofed shall be Class U4 finish in accordance with sub-Clause 1708.4.

5 Existing waterproofing systems to bridge decks between parapet up stands are to be repaired or replaced in accordance with Clause 2008.

6 An additional protective layer shall be applied immediately above bridge deck waterproofing only to those areas shown on the Drawings and shall comply with this Series

2002 Protection of Bridge Deck Waterproofing During Construction

1 On any structure, providing no damage results, plant and equipment all fitted only with rubber tyres may stand or travel on waterproofing systems solely for the purposes of laying an additional protective layer or surfacing course on that structure.

Rollers shall not be permitted to stand or travel directly on the waterproofing system.

Where it is necessary for plant, equipment or traffic to stand or travel on a bridge deck that has been waterproofed (mastic asphalt waterproofing or proprietary waterproofing systems) with a permitted system before the laying of an additional protective layer, suitable temporary protection shall be provided. All such plant and equipment shall have its tyre treads regularly inspected and any embedded hard objects removed.

2 Temporary protection shall be provided where damage to the waterproofing, protective layer or additional protective layer could result from particular site traffic.

3 The protective layer of a two layer waterproofing system, or any protective layer additional to that included as part of a waterproofing system, shall be laid immediately after the waterproofing layer's bonding agent has set or cured. Where a waterproofing membrane also serves as an adhesive for the protective layer, any additional protective layer shall not be laid until the liquid

waterproofing membrane/adhesive has set or cured.

2003 Materials for Waterproofing Concrete Bridge Decks

Primer for Mastic Asphalt

1 Primer for sealing concrete surfaces prior to waterproofing shall be spirit based and compatible with mastic asphalt. The viscosity of the primer shall be such that it penetrates the concrete without forming a skin.

Mastic Asphalt

2 Unless otherwise described in Appendix 20/2, mastic asphalt for waterproofing complying with NBS 6925, type R988. Where mastic asphalt for waterproofing complying with BS 6925, type T1097 is required, the hardness number at the time of laying shall not exceed 90 at 25 °C.

Proprietary Waterproofing Systems

3 Proprietary Waterproofing systems incorporated in the Permanent Works shall have a current International Agreement Board Roads and Bridges Certificate. Each System shall also have a current PWS (Proprietary Waterproofing System) Data sheet cleared through IAB in their certification procedure.

The contractor shall furnish the Engineer with 3 copies of the PWS Data Sheet and Annex 'A' a blank copy of which is shown in Appendix 20/1. The system shall not be adopted for the works until the Engineer has provided his written acceptance of the complete system, its component materials, their characteristic properties and the preparation and installation instructions all as stated on the PWS Data Sheet and it s Annex 'A'. When furnishing the Engineer with the PWS Data sheet the contractor shall include for acceptance any additional information or limitation necessary to cater for the conditions at site including climatic and environmental limitations, compatibility of materials and details at the interface of the waterproofing with the bridge deck movement joints. No departures from the specified constituent materials as stated on the International Agreement Board Roads and Bridges Certificate and the PWS Data Sheet shall be permitted.

Additional Bituminous Protection

4 Bituminous protection where shown on the drawings as an additional protective layer, shall comply with BS 594 : Part 1 recipe Type F wearing course mixture Designation 0/3 except that 5% ± 0.5% of the total mix shall be inorganic red oxide and regarded as part of the filler content, where the additional protective layer is required to be tinted.

2004 Materials for Waterproofing Below Ground Concrete Surfaces

Primer for Tar and Bitumen

1 Primer for sealing concrete surfaces prior to waterproofing shall be compatible with the selected tar or bitumen waterproofing material. The viscosity of the primer shall be such that it penetrates the concrete without forming a skin.

Tar

2 Tar shall comply with BS 76 of viscosity grade within the range 30-38°C equi-viscous temperature.

Cut Back Bitumen

3 Cut back bitumen shall comply with BS 3690 : Part 1 of viscosity grade 50 seconds.

Proprietary Materials

4 Subject to any restrictions specified in Appendix 20/2, proprietary materials may be used.

2005 Workmanship for Waterproofing Concrete Bridge Decks

Mastic Asphalt

1 Unless otherwise agreed by the Engineer, the concrete surface shall be thoroughly sealed with evenly applied primer. The primer shall be well brushed in to avoid pending in any depression in the desk.

2 Mastic asphalt shall be laid directly onto the primer surface:

(i) on horizontal surface and sloping surfaces up to 30 °C to the horizontal in two coats or equal thickness to a total thickness of not less than 20 mm;

(ii) on vertical surface and sloping surfaces of over 30 °C to the horizontal in two or three coats of equal thickness to a total thickness of not less than 20 mm.

