

GENERAL TECHNICAL SPECIFICATIONS

STANDARD SPECIFICATIONS FOR ROAD AND CIVIL WORKS

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SECTION 100 - GENERAL REQUIREMENTS**101 GENERAL**

1. The Specification shall be read in conjunction with all the other tender documents.

102 LOCATION OF THE SITE

1. The location of the works is described in the documents..

103 OUTLINE DESCRIPTION OF THE WORKS

1. The works to be executed under the Contract are described in brief in the specifications attached hereto.

104 ABBREVIATIONS AND DEFINITIONS USED IN THIS SPECIFICATION

1. 'BS' and 'CP' mean the British Standard and British Standard Code of Practice published or issued by the British Standards Institution, 2 Park Street, London W1A 2BS. All BS and CP's referred to in the Contract shall refer to the editions current at the time of tendering, including all amendments published thereto, unless some other edition is specifically referred to in the Contract.
2. 'AASHTO' means the American Association of State Highway and Transportation Officials.
3. 'ASTM' means the American Society of Testing and Materials.
4. The following abbreviations are used for Metric units:

| | | | | | |
|-----|---|--------|----|---|--------------------|
| sec | - | second | m | - | metre |
| min | - | minute | mm | - | millimetre |
| hr | - | hour | l | - | litre |
| cu | - | cubic | kg | - | kilogramme |
| sq | - | square | N | - | Newton |
| lin | - | linear | oC | - | degrees Centigrade |
| No | - | number | ha | - | hectare |
5. 'Approval' (and words derived therefrom) means approval in writing by the Engineer, unless stated otherwise.
6. 'Contractor's own use' means use by the Contractor himself and his sub-contractors.
7. 'As indicated' means as shown on Drawings or as stated in the Specification.
8. 'As directed' means as directed by the Engineer.

105 OBLIGATIONS AND RESTRICTIONS

1. The Contractor shall:
 - (a) comply with all enactments, regulations and working rules relating to safety, health and welfare;
 - (b) ascertain and comply with the regulations of the civil police affecting the execution of the Works;
 - (c) arrange for general purpose industrial safety helmets to BS 5240: 1975 to be provided for use by all persons on Site who could be in danger of head injury and endeavour to ensure that helmets are worn when necessary by all persons;
 - (d) not use the Site for any purpose other than carrying out the Works;
 - (e) not display or permit advertisements to be displayed on Site;
 - (f) prevent trespass on adjoining property by his work people;
 - (g) comply with all Government laws governing the importation licensing, etc. of all plant and machinery whether new or second-hand.

106 PREVENTION OF NUISANCE

1. Where the works are to be carried out adjacent to occupied premises, the Contractor shall proceed with the Works in such a manner as to cause the minimum inconvenience and nuisance to occupants and users. The Contractor must take all necessary precautions including regular watering of the road as directed to prevent any inconvenience from dust.

It is expressly stated that the Contractor shall be liable for damages to persons and property, including damages caused by dust resulting from the construction works. Access to properties adjacent to the Site shall be maintained at all times.
2. All reasonable precautions shall be taken by the Contractor to prevent any pollution being caused by the execution of the Works.
3. The Contractor shall ensure that the risk of infestation is minimised by adequate arrangements for the disposal of food waste or other matters attractive to pests. Should infestation occur, the Engineer shall be informed immediately.

107 COMPLAINTS AND CLAIMS BY THIRD PARTIES

1. During the course of the work, complaints and claims may arise from the public or from various authorities. The Contractor shall satisfy the Engineer that he is dealing with all such matters without delay until appropriate clearance certificates from any authority concerned are produced by the Contractor. This Clause shall in no way absolve the Contractor from his obligations under Clause 22 of the Conditions of Contract.

108 SETTING OUT

1. The Contractor shall set out the Works in accordance with the Drawings supplied by the Engineer or as instructed in writing by the Engineer. The Contractor shall construct and maintain any external survey points which are required for the accurate location of the centre line of the Works.

2. The Contractor shall be responsible for calculating the edge of carriageway, levels and superelevation requirements shown on the Drawings, having regard to the horizontal alignment to be constructed, particularly where no formal horizontal geometry is proposed. Such levels shall be submitted to the Engineer for approval fourteen days in advance of the time the Contractor proposes to construct that part of the Works.

109 DIMENSIONS AND LEVELS

1. All dimensions and levels shown on the Drawings or referred to in the documents forming part of or issued under the Contract, shall be verified by the Contractor on the Site, and he will be held responsible for pointing out promptly errors or discrepancies in such dimensions and levels.

110 DRAWINGS OF SURVEYS

1. The drawings for the purposes of recording initial, Monthly and Final Surveys shall be prepared by the Contractor to the satisfaction of the Engineer, and unless otherwise agreed shall be not larger than A 1 size including 10mm margin all around. The scales of the plans and cross sections shall be agreed between the Contractor and the Engineer.

111 WORKING DRAWINGS

1. Before any part of the work is put in hand, the Contractor shall prepare and submit for the approval of the Engineer copies in triplicate (in the first instance) of any further detailed Working Drawings and Schedules which may be required for such part of the work, and at the same time call the attention of the Engineer to any alternative detail or modification of the Contract Drawings which the Contractor may wish to make. Such drawings shall be submitted four weeks before approval is required.
2. The Engineer will, after any alteration which he may require have been made by the Contractor, record on the copies as amended his approval, and will return one copy to the Contractor, who shall carry out the work in accordance therewith. The Contractor shall forward to the Engineer three additional copies of the Working Drawings as approved.

112 ALTERATION TO DRAWINGS

1. In all cases where drawings are specified or required to be supplied by the Contractor for the approval of the Engineer for any work included in this Contract, any alteration to such drawings which the Engineer may require to have been made, shall be made by the Contractor to the Engineer's satisfaction.

113 TEMPORARY ACCOMMODATION AND EQUIPMENT FOR THE ENGINEER

1. Within four weeks of the Date for Commencement of the Works, the Contractor shall on land adjacent to the Site to be furnished by him provide, maintain, service and remove on issue of the Taking Over Certificate, a portable office approximately 12 square meters suitably furnished with desks and drawers, and provided with external sanitary accommodation, lighting, heating and attendance during the progress of the Works, for the use of the Engineer.
2. All equipment shall be of a quality appropriate to its proposed use and shall be delivered in a serviceable condition to the Engineer. The Contractor shall keep all equipment in good repair and shall repair or replace, as required by the Engineer, any equipment that becomes unserviceable.

117 SECURITY SERVICES FOR ENGINEER'S STAFF

1. The Contractor shall provide adequate security for the offices used by the Engineer's Representative staff.

118 ASSISTANCE FOR ENGINEER'S STAFF

1. The Contractor shall provide, from time to time during the continuance of the Contract and at the request of the Engineer, all such chainmen, staffmen, tradesmen, labourers, instruments, apparatus equipment and protective clothing, as the Engineer may deem to be necessary for the carrying out of duties in connection with the Contract. The workmen shall be selected for their intelligence and so far as possible, the same men shall be provided throughout the period of the Contract.
2. The Contractor shall be solely responsible for all such instruments and equipment and shall ensure that they are, at all times, in good repair and adjustment. All equipment other than expendable items shall revert to the Contractor on completion of the Works, unless otherwise provided in the Contract.

119 CONTRACTOR'S FACILITIES

1. The Contractor shall obtain the approval of the Engineer to the intended siting of all spoil heaps, temporary buildings, works and services.
2. The Contractor shall:
 - (a) provide all temporary roads, tracks crossings and hardstandings required for the execution of the Works;
 - (b) provide temporary offices, workshops and storage for the Contractor's own use;
 - (c) provide all temporary messrooms, sanitary accommodation and other welfare facilities required in connection with the works;
 - (d) provide adequate security arrangements, lighting, power equipment and attendance for temporary buildings;
 - (e) maintain, alter, adapt and move, as necessary, temporary buildings for the Contractor's own use, temporary works and services, and clear away when no longer required, and make good work disturbed.

120 CONTRACTOR'S PERFORMANCE OF TESTS

1. The Contractor shall perform the tests required by the Contract, at the frequencies specified therein, and he shall be responsible for his own quality control of the works.
2. Various clauses of the specification state the types of test which the Contractor shall carry out for the control of the quality of the Works, together with the frequencies at which each type of test shall be conducted. The Contractor's attention is drawn to the fact that the frequencies of testing specified in the relevant clauses are intended to represent only a general guide. The Engineer shall be empowered to vary the frequencies at which tests are conducted should he deem this necessary for the proper control of the quality of the Works.
3. Tests shall be carried out at and by a designated laboratory with which the Contracting Authority will have a contract.

4. Samples for tests shall be collected by the Contractor under the supervision of the Engineer and in accordance with instructions and procedures established by the designated laboratory.
5. One copy of the results from each test performed by the designated laboratory shall be submitted to the Contractor for his records.
6. Nevertheless, acceptance of those works, for which the tests have been carried out and test results are found to be positive, shall be made by the Engineer in writing to the Contractor within 7 days of having the results of such tests.
7. For those works for which tests have been carried out and results of such tests are found negative, the Contractor shall remove those works and shall do these again upon instructions from the Engineer. No payments shall be made to the Contractor for any works which are not accepted by the Engineer and subsequently removed.
8. If required by the Engineer the Contractor shall perform any or all tests in the presence of authorized representatives of the Engineer.
9. Without relieving the Contractor of his responsibilities under the Contract, the Contractor shall perform any additional tests which the Engineer may require, and/or repeat tests the results of which, in the opinion of the Engineer are not representative.

121 ACCESS TO THE SITE

1. The Contractor shall make all arrangements for providing safe and expeditious access to the various parts of the Site, where necessary, shall construct to an approved standard, maintain, safeguard, and reinstate, all to the satisfaction of the Engineer, all roads and other access works which may be required for that purpose.
2. The Contractor shall ensure that none of the aforementioned access work (whether of a permanent or temporary nature) shall obstruct or impede services, drainage, or irrigation systems, or have other avoidable effects on surrounding land or property.

122 PREVENTION OF MUD ON PUBLIC ROADS

1. The Contractor shall keep all public roads and highways clear of mud and other debris arising from the Works and shall avoid mud and debris from being brought on to the highway by construction traffic by washing down vehicles if necessary.

123 PROPRIETARY MATERIALS

1. Reference in this Contract to the names of any firms or proprietary articles shall be construed only as an indication of the quality performance and workmanship. Proprietary materials may be offered to the Engineer for approval.

124 SAMPLES

1. In addition to any specific provision in the Contract for the sampling and testing of materials, the Contractor shall submit to the Engineer, as he may require, samples of all materials and goods which he proposes to use or employ in or for the Works. Such samples, if approved, will be retained by the Engineer. No materials or goods, of which samples have been submitted, shall be used in the Works, unless and until such samples have been approved in writing by the Engineer.

2. The Engineer may reject any materials and goods which, in his opinion, are inferior to the samples thereof previously approved and the Contractor shall promptly remove such materials and goods from the Site.

125 TESTS IN GENERAL

1. The Engineer may examine and may require to be tested any materials or goods required in or for the Works such as he may decide from time to time. The Contractor shall arrange for the Engineer to have unrestricted access to the Contractor's Sub-Contractor's, and suppliers' premises for such purposes at all times.
2. The Contractor shall afford the Engineer all facilities, assistance, and labour necessary for the convenient examination, testing, or analysis of all such materials or goods.
3. Notwithstanding any tests which may have been carried out the Engineer shall be empowered to order further tests of any materials or goods and to reject any such materials or goods should they fail to pass such tests.
4. For manufactured materials or goods the Contractor shall obtain Certificates of Test which are representative of the delivered materials or goods from the suppliers of such materials and shall send four copies of certificates to the Engineer. Such certificates shall certify that the materials or goods concerned have been tested in accordance with the requirements of the Contract and shall give the results of all tests carried out. The Contractor shall provide adequate means of identifying the materials and goods delivered to the Site with the corresponding certificates.
5. Various clauses of the specification state the types of test which the Contractor shall carry out for the control of the quality of the Works, together with the frequencies at which each type of test shall be conducted. The Contractor's attention is drawn to the fact that the frequencies of testing specified in the relevant clauses are intended to represent only a general guide. The Engineer shall be empowered to vary the frequencies at which tests are conducted should he deem this necessary for the proper control of the quality of the Works.

126 MATERIALS AND WORKMANSHIP IN GENERAL

1. All materials incorporated in the Works shall be new and of the best quality and description of their respective kinds. All materials supplied shall be in accordance with the standards specified in this specification, or equivalent as decided by the Engineer. The workmanship in every case shall be of the best character and the whole shall be subject to the approval of the Engineer.
2. Before entering into any agreement for the supply of any materials or goods, the Contractor shall obtain the Engineer's approval in writing of the supplier from whom he proposes to obtain such materials or goods. Should the Engineer, at any time, be dissatisfied with such materials or goods or with the methods of operations carried out at such supplier's works or place of business, he shall be empowered to cancel his previously given approval of such supplier, or to approve another supplier for the supply of such materials or goods. The Contractor shall then obtain such said materials or goods from another approved supplier and shall bear any additional cost thereof.

127 SOURCES OF MATERIALS

1. For the purposes of the Contract, quarries and borrow areas shall mean and include all such areas as may be approved in writing by the Engineer as sources from which the Contractor may excavate or quarry materials for use in the Works.
2. The Contractor shall be wholly responsible for locating quarries and borrow areas and obtaining any necessary consent licences, permits, royalties etc., from land-owners and

relevant authorities for the use of borrow areas and quarries. The Contractor shall submit to the Engineer copies of all such consents licenses, permits, royalties, etc.

3. At the commencement of the Works, or as soon thereafter as is practicable, the Contractor shall submit to the Engineer for approval details of:
 - (a) the sources from which he proposes to obtain rock; aggregates, sand and filling for the Works;
 - (b) the periods during which he proposes to obtain material from each of the several sources;
 - (c) the means and routes by which he proposes to obtain and transport these materials;
 - (d) results of his investigations of the materials.
4. No approval by the Engineer of such proposals shall relieve the Contractor of his obligations to provide all the materials required for the Works, or any other obligation under the Contract.
5. Before commencing the removal of materials from any approved borrow area, the Contractor shall carry such investigations as he deems necessary to establish and to satisfy himself as to the quality and quantities of material available from the area and the suitability of the plant methods he proposes to use for its removal.
6. The Contractor shall work each borrow area in a systematic manner, and, on completion of the removal of material from an approved area, shall leave the site in a tidy condition, to the satisfaction of the landowner and relevant authority, without unsightly holes or heaps of excavated or in situ material. The area shall be left free draining without any features resulting from excavation operations which might result in erosion or instability.
7. The Engineer will offer administrative assistance to the Contractor in obtaining permits from Government bodies, but this shall not relieve the Contractor of his obligations and responsibilities. The Employer shall bear no responsibility for delays.

128 REMOVAL OF CONDEMNED MATERIALS

1. The Engineer may require the Contractor to remove and dispose of any materials employed in the construction of the Works, which, in the opinion of the Engineer, are unsuitable or have been incorrectly deposited or have suffered damage by exposure to the weather or otherwise are not in accordance with the specified requirements for such materials. The Contractor shall be entitled to no payment whatsoever in respect of the removal of such materials.

129 DISPOSAL OF SPOIL, RUBBISH AND SURPLUS MATERIALS

1. The Contractor shall prevent excavated spoil, rubbish and surplus materials arising from the Works being dumped on an area other than an area approved pursuant to Clause 82 of the conditions of Contract, and shall comply with legislation governing the controlled tipping of refuse.
2. Should any excavated spoil, rubbish or surplus materials be deposited elsewhere than at an approved area, the Contractor will be held responsible, clearing away such deposits and place them in an approved area at his own expense.

130 EXISTING SERVICE INSTALLATIONS

1. The Contractor shall notify the Engineer in writing of any existing service installations within the Site whether or not these are shown on the Drawings. The Engineer shall make all arrangements for the relocation or removal of any such services or direct the Contractor to carry out the work in which case payment shall be made against items in Bill of Quantities or at Dayworks rates. No claim for additional payment shall be allowed in respect of any extensions of time which may be granted due to any delay in the relocation of services.
2. The Contractor shall not use or interfere with the existing service installations without the permission of the Engineer and, where applicable, of service and utility authorities and private owners. He shall take precautions to avoid damage and draw employees' attention to the attendant risks and danger.
3. Should any damage to existing service installations occur, the Contractor shall immediately notify in writing the Engineer and, where applicable, service and utility authorities and private owners of any damage. He shall make arrangements for the repair at his own expense to the satisfaction of the Engineer and, where applicable, of service and utility authorities and private owners. For urgent repairs he shall accept any arrangements made by the Engineer. Such arrangements by the Engineer will not affect the extent of the Contractor's liability.

131 WORK DURING THE DEFECTS LIABILITY PERIOD

1. After the commencement of the Defects Liability Period, the Contractor shall do nothing which might endanger the safety of the general public or facilities and he shall obey all instructions of the Engineer or any other duly authorised persons in this regard.
2. Throughout the Defects Liability Period the Contractor shall notify the Engineer of the work or operations he intends to carry out on the Site and he shall obey any instructions which the Engineer may give as to times and manner of working so that any inconvenience is kept to a minimum.

132 TRAFFIC SAFETY MEASURES

1. The Contractor shall ensure that traffic along the existing roads and accesses to private ownership shall be maintained at all times. Similarly the Contractor shall maintain access along other roads and trucks that cross the alignment, unless otherwise directed by the Engineer.
2. The Contractor shall also ensure that there are adequate footways for pedestrians provided when the existing ones are disrupted by the Works. The footways shall be adequately maintained with at least a suitable all weather surface and kept free of dust. The Contractor shall also maintain pedestrian accessibility to adjacent buildings/ private ownership.
3. Steps shall be taken by the Contractor to ensure at all times the safety of both vehicle drivers and pedestrians. Similarly the Contractor shall take all necessary measures for the safety and health of the Employer's personnel as well as for the Contractor's employees working on the works. For this reason the Contractor shall take all necessary measures for compliance with the provisions of the relevant Law for the health and safety at work.
4. The Contractor shall construct and maintain detours for the diversion of traffic where this becomes necessary. Detours shall be of an approved standard with adequate signing to ensure traffic safety. Detours shall be removed by the Contractor when no longer needed, and the area shall be reinstated.
5. The Contractor shall provide, erect, maintain, reposition, cover and uncover and finally remove, as applicable, traffic signs, cones and other street furniture as the progress of the Works require and take such other measures as may be necessitated by the Works in order

- to direct traffic and take all other necessary precautions for the protection of the Works and the safety of the public.
6. Traffic signs shall comply with the UK or European traffic signs rules and dimensions.
 7. All details of traffic safety and management measures necessitated by the Works shall be submitted to the Engineer for his consent 15 days before the Contractor intends to commence any work which affects public roads. The Contractor shall also furnish any further relevant details and information requested by the Engineer.
 8. After their erection, the Contractor shall not remove or modify in any manner the permanent or temporary traffic signs, without the consent of the Engineer. Should the progress of the works necessitate the modification of the permanent or temporary traffic signs arrangement the Contractor shall follow the procedure described in sub-clause 9 above.

133 PHOTOGRAPHIC RECORD

1. The Contractor shall provide a photographic record of the execution of the Works by having colour photographs taken at chainage intervals from such points as the Engineer may specify from time to time. The number of such photographs shall be up to twenty per kilometre of road under construction. The Contractor shall supply three prints together with the negative of each photograph to the Engineer. Two of the aforementioned prints shall be captioned, dated and signed on the back by the Contractor and the Engineer's Representative. All prints shall be 130 mm X 180 mm size.

SECTION 200 - EARTHWORKS

201 DEMOLITION AND SITE CLEARANCE

1. The Contractor shall demolish, break up and remove buildings, structures and superficial obstructions on the Site in the way of or otherwise affected by the Works. He shall clear each part of the Site to the extent shown on the Drawings and at times approved by the Engineer.
2. Underground structures shall be demolished to the depths shown on the Drawings. They shall be properly cleaned out and filled with suitable material and compacted in accordance with Clause 208. Disused sewer and surface water drains within 1 metre of formation shall be removed and the trenches backfilled with suitable material and compacted in accordance with Clause 208.
3. Subject to the provisions of the Conditions of Contract, all materials arising out of Site clearance and demolition which are surplus to or not suitable for re-use in the Works shall become the property of the Contractor and shall be disposed of by him either off the Site in tips provided by the Contractor or, if agreed by the Engineer, on the Site in an approved manner. All materials suitable for re-use (e.g. fencing, railing) shall be removed with due care in order to avoid damaging them, and shall remain on the site and be used as instructed by the Engineer. Such materials if damaged or destroyed during their removal, due to the Contractor's negligence, these shall be replaced at the Contractor's own expense. The care and protection of these materials shall be the Contractor's responsibility.
4. Bushes, undergrowth or small trees the trunks of which are less than 300 mm in girth and 1 metre above ground level, tree stumps less than 100 mm diameter and hedges shall be uprooted. Unless otherwise directed by the Engineer, trees shall be uprooted or cut down as near to the ground as possible. Stumps and tree roots shall, unless otherwise directed by the Engineer, be grubbed up or blasted. Holes left by the stumps or roots in areas of fill shall be filled with suitable material and compacted in accordance with Clause 208.

5. All bushes, undergrowth, small trees, felled timber, roots and stumps arising out of the Site clearance shall be removed from the Site to dumps provided by the Contractor and burnt. The burning shall at all times be carefully controlled by the Contractor and shall not be carried out in locations or under weather conditions which are likely to cause a fire hazard to surrounding vegetation and forests.

202 TOPSOIL

1. Topsoil shall mean the top layer of soil which can support vegetation and shall be removed and disposed of by the Contractor unless otherwise directed by the Engineer. The topsoil shall be removed from the area of the Works prior to commencement of the general earthworks; the surface thus formed being defined as the natural foundation.

203 EXISTING ROAD PAVEMENT AND SHOULDERS

1. Where, as shown on the Drawings, the existing road is to be rehabilitated on its existing alignment, the existing pavement and shoulder shall be broken up or scarified to the full depth of the pavement. The fragments of the broken-up pavement shall not exceed 150 mm in size. The broken up or scarified material shall be re-shaped, as directed by the Engineer, and shall then be compacted by a maximum of 6 No. passes of a vibrating roller having a mass per metre width of vibrating roll of not less than 3000 kg.
2. Prior to commencement of the scarification and re-compaction of the existing pavement and shoulder, the Contractor shall carry out trials of the process under the direction of the Engineer on sections of the existing road not less than 50 metres long. Trials shall be carried out on each of the different types of existing pavement construction which might be identified along the road. Arising from these trials, the Engineer may vary the compaction requirements specified in sub-clause 1 of this Clause.
3. In the event that the trials show that the scarified and re-compacted pavement will not form a suitable foundation for the new pavement construction, the Contractor shall on instructions from the Engineer excavate the existing pavement and dispose of the excavated material in tips provided by the Contractor off the Site or, subject to the approval of the Engineer, incorporate the material in areas of fill.