3 The method of laying and workmanship shall comply with the recommendations of British Standard Code of Practice CP 144: Part 4: 1970, Section 4 except that:

(i) in addition to sub-clause 4.6.1., visible blow holes and other defects shall be made good before laying a subsequent coat.

(ii) Sub-Clause 4.6.2. and 3 and 4.7.1, 2, 8 and 9 shall no apply; and

(iii) details described in the contract shall prevail over any conflicting requirements in the Code of Practice.

4 Joints shall be staggered a distance of at least 150mm between courses and their position and the sequence of working shall be agreed by the Engineer before commencement of the work. The mating edges of all the joints shall be intimately bonded. The surfaces of gullies or other metal features with which the waterproofing will be in contact shall be clean, dry and painted with at least 2 coats of cut back bitumen.

5 Proprietary waterproofing systems shall be only installed by applicators approved by the manufacturers and in accordance with the PWS Data Sheet and its Annex ‘A’. The formation of defects affecting the integrity of the membrane including pin/blow holes (continuous or non-continuous) and blisters in the waterproofing shall:

(i) be made good by repair in accordance with the International Roads and Bridges Agrément

Certificate before any subsequent layers are applied; or

(ii) require the system to be replaced where directed by the Engineer.

For sheet membranes bonded with oxidized bitumen the heating and temperature of the bitumen shall comply with the manufacturer's requirements within the limits stated in BS 8000 : Part 4.

A means of checking the bitumen temperature shall be provided.

Sheet membranes shall wherever possible be laid in the direction that the additional protective layer or surfacing will be laid and compacted by roller.

6 Unless otherwise specified in the International Roads and Bridges Agrément Certificate, joints between sheets shall be lapped with end laps of at least 150 mm and side laps of at least 100 mm. The joints shall be arranged so that:

(i) at no point are there more than three thicknesses of sheeting and,

(ii) water will drain away from the exposed edge.

7 Proprietary waterproofing systems shall be laid to follow the contours of the concrete surface. Laps, ridges and ripples in waterproofing sheeting, and peaks and steps at butt joints in waterproofing boards, shall not be greater than 10 mm in height.

Additional Bituminous Protection

8 Bituminous protection complying with sub-Clause 2003.4 shall be laid on the clean and dry substrate, and compacted in accordance with Clause 901 to the areas and thickness shown on the Drawings.

Bond Between Additional Protective Layer or Surfacing and the Waterproofing System

9 The additional protective layer or surfacing laid on the waterproofing system shall be firmly bonded to the system for the life of the system. Where a tack coat for the additional protective layer or surfacing is not provided as part of the waterproofing system, a satisfactory bond to the membrane shall be obtained from

(i) a separate compatible tack coat or

(ii) the binder within the directly applied additional protective layer or surfacing.

Where the tack coat is of the type activated by the heat of the succeeding bituminous layer the rolling temperature of this layer shall be sufficient to ensure adhesion.

2006 Workmanship for Waterproofing Below Ground Concrete Surfaces

Priming for Tar and Bitumen

1 Unless otherwise described in Appendix 20/2 and prior to the application of the selected tar or bitumen waterproofing, concrete surfaces shall be

thoroughly sealed with an evenly applied primer. The primer shall be well brushed in and not allowed to pond in any depressions.

Tar

2 For tar waterproofing, two coats of tar shall be hot applied at a rate of spread per coat of 1 litre/m². The first coat shall be allowed to dry before the second coat is applied.

Cut Back Bitumen

3 For bitumen waterproofing two coats of cut back bitumen shall be hot applied at a rate of spread per coat of 0.6 litre/m². The first coat shall be allowed to dry before the second coat is applied.

Proprietary Materials

4 For proprietary materials the method of application, rate of spread, number of coats and other requirements for each system shall be as described in the manufacturer's method statement and application requirements and shall satisfy the requirements of Appendix 20/2.

2007 Integrity Testing of Concrete Bridge Deck Waterproofing

1 Waterproofing systems to concrete bridge decks shall be tested where required in Appendix 20/2 in accordance with the requirements therein to verify the integrity of the waterproofing.

2008 Repair and Replacement of Bridge Deck Waterproofing

1 The repair and replacement of existing bridge deck waterproofing systems shall comply with the requirements of Clauses 2002, 2003, 2005 and 2007 and any additional requirements described in Appendix 20/1.

BRIDGE BEARINGS

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PARAPETS

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BRIDGE EXPANSION JOINTS AND SEALING OF GAPS

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SERIES 2400

BRICKWORK, BLOCKWORK AND STONEWORK

Contents

BRICKWORK, BLOCKWORK AND STONEWORK

2401 Cement

1 Cement shall be one of the following:

(i) Portland cement CEMI complying with MSA EN 197-1;

(ii) Masonry cement complying with BS 5224;

(iii) Sulfate-resisting Portland cement complying with MSA EN 197-1 where described in Appendix 24/1.