204 SUITABLE MATERIAL

1. Suitable material shall comprise all that material which is acceptable in accordance with the Contract for use in the Works and which is capable of being compacted in accordance with the Contract.
2. No excavated suitable material other than that surplus to the requirements of the Contract shall be removed from the Site except on the direction or with the permission of the Engineer. Should the Contractor be permitted to remove suitable material from the Site to suit his operational procedure, then he shall make good at his own expense any consequent deficit of fill material arising there from.
3. If any suitable material excavated from within the Site is, with the permission of the Engineer, taken by the Contractor for purposes other than incorporation in the Works, sufficient suitable fill material to occupy, after full compaction, a volume corresponding to that which the excavated material occupied shall be provided by the Contractor at his own expense, unless otherwise directed by the Engineer.
4. Suitable material surplus to the requirements of the Works or to the Contractor's programmed sequence of Works shall be run to spoil in tips provided by the Contractor.

5. When the excavation reveals a combination of suitable and unsuitable materials the Contractor shall, unless otherwise agreed by the Engineer, carry out the excavation in such a manner that the suitable materials are excavated separately for use in the Works without contamination by the unsuitable material.
6. Should there be a deficit of suitable filling material within the Works, then the Contractor shall be permitted to import suitable fill material subject to the provisions of the Contract. If after excavation, suitable material reaches a condition such that it cannot be deposited and/or compacted in accordance with the requirements of the Contract, the Contractor shall at his own expense either:
 - (i) make good by removing the material either to tip or elsewhere until it is in a suitable physical condition for re-use and replace it with suitable fill; or
 - (ii) make good the material by mechanical or chemical means; or
 - (iii) cease work on the material until its physical condition is again such that it can be deposited and/or compacted as described in the Contract.

205 UNSUITABLE MATERIAL

1. Unsuitable material shall mean any material other than suitable material and shall include:
 - (a) material from swamps, marshes or bogs;
 - (b) peat, logs, stumps and perishable material;
 - (c) material susceptible to spontaneous combustion;
 - (d) materials having a moisture content greater than the optimum moisture content as tested in accordance with BS1377 Test 13 $\pm 2\%$;
 - (e) Clayey material exhibiting expansive properties or clayey material of liquid limit exceeding 50 and/or plasticity index exceeding 25;
 - (f) Very fine single graded materials unsuitable for compaction, as directed by the Engineer.
 - (g) material in a frozen condition.
 - (h) other materials which, after testing, the Engineer decides that they are unsuitable for use in the works.

++ Materials of class (g) if otherwise suitable shall be classified as suitable when unfrozen.
2. Unsuitable material below formation level in cuttings or where directed by the Engineer shall be removed to such depth and over such areas as the Engineer shall direct and be disposed of, in accordance with Terms of the Contract. The resultant excavation shall be backfilled with suitable material and compacted as specified in Clause 208.

206 EXCAVATION OF CUTTINGS

1. The Contractor shall excavate in cuttings to the lines and levels shown in the Drawings.
2. Excavations and hauling of material from cuttings or borrow pits to the embankments or other areas of fill shall proceed only when sufficient spreading and compaction plant are operating at the place of deposition to ensure compliance with the requirements of Clause 210.

The slopes of all cuttings shall be cleared of all boulders and rock fragments which move when prised with a crow-bar, where in the slopes of cuttings layers of rock and soft material alternate and the Engineer considers that the slope, immediately after dressing, will not permanently withstand the effect of weather, the Contractor shall excavate any insecure material to an approved depth. Alternatively the Engineer may direct further excavation to form a new slope.

3. In cuttings as indicated on the drawings or as directed by the Engineer, where the material at subgrade/formation level has a C.B.R. value of less than the design CBR stated on the drawings, when tested in accordance with the method described in Appendix A, the Engineer shall direct its excavation and replacement. Such excavated material shall either be disposed by the Contractor or shall be placed by the Contractor in other parts of the works if so approved by the Engineer. The depth of such excavation below subgrade/formation level shall be as shown on the drawings or as directed by the Engineer. The material to be used for backfilling (capping Layer) shall comply with the requirements of Table 2/1.

Table 2/1

Capping Layer

| Grading (BS1377 Test 7A) | BS 410 Sieve Size | Percentage by weight passing |
|--------------------------------|---|------------------------------|
| | 75 mm | 100 |
| | 37.5 mm | 85-100 |
| | 10 mm | 45-100 |
| | 5 mm | 25-85 |
| | 600 micron | 8-45 |
| | 75 micron | 5-10 |
| | Plasticity Index | 15 max |
| | Plasticity Modulus | 250 max |
| | CBR | 20 min |
| | Los Angeles (small size, AASHTO T96) | 50 max |
| | Los Angeles (Large size, AASHTO, C535-65) | 50 max |
| | Percentage swell at 2 day soak | 1 max |

4. Constructional plant shall not use the surface of the bottom of a cutting unless the cutting is in rock containing no soft material or the Contractor maintains the level of the bottom surface at least 300 mm above formation level. Any damage to the subgrade arising from such use of the surface shall be made good by the Contractor at his own expense. From the time the Contractor begins to trim the remaining material to formation in any area, the movement and use of constructional plant thereon other than that used to complete this operation shall be in accordance with Clause 211.

207 EXCAVATION FOR STRUCTURAL FOUNDATIONS

1. The Contractor shall excavate pits and trenches for structural foundations and the bottoms of all such excavations shall be formed to the lines and levels shown on the Drawings. Any pockets of soft soil or loose rock in the bottoms of pits and trenches shall be removed as directed by the Engineer and the resulting cavities and any large fissures shall be filled with general purpose grade concrete to Clause 719. After placing of any blinding concrete required by the Contract, no trimming of the side faces shall be carried out for 24 hours.
2. The sides of pits and trenches for structural foundations shall be adequately supported at all times. Unless otherwise described in the Contract, the sides of pits and trenches shall not be battered.

3. All excavated suitable material from excavations for structural foundations not required for refilling shall be deposited in embankments or other areas of fill or, if there is an overall surplus of excavated suitable material in the Works, be disposed of in tips off the Site.
4. The Contractor shall make good at his own expense with suitable material or general purpose grade concrete to Clause 719 as directed by the Engineer the following:
 - (i) Any excavation greater than the net volume required for the Works as described in the Contract.
 - (ii) Any additional excavation at or below the bottom of the foundations to remove material which the Contractor has allowed to become unsuitable.

208 REFILLING OF STRUCTURAL FOUNDATION PITS AND TRENCHES

1. Unless otherwise shown on the Drawings or directed by the Engineer, all refilling of structural excavation shall consist of suitable material as defined in Clause 204 or any other specified material, deposited in layers not exceeding 150 mm loose thickness and compacted by approved plant in accordance with Clause 210. The material to be used for backfilling behind abutments of bridges and under structural foundations shall be Subbase Material Type 2 as specified in Clause 401. Timber sheeting and other excavation supports shall be removed as the filling process except where they are required by the Contractor to be left in position, but the removal of such supports will not relieve the Contractor of his responsibilities for the stability of the Works.

209 FORMING OF EMBANKMENTS AND OTHER AREAS OF FILL

1. Embankments and other areas of fill shall be formed to the lines and levels shown on the Drawings of material defined as "suitable material" in Clause 204.

Earthworks material placed in the top 100cm below formation level shall be suitable and shall also comply with the following requirements:

| | |
|---|--------|
| Liquit Limit (BS1377, Cone Penetrometer method) | 40max |
| Plasticity Index (BS1377) | 20 max |
| Percentage passing No 200 sieve | 20 max |
| CBR (BS1377, test 16, sample at 95% maximum | 10 min |
| Dry Density BS 1377 Test 13, corresponding to the dry side of the Proctor Curve, 4.5 kg rammer with 2 day soak) | |
| Linear shrinkage | 12 max |

Suitable materials with more plasticity than the one specified above could be used if improved at the Contractor's cost, by adding lime at a proportion and methodology approved by the Engineer.

2. All earthworks material placed in or below embankments below formation level in cuttings and elsewhere in the Works, except as provided for in Clause 208, shall be deposited and compacted as soon as practicable after excavation in layers not exceeding 300 mm thick (loose measurements) and shall be compacted as specified with equipment appropriate to the type of soil before the next layer is placed.

Embankments shall be built up evenly over the full width and shall be maintained at all times with a sufficient camber and a surface sufficiently even to enable surface water to drain readily from then. During the construction of embankments the Contractor shall control and direct constructional traffic uniformly over their full width. Damage to compacted layers by constructional traffic shall be made good by the Contractor at his own expense.

3. Before commencing the formation of embankments or other areas of fill on sloping ground, the Contractor shall excavate any benching as shown on the Drawings or directed by the Engineer.
4. Compaction of embankments and other areas of fill shall be undertaken to the requirements of Clause 210.
5. Material used in rock fill embankments shall, except for any specified external cover to slopes or near formation level, be of such size that can be deposited in horizontal layers each not exceeding 500 mm loose depth and extending over the full width of the embankment. Layer containing rock-fill material shall terminate 600 mm below the formation level unless otherwise shown on the drawings. The material shall be spread and levelled by a crawler tractor weighing not less than 15 tonnes and compacted in accordance with Clause 210.

Each layer shall consist of reasonably graded material and all surface voids shall be filled with broken fragments before the next layer is deposited. The top surface and side slopes of embankments as formed shall be thoroughly blinded with approved fine graded material to seal the surface. Such material may on side slopes and verges to topsoil as defined in Clause 202.

6. Isolated boulders within the range of 0.015 cu.m. to 0.09 cu.m. in size may be incorporated in embankments not of rock fill at the discretion of the Engineer, provided that the specified compaction requirements are met and no boulder exceeding 0.015 cu.m. shall be placed less than 600 mm below formation level of carriageways.
7. In carrying embankments up to or over bridges, culverts and pipe drains, the Contractor shall bring the embankments up equally on both sides.
8. If the Contractor wishes to continue to use the surface of embankments for constructional plant before trimming to formation level, he shall bring up and maintain the area between the extremities of the carriageway and hard shoulders to a level not less than 150 mm above formation level, whereupon constructional plant will be allowed to use the surface so formed but any damage to the subgrade caused by use of such surface shall be made good by the Contractor.

210 COMPACTION OF EMBANKMENTS AND OTHER AREAS OF FILL

1. All materials used in embankments and as filling elsewhere shall be compacted as soon as practicable after deposition. Compaction shall be undertaken to the requirements of this Clause by approved plant. The Contractor shall use only those items of plant which are appropriate to the soil and site conditions.
2. Earthmoving plant shall not be accepted as compaction equipment under this Clause.
3. The Contractor shall employ only that plant which is suited to the soils to be handled. He shall not at any time use any plant which damages or reduces the natural strength of the soil either in its in situ state of during handling and placing or in its final compacted state.
4. Without prejudice to the provisions of the Conditions of Contract and in order that the Engineer may make proper provision for the supervision of compaction in the permanent work, the Contractor shall, not less than 24 hours before he proposes to carry out compaction processes during periods of overtime, apply in writing to the Engineer for permission to do so.
5. The Contractor shall compact the material placed in all embankment layers, except rock fill, until a uniform density of not less than 95% of the maximum determined by BS 1377 Test 13 is attained at a moisture content determined by the Engineer to be suitable for such densities. In the case of compaction of backfill to structures, the density to be achieved throughout, must

be 95% of the maximum determined by BS1377 Test 13. The Engineer will, during progress of the work, require density tests of compacted material in accordance with BS 1377 Test 15. If, by such tests, the Engineer determines that the specified density and moisture condition have not been attained, the Contractor shall perform additional work as may be necessary to attain the specified conditions. This method of construction shall be used unless the Engineer directs otherwise in writing. A minimum of one test per 500 sq. m per layer shall be taken. The Contractor shall carry out these tests at his own cost or in cases where the prepared compacted area is less than 500 sq. m., as directed by the Engineer.

6. Each layer in rock fill embankments shall be spread and levelled in accordance with Clause 209 and compacted by at least 12 passes of a towed vibratory roller with a static mass per metre width of roll of at least 1800 kg or other approved plant. Where rock is used as a general fill and has the properties of rock fill it shall be spread and compacted as for rock fill in embankments. Where rock is used as general fill and it contains or is mixed with sufficient soft material for satisfactory compaction the above density requirements shall apply.
7. Where in accordance with the drawings or the Engineer's instructions a capping layer is to be placed, notwithstanding the provisions of Clause 206.3, the material to be used for this purpose shall be placed and compacted to the requirements of Clauses 209 and 210.

211 PREPARATION AND SURFACE TREATMENT OF FORMATION

1. The preparation and surface treatment of the formation shall be carried out only after all trenches and excavations below the formation have been completed, filled with suitable material and compacted in accordance with Clause 208 to a density consistent with the density of the adjacent area and, unless otherwise agreed by the Engineer, immediately prior to laying the sub-base.
2. The preparation and treatment of the formation shall consist of the following operations:-
 - (i) Formation of Soft Materials.
 - (a) All surfaces below the carriageway and shoulders shall, after reinstatement of any soft areas, be well cleaned and freed from any mud and slurry.
 - (b) The formation shall be trimmed and regulated to the tolerances specified in the Contract.
 - (c) The trimmed formation shall be compacted in accordance with Clause 210.
 - (ii) Last Rock-fill Layer
 - (a) The last rock-fill layer shall be regulated and thoroughly blinded with fine graded material to the tolerances specified in the Contract.
 - (b) The trimmed formation shall be rolled by 1 pass of a smooth-wheeled roller having a mass per metre width of roll of not less than 2100 kg or a vibrating roller having a mass per metre width of vibrating roll not less than 700 kg or a vibrating-plate compactor having a mass per unit area under the base plate of not less than 1400 kg per sq m.
 - (c) The final formation shall be treated as described in (i) above, after completing the embankment with suitable material.
 - (iii) Formations of Rock Cuttings.

Unless otherwise shown on the drawings, excavation in rock cuttings shall be carried a nominal 150 mm below formation level, which shall be backfilled and regulated to the

tolerances specified in the Contract with sub-base material Type 2. Small fissures in the rock or areas where compaction of the sub-base material is impracticable shall be filled only with lean concrete. The Contractor shall allow in his unit rates for earthworks for all costs whatsoever in excavating rock below formation level and for carrying out these regulating measures including the provision and placing of the subbase material.

3. The subgrade shall be checked and approved before any foundation or pavement material is placed thereon. The Engineer will not approve any subgrade areas unless all adjacent slopes have been trimmed and shaped as specified and all adjacent side ditches have been fully completed as shown on the Drawings.

213 EXCAVATION OF WATERCOURSES

1. Excavation carried out in the diversion, enlargement, deepening or straightening of watercourses shall include the operations of all necessary trimming of slopes, grading of beds, disposal of excavated material or, if such material shall be suitable material and not surplus to requirements, deposition in embankments or other areas of fill shown on the Drawings and all operations for dealing with the flow of water.

214 FILLING EXISTING WATERCOURSES

1. Where watercourses have to be diverted and the original channels filled, the original channels shall be cleared of all vegetable growth and soft deposits and shall be carefully filled and with suitable material deposited and compacted in accordance with Clauses 209 and 210.

215 CLEARING EXISTING DITCHES AND CULVERTS

1. Existing ditches and culverts shall, where shown on the Drawings, be cleared by removing vegetable growths, debris and deposits. The sides of ditches shall be trimmed throughout and the bottoms uniformly graded and the ditches kept clean and maintained during the currency of the Contract.

216 EXPLOSIVES AND BLASTING

1. The Contractor may use explosives in the excavation but in so doing shall comply with all regulations regarding their proper storage, handling and use. The Contractor shall ensure that there is no unauthorised issue or improper use of explosives on the Site and shall maintain a strict record on quantities issued and consumed. Explosives shall be under the sole control and handled only by personnel who are qualified and experienced in their use.
2. Should the Contractor propose to use explosives on the Site he shall obtain the prior consent in writing of the relevant authority and shall comply with any conditions and requirements which they may prescribe. Notwithstanding any such consent, the written consent of the Engineer shall be obtained on each and every occasion the Contractor wishes to use explosives.
3. Explosives shall be used in the quantities and manner recommended by the manufacturers. When blasting is carried out the Contractor shall determine the danger zone likely to be created and ensure, by the use of heavy blasting mats when necessary to prevent material from being projected, that no damage is caused or likely to be caused to persons or property on or off the Site. Blasting in the proximity of buildings and other structures, existing or under construction, shall only be permitted if the Contractor can demonstrate, by preliminary site trials, to the satisfaction of the Engineer, that safe values of vibrational amplitude and particle velocity will not be exceeded.

217 EXISTING GROUND LEVELS

1. The Contractor shall satisfy himself that the existing ground levels as indicated in the Contract are correct. Should the Contractor wish to dispute any levels he shall submit to the Engineer a schedule of the position of the levels considered to be in error and together with the revised levels. The existing ground relevant to the disputed levels shall not be disturbed before the Engineer's decision as to the correct levels is given.

218 GEOTEXTILES USED TO SEPARATE EARTHWORKS MATERIALS

1. Geotextiles required as part of the Permanent Works to separate earthworks materials at locations shown on the drawings 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 Engineer, 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 according to the specifications.
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 number of samples, jointly selected by the Contractor and the Engineer, 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 approved by the Engineer to prove that the geotextile meets the manufacturer's criteria.
 - i) The geotextile shall sustain a tensile load of not less than that value given in specifications, 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 ϕ_{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 and where lapping is employed adjacent sheets or strips of geotextile shall be overlapped by a least 300 mm, or other dimension described in Contract.
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 until the completion of the Period of Maintenance when they shall be delivered to the Engineer. Prior to determination of pore size and tensile strength, test pieces shall be conditioned and brought into equilibrium at a temperature of $20^{\circ} \pm 2^{\circ}\text{C}$, and a relative humidity of $65 \pm 5\%$. The dry weight of the geotextile tested shall be quoted in g/m².

219 TOPSOILING

1. Topsoiling shall be carried out where shown on the drawings or directed by the Engineer. The topsoil to be used shall be of best quality, and suitable for supporting vegetation.

220 REINFORCED SOILS

1. Reinforced Soils structures shall comply with BS 8006 and the U.K. Department of Transport Technical Memorandums BD 70/97 dated February 1997, with the design parameters contained in the Contract Drawings of Specifications.

221 GABIONS

1. Gabions shall be constructed in compliance with this Clause and to the dimensions shown on the drawings.
2. Gabion units shall be assembled in accordance with the manufacturer's instructions and shall be sufficiently filled with hard, clean, non-weathered boulders or rock fragments, with an allowance for consolidation of fill, so as to minimise distortion during construction. The size of fill material shall be as described in sub-clause 5 of this Clause. 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 of this Clause, or other approved material.
3. The gabion mesh unless otherwise described in the Contract shall be a mesh manufactured from wire complying with BS 1052 having a minimum core diameter of 2.0 mm, unless otherwise described in the Contract.
4. All wire shall be galvanized in compliance with BS 443 and where shown on the drawings be coated with a minimum thickness of 0.55 mm of PVC which 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 ASTM G23-89.
5. The size of mesh openings and grading of fill shall be as described in the Contract, 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 the Contract, shall be not less than the size of the mesh opening.
6. Mechanical equipment may only be used for filling gabion units where the Engineer is satisfied that the results are equivalent to filling by hand.

SECTION 300 - ROADWORK GENERAL REQUIREMENTS**301 TOLERANCES****Horizontal Alignment**

1. Horizontal alignment shall be determined from the data shown on the Drawings. The edge of the pavement as constructed and all other parallel alignments shall be correct within a tolerance of ± 20 mm there from.

Surface Levels of Pavement Courses

2. The levels of pavement courses shall be determined from the true finished road surface calculated from the vertical profile and cross falls as shown on the Drawings. The vertical depth below the true pavement surface of any point on the constructed surface of the formation or pavement courses shall be within the appropriate tolerances stated in Table 3/1.
3. The surface level of the pavement at any point shall not deviate vertically from the true finished road surface by more than ± 10 mm, nor shall the thickness of the whole pavement, excluding sub-base, vary by more than 15 mm from the specified thickness.
4. For checking compliance with Table 3/1 measurements of surface levels will be taken at points to be selected by the Engineer at 10 m centres longitudinally and at 2 m centres transversely. In any length of pavement, compliance with the requirements of Table 3/1 shall be regarded as met when not more than one measurement in any consecutive ten longitudinally or one in any transverse line, exceeds the tolerances permitted in the Table, but this one measurement shall not exceed 5 mm more than the tolerance for the layer concerned.

Table 3/1
Tolerances in Surface Levels of Pavement
Courses and the Formation

| | |
|----------------------------------|---------------|
| Road Surface | |
| Basecourse & Bituminous Roadbase | ± 10 mm |
| Roadbase | ± 15 mm |
| Sub-base | + 10 mm/-30mm |
| Formation | + 20 mm/-30mm |

Rectification

5. Where any tolerances in this Clause are exceeded the Contractor shall determine the full extent of the area which is out of tolerance and shall make good the surface of the pavement course or formation the manner described below:

(i) Formation Level

If surface is too high it shall be retrimmed and recompact in accordance with Clause 210. If the surface is too low the deficiency shall be corrected by the addition of suitable material of the same classification and moisture content or other approved material laid and compacted in accordance with the Specification. In cohesive soils where the surface is less than 150 mm below the correct formation level, further soil shall be removed to a depth of at least 150 mm below formation before replacement soil is spread and compacted.

(ii) Roadbases and Sub-bases

Where these consist of unbound material the top 75 mm shall be scarified, reshaped with material added or removed as necessary and recompact all in accordance with the Specification.

(iii) Bituminous Roadbases, Basecourses and Wearing Courses

Basecourses and wearing courses shall have the full depth of layer removed. Road bases shall have the full depth of the top layer removed. In all cases the courses shall be replaced with fresh materials laid and compacted in accordance with the specification. Any area so treated shall be, in the case of roadbases and basecourses, 5 m. long, and in the case of wearing courses, 15 m. long, and the full width of the paving laid in one operation.

302 THICKNESS OF PAVEMENT LAYERS

1. The total thicknesses of the various layers of the pavement shall be as shown on the Drawings, which shall be the total thicknesses at any point after compaction.

303 COLD WEATHER WORKING

1. No material in a frozen condition shall be incorporated in the Works but shall instead be retained on Site for use if suitable when unfrozen.
2. Materials for use in road pavements shall not be laid on any surface which is frozen or covered in ice or snow.
3. Laying of bituminous materials shall cease if the temperature of the surface to be covered is at or falls below 2°C. Where, however, the surface is dry, unfrozen and free from ice or snow, laying may proceed at temperatures at or above – 1°C on a rising thermometer.

304 USE OF SURFACES BY CONSTRUCTIONAL PLANT

1. Constructional plant used on pavements under construction shall be suitable in relation to the material, conditions 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 on tracks of plant moving over the various pavement courses shall be kept free from deleterious material.
3. Bituminous materials shall be kept clean and uncontaminated for so long as it remains uncovered by succeeding layers or surface treatment. Should the material become contaminated, the Contractor shall make good by cleaning it to the satisfaction of the Engineer.