2402 Aggregates

1 Sand shall comply with BS 1199 and 1200.

2403 Water

1 If water for the Works is not available from a water company's supply, the Contractor shall ensure that the water complies with the guidance given in BS 3148. Water from the sea or tidal rivers shall not be used.

2404 Mortar

1 Cement mortar for brickwork, blockwork and stonework shall be mixed in the proportions given in Table 24/1 according to the mortar designation described in Appendix 24/1.

2 The chloride ion content of the mortar determined in accordance with BS 812 : Part 117 shall not exceed 0.3% of the mass of cement for mortar made with Portland cement and 0.2% for mortar made with sulfate-resisting Portland cement. Calcium chloride or admixtures containing calcium chloride shall not be used.

3 For work in which cement mortars of designation (ii) or (iii) as defined in BS 5628 : Part 3 are required, the Contractor shall select the appropriate mortar from one of the mixes for the designation given in Table 24/ 1. Admixtures shall comply with either BS 4887 or BS 5075 and shall not contain calcium chloride.

TABLE 24/1: Mortar Proportions by Volume

Mortar designation	Cement Lime: sand	Masonary Cement: sand	Cement Sand with plasticiser
(i)	1:0 to 1 / 4: 3	-	-
(ii)	1: ½ 4 to 4 ½	1:2 ½ to 3 ½	1:3 to 4
(iii)	1:1:5 to 6	1: 4 ½	1:5 to 6

4 The inclusion of lime in mortar designation (i) is optional. The proportions of lime given in Table 24/1 are for lime putty complying with BS 890. If the lime is measured as the dry hydrate, the amount may be increased up to 1.5 volumes for each volume of lime putty. Where a range of sand contents is given in the Table, the higher shall be used for sand that is well graded and the lower for coarse or uniformly fine sand.

5 Mortar shall be mixed thoroughly either by hand or mechanically until its colour and consistency are uniform. The constituent materials shall be accurately gauged, allowance being made for bulking of sand. Mortar shall be made in small quantities only as and when required. Mortar which has begun to set or which has been mixed for a period of more than one hour in the case of a mortar designation (i) or more than two hours in the case of other designations shall be discarded.

2405 Lime Mortar

1 Lime mortar shall consist of one part by volume of hydrated lime complying with BS 890 to 2.5 parts by volume of sand.

2406 Bricks

1 Clay bricks shall comply with the particular requirements of BS 3921 as described in Appendix 24/1.

2 Calcium silicate bricks (sand lime and flint lime) shall comply with BS 187.

3 Concrete bricks shall comply with BS 6073 : Part 1.

4 Bricks beneath frames for chambers and gullies, and for the construction of brick chambers, shall, unless otherwise described in Appendix 24/1, be Class B clay engineering bricks complying with BS 3921; or concrete bricks complying with BS 6073 : Part 1 having a crushing strength not less than 20 N/mm² when used for surface water drainage, or special purpose concrete bricks having a minimum cement content of 350 kg/m^3 when used for foul drainage and for situations where improved durability is required

2407 Blocks

1 Concrete blocks shall comply with the particular requirements of BS 6073 : Part 1 as described in Appendix 24/1.

2408 Reconstructed Stone

1 Reconstructed stone shall be used only in blockwork and shall comply with BS 6457 and any particular requirements described in Appendix 24/1.

2409 Natural Stone

1 Building stone shall be of the type and quality described in Appendix 24/1.

2410 Reinforcement

1 Wire or fabric, laid between brickwork or blockwork shall be austenitic stainless steel to BS 970 : Part 1 Type 304 S 15, 316 S 31 or 316 S 33, softened condition, excluding free machining specifications.

2 Steel bars laid between brickwork or blockwork shall be austenitic stainless steel to BS 6744 Grade 250 or 460, Type 304 S 31 or 316 S 33, softened condition, excluding free machining specifications.

2411 Anchorages, Dowels, Fixings and Ties

1 Anchorages, dowels, fixings and ties shall be austenitic stainless steel Type 304 S 15, 316 S 31 or 316 S 33, softened condition, excluding free machining specifications, complying with the requirements given in the British Standards listed in Table 24/2.

TABLE 24/2: Austenitic Stainless Steel

Form	Standard to be complied with
Strip	BS 1449 : Part 2
Rod	BS 970 : Part 1
Bar	BS 6744
Tube	BS 6323 : Part 8
Wire	BS 1554

2412 Brickwork and Blockwork

1 Brickwork and blockwork shall be laid on a full bed of mortar and bonded as described in Appendix 24/1. Single frogged bricks shall be laid with the frog uppermost. Perpends between bricks and blocks shall be filled with mortar before the next mortar bed is laid. Whole bricks and blocks shall be used except where it is necessary to cut closers or where otherwise agreed by the Engineer.

2 Brickwork and blockwork shall be built uniformly. Corners and other advanced work shall be stepped back and not raised above the general level more than 900 mm. Courses shall be kept horizontal and matching perpends shall be in vertical alignment.

3 Unless stated in Appendix 24/1, overhand work shall not be permitted.

4 Bed-joint reinforcement may have a 15 mm minimum of mortar cover to each masonry face. It shall not be laid dry on a bed face, but shall be completely embedded within the mortar bed thickness.

5 Where pointing is required in Appendix 24/1 the joint shall be raked out to a depth of 12 mm and after the completion of the entire facework, pointed in mortar as described in Appendix 24/1.

6 Where jointing is required in Appendix 24/1 it shall be done as the work proceeds to the finish described in Appendix 24/1.

2413 Stonework

General

1 Except where otherwise described in Appendix 24/1, the length of any stone shall not exceed three times its height. The breadth on the bed shall be not less than 150 mm, nor greater than three-quarters of the thickness of the wall.

2 All stratified stone possessing bedding planes shall be laid with its natural bed as nearly as possible at right angles to the direction of load. In the case of arch rings, the natural bed shall be radial.

3 Facework quoins shall be built to a height not exceeding 900 mm in advance of the main body of the work and adjacent walling stepped down on either side.

4 Stone facework between the quoins shall then be built to a height not exceeding 450 mm above the backing which shall then be brought up level with the completed facework. At no time shall the backing be built up higher than the facework.

5 Except for dry rubble walling, all joints shall be sufficiently thick to prevent stone-to-stone contact and shall be completely filled with mortar.

Ashlar

6 All stones shall be dressed to accurate planes on the beds and joints, and they shall be fair and neatly or fine tooled on the face as described in Appendix 24/1.

Block-in-course

7 Beds and joints shall be squared and dressed for a distance of at least 225 mm from the exposed face. Bond stones shall

form not less than one sixth of the area of the exposed face and shall extend at least 900 mm into the wall or for the full thickness of the wall if the latter is less than 900 mm. Unless described in Appendix 24/1 as tooled or worked, the exposed face of all stone shall be blocked and left rough. Arrises shall be dressed square at all beds and joints.

Squared Random Rubble Coursed and Uncoursed

8 All stones shall be truly squared and dressed on the beds and joints for a distance of at least 125 mm from the exposed face. Bond stones shall be provided at the rate of not less than one to every square metre of exposed face, and shall measure not less than 150 mm x 150 mm on the face, and not less than 450 mm or the full thickness of the wall if the latter is less than 450 mm. Sneck stones shall be not less than 75 mm in any dimension. Vertical joints shall not include more than three consecutive stones, and the horizontal lapping of the stones shall be not less than 100 mm.

Random Rubble Coursed and Uncoursed

9 All stones shall be carefully set with a bond stone provided at the rate of not less than one to every square metre of exposed face. Bond stones shall measure not less than 150 mm x 150 mm on the exposed face, and not less than 450 mm in length or the full thickness of the wall if the latter is less than 450 mm unless otherwise described in Appendix 24/1. For coursed work the joints shall be levelled as described in Appendix 24/1 and the backing flushed up in mortar.

Dry Rubble

10 Dry rubble stonework shall be constructed generally to the requirements of uncoursed random rubble stonework, as specified in sub-Clause 9 of this Clause but without mortar. All stones shall be carefully shaped to obtain a close fit at all beds and joints, any interstices between the stones being filled with selected stone chippings or spalls. The exposed tops or copings of dry rubble walls shall be formed as shown on the Drawings.

Special Stonework Including Quoins, Copings, Plinths, Voussoirs etc

11 Special stonework shall consist of selected stones dressed to the shapes and dimensions, and where required their faces worked, all as shown on the Drawings.

2414 Cold Weather Working

1 No bricks, blocks or stones shall be laid when the air temperature in the shade is below 3°C unless precautions are taken in accordance with BS 5628: Part 3.

2415 Protection of New Work

1 Immediately after laying and for 3 days thereafter, brickwork, blockwork and stonework shall be protected against the harmful effects of weather. The upper surface of newly laid brickwork, blockwork and stonework shall be protected against rain as the work proceeds until such time as the work is completed and the upper damp-course, coping or other finishing feature is laid.

2 All visible brickwork, blockwork and stonework and any surface below such work which is visible at the completion of the Works shall be clean and free from damage

and spillage. All purpose-made open joints shall be free from debris of any description.

2416 Brick, Block and Stone Facework Fixed to Concrete

1 Any loose material shall be removed from the concrete, and its surface washed with clean water before any bricks, blocks or masonry is laid.

2 The portion of the stainless steel fixing projecting from the concrete shall be completely embedded in the mortar of the facework and shall be kept back a minimum of 30 mm from the face of the brickwork and blockwork or 40 mm from the face of the masonry.