SECTION 400 - SUB-BASE, SHOULDERS AND ROAD BASE**401 GENERAL**

Unless otherwise is stated sub-base, base and shoulder material shall consist of crashed hard stone without any soft or surveyed materials. Its grading shall be in accordance with EN13242.

402 MATERIAL TYPE 1

1. Material Type 1 shall be all-in-aggregate and shall conform to the requirements of Table 4/1. It's grading shall lie within the limits defined in Table 4/2.
2. Moreover, Material Type 1 shall be non-plastic. When it's part that passes the 425µm sieve is checked according to BS1377, the Liquid Limit (cone penetrometer method) shall be less than 25% and the Plasticity Index shall be less than 6%. In the case of deviation, and provided that the Liquid Limit is equal or less than 30% and the Plasticity Index is equal or less than 6%, the Engineer may accept the material, provided it is improved by adding hydrated lime or cement in proportion not less than 1% by weight, in exact proportion and methodology provided by the Contractor and approved by the Engineer. In this case the Contractor shall bear all costs of such improvement. Limestone material ($\text{CaCO}_3 + \text{MgCO}_3$ content more than 85%) with Liquid Limit equal or less than 30% and Plasticity Index equal or less than 6% shall not need any such improvement.

Table 4/1*
Material Type 1 properties

A. All-in-aggregate

| Test | Test Standard | Limits (Category) |
|---|---------------|-------------------------|
| Density (min) | EN932-2 | 2,00Mg/m ³ |
| Fines content (max) | EN933-1 | f ₉ |
| Magnesium sulfate soundness value (max) | EN1367-2 | 25% (MS ₂₅) |

B. Coarse aggregate

| Test | Test Standard | Limits (Category) |
|---|---------------|--------------------------|
| Flakiness Index (max) | EN933-3 | 20% (FI ₂₀) |
| Percentage of crushed or broken particles | EN933-5 | C _{90/3} |
| Los Angeles coefficient (max) | EN1097-2 | 25%**(LA ₂₅) |
| Impact test value (max) | EN1097-2 | 26%**(SZ ₂₆) |

C. Fine aggregate

| Test | Test Standard | Limits (Category) |
|------------------------------------|---------------|-------------------|
| Sand equivalent value (min) | EN933-8 | 35 |
| Methylene blue test value*** (max) | EN933-9 | 10g/kg |

* Categories refer to EN13242 standard.

** For limestone materials ($\text{CaCO}_3 + \text{MgCO}_3$ content more than 85%), materials with Los Angeles coefficient less than 30% (LA₃₀) and Impact Test Value less than 32% (SZ₃₂) may be used.

*** Tested only in cases where fines content exceeds 3%

Table 4/2
Material Type 1 grading*

| Sieve size (BS410) | Percentage by weight passing |
|-------------------------------|-------------------------------------|
| 50 mm | 100 |
| 37,5 mm | 95 – 100 |
| 20 mm | 60 – 80 |
| 10 mm | 40 – 60 |
| 5 mm | 25 – 45 |
| 2,36 mm | 15 – 35 |
| 600 micron | 8 - 22 |
| 425 micron | 5 - 20 |
| 75 micron | 0 - 12 |

* If sieves defined in EN933-1 are used, grading limits should be equivalent to those given above.

3. Material Type 1 shall be placed, spread and compacted according to Clause 404.

403 MATERIAL TYPE 2

- Material Type 2 shall be all-in-aggregate and shall conform to the requirements of Table 4/3. It's grading shall lie within the limits defined in Table 4/4.
- Moreover, if Material Type 2 is used as a sub-base material, then when it's part that passes the 425µm sieve is checked according to BS1377, the Liquid Limit (cone penetrometer method) shall be less than 30% and the Plasticity Index shall be less than 11%. If Material Type 2 is used as a shoulder material, then when it's part that passes the 425µm sieve is checked according to BS1377, the Liquid Limit (cone penetrometer method) shall be less than 30% and the Plasticity Index shall be less than 13%.
- Moreover, Material Type 2 shall conform with the following requirements

CBR (BS1377, test 16, sample at 95% maximum Dry Density BS 1377 Test 13, corresponding to the dry side of the Proctor Curve, 4.5 kg rammer with 2 day soak) not less than 30%, and Percentage swell at 2 day soak less than 1
- Provided that all necessary permits are obtained by the Contractor and the Engineer's approval is given, Contractor may use as Material Type 2 naturally occurring sandy gravels or havarochiakkilo that conform with requirements of Paragraphs 1, 2 and 3 above and that complies with the requirements of EN13285. In this case, if the material is used as sub-base material, the Plasticity Index shall be less than 6%.

Table 4/3*
Material Type 2 properties

A. All-in-aggregate

| Test | Test Standard | Limits (Category) |
|---------------------|----------------------|--------------------------|
| Density (min) | EN932-2 | 2,00Mg/m ³ |
| Fines content (max) | EN933-1 | f ₁₅ |

B. Coarse aggregate

| Test | Test Standard | Limits (Category) |
|-------------------------------|----------------------|--------------------------|
| Flakiness Index (max) | EN933-3 | 35% (FI ₃₅) |
| Los Angeles coefficient (max) | EN1097-2 | 45%(LA ₄₅) |

C. Fine aggregate

| Test | Test Standard | Limits (Category) |
|-----------------------------------|---------------|-------------------|
| Methylene blue test value** (max) | EN933-9 | 20g/kg |

* Categories refer to EN13242 standard.

** Tested only in cases where fines content exceeds 3%

Table 4/4
Material Type 2 grading*

| Sieve size (BS410) | Percentage by weight passing |
|--------------------|------------------------------|
| 70 mm | 100 |
| 37,5 mm | 85 – 100 |
| 10 mm | 45 – 100 |
| 5 mm | 25 – 85 |
| 600 micron | 8 - 45 |
| 75 micron | 3 - 15 |

* If sieves defined in EN933-1 are used, grading limits should be equivalent to those given above.

5. Material Type 2 shall be placed, spread and compacted according to Clause 405.

404 LAYING AND COMPACTION OF MATERIAL TYPE 1

1. Material Type 1 shall be placed and spread evenly by means of a paving machine approved by the Engineer and operated with a mechanism which levels off the material to an even depth. The material shall be spread in layers not less than 100 mm and not more than 200 mm in uncompacted thickness.
2. Compaction of Material Type 1 shall be started immediately after spreading using appropriate compaction plant to achieve a relative density of at least 100% of the maximum dry density determined by BS 1377 Test 13 or 15. At least three tests in accordance with BS 1377 Test 13 or 15 shall be carried out on each day's production run of laying to ascertain compliance with the above requirement and such tests shall be made at more frequent intervals if deemed necessary by the Engineer. Test holes shall be filled with properly compacted materials to the satisfaction of the Engineer at no cost to the Employer.
3. The material shall be rolled in a longitudinal direction from the sides towards the centre of the carriageway overlapping on successive passes by half the width of the rear roller until the number of required passes had been made over each point of the surface of the layer.
4. The surface of any layer of material shall on completion of compaction and immediately before overlaying or surface treatment be well closed and free from movement under compaction and from compaction planes, ridges, cracks and loose or segregated material. All loose and segregated areas shall be removed to the full thickness of layer, relaid with new material and recompact.
5. The Contractor shall programme the laying of Material Type 1 and subsequent pavement courses and take such other steps as may be considered necessary to afford protection of all pavement courses.

405 LAYING AND COMPACTION OF MATERIAL TYPE 2

1. Sub-base Material Type 2 shall be placed and spread evenly by means of a paver operated with a mechanism which levels off the material to an even depth, or with a self-propelled grader. The plant used in either case must meet the Engineer's approval. The material shall be spread in layers not less than 100 mm or more than 200 mm in uncompacted thickness.

2. Shoulder Material Type 2 shall be spread evenly without segregation in layers not less than 100 mm nor more than 150 mm in uncompacted thickness. Spreading from piles of material deposited by transport vehicles shall not be permitted. Spreading shall be undertaken concurrently with or soon after deposition.
3. Compaction of sub-base and shoulder material shall be completed with appropriate plant as soon as possible after the material has been spread. The moisture content of the material at the time of compaction shall be adjusted by approved means to the range of $\pm 2\%$ of the optimum moisture content determined in accordance with BS 1377 Test 13 and the material shall be compacted to not less than 97% of the maximum dry density by BS 1377 Test 13. At least three tests in accordance with BS 1377 Test 15 shall be carried out on each day's final compaction operations on each course to ascertain compliance with the above requirements and such tests shall be made at more frequent intervals if deemed necessary by the Engineer. Filling of test holes shall be to the satisfaction of the Engineer at no cost to the Employer.
4. The deposited material shall be rolled in a longitudinal direction from the sides towards the centre of the carriageway overlapping on successive passes by half the width of the real roller until the numbers of specified passes have been made over each point of the surface.
5. The surface of any layer of material shall on completion of compaction and immediately before overlaying be well closed and free from movement under compaction plant and from compaction planes, ridges, cracks or loose or segregated material. All loose, segregated or otherwise defective areas shall be removed to the full thickness of layer, re-laid, with new materials and re-compacted.
6. The Contractor shall programme the laying of sub-base material and subsequent pavement courses and take such other steps as may be considered necessary to afford protection to the sub-base and subgrade.

406 WATER-BOUND MACADAM ROADBASE

1. Water-bound macadam roadbase shall be Material Type 1
2. The material shall be mixed in stationary mixing plant which shall be of power driven paddle or pan type and may be of the batch or continuous type. If batch mixers are used, the appropriate measured amounts of material shall be first placed in the mixer, water being then added as necessary to bring the moisture content of the resulting mixture within the range specified in this Clause. Mixing shall be for not less than 1 minute. If continuous mixing is used, the paddles, baffles and rate of feed of materials shall be adjusted to give a uniformity mixed material. If a spray is used for distributing water into the mixer, it shall be adjusted to give uniformity in moisture content through the mix. The Engineer may at his discretion allow the Contractor to employ other measures as the Contractor may propose for the mixing of constituent materials for the production of the roadbase.
3. The moisture content at the time of compaction shall be within the range of 1.0 per cent above and 0.5 per cent below the optimum as determined in accordance with BS 1377 Test 13.
4. Water-bound macadam roadbase shall be placed, spread and compacted according to Clause 404.

SECTION 500 - BITUMINOUS ROAD BASE AND SURFACING

1. All aggregates used for bituminous surfacing shall conform to the requirements of EN13043.
2. Grading of coarse aggregates shall comply with Category G_{c90/10} of EN13043. Overall limits and tolerances for coarse aggregate grading shall comply with Category G_{20/15}. Fines content shall comply with Category f₂.
3. Grading of fine aggregates shall comply with Category G_{F85} of EN13043. Overall limits and tolerances for fine aggregate grading shall comply with Category G_{TC10}. Fines content shall comply with Category f₁₆. For naturally occurring fine aggregates, fines content shall comply with Category f₃.
4. Coarse and fine aggregates from each supply source shall conform to the requirements of Table 5/1

Table 5/1**A. Coarse aggregates for bituminous mixtures**

| Test | Test Standard | Base Course and Road Base | Wearing Course |
|---|---------------|---------------------------|-------------------------|
| Flakiness Index (max) | EN933-3 | 20% (FI ₂₀) | 20% (FI ₂₀) |
| Percentage of crushed or broken particles | EN933-5 | C ₁₀₀ | C ₁₀₀ |
| Los Angeles coefficient (max) | EN1097-2 | 30% (LA ₃₀) | 30% (LA ₃₀) |
| Impact test value (max) | EN1097-2 | 32% (SZ ₃₂) | 32% (SZ ₃₂) |
| Polished stone value – PSV (min) | EN1097-8 | No requirement | 44 (PSV ₄₄) |
| Aggregate abrasion value– AAV (max) | EN1097-8 | No requirement | 15 (AAV ₁₅) |
| Water absorption | EN1097-6 | 3,5% max | 3% max |
| Magnesium sulfate soundness value (max) | EN1367-2 | 18% (MS ₁₈) | 18% (MS ₁₈) |
| Stripping Test (150 particles test) | Appendix B | 6 particles max | 6 particles max |

B. Fine aggregates for bituminous mixtures

| Test | Test Standard | Base Course and Road Base | Wearing Course |
|---|---------------|-----------------------------|-----------------------------|
| Fines quality* (max) | EN933-9 | 10g/kg (MB _{F10}) | 10g/kg (MB _{F10}) |
| Water absorption | EN1097-6 | 3,5% max | 3% max |
| Magnesium sulfate soundness value (max) | EN1367-2 | 18% (MS ₁₈) | 18% (MS ₁₈) |

* Tested only in cases where fines content exceeds 3%

5. Aggregates shall consist of crushed stone, free from organic and other deleterious substances, loam, clay, chalk dust or other material which could prevent thorough coating or which might adversely effect the strength or durability of the surfacing,
6. Aggregates shall also be free from sulphates, chlorides and other materials (including the products of decomposition) which may be liable to break down during drying or mixing or subsequently when exposed to the weather.

8. Fine aggregates shall be approved crushed rock and shall be free from loosely bonded aggregations and other foreign matter. The parent rock shall be tested for stripping in accordance with Appendix B.

502 FILLER

1. Filler shall conform to the requirements of EN13043
2. Filler shall be stored in dry conditions.
3. The type of filler to be used shall be either crushed aggregates or hydrated lime, as specified in Clause 532.
4. Filler quality, tested according to methylene blue test (EN939-9), shall conform to Category MB=10 (10g/kg).

503 BINDER

1. The binder to be used for the surfacing material shall be bitumen with a penetration of 50/70 at 25°C.
2. Petroleum bitumen shall comply with the properties specified in Table 5/2A, and a certificate shall be obtained from the supplier with each consignment delivered stating the grade of bitumen being supplied. This certificate shall include the relative density of the current production. Consignment certificates are to be submitted to the Engineer for his retention.

Table 5/2A**Bitumen specifications**

| Properties | Test Standard | Binder type | | |
|--|---------------------------------------|---------------------|---------------------|---------------------|
| | | 70/100 | 50/70 | 35/50 |
| Spec. gravity at 25°C (g/ml) | IP190 / ASTM D 70 | 1,00 -1,05 | 1,01 –1,06 | 1,01 –1,06 |
| Ductility at 25°C (cm) min | ASTM D 113 | 100 | 100 | 100 |
| Penetration at 25°C (mm / 10) | EN1426 / ASTM D 5 | 70 - 100 | 50 - 70 | 35 – 50 |
| Softening Point (°C) | EN1427 / ASTM D 36 | 43 - 51 | 46 - 54 | 50 – 58 |
| Resistance in hardening at 163°C - change in mass (+/- %) max - retained penetration (%) min - softening point after hardening (°C) min | EN12607-1 / EN12607-3 * EN1427 | 0,8 46 45 | 0,5 50 48 | 0,5 53 52 |
| Flash Point (°C) min | EN22592/ ASTM D92 | 225 | 250 | 250 |
| Solubility (% m/m) min | EN12592 / IP47 | 99 | 99 | 99 |

* In the case of conflict, EN12607-1 method prevails.

504 MIXTURE DESIGN

1. Base Course and Wearing Course
 - a. The Contractor shall design the mixtures in his laboratory using the size of aggregate grading appropriate to the course, as specified in Clause 531.
 - b. "Laboratory Design Mixtures" for asphaltic concrete shall be designed in accordance with Clause 533.

c. The grading curves of the aggregates shall be within and approximately parallel to the grading curves specified. The particle size distribution of the aggregates when plotted shall give a smooth curve throughout the whole range of sieve sizes.

2. Road Base

The grading of the mix must comply with Table 5/6 and the bitumen content shall be 4% +/- 0.4.

505 PRELIMINARY TRIALS

1. Preliminary trial mixtures shall be made up in the mixers the Contractor proposes to use with the aggregate proportioned in the various hot bins to produce the required aggregate grading and with the binder content at optimum or at mid point of the specified range as applicable for the surfacing material being laid.
2. Preliminary trial mixtures shall be made up from the "Laboratory Design Mixture" determined in accordance with Clause 533 for the base course and wearing course, and in accordance with Clause 504.2 for the road base.
3. The trial mixtures shall be laid as preliminary trials in locations selected by the Engineer with the spreading and compacting equipment the Contractor proposes to use.
4. If the preliminary trials indicate that the trial mixtures or the "Laboratory Design Mixtures" are unsatisfactory for mechanical spreading and compacting, or fail to produce the specified surface accuracy, or result in surface blemishes which are unacceptable, the proportion of binder shall be adjusted and the grading of the combined aggregates and filler may be slightly modified to ensure that, at the adjusted binder content, the values of the modified mixture remains within the specified limits for the materials being laid. Further preliminary trials shall then be laid to demonstrate that a satisfactory mixture has been achieved. The Engineer will then agree the mixture and authorise the laying of a final trial area, as described in Clause 506.
5. After completion of all preliminary trials, the edges of the lanes shall be feathered off in bituminous surfacing as necessary for the requirements of traffic to the approval of the Engineer.

506 TRIAL AREAS

1. Following completion of the preliminary trials described in Clause 505 a trial of surfacing not less than 50 m long by one lane width shall be laid for each course thickness of each mixture to establish the most suitable compaction method.
2. When the Engineer has approved the trial area (s) the Contractor shall confirm in writing the weights and proportions of the approved mixture to the Engineer and they shall be used thereafter as a basis for all future plant mixing.
3. The trial areas shall be permanently marked "Approved" and dated.
4. Until approval has been given, the general laying of bituminous surfacing required by the Contract will not be permitted to start.
5. The standard of workmanship and finish of all layers included in the Contract shall be equal in all respects to that of the "Approved" areas and shall not be changed afterwards without the specific approval of the Engineer.
6. If, for any reason, the quality, grading, or supply source of the aggregates is changed, a new mixture shall be designed and approved on the basis of further trial areas.

7. Based on the trials, the rollers and rolling method to be adopted for each course, following compaction as described in Clause 522 shall be agreed with an approved by the Engineer.
8. No change shall be made afterwards in the mixing and spreading plant of rolling method without the approval of the Engineer and then only after new trials have been carried out and approved.
9. Trial materials laid which do not form part of the approved trial area, and which are unacceptable to the Engineer, shall be removed and replaced with new material to the approved standard.

507 WORK IN ADVERSE WEATHER

1. Bituminous Road base and surfacing shall not be laid during periods of continuous or heavy rain, or when free water is present on the surface, or when the degree of moisture on a wet surface could be detrimental to the finished product.

508 HANDLING AGGREGATES

1. Test requirements on bulk supplies are specified in Clause 543.
2. Aggregates of different nominal size of grading shall be stockpiled separately as supplied and aggregates from different supply sources though of similar grading shall be stockpiled separately for each source of supply.
3. Stockpiles shall be on a concrete or bituminous paved surface, laid to falls. The citing and preparation of the sites shall be approved by the Engineer. Aggregates of different grading in close proximity shall be separated by sturdy bulkheads.
4. The methods to be adopted to prevent "overspill" between adjacent stockpiles, particularly during tipping, shall be agreed with the Engineer.
5. Care shall be taken to avoid crushing by stockpiling equipment.
6. At all times, the stockpiles shall be kept free from contact with deleterious matter.
7. All aggregates produced or handled by hydraulic methods, or which have been washed, shall be stockpiled for at least 24 hours before use.

509 STATIC PLANT

1. The citing of all static plant shall be agreed with the Engineer and the layout of units shall be considered in relation to prevailing winds. All necessary permits according to the Law shall be obtained for all static plant.
2. The plant weighing, measuring and recording mechanism and temperature control gauges shall be checked by the manufacturer of the mechanism and gauges, or by an independent testing authority, and the Contractor shall submit proofs certifying that each device is operating accurately or reporting deviation allowances required in respect of each dial, to the Engineer for his retention. These checks shall be carried out before mixing starts, at the end of each month during mixing, and whenever the plant is recited or disturbed.
3. All plant shall be maintained in good working order, controlled by an experienced operator, and shall be subject to inspection by the Engineer.

510 PROPORTIONING COLD AGGREGATES

1. There shall be at least one cold hopper for each size of stockpiled aggregate. Each cold hopper shall be kept sufficiently charged to ensure a uniform rate of delivery.

2. Discharge from individual cold hoppers shall be adjusted so that the correct proportions required for the mixture are delivered to the drier.
3. Overspill between cold hoppers shall be prevented.

511 HEATING BINDER

1. The binder shall be separately heated to the temperature (s) specified in Clause 513 in approved heating tanks. The temperature dials shall be readily accessible and shall be kept clean at all times.

512 DRYING AND HEATING AGGREGATES

1. The plant shall include at least two cold hoppers for coarse aggregate and one for fine aggregate.
2. When two or more fine aggregates are being incorporated in the mixture, a separate hopper shall be provided for each. The feed gates, or other devices provided for controlling the output from each hopper, shall be capable of accurate adjustment to ensure a uniform rate of feed.
3. Aggregates shall be thoroughly dried and heated so that when proportioned into the mixer they shall be within the temperature ranges specified in Clause 513.
4. The Contractor shall carry out moisture tests, as described in Clause 534, at least once a week on a sample from each hot bin to check the effectiveness of the drying processes. If, at any time the test indicate that the drying facilities are inadequate, mixing is to cease until the Contractor has augmented his drying capability to the satisfaction of the Engineer. All drying plant shall be equipped with efficient dust extractors.

513 MIXING TEMPERATURES

1. Mixing temperatures related to a particular surfacing material shall be in accordance with Table 5/3.

Table 5/3**Mixing Temperatures**

| Binder Type | Aggregate temperature (°C) | | Binder Temperature (°C) | | Mixture temperature at discharge from mixer (°C) | |
|-------------|----------------------------|-----|-------------------------|-----|--|-----|
| | min | max | min | Max | Min | max |
| 35 – 50 | 150 | 170 | 155 | 165 | 150 | 170 |
| 50 – 70 | 150 | 170 | 145 | 165 | 145 | 165 |

NOTE: At the time of mixing, the temperatures of the aggregate and binder shall be within 15° C of each other.

2. The aggregates and binder shall not be overheated.
3. Re-heating of mixtures condemned because of heat loss, or for any other reason will lead to the rejection of the affected material.

514 MIXING

1. After heating, the hot aggregates shall be screened and separated into the hot bins for batching by weight in at least three different sizes into the mixing unit. Mixing plant which does not incorporate this requirement is prohibited.
2. The proportion of filler shall be measured by weight. The proportion of binder may be measured by weight or volume.