3 The cavity between brick and block facework and the concrete shall be completely filled as the work proceeds with mortar of the same mix as that specified for the facework.

4 The variation in depth, front to back of stones for natural stone facework shall not exceed that described in Appendix 24/1 and the space between the facework and the backing shall be completely filled as the work proceeds with concrete Class 15/10 complying with the 1700 Series.

SPECIAL STRUCTURES

Contents

SERIES 2600

MISCELLANEOUS

Contents

MISCELLANEOUS

2601 Bedding Mortar General

1 Bedding mortar shall satisfy the following performance requirements:

(i) Unless otherwise described in Appendix 26/2, bedding mortar shall have a compressive strength not less than 50 N/mm² when tested in accordance with sub-Clause 4(iv) or 4(v) of this Clause.

(ii) The flow characteristics shall be such that the volume of the bed or plinth as shown on the Drawings is completely filled with homogeneous material when placed within the range of ambient temperature between 5°C and 30°C, or as otherwise described in Appendix 26/2.

(iii) The physical and chemical properties shall be compatible with those of all adjoining surfaces. The stress in the mortar shall not exceed that defined in Appendix 21/1 for bridge bearings and Appendix 26/2 for other applications. Where the mortar is required to resist stress before attaining its 28-day strength the compressive strength shall be confirmed by tests on mortar cubes stored under conditions that simulate the field conditions.

Materials

2 (i) The maximum aggregate size in bedding mortar shall be 2.36 mm.

(ii) Proprietary materials shall be stored as follows:

(a) The materials shall be stored in a dry environment at a temperature of between 10°C and 27°C.

(b) The containers shall be damp-proof, leak proof and readily emptied of their contents.

(c) Containers shall be marked with the batch reference number, component identification,manufacturer's name, net weight and such warnings or precautions concerning the contents as are required.

(iii) The material shall not be removed from the store for use in the Works until immediately prior to mixing.

(iv) Material shall not be used more than six months after the date of manufacture or any lesser period specified by the manufacturer or supplier.

(v) The Contractor shall supply with each batch or part of a batch of the material delivered to the Site,

certificates furnished by the supplier or manufacturer stating the following:

(a) Manufacturer's name and address.

(b) Manufacturer's agent's name and address where applicable.

(c) Description of material and brand name.

(d) Batch reference number, size of batch, and number of containers in the delivery order.

(e) Date of manufacture.

(f) The chloride ion content, expressed as a percentage by mass of cement.

(vi) Calcium chloride or admixtures containing chloride salts shall not be used and the total chloride ion content shall not exceed 0.1% of the mass of cement.

(vii) Portland cement shall comply with MSA EN 197-1.

(viii) The total acid-soluble sulfate content of the mix expressed as SO3 shall not exceed 4% of the mass of cement in the mix. The sulfate content shall be calculated as the total from the various constituents of the mix.

(ix) If water for the Works is not available from a water company's supply, the Contractor shall ensure that the water complies with the guidance given in BS 3148. Water from the sea or tidal rivers shall not be used.

(x) Resinous bedding mortars shall be based on thermosetting organic polymers consisting of stable fluid and/or solid components which on mixing react chemically to form a hardened solid mass. Products shall be formulated from epoxide, polyester, polyurethane or acrylic resin systems. Fillers or aggregates to be incorporated in accordance with the manufacturers recommendations, to extend or modify the properties of the resinous composition, shall be pre-bagged, dry and factory proportioned. The addition of other fillers or aggregates shall not be permitted.

Site Mixing, Placing and Curing

3 (i) Mixing, placing and curing of proprietary bedding mortar shall be carried out in accordance with the manufacturer's written instructions together with the following:

(a) The material shall not be mixed or placed in the Works at ambient temperatures of less than 5°C. If for 24 hours before, during or after placing, the ambient temperature falls below 5°C the Contractor shall maintain the temperature of the substrate and other adjoining surfaces at not less than 5°C for the duration of the curing period

recommended by the manufacturer.

(b) For cementitious bedding mortars the water/cement ratio shall not exceed 0.4. The water content shall be confirmed during the approval tests, and maintained within a tolerance of ± 1 per cent in mortars placed in the Works.

(c) Only full packs of mortar as supplied shall be mixed. On-site proportioning shall not be permitted.

(d) The temperature of the mortar on completion of mixing shall be between 5°C and 30°C.

(ii) For cementitious bedding mortars, the substrate shall be flushed clean with water two hours before placing and maintained wet until placing commences. Any free water on the surface of the substrate shall be removed before placing the mortar. The underside of the base plate shall be clean and free from loose rust and loose mill scale at the time of bedding. The mortar shall be placed in its final position within 25 minutes of commencement of mixing. Immediately after casting, the mortar shall be protected to prevent evaporation for at least three days.

(iii) For resinous bedding mortars the substrate shall be dry, free from loose dirt and dust and shall meet the conditions specified by the manufacturer. The underside of the base plate shall be clean and free from loose rust and loose mill scale at the time of bedding. The mortar shall be placed in its final position within one hour, or lesser period specified by the manufacturer, of commencement of mixing.

(iv) The mortar shall be poured in one corner of the plinth. The addition of mortar to the sides of the plinth shall only be permitted after the mortar has flowed completely under the plinth.

(v) When the mix proportion have been approved by the Engineer no variations shall be made in the manufacture, supply, mix proportions of method of mixing of the material without he consent of the Engineer.

(v) No internal metal shims shall be allowed to remain in the hardened bedding mortar except where described in Appendix 26/2. The contractor shall submit his proposals for shims for approval to the Engineer

Laboratory Approval Tests

4 (i) General

Every batch of mortar to be used in the Works shall be tested by the Contractor. Where more than one batch of mortar is to be used in the Works the Elastic Stability Test may be omitted from the testing regime subsequent to the initial laboratory approval tests. The Contractor shall state the water content to be used, expressed as a

percentage by weight of the material. Mixing shall be carried out in accordance with the manufacturer's written instructions.

(ii) Flow Cone Test, Calibration of Flow

(a) The flow characteristics of the mortar shall be determined by the Flow Cone Test method described in ASTM Standard C939-87.

(b) Tests shall be conducted at ambient temperatures of 5°C and 30°C within 15 minutes of commencement of mixing.

(c) For the test at 5°C the temperature of the flow cone and the mixer shall be 5°C, the temperature of the dry material 10°C, and the temperature of the water where required, 20°C.

(d) For the test at 30°C the temperature of the flow cone, the mixer, the dry material and the water where required shall be 30°C.

(e) For each temperature at least two tests having times of efflux within ± 5% shall be made and the average time of efflux to the nearest 0.2 second shall be reported.

(iii) Flow Between Glass Plates

(a) The flow characteristics of the mortar between glass plates shall be determined using the apparatus shown in UK Department of Transport Road Construction Details.

(b) Tests shall be conducted at ambient temperatures of 5°C and 30°C.

(c) The temperature of the apparatus, dry material and water for each test shall comply with sub-Clause 4(ii)(c) and (d) of this Clause.

(d) The mortar shall be poured in one corner of the apparatus commencing between 18 minutes and 20 minutes after commencement of mixing.

(e) A satisfactory flow shall be achieved when the mortar flows under the glass plate and rises at least 10 mm above the underside of the top plate at all positions, without signs of segregation, bleeding, effervescence or air inclusions.

(iv) Compressive Strength (Cementitious)

(a) The compressive strength of cementitious bedding mortars shall be carried out on six 70 mm cubes at an age of 28 days.

(b) The temperature of the mixer, the dry material, the water and the moulds shall be 25°C.

(c) The 70 mm cube moulds shall comply with BS 1881 : Part 108. Test specimens shall be made by filling the moulds carefully through a funnel to produce a void-free mortar. The moulds shall be covered by a steel plate to prevent expansion of the mortar.

(d) There shall be no compaction. Specimens shall be damp-cured for the first 24 hours, removed from the moulds and then water cured. Curing shall comply with BS 1881 : Part 111.

(e) Testing shall comply with BS 1881 : Part 116.

(f) The strength requirement shall be satisfied if none of the compressive strengths obtained is lower than 50 N/mm² and the difference between the highest and lowest values is not more than 20% of the average. All results shall be reported.

(v) Compressive Strength (Resinous)

(a) The compressive strength for resinous bedding mortars shall be carried out on six 40 mm cubes at an age of 24 hours.

(b) The 40 mm cube moulds shall comply with BS 6319 : Part 1 and shall be carefully filled using a funnel to ensure void-free cubes. There shall be no compaction.

(c) Testing shall comply with BS 6319 : Part 2.

(d) The strength requirement shall be satisfied if none of the compressive strengths obtained is lower than 50 N/mm² and the difference between the highest and lowest values is not more than 20% of the average. All results shall be reported.

(vi) Expansion Test

(a) Short term expansion shall be determined by the method described in ASTM Standard C827-87. Results shall be determined from the mean of two tests.

(b) The expansion of cementitious bedding mortars at 24 hours shall be less than 2.5% and greater than 0.25%.

(c) The volume change of resinous bedding mortars at 24 hours shall be between -0.6% and +1.0%.

(vii) Water Absorption Test

(a) Absorption of water by resinous bedding mortars shall be determined by the method described in ASTM Standard C413-83. The absorption shall be not more than 0.4%.