3. The hot aggregate and binder shall be thoroughly and intimately mixed together in the correct proportions until every particle of aggregate is completely coated, but for not longer than 1 1/2 minutes. Filler may be added before or after the binder, but mixing shall continue for at least 1 minute after the addition of the filler. The total mixing time may be reduced if the Engineer is satisfied that thorough mixing can be achieved in less time. In such cases the Contractor shall obtain the Engineer's written authority to reduce the mixing time to a specific period.
4. Where the specification for the material being mixed requires a definite proportion of an added filler, extracted dust shall not be automatically fed back into the mixer. When extracted dust satisfies the specified requirement for filler stipulated in Clause 502, it shall be weighed into the mixtures as a separate proportion.
5. Mixing plants shall comply with the manufacturer's requirements and unless otherwise approved in writing, they shall be of the batch-mixing type or of the continuous drum-mixing type. All mixing plant shall incorporate means of access to all bins in the plant to enable samples to be taken.

515 VARIATIONS IN PLANT MIXTURES

1. Any variations outside the limits specified for the particular material being mixed shall be investigated. If such variations continue for more than 24 hours, all mixing shall cease. All plant and processes shall then be checked and immediate arrangements shall be made by the Contractor to make the necessary modifications or corrections, until the Engineer is satisfied that when mixing restarts the mixtures will comply with these requirements. Before laying continues in the construction area, the Engineer may instruct the Contractor to lay a further trial area of surfacing as described in Clause 505.

516 TRANSPORTING PLANT MIXTURES

1. The plant mixtures shall be transported without delay from the mixing plant, with care to prevent segregation, to the laying sites. They shall be covered during transit, and while waiting, to prevent loss of heat, contamination, and wetting. All vehicles shall be mechanically sound and shall be suitable for the spreading equipment in use.
2. The use of dust, oil, or water on the surfaces of the transporting vehicles to facilitate discharge must be strictly regulated to the absolute minimum and if the Engineer considers that contamination of the mixture is occurring, the vehicle shall be thoroughly cleaned out to his satisfaction before being used again.
3. The temperature of the load in every transporting vehicle shall be checked immediately prior to discharge into the spreader. If the temperature of any batch is below the laying temperature specified in Clause 519, the load shall be rejected and shall be removed from site immediately.

517 PERMITTED TOLERANCE OF COURSE THICKNESS

1. The total compacted thickness of any layers of the surfacing material at any point shall not be less than 5 mm of the course thickness shown on drawings or exceed this thickness by more than the limits of Table 5/4.

**Table 5/4
Permitted Tolerances**

| Surfacing material | Maximum permitted tolerance over course thickness shown on drawings |
|---------------------------|--|
| Roadbase | 25mm |
| Base Course | 15mm |
| Wearing Course | 5mm |

2. If so directed by the Engineer, cores shall be taken to determine course thickness.

518 LAYING REQUIREMENTS

1. A competent supervisor shall be in charge of all laying and finishing operations.
2. The mixtures shall be spread initially to the depths necessary to give the specified nominal course thickness, and to comply with the finished levels profiles, and widths shown on the Drawings or otherwise provided for or instructed after compaction. Basecourse and Wearing Course shall be laid in one single layer. For Basecourses specified course thickness 70 to 100mm the 0/28mm nominal size grading shall be used and for specified course thickness 50 to 80mm, the 0/20mm nominal size aggregate shall be used. For Wearing Courses the 0/14mm nominal size aggregate shall be used unless otherwise ordered by the Engineer. In the case of the bituminous roadbase, the course shall be laid in more than one layer where required. The minimum layer thickness shall be 80mm and the maximum 160mm
3. Each course shall be firmly united with the underlying course.
4. Wearing course and base course shall be laid on the underlying layers as soon as practicable.
5. Trafficking of road base and base course shall be avoided. Where overlying courses are laid in less than twenty four hours, the Engineer may allow their laying without the application of tack-coat if he considers the surface suitable to accept the overlying course. Where tack-coated surfaces were, in the opinion of the Engineer, allowed to be contaminated, the Engineer may order the re-application of tack-coat at the Contractor's own expense.
6. The use of handrakes shall be prohibited when the mixtures are laid by spreading and finishing machines in accordance with Clause 520 except at joint edges and around manholes and pits where their use shall be restricted to an absolute minimum.
7. After the spreading units have passed, handcasting of fines behind the spreader as a means of making-up irregularities or disguising blemishes left by the spreader will not be permitted.
8. At all times the courses shall be kept free from all extraneous matter.

519 LAYING TEMPERATURES

1. The minimum laying temperature for surfacing material shall be 130°C.
2. The Contractor shall supply approved thermometers calibrated in accordance with the requirements of Appendix C and shall check the temperature of the load in the hopper at the following intervals:
 - (a) Immediately before restarting the spreader following stoppage.
 - (b) At 30 minute intervals during forward progress.
 - (c) At any time the Engineer or his representative directs.

520 SPREADING BY MACHINE

1. Except where the conditions of Clause 523 apply, the mixture shall be spread, levelled and tamped by approved self-propelled spreading finishing machines. The machines shall be fitted with self-levelling devices and averaging beams. The averaging beam shall be utilized, as warranted in accordance with the manufacturer's specification and according to the Engineer.

2. Any extension beyond the basic width of the machine shall be strictly in accordance with the manufacturer's recommendations and shall give a uniform surface over the full width of the lane to the satisfaction of the Engineer.
3. Each spreader shall be maintained in good mechanical condition and shall be correctly adjusted for operation at the speed consistent with the character and rate of delivery of the mixture and the thickness and agreed rolling procedures for the course to produce a surface of uniform density and texture free from segregation, dragging, irregularities, or other unacceptable surface blemishes. If dragging or other faults should occur, the mechanism and operation of the units shall be checked and the defects shall be rectified or modifications made.
4. As soon as possible after arrival at the laying site, the mixtures shall be discharged continuously to the spreader and shall be laid in accordance with the requirements of Clause 518 without delay. When discharging into the spreader the latter shall approach and make contact with the rear wheels of the lorry.
5. Intermittent stopping of the spreader shall be avoided and the rate of delivery to the spreader shall be so regulated to enable the spreader to be operated continuously.

521 COMPACTION TEMPERATURE

1. The temperature of surfacing material after spreading and immediately prior to the beginning of compaction shall not be less than 130 C.
2. The Contractor shall supply approved thermometers and shall check and record the temperature of the material at the following intervals in accordance with Appendix C:-
 - (a) Immediately before it is rolled and at any time the Engineer or his representative directs.
 - (b) At 30 minute intervals during forward progress.
3. The test records shall be recorded in an approved form linking the temperature taken with the location of the material tested and shall be submitted daily to the Engineer.

522 COMPACTION

1. Compaction shall be carried out using 8-10 tonnes deadweight smooth wheeled rollers having a width of rill 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 to the approval of the Engineer. Wearing course and basecourse material 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.
2. Rollers shall be in good condition and fitted with smooth quick acting reverse controls. They shall be equipped with roll scrapers, absorbent mats and tanks connected to spray pipes on both front and rear rolls to ensure a uniform application of water or parting fluid. The rollers shall be operated by skilled and experienced drivers.
3. The weight to which each roller shall be ballasted shall be agreed with the Engineer during the laying of the trial (s).
4. Rolling shall proceed in the direction of laying with the rear wheel lapping the edge of any previously laid surfacing and shall progress gradually to the opposite edge of the lane, so lapping the rolling that, on completion, all roller marks are obliterated.
5. During rolling the roller wheels shall be kept moist with only enough water to avoid picking up the material.

6. Rollers shall move at a slow but uniform speed which should not exceed 5 kph for steel wheeled rollers, or 8 kph for pneumatic tyred rollers, and any pronounced steering change in direction of the roller shall be made on stable material.
7. The line of rolling shall not be suddenly changed or the direction of rolling suddenly reversed, thereby displacing the mix.
8. A water browser shall be provided alongside each spreading unit to ensure that rolling continues with the minimum interruption.
9. Rollers shall not be left standing on the new surfacing.

523 SPREADING AND COMPACTING BY HAND

1. Spreading by hand will be permitted for feathering and for areas of irregular shape.
2. With the approval of the Engineer, spreading by hand will also be permitted in areas where manholes or pits are concentrated and in areas which are inaccessible to the spreading and finishing machines specified in Clause 520.
3. The mixture shall be unloaded with care to avoid segregation onto an existing hard clean surface adjacent to the area on which it is to be placed, or when this is not available, onto an approved metal sheet alongside the area.
4. The mixture shall be spread portion to portion, without break, with hot shovels, in a uniform thickness, which, after compaction, shall not exceed the maximum specified for the mixture, and the material shall then be finished with hot handrakes, by skilled rakers, to the level required to give the correct shape and profile after compaction.
5. The exposed edges of manhole frames, grating frames and any fixtures in the pavement, or the concrete surrounds thereto against which the new surfacing abuts, shall be scraped and thoroughly cleaned to the satisfaction of the Engineer and painted with an application of hot Bitumen immediately before the surfacing is placed.
6. The surfacing shall then be packed tightly around the fixture and firmly tamped into position.
7. On completion of compaction, the finished surface of the wearing course shall be level with the top of the fixture to the accuracy specified in Clause 527.
8. In places inaccessible to the rollers compaction shall be achieved by suitable vibrating rollers, or by tamping.
6. In places inaccessible to the rollers compaction shall be achieved by suitable vibrating rollers, or by tamping.
7. Surfacing which is spread by hand and compacted shall comply with the density and surface regularity requirements of this Specification.

524 LONGITUDINAL LANE JOINTS

1. The longitudinal lane joints shall be truly vertical in straight lines which are continuous for the full length of the pavement, or in smooth curves around bends.
2. The exposed vertical edges of the longitudinal lane joints in the surfacing materials shall be carefully cut back and trimmed to firm material in the compacted lane, or for a minimum of one and half times the layer thickness, whichever is the greater, and all loose material arising from this operation shall be removed from the pavement before the cut edge is painted.

3. Cutting back and trimming will not be required when two or more spreading units operate in echelon in close proximity, permitting adjacent lanes to be continuously compacted before the material around the joint between the lanes falls below the compaction temperatures specified in Clause 521.
4. After cutting back and trimming, the exposed vertical edges of the longitudinal lane joints of all surfacing materials shall be thoroughly cleared of all adherent material and shall then be painted with hot bitumen just ahead of the spreading unit laying the adjacent lane.
5. Painting shall completely and uniformly cover the exposed edge for its full depth. Excess material to the top and base of the joints, streakiness and blobs, shall be avoided.
6. On completion, the joints shall present the same density and texture as the remainder of the surfacing and the accuracy of surface across the joints shall meet the criteria specified in Clause 527.

525 TRANSVERSE JOINTS

1. Transverse joints are required at the end of a day's work and following an interruption in laying which prevents continuity of rolling at the specified minimum temperature.
2. They shall be formed at right angles to the longitudinal joints and be truly vertical.
3. The exposed vertical edges of the transverse joints of all courses shall be cut back for at least 300 mm and trimmed. Arising from this operation shall be removed from the pavement and the underlying surface cleaned.
4. The exposed joint edges shall then be cleaned and painted with hot bitumen as specified in Clause 524 immediately before the laying or the lane continues.
5. On completion, the joints shall present the same density and texture as the remainder of the surfacing and the accuracy of the surface across the joints shall meet the criteria specified in Clause 527.

526 FINISHED LEVELS

1. The finished surface levels shall conform with the levels, profiles and contours shown on the Drawings and the finished levels of the underlying courses are to be such that, at no point, will the thickness of any overlying courses be less than the nominal thickness specified.
2. Where the Engineer so directs, deviations from the required levels exceeding the tolerances permitted in Clause 301 shall be corrected by replacement with new surfacing at its full nominal thickness after total removal as detailed in Clause 528.

527 SURFACE ACCURACY

1. The longitudinal regularity of the surfaces of wearing courses, basecourses, and roadbases shall be within the relevant limits stated below:

| Maximum Permitted Number of Surface Irregularities | | |
|--|---|---|
| | Surface of carriageways hard strips & hard shoulders | Surfaces of Lay-bays, Services areas, all bituminous basecourses and roadbases |
| | | |

| Irregularity | 4mm | | 7mm | | 4mm | | 7mm | |
|----------------------------------|-----|----|-----|----|-----|----|-----|----|
| Length (m) | 300 | 75 | 300 | 75 | 300 | 75 | 300 | 75 |
| Number of, surface, irregularity | 20 | 9 | 2 | 1 | 40 | 18 | 4 | 2 |

An irregularity is a variation of not less than 4mm or 7mm of the profile of the road surface as measured by the rolling straight-edge, set at 4mm or 7mm as appropriate. No irregularity exceeding 10mm shall be permitted. Prior to testing any final road surface, basecourse or roadbase for level or regularity, it shall be cleaned of loose or extraneous materials. These operations shall be carried out without damaging the surface of the pavement, as soon as possible and within 3 working days of construction of the pavement.

2. Compliance with the above will be tested by the rolling straight-edge of the type designed by the Transport and Road Research Laboratory, along any line or lines parallel to the edge of pavement on sections of 300m selected by the Engineer, whether or not it is constructed in shorter lengths. Sections shorter than 300m forming part of a longer pavement shall be assessed using the number of irregularities for a 300m length pro-rata to the nearest whole number. Where the total length of pavement is less than 300m, the measurements shall be taken on 75m lengths.
3. Pavements will be measured transversely for irregularities at points decided by the Engineer, by a 3m long straight-edge placed at right angles to the centre line of the road. The maximum allowable difference between the pavement surface and the straight-edge shall be 3mm.
4. A straight edge 3 metres long, will be used to test longitudinal surface regularity in the following cases:-
 - i) for lengths of less than 75m of wearing course, basecourse, or bituminous roadbase in pavements;
 - ii) where use of the rolling straight edge is impracticable.

The maximum allowable difference between the surface and the underside of the straight-edge, when placed parallel with, or at right angles to, the centre line of the road at points decided by the Engineer shall be as in Table 5/5 below:

TABLE 5/5

| Surface accuracy Surfacing Material | Maximum Gap under a 3m long test straightedge (mm) | |
|--|--|--------|
| | along | across |
| Wearing Courses | 5 | 7 |
| Base Courses | 8 | 10 |
| Bituminous Road Bases | 10 | 12 |

5. One rolling, straight edge and an adequate number 3m long straight edges shall be provided by the Contractor.

Rectification

6. If any tolerances or limits in this Clause are exceeded, 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) Bituminous roadbases:

With coated macadam or asphalt roadbases, 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 5m long and the full width of the paving laid in one operation. Alternatively for low areas in flexible pavements the Contractor may make up with the material of the layer immediately above the one being rectified, when the subsequent layer is laid.

ii) Wearing courses, basecourses

These shall have the full depth of the course removed, or in the case of upper roadbase 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 5m long if basecourse or 15m if wearing course.

Where the number of surface irregularities exceeds the above limits, the area to be rectified shall be 300m or 75m long as appropriate and the full width of the lanes affected, of such lesser area to be determined by the Engineer as necessary to make the surface regularity conform with the limits.

Testing 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.

7. Attempts to correct the surface accuracy with any dressing whatsoever, shall not be allowed.

8. The condemned areas shall be rectified at the Contractor's expense.

528 CUTTING OUT DEFECTIVE SURFACING

1. When surfacing is cut out, for any reason, it shall be removed for the full depth of the layer.
2. The area to be cut out shall extend across the full width of the lane between the longitudinal joints.
3. The area of the lane to be cut out shall be defined by straight saw cuts, at least 40 mm deep or for the full thickness of the layer, whichever is the thinner, at right angles to the longitudinal joints.
4. The area shall be cut away carefully by pneumatic spade cutters or by approved mechanical scrubbling or planing machines. Where spade cutters are used, the cutting tool blades shall overlap the previous cut on each move and each cut shall penetrate the course for its full thickness.
5. The surface of the exposed material below shall be thoroughly cleared of all loose fragments and cleaned.
Replacement shall not start until the Engineer has approved the condition and cleanliness of the exposed surface.

529 REPLACEMENT OF DEFECTIVE SURFACING

1. A tack coat in accordance with Clause 548 shall be applied over the exposed surface, care being taken to include all corners, angles and irregularities by vigorous brooming provided that consist asphalt base. Otherwise shall be applied prime coat in accordance with clause 549.
2. The exposed vertical faces of the surfacing shall be painted with hot bitumen.
3. Replacement surfacing shall comply with the nominal course thickness shown on the drawings and tolerances specified in Clause 301 and with the standards detailed in this Specification.

530 FILLING CORE HOLES

1. The walls and base of all holes from which core samples have been cut are to be painted with hot bitumen and filled with the specified surfacing material, well rammed, in lifts not exceeding 50 mm.

531 AGGREGATES

1. Aggregates shall be mixed in such proportions so that the grading of the resulting all-in-aggregate, when tested according to EN 933 – 1:1997 and to comply with class GA 85 and in accordance with Table 5/6 and 5/7.

All-in-aggregate grading for Roadbase and Base Course

| Sieve size (BS410) | Percentage by mass passing (%) | | | |
|-----------------------|--------------------------------|------------------------|--------------------------|--|
| | Base Course | | Roadbase | |
| | Nominal size 0/28mm | Nominal size 0/20mm | Nominal size 0/37,5mm | |
| 50 mm | - | - | 100 | |
| 37,5 mm | 100 | - | 95 - 100 | |
| 28 mm | 90 - 100 | 100 | 70 - 94 | |
| 20 mm | 71 - 95 | 95 - 100 | - | |
| 14 mm | 58 - 82 | 65 - 85 | 55 - 75 | |
| 10 mm | - | 52 - 72 | - | |
| 6,3 mm | 44 - 60 | 39 - 55 | 44 - 60 | |
| 3,35 mm | 32 - 46 | 32 - 46 | 32 - 46 | |
| 300 micron | 7 - 21 | 7 - 21 | 7 - 21 | |
| 63 micron | 2 - 8* | 2 - 8* | 3 - 8* | |

* The material passing the 63 micron BS 410 sieve shall include hydrated lime or fines only where the fine aggregate is solely of limestone origin, as specified in Clause 502 and 532.

TABLE 5/7

All-in-aggregate grading for Wearing Course

| Sieve size (BS410) | Percentage by mass passing (%) | |
|-----------------------|--------------------------------|------------------------|
| | Nominal size 0/20mm | Nominal size 0/14mm |
| 20 mm | 100 | 100 |
| 14 mm | 87 - 100 | 85 - 95 |
| 10 mm | 72 - 92 | 70 - 90 |
| 6,3 mm | 58 - 78 | - |
| 5 mm | - | 45 - 65 |
| 3,35 mm | 43 - 60 | - |
| 2,36 mm | - | 29 - 43 |
| 1,18 mm | 27 - 39 | 19 - 31 |
| 600 micron | - | 14 - 26 |
| 300 micron | 13 - 23 | 10 - 20 |
| 150 micron | - | 6 - 14 |
| 63 micron | 4 - 7* | 5 - 8* |

* The material passing the 63 micron BS sieve shall include hydrated lime, or crushed limestone filler as specified in Clause 502 and 532.

532 FILLER

1. Part of the filler shall be hydrated lime. In the case where the fine aggregate and the filler consist of limestone material ($\text{CaCO}_3 + \text{MgCO}_3$ content more than 85%), then the amount of hydrated lime filler shall be not less than 1% by weight of the total aggregate. In all other cases the amount of hydrated lime filler shall not be less than 2% by weight of the total aggregate.
2. Both the fine aggregate filler and the hydrated lime filler shall be stored in separate silos. The hydrated lime filler shall be added prior to the addition of the binder. After the addition of the binder, the fine aggregate filler shall follow.
3. That part of the added filler which is retained on the 63 microns BS sieve shall be regarded as fine aggregate.

533 MIXTURE DESIGN

1. The "Laboratory Design Mixture" for the wearing course and the base course mixtures shall comply with the requirements listed in Table 5/8 and precise values for each requirement shall be determined for each mixture in accordance with the Asphalt Institute Manual (M.S.-2) "Mix-Design Methods for Asphalt Concrete and Other Hot-Mix Types".

Table 5/8**Requirements for Laboratory Design Mixture**

| Requirement | Base Course | Wearing Course |
|--|--------------------|-----------------------|
| Optimum binder content (%) | 4 to 7 | 5 to 7 |
| Stability (min) | 6600 N | 6600 N |
| Flow (mm) | 2 to 5 | 2 to 5 |
| Voids in total mixture (%) | 3 to 5 | 3 to 5 |
| Voids filled with binder (%) | 67 to 77 | 76 to 82 |
| Index of retained stability after 24 hours (% min) | 75 | 75 |
| Index of retained stability after 5 days (% min) | 70 | 70 |

534 PRELIMINARY TRIALS

1. Preliminary trial batches of the approved "Laboratory Design Mixture" shall be made up and laid as specified in Clause 505.
2. As a result of the preliminary trials the Contractor and the Engineer shall agree a provisional "Job Standard Mixture" for each mixture required.
3. The provisional "Job Standard Mixture" so agreed shall comply with the "Laboratory Design Mixture" modified when necessary as described in Clause 505 and shall be within the limits for grading binder content, stability, flow and voids in Clauses 531 and 533.

535 TRIAL AREAS

1. At least two samples of the provisional "Job Standard Mixture" for each trial area laid in accordance with Clause 506 shall be taken, as described in BS 598 after discharge from the mixer and before loading into the paver, for analysis of aggregate/filler grading, binder content, and in the case of basecourse and wearing course for the manufacture of Marshall specimens to determine unit values for stability, flow, voids, total mix, and voids filled with bitumen. Specimens for the determination of the "Job Standard Mix Relative Density" as described in Clause 536 shall also be prepared from these samples.

2. The Contractor shall cut three pairs of 150 mm diameter cores through the finished course with an approved coring machine for the determination of the field relative density of the course. The mean field relative density shall be not less than 96 per cent and not more than 98 per cent of the "Job Standard Mixture Relative Density" or not less than 93 per cent and not more than 95 per cent of its theoretical relative density when this is appropriate, as defined in Clause 536, for Base Course and Wearing Course. In the case of Roadbase the mean field relative density shall be not less than 95% of the percentage refusal density (PRD) as determined in accordance with clause 927 of the Specification for Highway Works Part 3, 1986 published by HMSO - U.K. or B.S. 598 Part 104. No field density result may fall below 93%.
3. If the required field relative density is not obtained, further trials shall be conducted and new cores shall be taken and retested. This procedure shall be repeated until satisfactory relative density results have been obtained and the finished courses are equally satisfactory in all other respects and final trial areas have been approved by the Engineer.
4. As a result of the approved trials, the "Job Standard Mixture" for the basecourse and the wearing course shall be confirmed and the Contractor shall report to the Engineer in writing a precise grading curve for the combined aggregate/filler and the hot bin quantities by weight required to meet the grading, the precise binder content and unit values (on the basis of the mean value of not less than four or more than six specimens) for stability, flow, voids, in total mixture and voids filled with binder, for his approval and as a basis for all future mixing.
5. The approved "Job Standard Mixture" shall comply with the "Laboratory Design Mixture" modified when necessary as described in Clause 505 and shall be within the limits for grading, binder content, stability, flow and voids given in Clauses 532 and 533.
6. If, for any reason, the quality grading or supply source of aggregate is changed, or if, at any time, the cause of variations outside the permissible limits specified in Clause 537 cannot be corrected for reasons beyond the control of the Contractor, the Engineer may request a new "Laboratory Design Mixture" or "Job Standard Mixture" depending on the extent of the change or variation.

536 JOB STANDARD MIXTURE RELATIVE DENSITY

1. The relative density of the compacted courses throughout the work shall be related to the "Job Standard Mixture Relative Density" when not more than 10 percent mass of the total aggregate is retained on a 28 mm sieve, or to the theoretical relative density when more than 10 percent is retained.
2. The "Job Standard Mixture Relative Density" shall be obtained by making six standard Marshall specimens from samples of the approved "Job Standard Mixture"; determining the relative density of each, and comparing them with the mean value of the six. Any individual result which differs from the mean by more than 15 kg/cu m shall be rejected and, provided not more than two results are so rejected, the mean of the remaining results shall be designated the "Job Standard Mixture Relative Density".
3. The theoretical relative density shall be calculated in accordance with MS-2, "Mix Design Methods for Asphalt Concrete and other Hot Mix-Types".

537 VARIATIONS IN PLANT MIXTURES

1. Mixtures which are turned out by the mixing plant during normal routine production shall be designated the "Plant Mixture". The limits of permissible variations between the "Plant Mixture" and the "Job Standard Mixture" approved in accordance with Clause 535 for basecourse and wearing course shall, at all times, comply with Table 5/9. All plant mixtures for Roadbase must comply with Clause 504.2.

Table 5/9**Permissible variations in Plant Mixtures**

| Requirement of dry aggregate and filler | Permissible variation | |
|---|-----------------------|----------------|
| | Base Course | Wearing Course |
| Retained 6,3mm sieve or larger | ± 5% | ± 4% |
| Passing 3.35 mm, 1.18 mm, 425 micron, 150 micron sieves | ± 4% | ± 3% |
| Passing 75micron sieve | ± 1,5% | ± 1,5% |
| Binder content | ± 0,3% | ± 0,3% |
| Voids total mixture | ± 1% | ± 1% |
| Voids filled with binder (%) | ± 5% | ± 5% |

Plant Mixture for Base Course and Wearing Course shall also comply with the following requirements:

- Voids shall not be less than 3%
- Stability shall not be less than 6600N
- Flow should be more than 2mm and less than 5mm
- The binder content shall not be less than 4% for Base Course and not less than 5% for Wearing Course.
- Regarding the grading of the aggregate, the variation in plant mixtures shall be used without exceeding the grading limits set in tables 5/6 and 5/7

538 TEST CERTIFICATES

1. Both before work starts and during mixing, the Contractor shall submit the proofs required to comply with Clause 509.

539 TESTS FOR INITIAL APPROVAL OF MATERIALS

1. Before mixing starts, the Contractor shall carry out tests as required to determine the qualitative values and grading of the aggregates and filler for comparison with Clauses 501 and 502 respectively.
2. Before and during production of binder the Contractor shall submit to the Engineer the necessary certificates that aggregates and filler are in accordance with EN 13043.

540 ADDITIONAL TESTS ON MATERIALS

1. If called upon to do so by the Engineer, either before mixing starts or at any time throughout the work, the Contractor shall make the necessary arrangements as required for check tests to be made on any of material specified for compliance with the requirements Specifications.

541 CERTIFICATES FOR COMPLIANCE WITH THE RELATIVE SPECIFICATION

1. Throughout the course of the work, the Contractor shall submit the certificates of compliance with the relevant specification required to comply with Clause 503.

542 TEST FOR PROPORTIONING AND DESIGN OF MIXTURES

1. The Contractor shall undertake the series of tests necessary to comply with Clauses 506 and 533.

543 ROUTINE TESTS ON BULK SUPPLIES OF AGGREGATE THROUGHOUT THE MIXING PERIOD

1. As a check on the consistency of bulk supplies, for comparison with the qualitative values and grading of the samples approved and as a check on the capability of the dryers to function efficiently with aggregates exposed to variable wetting, the Contractor shall carry out the following tests:-
 - (a) A sieve analysis of all aggregates in accordance with BS 812, Part 1, not less than once a day on a representative sample from each stockpile, for comparison with the grading of the initial samples.
 - (b) A sieve analysis in the same manner every 4 hours, on a sample taken from each hot bin, for computation of the combined grading as an initial check on the production, and for comparison with the approved grading for the mixture being laid.
 - (c) The moisture content weekly on a sample taken from each hot bin. The samples shall be weighed dried in a ventilated oven at a controlled temperature of $175 \pm 2^{\circ}\text{C}$ for 24 hours, and shall then be weighed again.
2. If the difference in the weight of the sample before and after oven drying exceeds 0.5 per cent, measures shall be taken in accordance with Clause 512 to augment the drying process.

544 ROUTINE TESTS ON MIXTURES THROUGHOUT PLANT MIXING

1. Throughout the work, whenever mixing is in progress, the Contractor shall carry out the tests specified in paragraph 3 below in his site laboratory.
2. Particular attention shall be given to ensure that the position of plant mixtures from which test samples are taken or specimens made can be accurately located in the finished pavement layer.
3.
 - (a)
 - (i) Analysis of the plant mixtures in accordance with the American Asphalt Institute recommended practices on samples taken after completion of the mixing process for the determination of binder contents and aggregate/filler proportioning and grading.
 - (ii) An analysis shall be carried out every 4 hours and in any case not less than twice a day for each mixer in use. At least one test per day shall be carried out in such a manner as will enable the water content to be determined.
 - (iii) The results of the grading tests shall be plotted on graphs to show comparison with the grading curve of the mixture approved in accordance with Clause 531 and the permissible variations allowed by Clause 537 and the relevant binder content shall be shown.
 - (iv) If either the grading of the binder content of any individual test out of the total number of tests for the day's production fails to comply with the specified requirements, the additional tests specified in Clause 547 shall be carried out.
 - (b) Temperature readings, which shall be taken and recorded in compliance with the Specification.

545 ROUTINE TESTS ON COMPACTED COURSES

1. Surface accuracy tests shall be made daily on the previous day's work to ensure compliance with Clause 527.
- If more than 2 tests in each group of 20 fail to comply with the specified requirement, the additional tests specified in Clause 547 shall be carried out.

2. Duplicate core samples of the previous day's surfacing from every 1,000 sq.m. laid (or from every 2 hours' work, whichever is the more frequent) and at locations agreed with the Engineer, shall be cut through the surfacing to the under side of the previous layer 150mm diameter to check the course thickness and adhesion.

Where the course thickness measured on any individual core fails to meet the requirement of Clause 504, the additional tests specified on Clause 547 shall be carried out.

The requirements of Clause 509 shall be checked when cores fail in adhesion, and the necessary corrections and adjustments shall be made to eliminate the cause of the failure.

546 ROUTINE FIELD AND RELATIVE DENSITY TESTS

1. Twin core samples 150 mm in diameter shall be taken in accordance with Clause 545 with an approved coring machine, and their densities determined within 48 hours of their being cut. The mean value obtained from the twin samples from the same area shall be taken as the field relative density of the compacted course.
2. The field density shall be such that, of twenty consecutive mean values, not more than three results shall be below 96% of the "Job Standard Mixture Relative Density", or 93% of the theoretical relative density when appropriate, as specified in Clause 536, for base course and wearing course. In no case any mean value shall fall below 93% of the "Job Standard Mixture Relative Density".
3. In the case of the Road base, the mean field relative density shall be not less than 95% of the percentage refusal density (PRD) as determined in accordance with Clause 927 of the Specification for Highway Works Part 3, 1986 published by HMSO - U.K. No field density result may fall below 93%.
4. Material which does not meet this requirement shall be cut out and replaced as detailed in Clauses 528 and 529 following further testing as described in Clause 547.
5. The samples shall also be used to determine the course thickness in accordance with Clause 545 and for comparison with the nominal course thickness required in accordance with Clause 517".

547 ADDITIONAL TESTS WHEN ROUTINE TESTS ON THE MIXTURE AND ON THE COMPACTED COURSES FAIL

1. The Contractor shall carry out the following additional tests when routine tests fail to establish the extent to which material already laid in the course fails to meet the requirements specified:-
 - (a) for aggregate/filler grading, and binder content
 - (b) for surface accuracy
 - (c) for course thickness
2. These additional tests shall be made on four 0.3 m square samples for checking grading and binder content or on four 0.15 m diameter cores for checking course thickness. The samples or cores shall be cut from the compacted course, at positions selected by the Engineer within the lane width at a distance of not more than 5 m from the location in the pavement, at which the mixture was laid which failed to satisfy the routine test requirements specified.
3. If any one of these additional tests also fails to meet the specified requirement, further tests shall be made on 3 more samples or cores. These samples or cores shall be cut at further

positions selected by the Engineer also within the lane width and at a distance of not more than 10 m further along the lane from the location of the subsequent failure point.

4. Should one of these additional samples or cores also fail to meet the specified requirement, the above process of paragraph 2 shall be repeated until all samples or cores are satisfactory.
5. The area covered by the failed samples or cores shall be cut out and replaced as detailed in Clauses 528 and 529.
6. When the routine tests fail to meet the requirements of Clause 527 an additional 20 straightedge tests shall be made over the area between the two routine fail-points, extended by 5 m either side of each along the length of lane.
7. If three or more of these additional tests also fail to meet the specified requirement, this area of the surfacing shall be condemned.
8. The condemned areas shall be removed and replaced by the Contractor, at his own expense, as specified in Clauses 528 and 529.
9. Attempts to correct the surface accuracy with fine bituminous dressings synthetic resin formulations, surface dressing applications, or emulsion slurry films shall not be allowed.

548 TACK COAT

1. The tack coat shall be a bitumen emulsion to BS 434, Anionic Class A1-40 or cationic Class K1-40 and shall be applied at a rate of between 0.25 and 0.40 litre/sq.m., the actual rate to be proposed by the Contractor and approved by the Engineer.
2. Bitumen emulsion tack coat may be applied to damp surfaces but free water shall be removed by sweeping the surface.
3. The tack coat shall be applied uniformly, free of streaks and blobs by mobile mechanical tank spraying units complying with BS 1707 or BS 3136 at least 6 hours in advance of surfacing but not more than 48 hours in advance.
4. Where the size or shape of an area to be sprayed precludes mobile operation, the Engineer may permit the use of pressure spraying equipment for hand-spraying which complies with the requirements of BS 1707 or of BS 3136.
5. After application no traffic of any kind shall be allowed to run over the tack coat until surfacing starts and arrangements shall be made to cordon off the sprayed area until that time.
6. When surfacing starts only the minimum amount of traffic essential to the surfacing operations shall be permitted.

549 PRIME COAT

1. The Prime Coat shall be 80/100 penetration bitumen or cut back bitumen type S-125 in accordance with specifications shown in Tables 5/2A and 5/10 respectively, blended with the necessary type and percentage of solvent to render it equivalent to MC30" to ASTM D2027-76 and shall be applied at the rate of between 0.6 and 1.5 litres per square metre. The actual rate shall be determined by the Engineer having regard to the properties of the road base, and the Contractor shall be informed accordingly.

Table 5/10**Cut-back Bitumen S-125**

| Properties | Test | Limits | |
|--|--------------------------|---------|---------|
| | | Minimum | Maximum |
| Density at 25°C (g/ml) | ASTM D 70 | 0,95 | 1,04 |
| Viscosity (Standard Tar) at 40°C (sec) | IP 72 | 100 | 150 |
| Viscosity (kinematic) at 25°C (stokes) | EN ISO 3104 ASTM D445 | 3000 | 4800 |
| Flash point in CS2% wt (°C) | EN 22592 ASTM D 92 | 50 | - |
| Distillation: | ASTM D 402 | | |
| - Distillate to 225° C % vol. max | | - | 2 |
| - Distillate to 316° C % vol. max | | 4 | 13 |
| - Distillate to 360° C % vol. max | | - | 16 |
| Tests on Residue after Distillation: | | | |
| - Penetration at 25°C (x 0,1mm) | ASTM D 5 | 100 | 350 |
| - Softening Point R&B (°C) | ASTM D 36 | 30 | 50 |
| - Solubility in CS2% wt. | IP 47 | 99 | - |

2. The prime coat shall be applied uniformly, free of streaks, pools and blobs, by mobile mechanical tank spraying units complying with BS 1707 or BS 3136 at least 24 hours in advance of surfacing.
3. Where the size of shape of an area to be sprayed precludes mobile operation, the Engineer may permit the use of pressure spraying equipment for hand-spraying which complies with the requirements of BS 1707 or of BS 3136.
4. After application no traffic of any kind shall be allowed to run over the prime coat until surfacing starts and arrangements shall be made to cordon off the sprayed area until that time.
5. When surfacing starts only the minimum amount of traffic essential to the surfacing operations shall be permitted.

550 REGULATING COURSE

1. Where specified in the Contract or instructed by the Engineer, regulating course material shall be made and laid in accordance with the requirements for the wearing course materials in this specification. The nominal size of aggregate shall be 14 mm (Table 5/7).
2. All areas where regulating course is required, will be indicated to the Contractor by the Engineer on site.
3. Prior to the laying of the regulating course, tack-coat will be applied in accordance with Clause 548. The surface of the existing pavement on which the tack coat will be applied, shall be swept clean from soil and dust particles and from any other impurities.
4. The minimum compacted thickness of the regulating course layer will be 20 mm and the maximum 40 mm and it will be laid in more than one layer if required.

551 STRUCTURAL PATCHING OF PAVEMENT

1. All areas where structural patching of pavement is specified or required will be indicated to the Contractor by the Engineer on site.

2. For the repairs the Contractor shall remove all asphalt road surface and roadbase as deep as necessary to reach firm support extending at least 30 cm into good pavement. This may mean that excavation may extend beyond the roadbase. The extent in plan and in depth of the area excavated shall be subject to the Engineer's approval.
3. The cut must be square or rectangular with faces straight and vertical. One pair of faces shall be at right angles to the direction of the traffic. A pavement saw shall be used for cutting the pavement.
4. After inspection and approval by the Engineer, the Contractor shall backfill the hole with roadbase material complying with the Specification, Clause 403. Each loose backfill layer shall not exceed 15 cm in thickness. Compaction shall be done with equipment suitable for the job, and densities achieved must meet the requirements of Clause 404. For small patches a vibrating plate compactor may be used. For large patches a vibrating roller or other suitable equipment must be used. The finished surface of the compacted roadbase material shall be at 8 cm below the existing pavement surface.
5. Prime coat shall be applied to the horizontal finished surface according clause 549, and tack coat shall be applied to the vertical faces of the hole according clause 548.
6. The last 8 cm remaining, shall be backfilled with a single layer of basecourse material. The basecourse material shall be made, laid and compacted in accordance with this specification.
7. A straight-edge or a stringline shall be used to check the finished surface of the patch.
8. Before proceeding with laying asphaltic wearing course the Contractor must obtain the written approval of the Engineer.

552 PREPARATION OF SURFACE TO BE PAVED

1. The surface of areas to be paved shall be checked for uniformity to the lines and grades and tolerance specified in the Contract. All loose and foreign matter or free water shall be removed by brooming or blowing with compressed air.
2. Surfaces of kerbs, gutters, vertical faces on bridges and all other structures which shall be in contact with the asphalt concrete shall be given a thin even coating of tack coat. Care shall be taken to prevent any coating on any exposed surface.
3. Prior to spraying the prime coat, the cleaned surface of the base shall be given a light application of water and allowed to dry to a surface dry condition before the bituminous material is applied.
4. No asphalt surfacing shall be laid over bridge decks before consulting and receiving in writing permission from the Engineer. Where asphalt surfacing is to be laid on bridge decks the existing surfacing will be removed, unless otherwise instructed by the Engineer, to a depth of 20 mm by cold milling and the new surfacing shall unless otherwise instructed, be laid to an equal thickness.

SECTION 600 – NOT USED**SECTION 700 - CONCRETE AND CEMENTATIOUS WORKS****701 GENERAL**

1. All materials supplied by the Contractor for use in the execution of the Works shall comply with the appropriate European Standards.
2. Whenever required by the Engineer, the Contractor shall provide samples of the materials which he proposes to incorporate in the Works. The approval of the Engineer to the samples submitted shall be obtained before any such materials are brought to the Site and the whole of the materials delivered to the Site for use in the works shall be equal in every respect to the deposited samples. Samples of materials to be used as aggregate shall be taken and tested in accordance with the Specifications.
3. No materials of which samples are required shall be used until such samples have been approved, in writing, by the Engineer.

702 CEMENT

1. Cement shall comply with EN197-1:2000 (Type CEM I, CEM II/A-M, CEM II/A-L and CEM II/A-P). Unless otherwise shown on the drawings, cement shall have 42,5MPa minimum typical strength (28 days) and shall be of type N. The Contractor shall submit to the Engineer the type of cement that he will use.
2. Cement shall be protected from the weather during transit. All cement shall be delivered in sound and properly secured bags or drums and shall be stored in a dry weatherproof shed with a raised wooded floor, or other building approved by the Engineer. Cement condemned by the Engineer as being injuriously affected by damp, or any other causes, shall be removed from Site immediately.
3. If the Engineer calls for check tests on any consignment the Contractor shall arrange and carry them out. Any consignment that does not comply with the specifications shall be removed from the Site immediately.
4. Cement shall be delivered in quantities sufficient to ensure that there is no suspension or interruption of the work of concreting at any time and each consignment shall be kept separate and distinct. Cement shall be used as soon as possible after delivery and shall be so stored that it can be used in the order in which it is delivered.

703 AGGREGATES

1. All aggregates used for concrete and other cementitious works shall conform to the requirements of EN12620. Coarse, fine and all-in-aggregates from each supply source shall conform to the requirements of Table 7/1

Table 7/1**Aggregates used for concrete works**

| Properties | Relevant paragraph in Standard | Limits (EN12620 Category) | | |
|----------------|--------------------------------|---------------------------|--------------------------|--------------------------|
| | | Coarse aggregate | All-in-aggregate | Fine aggregate |
| Particle size | 4.2 | d/D declared | d/D declared | d/D declared |
| Particle shape | 4.4 | 20% (Fl ₂₀) | 20% (Fl ₂₀)* | - |
| Fines content | 4.6 | 1,5% (f _{1,5}) | 3% (f ₃) | 10% (f ₁₀ **) |

| | | | | |
|---|-------|--|--|---|
| Fines quality | 4.7 | - | - | If fines content is greater than 5%, MB value shall be less than 10g/kg |
| Resistance to fragmentation | 5.2 | 30% (LA ₃₀) | 30% (LA ₃₀)* | - |
| Particle density (min) | 5.4 | 2Mg/m ³ | 2Mg/m ³ | 2Mg/m ³ |
| Water absorption (max) | 5.5 | 4% | 4% | 4% |
| Durability against freeze-thaw | 5.7.1 | 18% (MS ₁₈) | *** | 25% (MS ₂₅) |
| Durability against alkali-silica reactivity | 5.7.3 | Declared for naturally occurred aggregates | Declared for naturally occurred aggregates | Declared for naturally occurred aggregates |
| Chlorides (max content) | 6.2 | 0,1% | 0,1% | 0,1% |
| Acid soluble sulfates | 6.3.1 | 0,8% (AS ₀₈) | 0,8% (AS ₀₈) | 0,8% (AS ₀₈) |
| Total sulfur (max content) | 6.3.2 | 1% | 1% | 1% |
| | | | | |

* The limits refer to coarse aggregate part of all-in-aggregate.

** For fine aggregates produced from naturally occurred sandy-gravels category f3 is used.

*** Fine aggregate part and coarse aggregate part of all-in-aggregate shall conform to the requirements for Fine Aggregates and Coarse Aggregates respectively.

- Aggregates shall be stockpiled separately for each size delivered from each source of supply and each size from each source shall be separated in the stockpiles by sturdy bulkheads. Stockpiles shall be on concrete or other approved paved hard surfaces, laid to falls, the citing and preparation of the sites to be to the approval of the Engineer.
- The methods to be adopted to prevent overspill between adjacent stockpiles, coning or segregation of the aggregates in the stockpile, particularly during tipping, shall be agreed with the Engineer.
- Care shall be taken to avoid crushing by stockpiling equipment and at all times the aggregates shall be kept free from contact with deleterious matter. All aggregates shall be handled from the stockpiles to the batching plant in a way which will ensure a uniform grading of the material.
- If the Engineer calls for tests to check that aggregates comply with the specifications, the Contractor shall arrange and carry them out. If directed by the Engineer, aggregates which do not comply with the above specifications shall be removed from the Site immediately.

704 WATER

- The best available water supply shall be used. Water used shall be potable. Non-potable water may be used if it complies with the requirements of BS EN1008:2002 or if otherwise approved by the Engineer.

705 ADMIXTURES

- The quantity and method of use of admixtures shall be in accordance with the manufacturer's recommendations and in all cases shall be subject to the approval of the Engineer.

706 QUALITY OF CONCRETE

- The grade of concrete used shall be as specified at the drawings.
- Concrete shall comply with requirements defined in Table 7/2.

Table 7/2**Concrete requirements**

| Grade (Class Designation) | C10 | C15 | C20 | C25 | C30 | C35 | C40 |
|---|------------|------------|------------|------------|------------|------------|------------|
| Maximum size of aggregate (mm) | 40 | 40 | 20 | 20 | 20 | 20 | 20 |
| Minimum cement content (cu.m) | 180 | 220 | 300 | 325 | 350 | 375 | 400 |
| Slump value (mm) | 120 | 120 | 120 | 120 | 120 | 120 | 120 |
| Water/cement ratio | 0.55 | 0.55 | 0.55 | 0.55 | 0.55 | 0.55 | 0.55 |
| Indicative characteristic 150mm cube strength at 7 days (N/sq.mm) | 6.5 | 10 | 13.5 | 16.5 | 20 | 25 | 30 |
| Characteristic 150mm cube strength at 28 days (N/sq.mm) | 10 | 15 | 20 | 25 | 30 | 35 | 40 |
| Preliminary laboratory 150mm cube strength at 7 days (N/sq.mm) | 9 (11) | 13 (17) | 18 (22) | 21 (25) | 24 (28) | 28 (33) | 33 (36) |
| Preliminary laboratory 150mm cube strength at 28 days (N/sq.mm) | 13 (17) | 20 (25) | 27 (33) | 32 (38) | 37 (43) | 42 (48) | 47 (52) |

Note: Values in the parenthesis refer to non ready-mixed concrete

707 REINFORCEMENT

1. The reinforcement shall be of high yield and mild steel and shall comply with the requirements of BS 4449. Fabric reinforcement shall comply with BS 4483.
2. A certificate stating that the steel complies with the relevant standards in all respects shall be forwarded to the Engineer. Test certificates shall be held by the manufacturer or supplier and be available for inspection by the Engineer in accordance with the above standards.
3. All bends required shall comply with the requirements of BS 4466 as shown on the reinforcement schedules.