(viii) Elastic stability tests for cementitious bedding mortars shall be carried out on one set of three cubes made at 25°C as described in sub- Clause 4(iv) of this Clause.

(a) Curing shall comply with BS 1881 : Part 111. After a minimum of 28 days, the cubes shall be placed in water at 20°C heated at a uniform rate to 45°C in 24 hours.

(b) Upon attaining 45°C the cubes shall be sealed in a plastic bag and then loaded at a compressive stress of 30 N/mm² maintained for six hours at 45°C and the strain measured.

(c) The total compressive strain shall not exceed 1% on each cube.

(ix) Elastic stability tests for resinous bedding mortars shall be carried out on one set of two 40 mm cubes complying with BS 6319 : Part 1.

(a) On removing the cubes from the moulds after 24 hours they shall be heated at a uniform rate to 45°C in a further 24 hours.

(b) Upon attaining 45°C the cubes shall be loaded at a compressive stress of 30 N/mm² maintained for six hours at 45°C and the strain measured.

(c) The total compressive strain shall not exceed 1% on each cube.

Site Control Tests

5 (i) If the efflux times at 5°C and 30°C determined as described in sub-Clause 4 (ii) of this Clause are within 10% or two seconds of each other, whichever is the greater, then site control tests for flow shall be carried out as described in (a) below. In other cases, when the air temperature is less than 10°C site control tests for flow shall be carried out as described in (b) below and when the air temperature is greater than 10°C site control tests for flow shall be carried out as described in (a) below.

(a) Each load of mortar mixed for placing in the Works shall be tested at ambient temperature by the flow cone test method as described in sub-Clause 4(ii) of this Clause. The results shall agree within ± 10% or ± two seconds whichever is the greater, of the values obtained in the approval tests at 30°C.

(b) Each load of mortar mixed for placing in the Works shall be tested at ambient temperature by the flow cone test method as described in sub-Clause 4(ii) of this Clause. The results shall agree within ± 10% or ± two seconds whichever is the greater, of the values

obtained in the approval tests at 5°C. (ii) Compressive Strength. Three cubes from each load of mortar mixed for placing in the Works shall be tested for compressive strength as described in sub-Clause 4(iv) or 4(v) of this Clause as appropriate.

Tolerances

6 The following tolerances shall apply to all temperatures referred to in this Clause:

5°C (- 0°C + 2°C)
10°C (- 0°C + 2°C)
30°C (- 0°C + 2°C)
45°C (- 2°C + 2°C)
110°C (- 5°C + 5°C)

The tolerances applying to all linear dimensions, unless otherwise shown on the Drawings shall be ± 1%.

2602 Concrete for Ancillary Purposes General

1 Concrete mixes referred to in the Contract as ST followed by a number shall mean concrete for ancillary purposes which shall comply with this Clause and any additional requirements in Appendix 26/1.

2 Concrete for ancillary purposes shall be a standard mix complying with BS 5328 and with the additional requirements of this Clause.

Cement

3 Cement shall be Portland cement CEMI complying with MSA EN 197-1, Portland blast furnace cement CEM III/A complying with MSA EN 197/1, Portland pulverised-fuel ash cement CEM II/B-V complying with MSA EN 197/1 or, where required in Appendix 26/1, sulfate-resisting Portland cement complying with BS 4027, or sulfate-resisting Portland cement type Low Alkali (LA) complying with BS 4027.

Aggregates

4 Aggregates shall comply with Clause 1702, Sub-Clause 2 and unless otherwise described in Appendix 26/1 the nominal maximum size shall be 20 mm. The total acid-soluble sulfate content in the mix expressed as SO3, shall not exceed 4% of the mass of cement in the mix.

Workability

5 The workability of the mix shall be defined by its slump and be within either the medium (75 mm) or high (125 mm) range of BS 5328: Part 2 as appropriate to the purpose.

Concrete Mix

6 The concrete mix used for each purpose shall be as described in Table 26/1 unless otherwise described in Appendix 26/1.

TABLE 26/1: Concrete for Ancillary Purposes

Purpose	Mix*
1 Footings for fence posts and augered foundations for traffic sign posts	ST 2
2 Foundations for safety fence posts, environmental barrier posts and planted lighting columns	ST 5
3 Anchor blocks for safety fencing	ST 5
4 Blinding concrete, backfill for structural foundations, overdig of post holes and preparation of formation to Clause 616	ST 1
5 Bedding and backing to precast concrete kerbs, channels, edgings and quadrants	ST 4
6 Foundations, channels and benching to chambers	ST 4
7 Bed, haunch and surround to drains Surround to chambers and gullies	ST 2

* Unless otherwise described in Appendix 26/1 # Refer to RCD drawing number F1 and F2

Transporting, Placing and Compacting Concrete

7 Concrete shall be transported and placed so that contamination, segregation and loss of materials does not occur. The maximum temperature of the concrete at any time between mixing and placing shall be no greater than 30°C. Concrete shall be placed and compacted within two hours of mixing. After compaction it should not be disturbed within 12 hours.

8 Concrete shall be compacted by tamping or vibrating until it is thoroughly worked around any embedded metal and into corners of formwork or excavations, until a solid mass substantially free from voids is obtained without segregation and with no free water on the surface. The Contractor shall select the workability as described in sub-Clause 5 of this Clause to achieve this.

9 Surface finishes shall comply with Clause 1708 and, unless otherwise described in Appendix 26/1, the following:

Buried surfaces:

Unformed surfaces shall be Class U1
Formed surfaces shall be Class F1

Exposed surfaces:

Unformed surfaces shall be Class U2 except benching to chambers, which shall be Class U3 Formed surfaces shall be Class F2

10 Formwork shall be struck without damage to the concrete not less than two days after placing the concrete and exposed surfaces shall be cured as described in Clause 1027 or by covering them with an opaque impermeable membrane or with hessian or sand which shall be kept damp. Such covering shall not be removed for two days after placing.

11 This Clause shall be complied with where standard mixes to BS 5328 are shown on the Drawings for purposes other than those in Table 26/1.

2603 Porous No Fines Concrete, Concrete for Pipe Areas

1 No fines concrete shall consist of Portland cement according to MSA EN 197-1 and 40 mm single size aggregate complying with Clause 1702, Sub-Clause 2.
2 The ratio of aggregate to cement shall be 8:1 by volume or 10:1 by mass.

3 The concrete shall be mixed by machine or by hand to a uniform colour and consistency before placing. The quantity of water used shall not exceed that required to coat all of the aggregate particles without forming excess grout.

4 The concrete shall be compacted by hand only.

Concrete for Pipe Areas

5 The sections in the pipe area which cannot be perfectly backfilled and compacted are to be backfilled with concrete, light weight concrete or a soil-binder-mixture with a 28 days compressive strength of 0.5 N/mm²

2604 Plastic Coating to Fencing Posts, Gates and Ancillaries

1 Plastic coating to steel or galvanized steel fence posts, gates and ancillaries shall comply with BS 1722: Part 16. Preparation of steel and galvanizing shall comply with the 1900 Series.

2605 Plastic Coated High Tensile Wire

1 Wire shall be 3.15 mm nominal diameter high tensile drawn carbon steel wire with a minimum tensile strength of 1050 N/mm², zinc coated to comply with BS 443 and plastic coated to comply with the following sub-Clauses and shall be grade designated Grade A.

2 Plastic coatings shall be applied to wire by extrusion using a compound complying with BS 2571 Type E1A and with the following additional requirements (i) to (iii):

(i) The Vinyl chloride homopolymer shall be mixed with appropriate primary plasticizers, heat and light stabilizers or pigments shall be used. No other material shall be added to the compound.

(ii) Not more than 5% of clean, once re-worked material, which shall be of the same composition, shall be added to the virgin material from which the compound is to be manufactured.

(iii) The softness number of the compound shall be not less than five nor greater than 15, when tested as described in BS 2782: Part 3: Method 365A.

3 The surface of extruded plastic coatings shall be smooth, continuous and free from discoloration. The colour of the coating shall be as required by Appendix 3/1 either green or black in accordance with BS 4800.

4 The overall nominal diameter of the plastic coated wire shall be 4.00 mm. When two diameter measurements are made at right angels to each other at a cross-section, the average of the two measurements shall not differ from the specified nominal diameter by more than + 0.05mm.

2606 Cored Thermoplastic Node Markers General

1 Cored thermoplastic node markers shall be white and installed in pairs or sets of three at the locations described in Appendix 26/3.

Node Markers

2 The node markers shall be constructed as follows:

(i) 100 mm diameter pockets 10 mm ± 5 mm deep shall be cored in the finished road surface at 175 mm ± 5 mm centres within a longitudinal tolerance of ± 0.25 m. The pockets shall be cored using a drill consisting of central pilot bit surrounded by a 100 mm annular bit. The material within the annulus shall be carefully broken out leaving a rough surface to the base of the pocket. The line joining the centres of the markers shall be perpendicular to the centre line of the lane in which the markers are installed.

(ii) The base of the pockets should be cleaned and dried ensuring that all loose material is removed.

(iii) Thermoplastic material complying with BS 3262: Part 1 Class A shall then be poured into the pockets until the material projects slightly above the level of the road surface, but the material must not be allowed to spread onto the surrounding carriageway surface. Solid Glass Beads complying with BS 6088 shall be incorporated in the thermoplastic material but shall not be applied to the wet surface of the material.

2607 Not Used

LANDSCAPE AND ECOLOGY

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