708 MIXING

1. The mixes shall be designed by the Contractor in accordance with BS 8110 to achieve the required strength and workability, but the cement content of the mix will be subject to approval by the Engineer, but within the limitations of Table 7/1. The type of cement for each part of the works shall be as specified. Additives will not be accepted except after prior written approval of the Engineer.
2. The Contractor shall make and test cubes of trial concrete mixes. 6 No. cubes are to be taken from each trial mix and tested at 7 and 28 days and for acceptance the average cube strength shall be the minimum preliminary trial compressive strength in Table 7/1.
3. After the value of the water cement ratio and the mix proportions have been determined in the preliminary tests and prior to the main concreting programme the Contractor shall make up a sample mix on Site to be used in a location to be approved by the Engineer, and cubes shall again be taken from this sample mix.
4. Once the water/cement ratio and mix proportions have been determined and agreed with the Engineer, these shall be used throughout the course of the Works and no variation shall be made without the approval of the Engineer. Concrete having slump greater than the slump value of the design mix shall not be used in the works.
5. If the materials or mixes are changed during the course of the Work the Contractor shall be required to arrange for the preparation, testing and approval of additional trial mixes.

709 CONCRETE - BATCHING

1. The proportion of each constituent in the mix, by weight, shall be that approved by the Engineer in accordance with Clause 708, allowance being made as detailed below for the weight of free water in the aggregate.
2. The allowance made for free water in the aggregates shall be determined on representative samples from each of the aggregate stockpiles in accordance with Clause 7 of Part 2 of BS 812 or with the approval of the Engineer by any other method. Regular determinations shall be made before mixing starts each day and afterwards at 4 hourly intervals unit mixing stops for the day. Additional determinations shall be made when mixing restarts after temporary stops made during the day because of prolonged or heavy rain.
3. Following each determination of free water in the aggregates the precise quantity of added water required to make up the total proportion of mixing water approved shall be calculated.
4. Aggregate from each stockpile shall be proportioned separately by weight to within a tolerance of ± 2 per cent.
5. The cement content shall be weighed separately from the aggregates to within a tolerance of ± 2 per cent. When it is delivered in bags, proportioning by weight of all constituents shall be based on the incorporation of whole bags.
6. The added water content calculated as detailed above may be measured by either weight or volume.

710 CONCRETE MIXERS

1. Mixers shall be of sufficient mixing capacity to provide the required output without overloading. The Contractor shall submit to the Engineer the following information relating to the mixing plant which he proposes to use:-
 - (i) Technical description of the plant, including recommended methods of erection, maintenance and operational control.
 - (ii) Minimum mixing time recommended for all the mixes specified.
 - (iii) Time required for charging and discharging.
 - (iv) Estimated theoretical output in terms of unit time for all the mixers specified.
 - (v) Any other information for the production of a consistently uniform concrete of the quality required by this Specification.
2. The citing of mixing plant shall be agreed with the Engineer.
3. Mixers shall be maintained in first-class condition throughout the contract and any mixer of plant which is faulty in any respect shall not be used. The drums of all mixers shall revolve at the speed recommended by the maker.
4. The drums of all mixers shall be thoroughly cleared out after each use, the inner surfaces and blades being free of any build-up of concrete or mortar before being used again.
5. During concrete production, mixers which have been out of use for more than 30 minutes shall be thoroughly cleaned out before mixing restarts.
6. Water measuring devices shall be calibrated before production starts and shall be checked at weekly intervals.

7. Weighing devices shall be checked by the Contractor before mixing starts, at intervals agreed with the Engineer and whenever a mixer is recited or disturbed.

711 TIME ALLOWED FOR CONCRETING AND TRANSPORTING OF CONCRETE

1. The total time taken from the addition of water to the mixes to the completion and its initial curing, shall not exceed 30 minutes.
2. A record shall be kept by the Contractor of areas of concrete which fail to meet the requirement. The record shall be agreed daily with the Engineer and only qualified acceptance of the concrete in these areas will be given. Work may continue on the understanding that before final acceptance is given the Contractor shall cut out and replace the concrete in these areas if directed to do so by the Engineer.
3. The concrete shall be transported from the mixer to a position of placing quickly and in such a way that the materials do not segregate. Under no circumstances shall the time between the start of mixing and the finish of placing a batch of concrete exceed 40 minutes.
4. Retarders may be used only after approval by and in accordance with the Engineer's instructions, at no extra cost to the Employer. Where retarders are approved, the time allowed for transporting and placing of concrete shall be as directed by the Engineer.

712 CONCRETE PLACING

1. Concrete shall only be placed on surfaces prepared to receive it. Reinforced concrete shall only be placed on formwork on general purpose grade concrete laid on the ground as 'blinding' 75 mm thick or as shown on the Drawing.
2. Before any concrete is placed, inspection must be made to ascertain that no dirt, shavings, loose stones, etc. have been allowed to remain in or about the formwork, and concrete in construction joints has been prepared in accordance with Clause 717. Existing concrete other than construction joints shall be well watered so that no moisture is drawn from the new concrete.
3. Concrete shall be deposited carefully to avoid segregation and shall not be permitted to drop more than 1.8 m in free-fall. In the case of reinforced concrete, care must be taken to see that the steel reinforcement is thoroughly surrounded by the concrete and that no voids or cavities are left. It is essential that the reinforcement should not be displaced whilst the concrete is being deposited or that the reinforcement be disturbed after the initial set of the concrete has taken place.
4. Concrete shall not be placed against surfaces, including earth faces, which are hot and dry or which are coated with ice or frost. All hot surfaces, including reinforcement, shall be shaded from direct sunlight and cooled by sprayed water as necessary to prevent their temperatures rising above 30°C. Where such precautions prove inadequate, the placing of concrete shall be deferred to cooler periods of the day or, subject to the permission in writing of the Engineer, carried out at night.
5. Concrete shall not be placed in the permanent works:
 - during heavy rain or dust storms;
 - when the air temperature in the shade is more than 35°C;
 - when the air temperature in the shade is less than 5°C and falling.

Concreting may be resumed when the air temperature in the shade rises to 2 °C if in the opinion of the Engineer it will continue to rise.

6. The concrete shall be efficiently compacted into all angles of the formwork and around all reinforcement and embedments using mechanical vibration. Care shall be taken to ensure that the vibration does not cause segregation. Vibrators shall not be used on the formwork or allowed to come into contact with the reinforcement or shutter ties. Internal vibrators shall have a frequency of not less than 10,000 cycles per minute.
7. If, when the formwork is stripped, the surface is found to be honeycombed, the Engineer may give instructions for the whole or part of the work to be removed and replaced at the expense of the Contractor.
8. When the concreting of any section of the work is commenced no cessation of the work will be allowed until concreting of the section is completed up to a properly formed construction joint, the position of which shall have been approved by the Engineer, prior to that start of concreting.

713 CONCRETE CURING

1. Freshly deposited concrete shall be protected from the sun, wind and rain until it is set properly and it shall also be prevented from drying too quickly by being kept covered with damp sacking or other material which shall be constantly kept wet for at least 7 days after casting. Other methods of curing by means of curing compounds may be used if prior approval of the Engineer is obtained.

714 CONCRETE FORMWORK

1. Formwork shall be constructed to attain the required surface textures of the structures and be such that it remains rigid during placing and setting of the concrete, with joints fitting sufficiently closely to prevent leakage of liquid cement.
2. It shall be fixed in perfect alignment and to the true shape and dimensions of the permanent work shown on the Drawings. A method of support which would result in holes or tie wires extending the whole width of a member will not be permitted.
3. Top shuttering is to be provided to concrete faces where the slope exceeds 1 (vertical) : 2 1/2 (horizontal).
4. The Contractor shall submit the design and details of shuttering for the Engineer's approval.
5. Before each concreting operation is commenced, shuttering shall be carefully examined and cleaned out, and the concrete contact faces of the shuttering shall be thoroughly cleaned and treated with a suitable mould oil. Retarding liquid must not be used unless specifically approved by the Engineer.
6. No concreting shall be commenced until the Engineer has inspected and approved the erected shuttering.
7. Shuttering shall only be removed with the permission of the Engineer and the work of striking after receipt of such permission shall be carried out under the personal supervision of a competent engineer. Great care shall be exercised during the removal to avoid shocks and reversal of stress in the concrete.
8. The times given in Table 7/3 may be taken as a guide for the removal of formwork (it being assumed that the member concerned will only be carrying its own weight).

Table 7/3

Times for removal of formwork

| | |
|--|--------|
| Vertical surfaces | 2 days |
| Walls, columns (beam sides etc) slabs (props left under) | 3 days |
| Beam soffits (props left under) | 7 days |

| | |
|-------------------------------------|--------------|
| Removal of props to beams and slabs | 21 – 28 days |
| Removal of props to cantilevers | 28 days |

9. Notwithstanding any advice, permission or approval given by the Engineer's Representative, the Contractor shall be responsible for any injury to the work and any consequential damage caused by or arising from the removal of shuttering.

715 CONCRETE PROTECTION

1. All concrete shall be protected in a suitable manner to prevent damage from any cause and the protection methods used shall be to the satisfaction of the Engineer.
2. Any defacement, defects or damage shall be made good to the satisfaction of the Engineer.

716 CONCRETE FINISHES

1. All formed surfaces are to be left on removal of the formwork, except where otherwise specified. No plastering of defective concrete will be permitted.
2. Finishes to concrete surfaces shall be shown on the Drawings and shall comprise the following:-
 - (i) Type A (Wrot). The irregularities in the finish shall be no greater than those obtained from the use of wrought thickness square edged boards arranged in a uniform pattern. The finishes shall be left as stark but imperfections such as fins and surface discolouration shall, if required, be made good by methods approved by the Engineer.
 - (ii) Type B (Fair faced). The formwork shall be lined with material approved by the Engineer to provide a smooth uniform texture. The lining material shall leave no stain and shall be so joined and fixed to the backing that it imparts no blemishes. The Contractor shall make good any imperfections in the finish as required by the Engineer. Imbedded metal parts and internal ties may be used provided that they can be plugged with concrete so as to prevent rust staining of the surface.
 - (iii) Type C (Screeded Surface). The concrete shall be uniformly levelled and screeded to produce a plain textured surface.
 - (iv) Type D (Floated Surface). When the surface moisture has disappeared and the concrete hardened sufficiently to prevent laitance being brought to the surface, a Type C finish surface shall be steel trowelled under firm pressure to produce a dense, smooth uniform surface free from trowel marks.

717 CONCRETE CONSTRUCTION JOINTS

1. The Contractor shall submit for approval by the Engineer his proposals for the position of construction joints, having due regard to any that may be shown on the Drawings. Rebates shall be provided in all horizontal and vertical construction joints in mass concrete gravity walls.
2. Before placing new concrete against concrete which has already set, the latter shall be treated to expose the aggregate over the full section and leave a sound irregular surface. This shall be done while the concrete is still green by means of a water spray and light brushing with or without the use of a retarding agent of a type approved by the Engineer.
3. Immediately before the fresh concrete is placed all foreign matter shall be thoroughly cleaned away and the surface moistened.

718 PLACING REINFORCEMENT

1. All steel reinforcement shall be completely free from dirt, oil, paint, loose rust or scale when in position ready for concreting.
2. The reinforcement shall be accurately bent to the shapes indicated and all bends shall comply with BS 4466. Straight portions shall be true and bends kept from winding.
3. The steel shall be fixed in position exactly as shown on the Drawings and the bars shall be securely wired together with No. 16SWG annealed steel wire or approved sprung steel clips wherever necessary to prevent any displacement during concreting. The placing of all reinforcement shall be checked by the Engineer and under no circumstances shall concrete be poured around any reinforcement which has not been approved.
4. The insertion of bars after the concrete has been placed will not be permitted.
5. The concrete cover to all reinforcement shall be as indicated on the Drawings.
6. Except where otherwise shown on the Drawings, the lengths of lap joints shall be not less than fifty times the diameter of the largest bar. Fabric reinforcement shall be laid with lapping joints of not less than 300 mm for main bars and 150 mm for transverse wires. The use of off-cuts shall not be permitted.

719 CEMENT MORTAR

1. Cement mortar shall consist of cement and sand gauged by volume in wrought wooden boxes in the proportions shown in Table 7/4.

Table 7/4**Cement Mortar**

| Class | Proportion by Volume | |
|-------|----------------------|------|
| | Portland Cement | Sand |
| 1 | 1 | 2 |
| 2 | 1 | 3 |

2. Unless otherwise specified cement mortar shall be Class 2.
3. The ingredients shall be mixed in an approved mechanical mixer, or shall be mixed together dry on a clean wooden stage until the mix is homogeneous in colour. Water shall then be added in sufficient quantity to give no more than stiff workability. The whole shall then be turned until thoroughly mixed.
4. Mortar shall be used within one hour of mixing and shall not be remixed or worked up again after it has stiffened. Any mortar which has commenced to set shall be removed from the works.

720 GENERAL PURPOSE GRADE CONCRETE, BLINDING CONCRETE

1. General purpose grade concrete shall be composed of ordinary Portland Cement and aggregates complying with Paragraph 703.
2. The ratio of the combined aggregate of all-in aggregate to the cement shall not be more than 8:1 by volume or 10:1 by mass. No account need be taken of bulking.
3. The concrete shall be mixed by machine or by hand to a uniform colour and consistency before placing. The quantity of water shall not exceed that required to produce a concrete with sufficient workability to be placed and compacted in the required location.
4. The concrete shall be compacted by hand or by mechanical vibration.

721 ROUTINE TEST ON CONCRETE MIXES THROUGHOUT PLANT MIXING

1. The Contractor shall carry out tests in his site laboratory as required by Section 700, throughout the work whenever mixing is in progress and, in addition, he shall take samples of concrete and make cubes as specified below:

Unless otherwise directed by the Engineer the rate of sampling for each class of concrete shall be as given below but not less than one sample shall be taken on each day that concrete of that grade is used.

Rates of Sampling and Testing

| | |
|---------------------|--|
| Use of Concrete | Sample from one batch selected randomly to represent an average volume of not more than the lesser of. |
| Reinforced Concrete | 20 cu.m. or 20 batches |
| Mass Concrete | 50 cu.m. or 50 batches |

One cube shall be made from a sample taken from a randomly selected batch of concrete. Samples shall be taken at the point of discharge from the delivery vehicle. The number of cubes may be reduced by the Engineer if consistently satisfactory results are obtained or increased if, in the opinion of the Engineer, additional tests are required as for example in the early stages of the works. All costs for the tests shall be borne by the Contractor.

2. The cubes shall be made, cured, stored and tested in accordance with B.S. 1881, in a site laboratory or in a laboratory approved by the Engineer. Reports of all tests made shall be supplied to the Engineer within 24 hours of the cubes being tested.
3. Compliance with the specified characteristic strength shall be based on tests made on cubes at 28 days, and shall be assumed if the conditions given in both (a) and (b) below are met:
 - (a) the average strength determined from any group of four consecutive test cubes exceeds the specified characteristic strength by

3 N/sq.mm for concretes of class C20 and above,
2 N/sq.mm for concretes up to class C15
 - (b) the strength determined from any individual test result is not less than the specified characteristic strength minus

3 N/sq.mm for concretes of class C20 and above,
2 N/sq.mm for concretes up to C15

If only one cube result fails to meet the second condition (b) then that result shall be considered to represent only the particular batch of concrete from which that cube was taken.

If the average strength of any group of four consecutive test cubes fails to meet the first condition (a), then all the concrete in all the batches represented by all such cubes shall be deemed not to comply with the strength requirements. For the purposes of this clause the batches of concrete represented by a group of four consecutive test cubes shall include the batches from which samples were taken to make the first and the last cubes in the group of four, together with all the intervening batches.

4. In the event of concrete failing to meet the specification, cores may be cut and tested to B.S. 1881, if the Engineer so directs.

5. In the event of non-compliance, the Engineer shall decide the action to be taken which shall include the braking out and removal of concrete by the Contractor at the Contractor's own expense.
6. If non-compliance of concrete is established, no further concreting shall be carried out until the Contractor shall have taken corrective action to the satisfaction of the Engineer.

722 - DAMPROOFING FOR CONCRETE STRUCTURES

722.1 General

1. Unless shown otherwise on the Drawings, the upper and vertical surfaces of reinforced concrete structures which will be in contact with fill shall be damproofed by the application of cut back bitumen complying with Clause of the specification.
2. Immediately before the application of primer or laying of the waterproofing system or protective layer, the concrete surface or primed surface shall be clean, dry and free from ice, frost, laitence, loose aggregate, dust and other debris and where the adhesion to the concrete would be impaired, free from curing liquids, compounds and membranes.
3. The waterproofing membrane, primer and bonding agents including tack coat shall be compatible with each other.
4. 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 specification.

722.2 Material for waterproofing below ground concrete surfaces

1. Primer for Tar and Bitumen

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.

2. Tar shall comply with BS 76 of viscosity grade within the range 30-38°C equiviscous temperature.

3. Cut Back Bitumen

Cut back bitumen shall comply with BS 3690:Part 1 of viscosity grade within the range 25-50 seconds (standard tar viscometer) at 40°C.

4. Proprietary Materials

Subject to any materials specified on the Drawings proprietary materials shall be as proposed by the Contractor and as agreed by the Engineer.

722.3 Workmanship for waterproofing below ground concrete surfaces

1. Priming for Tar and Bitumen

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.

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.

3. Cut Back Bitumen

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.

4. Proprietary Materials

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 as agreed by the Engineer.

722.4 Materials for waterproofing concrete bridge decks

1. Primer for Mastic Asphalt

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.

2. Mastic Asphalt

Mastic asphalt for waterproofing shall comply with BS 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.

3. Proprietary Waterproofing Systems

Proprietary waterproofing systems incorporated in the Permanent Works shall have a current British Board of Agreement Roads and Bridges Certificate.

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 in accordance with the details and specifications shown on the Drawings. The Contractor should furnish the Engineer with a data sheet which shall include for acceptance any additional information or limitations, compatibility of materials and details at the interface of the waterproofing with the bridge deck movement joints. No departure from the specified constituent materials as stated on the British Board of Agreement Roads and Bridges Certificate shall be permitted.

722.5 Workmanship for waterproofing concrete bridge decks

1. Mastic Asphalt

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 ponding in any depressions in the deck.

2. Mastic asphalt shall be laid directly onto the primed surface:

- (i) on horizontal surfaces and sloping surfaces up to 30° to the horizontal in two coats of equal thickness to a total thickness of not less than 20 mm.
- (ii) on vertical surfaces and sloping surfaces of over 30° to the horizontal in two coats 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-Clauses 4.6.2 and 3 and 4.7.1, 2, 8 and 9 shall not apply; and
 - (iii) details described in the Contract shall prevail over any conflicting requirement in the Code of Practice.
4. Joints shall be staggered a distance of at least 150 mm 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 any 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
- Proprietary waterproofing systems shall be installed only by applicators approved by the manufacturers.
- The formation of defects affecting the integrity of the membrane including pin/blow holes and blisters in the waterproofing shall:
- (i) be made good by repair 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 British Board of Agreement Roads and Bridges 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 3 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.
8. Bond Between Additional Protective Layer or Surfacing and the Waterproofing System
- The additional protective layer or surfacing laid on the waterproofing system shall be firmly bonded to 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.

1. Ready-mixed concrete, batched off the Site, may be used only with the agreement of the Engineer and shall comply with all requirements of this Section and generally of the Contract.

724 HIGH WORKABILITY CONCRETE C10

1. A high workability concrete C10 shall be used for the backfilling of possible solution cavities in Gypsum where directed by the Engineer. The high workability concrete C10 shall comply with the provisions of Section 700 of the Specification except that the quantity of water shall be increased so that it shall have a slump between 150 and 200 mm. Care must be taken to avoid any excessive segregation due to the high water content of the high workability concrete. A suitable admixture should be utilised in order to maintain a constant cohesiveness of the mixture.

SECTION 800 - DRAINAGE**801 PIPES FOR DRAINAGE****General**

1. Where the term drain is used in this Series it shall be deemed to include the terms sewers and piped culverts.
2. Unless otherwise described in the Contract or agreed by the Engineer, only one type of pipe shall be used within any individual drain or service duct between consecutive chambers. Contractors shall ensure that plastic 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 comply with Table 8/1. Unless otherwise shown on the drawings, pipes for drainage shall be concrete pipes.

TABLE 8/1

Pipes for Drainage

| Material | Standard/Basis of Acceptance | | | | | | | | | | |
|--|--|-----|------|------|-----|-----|-----|-----|------|-----|-----|
| Concrete Pipes (with Ordinary Port-land Cement or sulphate Resisting Cement if required by the Contract) | Concrete pipes shall be non-reinforced. Aggregates for the concrete shall comply with Paragraph 703. The grading of aggregates may be varied to suit the method of manufacture. In no case shall the maximum nominal size of aggregate, exceed 20 mm. The fresh concrete shall be adequately compacted after placing in the mould and cured for a minimum period of 7 days using an internationally accepted curing method. The minimum cement shall be 350 kg/cu.m. of compacted concrete and the water/cement ratio shall not exceed 0.45. | | | | | | | | | | |
| | Concrete pipes must be robust and bear handling and transport loads. They shall be of uniform and smooth surface, consistent diameter, very limited absorption and free of cracks, broken lips or ends and other imperfections. The following nominal sizes shall be used: | | | | | | | | | | |
| Internal Pipe Dia* (mm) | 150 | 200 | 250 | 300 | 400 | 450 | 500 | 600 | 700 | 800 | 900 |
| Min. wall Thickness* (mm) | 16 | 19 | 22 | 25 | 34 | 38 | 42 | 54 | 84 | 92 | 100 |
| Three-edge Bearing Strength (kN) | 22 | 22 | 23.5 | 26.5 | 30 | 32 | 33 | 38 | 43.5 | 45 | 48 |

*The allowable tolerance in dimensions shall be in accordance with AASHTO-M86

| | |
|---|---|
| Unplasticised Polyvinyl Chloride (UPVC) | Unplasticised Polyvinyl chloride pipes shall comply with BS 4660, BS 5556 or BS 5481 depending on the diameter. |
| Filter Drains | Filter Drains shall comply with BS 4660, perforated with not less than 1000 sq.mm of holes per metre length of pipe. Circular perforations not greater than 10 mm nor less than 3 mm in diameter. |

802 EXCAVATIONS FOR PIPES AND CHAMBERS

- Excavations shall be carried out in compliance with SECTION 200 of the Specification to the correct width, depth, line and level shown on the drawings and with the following:-
- Soft spots existing below the bottom of excavation shall be removed as directed by the Engineer and the resulting voids backfilled with Type 1 sub-base material complying with Clause 402 or pipe bedding material complying with Clause 803, both well compacted, or Grade 7,5 concrete.
- Any additional excavation below the bottom of an excavation that is required because the Contractor has allowed the bottom to become soft and otherwise unacceptable for the construction of the pipeline or chambers shall be made good as described in sub-Clause 2 of this Clause.
- 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 Sub-Clause 2 of this Clause, at the Contractor's expense.
- The bottom of the trench shall be graded and compacted well after removal of all loose material.
- The trench sides shall be adequately supported as required by the said conditions and the excavation shall be kept free from water at all times. In case of failure of the trench sides due to the Contractor's negligence, these shall be made good at his own expense and he shall be liable for any damage or delays.
- Trench excavation in hard material or rock shall be carried out with suitable equipment. The use of explosives shall not be allowed.
- Trench excavation in road pavements or walkways shall commence after compaction of earthworks is complete upto formation level or upto 300 mm above the level of the surrounding material whichever is less. At the location of cuttings trench excavation shall commence at the earthworks outline but before grading is carried out.

803 BEDDING, LAYING AND SURROUNDING OF PIPES

- Immediately following the excavation of the trench the Contractor shall give notice to the Engineer for inspection and approval of the excavation and he shall proceed with pipe laying immediately after such approval is secured. 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. 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 described as hard in the Contract so that the socket or sleeve does not bear on the bed.
- Pipe bedding and haunching or surrounding material shall comply with Table 8/3, unless otherwise described in the Contract.

TABLE 8/3

Granular Materials to BS 882

| Nominal Pipe Diameter | BS 882 Coarse Aggregate (Table 4) | |
|-------------------------------------|-----------------------------------|-----------------------------------|
| | Graded aggregate ranges (mm) | Single sized aggregate sizes (mm) |
| Not exceeding 140 | - | 10 |
| Exceeding 140 but not exceeding 400 | 20 to 5 or 14 to 5 | 10, 14 or 20 |
| Exceeding 400 | 14 to 5, 20 to 5 or 40 to 5 | 10, 14, 20 or 40 |

3. Where concrete is specified for bed and surround to pipes, this shall be Class C20 unless otherwise shown on the drawings. The backfilling of the trench shall be carried out after the completion of the curing of the concrete.
4. Unless otherwise required by the Contract, haunch and surround shall be provided to a height of 300 mm above the top of the pipe where the surround material is aggregate and 150 mm where the surround material is concrete.
5. Unless otherwise described in the Contract the bed and surround material to filter drains shall comply with Table 8/3.
6. Except where the pipeline is to be tested in compliance with Clause 809 before backfilling the completion of the bedding, haunching and the 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 and the pipeline accepted by the Engineer.

804 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 partly watertight complying with sub-Clause 4 of this Clause as required by the Contract. 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.
3. Watertight joints shall comply with the appropriate British Standards, the manufacturers instructions and the requirements of the Contract.
4. Partly watertight joints for surface water drains shall be tested in accordance with Clause 809.7.
5. Where a concrete bed, cradle, arch or surround is used with rigid pipes having flexible joints a compressible board or a preformed joint filler as described in the Contract shall be placed in contact with the end of the socket at a pipe joint and shall extend through the full thickness of any concrete in contact with the pipe. Such joints in any concrete bed, haunch or surround shall be at intervals not exceeding 5 metres.

6. Joints in Pipes for Filter Drains shall comply with the appropriate British Standard. Perforated UPVC pipes with spigots and sockets or sleeves may be dry jointed.
7. Joints in pipes for service ducts shall comply with the appropriate British Standard and 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.

805 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 the Contract, trenches except filter drains shall be backfilled above the pipe surround material described in Clause 803 with general fill material complying with the following:

| | | |
|------------------------|----|-----------------|
| Nominal size | | Less than 40 mm |
| Uniformity Coefficient | 10 | |
| Plasticity index | | 15 max |
| Liquid Limit | | 40 max. |

3. Filter drains shall be backfilled as described in the Contract with Type A or Type B filter material with the following characteristics:

TABLE 8/4
Grading Requirements for Filter Drain Material

| BS Sieve Sizes | % by mass passing sieve | | Other properties |
|-------------------|-------------------------|--------|---|
| | Type A | Type B | |
| 63 mm | | 100 | The material when tested in accordance with Test No. 4 of BS 1377 shall be non-plastic and the Los Angeles Value shall not exceed 30% |
| 37.5 mm | | 85-100 | |
| 20 mm | 100 | 0-25 | |
| 10 mm | - | 0-5 | |
| 5 mm | 60-100 | | |
| 1.18 mm | 15-45 | | |
| 600 micron | 0-25 | | |
| 150 micron | 0-5 | | |

When Type A material is used at least 15% of the material shall be larger than the diameter of hole.

4. Backfilling shall be deposited and compacted in compliance with Section 200, except for filter drains where the filter material shall be deposited in layers not exceeding 225 mm loose depth each layer being compacted in compliance with Section 200 unless otherwise agreed by the Engineer.
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 are not to be used within 300 mm of any part of the pipe or joint.
6. Except in carriageways and other paved areas, or as described in the Contract, 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, or of the same thickness and quality of topsoil as the surrounding ground. 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, or such lower level as described in the Contract. Sheet piling and other excavation supports shall be removed as the filling proceeds unless otherwise described in the Contract.

7. The position of service ducts shall be marked when the trenches are backfilled and permanent markers provided as described in the Contract.
8. The Contract shall protect the pipes from moving loads after their laying, during the construction of the Works. Any pipes damaged after their laying shall be replaced and the Contract shall be liable for all expenses and delays caused.

806 CONNECTING TO EXISTING DRAINS CHAMBERS AND CHANNELS

1. Where described in the Contract, existing drains 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 Engineer 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 the Contract.
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. Unless otherwise shown on the drawings the Contractor shall form a hole into the existing chambers of such a size that will allow the proper jointing and the opening shall then be sealed with class C25 Concrete.
3. Existing drains no longer required shall, at the direction of the Engineer, be sealed with Grade C5 concrete or removed and replaced with suitable material complying with and compacted in accordance with Section 200.

807 CHAMBERS

1. Chambers shall include Manholes, Catchpits, Inspection Chambers, Draw Pits and walled soak ways.
2. Unless otherwise shown on the drawings foundations to chambers shall be of Grade C20 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 Grade C10 concrete.
3. Chambers shall be constructed in accordance with the drawings. Precast Units for the shaft of chambers shall be of non-reinforced concrete pipes units complying with clause 801.3. Cast in situ concrete chambers shall be constructed of Grade C20 concrete complying with section 700 or as otherwise described in the Contract.
4. Where the depth of invert of chambers exceeds 900 mm below the finished surface of the carriageway or the adjacent ground, step-iron steps shall comply with BS 1247 and be built in as specified in BS 5911: Part 1. Steelwork used for ladders, handholds and other fittings shall comply with BS 970 and be galvanised in compliance with BS 729 after fabrication. Threaded components shall be galvanised in compliance with BS 729 "Hot-dip Galvanized Coatings on Iron and Steel Articles".
5. Excavation around chambers unless otherwise described in the Contract shall be backfilled with subbase material Type 2 in compliance with Clause 208. Where mechanical compaction

is impracticable, the excavation shall be backfilled with Grade C10 concrete at no extra cost to the employer. Where there are precast concrete access shafts to precast concrete chambers, the shafts shall be surrounded by a minimum thickness of 150 mm of Grade C20 concrete, and the remaining excavation backfilled with suitable fill compliance with Clause 208.

6. Chambers for foul drains shall be tested for watertightness as and where described in the Contract.
7. Chamber covers, gratings and frames shall be as described in the Contract and shall be manufactured from grey or ductile cast iron in accordance with EN 124 to the categories and sizes specified in the Contract. Their acceptance shall be subject to the submission of a satisfactory test certificate from an independent recognized laboratory/ organization, acceptable by the Employer.
8. Chamber cover bolts shall comply with BS 4190 and be galvanised in compliance with Clause 1911.
9. Requirements for special duty covers for use in carriageways shall be as described in the Contract.
10. Gratings for catchpit chambers shall have a minimum waterway area as described in the Contract.
11. Two sets of keys shall be delivered to the Engineer for each type of keyway in the covers supplied.
12. Frames for chamber covers and gratings shall be set in 1:3 cement mortar or a proprietary quick setting mortar approved by the Engineer.
13. Where the adjustment or replacement of existing frames and covers or gratings is required, the units shall be taken up and refixed or replaced with new units complying with sub-Clauses 7 to 11 of this Clause or such other specification as required by the responsible Authority at the correct level on a mortar bed complying with sub-Clause 12 of this Clause. The finished thickness of the mortar bed shall be between 10 mm and 25 mm. Any additional adjustments shall be by modifying the brickwork or by using a frame of a suitable depth.
14. The Contractor shall give the requisite notice to the Engineer before work commences on Statutory Undertakers chambers, as required by any Special Requirements described in the Contract.

808 GULLIES AND PIPE JUNCTIONS

1. Gullies shall be constructed in accordance with the drawings. Precast units shall be of non-reinforced concrete pipe units complying with Clause 801.3. In situ concrete gullies shall be as described in the contract and constructed of Grade C20 concrete of 150 mm minimum thickness, using permanent or removable shuttering.
2. Iron gully gratings, kerb type gully covers and frames shall comply with CYS 183 Part 2 except that they shall be supplied uncoated and shall be of the classes and sizes as described in the Contract.
3. The upper surface of gully gratings shall be flat except where otherwise described in the Contract. 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. They shall be bedded on cement mortar 1:3.
4. Backfilling to precast gullies shall be carried out up to formation level with subbase material Type 2, as described in Section 200 compacted in compliance with Clause 208. Where mechanical compaction is impracticable, the backfilling shall be in Grade C10 concrete. The

remainder of the backfilling shall be in appropriate road pavement materials except that where mechanical compaction of granular sub-base is impracticable Grade C10 concrete shall be used.

5. 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. Junction pipes shall be manufactured of the same type and Class of material as the remainder of the pipes in the run unless otherwise agreed by the Engineer. 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. Only with the Engineer's approval may saddles be used to form junctions. No internal projections greater than 5 mm will be permitted. Saddles for asbestos cement and plastic pipes shall be installed in accordance with the manufacturer's recommendations.

809 TESTING AND CLEANING

1. Drains required in the Contract to have watertight joints shall be tested as directed by the Engineer, in sections, e.g. 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 the Engineer may agree to the Contractor, as part of the rectification work, carrying out a water test as described in sub-Clause 3 of this Clause 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 to the satisfaction of the Engineer.
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 shall not be exceeded. Unless otherwise agreed by the Engineer the test shall commence 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 maintain 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 mm less than the smallest internal pipe diameter permitted by the allowable tolerances specified for the pipes being tested unless an alternative method of checking is agreed by the Engineer.
5. On completion of the whole of the works or earlier if the Engineer directs all chambers gullies and drains other than filter drains shall be flushed from end to end with water and left free from obstructions. 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 required by the Engineer, samples of one or more non-watertight joints for pipelines up to and including 900 mm diameter shall be tested but with the head kept level with the crown of the pipe. The joint will not be accepted if the flow through the joint exceeds 20 times the square of the nominal internal diameter of the pipe in litres per minute.

8. Service ducts shall be checked by drawing a wooden mandrel 1.5 m long and 90 mm diameter for 100 mm and 138 for 150 mm diameter duct respectively through as the ducts are laid. where the ducts do not comply or they are faulty or damaged, these shall be replaced by new ones at the Contractor's own expense.

810 SURFACED ROADSIDE CHANNELS

1. Surfaced roadside V shape shall be un-laid.
2. Excavation for surfaced roadside channels shall comply with section 200.
3. Surfaced roadside channels shall be maintained free of all deposits and obstructions throughout the Contract period.

811 PERMEABLE BACKING TO EARTH RETAINING STRUCTURES

1. Unless otherwise described in the Contract, permeable backing shall consist of one of the following materials.
 - i) A minimum thickness of 300 mm of Type A material complying with Clause 805.
 - ii) Precast hollow blocks complying with the CYS 19 laid with dry joints in 200 mm thick walling with holes vertical.

SECTION 900 - KERBS, FOOTWAYS AND PAVED AREAS**901 PRECAST CONCRETE KERBS, CHANNELS, EDGINGS AND QUADRANTS**

1. Pre cast concrete kerbs, channels, edgings and quadrants shall be hydraulically pressed complying with EN13340:2003 and shall be manufactured to the dimensions shown on the drawings. They shall be laid and bedded with wide joints, and to the tolerances stated on the drawings. Their absorption shall be less than 6% (class 2B), their characteristic tensile strength not less than 5MPa (class 2T), and their abrasion resistance of class 3H.
2. For curves of radius 12 m or less, kerbs of appropriate radius shall be used.
3. At the time of placing the mortar bed shall cover the whole of the bottom surface of the kerb. Mortar between the side faces of the kerb shall be placed after the kerbs have been checked for line and level. Joints between kerb stones shall be 6 mm wide and they shall be evened off by a bent steel rod of circular cross-section of 4 mm dia. All excess material shall be removed. Expansion joints shall be provided in kerbs channels and backing extending through the full depth of the construction, at 40 m intervals. The joints shall be filled with approved joint filler.

902 IN-SITU ASPHALT KERBS

1. The making and placing of in situ asphalt kerbs shall comply with the recommendations of BS 5931 and shall be laid by a machine approved by the Engineer.
2. Materials for in situ asphalt kerbs shall comply with BS 594: Part 1 Clauses 3 and 4. The mixed asphalt shall comply with BS 594: Part 1 Clause 7 Table 5 columns 19 or 20 or 21, or Table 6 columns 25 or 26.
3. Kerbs shall be laid to the lines and dimensions described in the Contract.
4. Vertical expansion and contraction joints shall be formed in kerbs laid on unreinforced concrete slabs and jointed reinforced concrete slabs to coincide with transverse expansion and contraction joints.

903 IN-SITU CONCRETE KERBS AND EDGE DETAILS

1. In situ concrete kerbs and edge details shall comply with the recommendations of BS 5931 and shall be laid by a machine approved by the Engineer. Alternatively, they may be cast in situ, using steel forms. The kerbs shall be dense with regular sides, rises and chamfers, finished to a fine surface free from blow holes and dragging and constructed to the lines and dimensions described in the Contract, and shall not deviate by more than 3mm in 3 m from line and level.
2. Unless otherwise specified the concrete shall be C40 grade complying with Section 700.
3. Kerbs and edge details shall be firmly secured to the surface on which they are laid. Vertical expansion joints at 40 m spacings and intermediate contraction joints at 5 m spacings shall be formed in kerbs and edge details laid on or adjacent to flexible pavements. All joints in kerbs and edge details shall be sealed with approved joint filler and sealant.

904 FOOTWAYS AND PAVED AREAS (PRECAST CONCRETE FLAGS)

1. Precast concrete flags shall be hydraulically pressed complying with EN1339:2003 and to the dimensions shown on the drawings. Their absorption shall be less than 6% (class 2B), their

characteristic tensile strength not less than 5MPa (class 2U), and their abrasion resistance of class 3H.

2. Flags shall be laid to the required cross falls with a bond as described in the Contract and with joints at right angles to the kerb. Flags shall be bedded on a layer of mortar not less than 10 mm and not more than 40 mm thick. Mortar shall be 1:2:9 cement, lime, sand on 50 mm of sand lightly compacted. Where permitted by the Engineer as an alternative, flags may be bedded on a layer of clean sharp sand complying with BS 882 grading C of M 25 mm \pm 10 mm thick, unless otherwise specified.
3. On circular work where the radius is 12 m or less all flags shall be radially cut on both edges to the required line. Flags near manholes, chambers or other obstructions shall be cut to the right shape and dimensions using a diamond saw.
4. The joints between flags shall be filled with grout, and evened off as described in Clause 901.

905 FOOTWAYS AND PAVED AREAS (FLEXIBLE SURFACING)

1. Flexible surfacing for footways and paved areas shall be made and laid in compliance with the appropriate British Standard for the type of material described in the Contract.
2. Surfacing shall be laid to the levels and crossfalls and be of the thickness described in the Contract.

906 FOOTWAYS AND PAVED AREAS (IN-SITU CONCRETE)

1. In situ concrete for footways and paved areas shall be made laid and cured as required by the Contract. The grade of concrete and surface finish shall be as described in the Contract.
2. In situ concrete shall be laid to the levels and crossfalls and be of the thickness described in the Contract.

907 FOOTWAYS AND PAVED AREAS (CONCRETE BLOCK PAVING)

1. Precast concrete paving blocks shall be chamfered and shall comply with EN1338:2003. Their absorption shall be less than 6% (class 2B), their characteristic tensile splitting strength not less than 3,8MPa, and their abrasion resistance of class 3H.
2. Precast paving blocks shall be laid in accordance with BS 6717 Part 3:1989 "Code of Practice for Laying Precast Concrete Blocks".
3. The layout of blocks and details at edges, manholes, gullies and other openings shall be agreed with the Engineer prior to laying.

SECTION 1000 - WORKS FOR SERVICES (NOT APPLICABLE -SEE VOLUME 5)**SECTION 1100 - ANCILLARY WORKS****1101 ROAD SAFETY FENCE****1102 ROAD SAFETY FENCE (METAL BEAM GUARDRAIL)****Materials**

The materials shall meet the requirements specified below:

Concrete : as specified in Section 700

Other Materials : as shown on the drawings

Metal Beam Rail

Steel rail elements shall be corrugated sheet steel beams conforming to the requirements of AASHTO M180 of the designated strength class A, Type 1.

Rail Posts

Steel posts shall be of the Section and length as shown on the Drawings. Steel shall conform to the requirements of AASHTO M183.

Guard Rail Hardware

Offset brackets of the resilient and non-resilient types shall be of the type shown on the Drawings.

Splices and end connections shall be of the type and design specified or shown on the Drawings, and shall be of such strength as to develop the full design strength of the rail elements.

End spring assemblies, when specified, shall be positive and of a type and design coinciding with the intended, design and strength of the railing structure, and shall be as shown on the Drawings.

End anchor rods and accessories shall be as specified or as shown on the Drawings and shall be of such size and strength as to develop the full design strength of the rail elements.

Unless otherwise specified all fittings bolts, washers and other accessories shall be galvanized in accordance with the requirements of AASHTO M111.

The entire length of the guard rail shall be furnished with two aspect reflectors, one red and the other white suitable for easy fixing on guard rails spaced every 8 m or as directed by the Engineer. The shape of the reflectors shall be as shown on the drawings.

1103 CONSTRUCTION REQUIREMENTS

Metal posts shall either be machine driven or set in general purpose concrete where described in the Contract.

Where the guard rail is mounted on a structure the posts shall be provided with a base plate for bolting down with four approved bolts which shall be contained within the supporting concrete and after fixing each bolt shall resist a tensile load of not less than 85 KN.

All guard rails shall be shaped and all bolts and screws so located that the whole assembly presents no sharp edges or projection to traffic. Lap joints shall be made in the direction of adjacent traffic.

Other than at a flare or ramp or as shown on the Drawings:

- The overall horizontal alignment of guard rails shall not depart from the road alignment by more than ± 30 mm nor deviate in any two successive section lengths from the straight or required radius by more than 10 mm.
- The guard rail shall be at the specified height above the edge of the nearest adjacent carriageway, hard shoulder or hard strip or if the guard rail is located more than 1.5 metres from the carriageway hard shoulder or hard strip, above the level of the surface vertically beneath the rail face within a tolerance of ± 30 mm. In addition the deviation from the straight shall not exceed ± 5 mm in any two successive section lengths.

No site drilling or cutting of guard rails will be permitted without the prior approval of the Engineer and unless otherwise approved special closure pieces shall be fabricated prior to galvanising. Under no circumstances will flame cutting equipment be used for cutting rails and forming holes.

Galvanized surfaces which have been abraded so that the base metal is exposed, threaded portions of all fittings and fasteners and cut ends of bolts shall be protected in a manner as may be specified or directed.

Double beam guard rail shall be as shown on the drawings.

1104 REMOVAL AND RE-ERECTION OF EXISTING GUARDRAIL

The Contractor if so directed, shall carefully remove, store and re-erect existing guard rails and posts, which are presently in position alongside the road.

The barrier shall be re-erected to the same construction tolerances as new guard rail. The barrier shall be erected in the location specified on the Drawings or as directed by the Engineer.

1105 PEDESTRIAN SAFETY FENCE AND METAL PARAPETS (NOT APPLICABLE)

1106 CONSTRUCTION REQUIREMENTS (NOT APPLICABLE)

1107 HANDRAILS (NOT APPLICABLE)

1108 CONSTRUCTION REQUIREMENTS (NOT APPLICABLE)

1109 ANTI-DAZZLE FENCES (NOT APPLICABLE)

SECTION 1200 – FENCING (NOT APPLICABLE)**SECTION 1300 - ROAD MARKINGS****1301 GENERAL**

1. The work under this Section comprises the supply and application of reflectorised tropical thermoplastic road marking paint in white and yellow for lines and traffic markings as follows:
2. Unless otherwise shown, lines shall be yellow for edge lines and white for all other lines to the width specified. The edge lines shall be solid and the lane lines shall be as shown on the drawings.
3. On completion, the material shall produce an adherent reflectorised line or marking of the specified thickness.

1302 MATERIALS

1. The material shall conform to British Standard BS3262:1987 Hot Applied Thermoplastic Road Marking Materials or other equivalent approved international standard, with the additional specific requirements stated herein.
2. The material when laid shall consist of light coloured aggregate, pigment and extender, bound together with hard wearing resins, plasticised with oil as necessary, in the following proportions:

| Constituents | Percentage by Weight | |
|----------------------------------|----------------------|---------|
| | White | Yellow |
| Binder | 20 ± 2 | 20 ± 2 |
| Glass Beads (Ballotini) | 20 min. | 20 min. |
| Titanium Dioxide (white pigment) | 8 min. | - |
| Aggregate, Extender | 54 max | 62 max. |
| Yellow Pigment | - | - |

3. The binder, aggregate, glass beads, pigments and extenders shall all conform to the requirements of BS3262.
4. The binder shall consist of synthetic resins, plasticised to meet the specification requirements. The resin shall comprise synthetic hydrocarbon resin or maleic modified glycerol ester resin (alkyd binder). Documentation describing the specific resin type shall be submitted with the tender.
5. The thermoplastic paint shall be formulated to have the following specific properties when tested in accordance with BS3262-1987:

| | |
|---------------------------|-----------------------|
| 1. Softening Point | 95 Deg. C |
| 2. Luminance (White) | 75 |
| (Yellow) | 50 |
| 3. Heat Stability (White) | 70 |
| (Re-melted) (Yellow) | 45 |
| 4. Skid Resistance | 45 |
| 5. Abrasion Resistance | 0.25g/100 revolutions |

6. Certification from a nationally registered laboratory either in Cyprus or overseas shall be presented to the Engineer stating that the thermoplastic paint complies with the specification requirements for constituent materials and for properties of the hardened paint, on the basis of one certificate per 25 tonnes of product or part of 25 tons.

1303 REMOVAL OF ROAD MARKINGS

1. Where existing road markings are to be removed these shall be removed from the road surface at locations to be instructed by the Engineer on site. Removal shall be preferably by using a cold planer or by sand blasting or an approved hot air process. Chemical solvents shall not be used. All removed material, loose fractions and other debris shall be disposed off site and the road surface shall be swept clean to the Engineer's satisfaction using a compressed air jet.

1304 APPLICATION

1. Application for lines up to and including 300 mm wide shall be with a self propelled mobile screed machine. Lines shall be a minimum of 2 mm thick.
2. Application for traffic markings, such as arrows, stripes, etc. shall be constructed using a template and shall be a minimum of 3 mm thick.
3. Equipment shall be capable of placing the thermoplastic material to a uniform thickness and width and with clean edges. It shall provide continuous uniform heating to mixing and conveying equipment. The temperature limits shall not exceed the manufacturers declared safe heating temperatures.
4. Application shall commence only after the asphalt surface which is to receive the paint is at least two weeks old. The road surface shall be dry and free of all foreign matter and loose material. The temperature of the road shall be above 10 Deg. C at the time of application. Where old paint or thermoplastic materials are to be covered by new, the old markings shall be vigorously mechanically wire-bushed to remove loose material.
5. Where thermoplastic paint is to be applied to polished road surfaces, a tack coat shall be applied first. The tack coat shall be of the type recommended by the manufacturer of the thermoplastic material and shall be applied strictly in accordance with the manufacturer's instructions.
6. Application shall generally be in accordance with BS3262:1987 Part 3. In addition to the glass beads included in the mix, an additional quantity of glass beads shall be pressure sprayed on to the hot line at the time of application at the rate of not less than 400 grams per square metre.
7. The lines and markings produced shall have surfaces free from streaks, blisters, lumps and other defects and be free from ragged edges.
8. Quality assurance records shall be maintained by the Contractor on a daily basis. Weather and road conditions shall be recorded. Temperature records both ambient and of material being deposited, as well as material consumption records and records of thickness, width and colour of markings shall be maintained. Thickness measurement shall be checked and recorded by the Contractor for every 500 m of line placed and at each traffic marking. Measurement shall be by placing tape or film in the area to be marked. Once marked, the sample shall be removed by making sharp cuts with a knife and measurement made with a vernier caliper with a proper correction for the film base.

1305 TOLERANCES

1. The Contractor shall establish the necessary tack points at appropriate intervals for setting the alignment of the stripes and will set a string-line from such tack points under the supervision of the Engineer.
2. No stripe shall be less than the specified width. No stripe shall exceed the specified width by more than 12 mm. The length of the painted segments and the gap between segments may each vary by plus or minus 100 mm except that over-tolerance and under-tolerance lengths must approximately compensate. The dimensions of both continuous and broken lines shall be in accordance with the Drawings.
3. On tangents and on curves of more than 2000 m radius, the alignment of the painted stripe shall not deviate from the string-line by more than 25 mm.
4. On curves of less than 2000 m radius the maximum permissible deviation will be 50 mm. In addition, the outer edge of the edge stripe shall fall uniformly at not less than 50 mm nor more than 100 mm from the edge of the pavement, and shall have no noticeable breaks or deviations in alignment or width.
5. Where a stripe deviates from the correct alignment, as indicated by the string-line, by more than 25 mm in any 15 m it shall be obliterated and corrected by the Contractor at his own expense.

1306 SAMPLING AND TESTING

1. Sampling and testing will be carried out by the Employer generally in accordance with BS3262:1987, to confirm compliance of the materials and finished work with the requirements of the specification. Samples may be taken of the cold or hot thermoplastic materials and also of the applied materials by means of a metal sheet placed in the path of the laying equipment. Line thickness and application rate of glass beads will be tested in accordance with BS3262:1987 Part 3.

1307 TRAFFIC CONTROL AND PROTECTION OF THE WORK

1. The Contractor shall control the traffic in such a manner as to protect the freshly marked surface from damage. The traffic control shall be so arranged as to give minimum interference to the travelling public. Signs, barricades, flagmen and control devices shall be supplied by the Contractor and a system of spaced warning flags or blocks shall be used to protect the fresh marking until it has dried. Any lines, stripes or markings which become blurred or smeared by the traffic shall be corrected by the Contractor at his own expense.

1308 EDGE MARKER POSTS (DELINEATORS), KILOMETRIC INDICATORS

Where existing delineators and kilometric indicators are affected by the works, these shall be carefully removed stored in a safe approved place and after completion of the works, brought back and reinstalled. The Contractor shall replace with new ones at his own expense, any delineators and kilometric indicators that in the Engineer's opinion, these were damaged due to the Contractor's negligence. Where there are no existing kilometric indicators, new ones shall be installed. These shall be similar in all respects to the posts that are already in use on the road network of the island.

New edge delineators shall be installed in the locations directed by the Engineer. These shall be plastic, fitted with red and white prismatic reflectors. The coefficient of retroreflection of the retroreflective surfaces shall comply with BS 873 Part 6, Table 1 for Class A material.

1309 DELINEATORS

The delineators shall be fabricated from a durable plastic material similar to high pressure polythene with aluminium incorporated into the plastic. The delineator shall be white on the exterior and capable of resisting local climatic conditions. The total weight of the delineator shall be in the range of 1,000-2,000 grammes.

The delineators shall be one of the following types:

- A circular post not less than 75mm in diameter and 950mm long, having a domed top and a bevelled or conical base with an anchoring device. The upper 150mm of the post shall have the sides flattened at about 15 degrees to provide for centering and fitting the reflectors. The red reflector shall be on the left face and the white reflector on the right face from a front view or as directed by the Engineer.
- A rounded corner triangular post not less than 950mm long with a closed top and an anchoring device in the base. Two sides of the triangle shall not be less than 100mm and the short side not less than 70mm. The reflectors shall be centered and fitted in the upper 150mm of the 120mm sides. The red reflector shall be fitted on the left face and the white reflector on the right face from a front view or as directed by the Engineer.

Glass or plastic prismatic reflective elements shall be any geometric shape as long as the area of the unit is 30 sq.cm.

A 300mm diameter post-hole approximately 550mm deep shall be excavated in the shoulder at the locations directed by the Engineer. The delineator shall be placed in the hole, then it will be installed in a vertical position and held while the remaining space is filled with subbase material type 2 and compacted according to the specification.

1310 DISTANCE MARKER POSTS

1. Materials for Distance Marker Posts shall consist of polyvinyl-chloride (P.V.C.) or any other plastic material equivalent approved and shall have the following properties:

| | | |
|---|-----------------|------------------------------|
| Wall thickness | for Type 1 | 1,4 mm min. |
| | for Types 2 & 3 | 2,0 mm min. |
| Density | for Type 1 | 1100 gr/cm ³ min. |
| | for Types 2 & 3 | 950 gr/cm ³ min. |
| Tensile Strength | for all types | $\sigma > 40 \text{ Mpa}$ |
| Elongation at a speed of 5 mm/min and at a temperature $23 \pm 2 \text{ }^{\circ}\text{C}$ | | $\epsilon > 80\%$ |

During the test for accelerating aging in accordance with relevant European Standard (exposure to XENON radiation for 1000 hours) the test specimens shall not change substantially in colour. The crushing strength shall comply with DIN 8061/71 or other equivalent European Standard and shall not shrink axially for more than 5%. The softening point VICAT in accordance with the Greek relative standards or any other equivalent European Standard shall not be less than 70 °C. The reflective membrane for lettering shall be in accordance with BS 873, Part 6, Class 2.

2. During the construction stage the Engineer shall provide the Contractor with full details as regards names of places, numbers, letters etc. in order that he may prepare the Distance Marker Posts before their installation.
3. Distance Marker Posts shall be installed in accordance with the drawings and the Engineer's instructions. The base for Type 1 post shall be of concrete as shown on the drawings. Types 2 and 3 posts shall be installed on the verge as shown on the drawings.

1311 TRAFFIC SIGNS, DESCRIPTION

1. This work shall consist of furnishing and installing road signs and posts assemblies as shown on the Drawings and in accordance with the Specifications or as directed by the Engineer. All sign faces and lettering shall be in accordance with the Employer's sign standards as shown on the Drawings or as directed by the Engineer.
2. Permanent traffic signs shall be reflectorised or non-reflectorised illuminated and shall, in respect of quality, comply with the requirements of (i) BS 873 (ii) the Traffic Sign Regulations and General Directions and the Traffic Sign Manual, published by HMSO U.K.
3. All foundations, framing and fixings for Information Signs shall be suitable for local conditions. The design calculations shall be submitted to the Engineer for approval. The design wind speed shall be taken as 120km/hr with gusts up to 160km/hr.
4. Within 3 weeks of acceptance of the manufacturer's tender the Contractor shall submit for approval working drawings for signs posts and base plates. Fabrication shall not be commenced until approval has been given. The Contractor shall submit samples of the proposed materials for approval on request by the Engineer prior to delivery to site, at his own cost.

1312 REQUIREMENTS FOR ROAD SIGN MATERIALS

General

1. Sign plates shall be manufactured either from sheet aluminium to BS 1470, SIC - 1/2H, NS3-3/4N, NS-1/2H or HS 30-WP with a minimum thickness of 3mm (11 swg) or from extruded aluminium plank sections to BS 1476, HE 9-WP, HE 9-P or HE 30-WP or extruded aluminium alloy plank sections to BS 1474, HE 9 TE and HE 30 TF. However information signs shall be constructed in extruded aluminium planks, which will either be self-locking or rear fixing, and the aluminium shall be BS 1470, BS 1474 or BS 1490 or other approved equivalent international standard.
2. All sign plates shall have clean, smooth edges cut to the required shape of the sign, and shall be etched and degreased to the sign sheeting manufacturer's specifications before application of the sheeting.
3. Illuminated sign shall be covered with "Engineering Grade" reflective sheeting. Reflective signs shall be covered over the whole front face with "High Intensity" reflective sheeting. The sheeting of the specified colours must have the manufacturer's guarantee of not less than 5 years has been obtained. The rear faces shall be non-reflective grey and should give a similar lifespan to the sign face.
4. The reflective sheeting shall be fixed to the sign-plate either with a heat activated adhesive using vacuum applicator or with a pressure sensitive adhesive using a pressure roller in accordance with the sheeting manufacturer's instructions.
5. Sign faces shall be formed from a single piece of reflective sheeting, but if for any reason the sign face must be fabricated from more than one piece of material all joints in the material

shall be over-lapped by not less than 6mm and where sheeting is applied to extruded sections it shall extend over the top and bottom edges of the sections by not less than 3mm. No butt joints shall be permitted and in horizontal joints the overlap shall be from the top.

6. The corners of all direction signs shall be rounded to a radius of 75mm.

Stiffening and Framing

7. All stiffening and framing shall be of aluminium, unless otherwise shown on the drawings.
8. Signs constructed of aluminium sheet shall be framed on all edges using hot dipped galvanized steel angle or angle-channel of adequate section.
9. Stiffening to signs constructed of aluminium sheet, having an area exceeding 0.10 sq.m. shall be confined to horizontal lengths at the top and bottom edges of the sign plate.
10. Signs constructed from extruded aluminium plank sections are to present the same flanged appearance on all edges of the sign by fitting an aluminium end capping to the exposed ends of the plank section on both sides of the sign.
11. Where the specified sign width requires the use of more than one length of plank section, support beams shall be provided and positioned as approved by the Engineer.
12. For plank type signs supported on two posts the plank rails and support beams shall be manufactured from one length of extruded aluminium section. One tie bar shall be fitted between the bottom two plank rails (or the plank rail and support beam) at the centre of the span between the mounting posts.
13. Where plank type signs are supported on more than two posts, and the specified sign width is wider than the plank rail and support beams, the plank rail and support beam may comprise two or three lengths provided butt joints occur at an inner post. One tie bar shall be fitted between the bottom plank rail and support beam at the centre of the span between the mounting posts.
14. All stiffening and framing shall be continuous.
15. All rivets or other devices fixing sign plates to their framework shall be of non-staining steel or other material approved by the Engineer and shall have a sufficient cross-sectional area to prevent failure from thermal stresses or wind-pressure or such other stresses as may be specified. All rivet and bolt holes shall be edge-sealed with clear lacquer after the application of the plastics sheeting. Rivets shall be spaced at not more than 150mm apart, around the outside edge of the sign plate and on cross braces the spacing shall be not more than 300mm.
16. Any rivet brought through the sign face shall be coloured to match the sign face. Any rivet or other device fixing sign plates to their frame work shall have a protective washer of nylon or other approved insulating material inserted where they would be in contact.
17. All brackets, clips, screws, bolts, nuts and washers used for mounting sign plates to support posts shall be manufactured from stainless steel. For plank type signs brackets and clips shall be extruded aluminium alloy section.
18. Saddles shall be aluminium alloy or other material approved by the Engineer and shall be provided with a nylon strip or other approved insulating material.

Finish

19. There shall be full adhesion of all sheeting material including letters, symbols and borders and there shall be no air bubbles, creases or other blemishes.

20. All panels, cut-out letters, numbers, borders, symbols and back grounds on reflective sheeting 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. Non uniform shading or undesirable contrast between reflective sheeting on any one sign will not be accepted.
21. The edges of all applied sheeting materials including edges of all plates which make up a sign, letters, symbols and borders shall be sealed as specified by the manufacturer.
22. Where required by the sheeting manufacturer the face of the sign plate shall have a coat of clear lacquer of a type specified by him.

1313 CONSTRUCTION REQUIREMENTS FOR ROAD SIGNS

1. All sign faces shall be of the type, colour and size shown on the Drawings or as specified by the Engineer.
2. The Contractor shall submit to the Engineer for approval three (3) copies of his working drawings for all sign faces in Greek and English. Size and style of lettering shall be as shown on the Drawings or as otherwise approved by the Engineer.
3. No order shall be placed without written agreement of the Engineer.
4. The approximate position and mounting height of each sign is indicated on the Drawings, the exact sign position and mounting height shall be determined on site and marked on the ground by pegs or painted marks. The exact position shall be agreed by the Engineer.
5. Post length shown in the Drawings are approximate only. When progress of the work is at the appropriate stage the Engineer will authorise the location of each sign, with the station and off-set distance from the edge of the pavement. The Contractor shall be responsible for determination of the exact post lengths to provide the vertical clearance shown on the Drawings. Field cutting of posts shall be performed by sawing. Welded posts will not be permitted.
6. All excavation shall be approved by the Engineer before the sign is erected and prior to the backfill with sand or concrete as shown or directed by the Engineer. The sides of excavation shall be vertical and any additional excavations carried out beyond that specified, for the particular post and sign being erected, shall be filled at the Contractor's own expense with Class C20 concrete or granular material as directed by the Engineer.
7. Where the sign has an area in excess of 10 sq.m. or the posts have a diameter in excess of 110mm, each foundation, above the foundation screed, shall be poured with concrete consolidated and compacted in 150mm thick layers up to the finished foundation level shown on the drawings.
8. All posts shall be erected vertically and where two or more posts are provided for any sign the faces of these posts shall be lined up and their deflection angle checked for compliance with sub-clause 12 of this clause, before concreting in.
9. For a period of 14 days after concreting in position, all posts shall be suitably braced to prevent movement. Sign faces should not be fixed to posts until after the bracing has been removed and the Engineer has inspected and approved the post stability and foundations.
10. All posts shall be of the type specified on the Drawings and all non-galvanized sections shall be protected against corrosion by painting in accordance with clause 1315

11. Signs delivered for use in the project shall be in new and unused condition, except where otherwise specified; and shall be stored off ground and under cover in a manner approved by the Engineer. Any sign damaged, discoloured or defaced during transportation, storage or erection shall be rejected.
12. Unless otherwise shown on the Drawings all signs shall be erected so that the edge and face of the sign are truly vertical and the face is at an angle of ninety five (95) degrees to the centreline; that is, facing slightly away from the centreline of the lane which the sign serves. Where lanes divide or are on sharp curves, the Contractor shall orient sign faces as indicated on the Drawings or by the Engineer so that they will be most effective both day and night and such to avoid reflection and glare. All sign supports shall be plumbed vertical.
13. The distance between the lower edge of the signs and the road surface shall be in accordance with the Drawings.
14. Signs shall be fastened to sign supports in accordance with the requirements of the Drawings, Specifications and the Recommendations of the sign manufacturer to the satisfaction of the Engineer.

Covering of Signs

15. The Contractor shall at his own expense, immediately after erection and approval by the Engineer cover the sign in order to prevent misleading information being displayed. The covering shall be close weave hessian securely fixed over the face of the sign using a lacing of nylon cord so as not to damage the sign. The Contractor shall maintain such coverings in good order until receipt of the Engineer's instruction for their removal.

Cleaning of Signs.

16. Signs shall be thoroughly cleaned immediately prior to being handed over. The cleaning shall be carried out in the manner described in the Traffic Sign Manual, Chapter 12(3). The type of detergent used shall be approved by the Engineer.

Identification of Signs, Posts and all Fittings.

17. The reference number of the sign shall be indicated by self-adhesive numbers on the reverse side of the sign in the bottom left hand corner and in a consistent and readily visible position on all posts and fittings. The manufacturer's name or trademark will not be permitted on the face of the sign together with the date of manufacture. It may be affixed on the back of the sign, provided approval to the size and colour of the mark has been obtained from the Engineer.

1314 GUARANTEE OF ROAD SIGNS BY CONTRACTOR

1. All road signs shall be guaranteed by the Contractor against any defect in material and workmanship for a period of five years from the date of completion of the Works under the Contract. If any defect should arise due to poor material or workmanship it shall be rectified by the Contractor at his own expense.
2. If such defect is rectified by other than the Contractor in accordance with the Employer's instruction, the expense of rectification shall be deducted from any monies due to the Contractor.

1315 PAINT AND OTHER PROTECTIVE COATINGS

1. All paints forming any one painting system shall be obtained from one manufacturer and, unless otherwise agreed by the Engineer, the source of supply shall not be changed after the

Engineer's approval has been given. Paint shall be supplied in sealed containers of not more than 5 litres capacity and these shall be used in strict order of delivery.

2. The Contractor shall obtain from the paint manufacturer paint ready for the use specified under the Contract. The paints shall be adequate in all respects for the purpose intended.
3. The system of protection for all non-galvanised steelwork shall be as follows:
 - Primer Coat: Interzinc QHA 027/028 minimum dry film thickness 65 microns.
 - Second Coat: Intergard EBA 070/EBA 100 JB natural M.I.O. minimum dry film thickness 100 microns.
 - Third Coat: Intergard EBA 070/EBA 100 JB silver grey M.I.O. minimum dry film thickness 50 microns.
 - Fourth Coat: Intergard EFK 724 epoxy finish grey minimum dry film thickness 50 microns.

Total dry film thickness - 315 microns (minimum).

The coating shall have a minimum adherence to the steelwork of 2.5 MPa when tested with an adhesive tester.

4. Prior to painting the steelwork shall be gritblasted to SA 2-1/2 Swedish Standard 055900 or by other approved method to equivalent standard. Before the steel surface shows signs of flash rusting the first coat of zinc primer shall be applied. If the steel does flash rust then the cleaning process is to be repeated.
5. Steelwork specified as galvanised shall be hot-dipped galvanised to the standard required by BS729.

SECTION 1400 - ROAD LIGHTING (NOT APPLICABLE)**SECTION 1500 - SANITARY SEWERS, IRRIGATION MAINS AND ASSOCIATED WORKS (NOT APPLICABLE)****SECTION 1600 - PRESTRESSING FOR BRIDGE STRUCTURES (NOT APPLICABLE)****SECTION 1700 - BRIDGE BEARINGS AND MOVEMENT JOINTS (NOT APPLICABLE)****SECTION 1800 - CONCRETE PILE FOUNDATIONS (NOT APPLICABLE)**

APPENDIX A**C.B.R. AT SUBGRADE/FORMATION LEVEL****A1 SCOPE**

1. This method or an appropriate method (e.g. for expansive soils) shall be followed to determine the C.B.R. value at Subgrade/Formation Level. All testing shall be carried out by the Engineer, who will finally decide the C.B.R. value. In this particular case all expenses for testing shall be borne by the Employer.

A2. APPARATUS

1. All necessary apparatus for C.B.R., and Atterberg Limits.

A3. PROCEDURE

1. Site inspection by Engineer or Engineer's Representative of all subgrade areas when construction is near or at subgrade level.
2. Location of all suspect areas. Collection of Samples.
3. Atterberg Limits tests of samples taken and soil classification tests as per M145 AASHTO.
4. Proctor Tests in 152 mm mould, using light compaction hammer (2.5 kg 300 mm drop). Three equal layers at 62 blows per layer for at least five different moisture contents.
5. C.B.R. test on bottom side of each sample prepared as per (4) above, after two days of soaking.
6. Determination of subgrade design C.B.R. by plotting C.B.R. values Vs moisture content and taking the required C.B.R. value at or near Plastic Limit moisture content depending on the grading of the material and as decided by the Engineer.
7. If subgrade C.B.R. is below the design CBR, proceed with capping layer treatment as shown on the drawings or as directed by the Engineer.
8. When the subgrade material exhibits expansive properties then the Engineer after further laboratory investigation, than described above, shall decide the type and thickness of material to be used for the capping layer.

APPENDIX B**STRIPPING TEST****B1 SCOPE**

1. This method details the procedure to be followed to determine the resistance of aggregates to stripping.

B2 APPARATUS

- (a) Shallow tray (s)
- (b) Mixing bowl of 1.5 litres capacity
- (c) Means of separate heating the aggregate and the binder to a temperature not exceeding 175°C.
- (d) Distilled water.

B3 SAMPLES

1. Binder

The binder shall comply with the Specifications and shall be a representative sample of the binder to be used in the plant mixtures.

2. Aggregates

The test shall be carried out on a separate sample from each source of supply. The sample shall be taken from the bin or stockpile at the quarry in which the 10.0-6.3 mm size predominates. It shall be a representative sample of the rock that is to be used in the plant mixtures.

B4 PROCEDURE

1. Each sample of aggregate shall be quartered and sieved out to provide a specimen of 150 particles each passing the 10.0 mm and retained on the 6.3 mm BS sieve. The specimen and the binder shall be heated separately. In no circumstances shall the binder be heated to a temperature greater than the shown in para B2© above. The specimen shall be place in a heated mixing bowl and, when both specimen and binder are at temperature of 150°C, a quantity of binder equivalent to 4 per cent by mass of the specimen shall be added to it. The two shall be hand mixed until coating of the aggregate is complete. If, after prolonged mixing, coating is incomplete, this procedure shall be repeated with a fresh specimen and a increased proportion of binder. The binder shall be increased in steps not greater than 1 per cent by mass of the specimen until a mix giving complete coating of the aggregate is obtained.
2. The coated specimen shall be placed in one or more trays which have been previously treated with a mixture of equal parts of glycerol and dextrin or similar agent ot prevent adhesion of the binder to the tray. Each particle shall be completely separated from adjacent ones.

After standing for one hour, the coated specimen shall be covered with distilled water at 18°C – 20°C and maintained at that temperature. After immersion for 48 hours the water shall be decanted and the coated specimen allowed to dry at air temperature.
3. The dried sample shall then be examined, particle by particle while still in the tray(s).
4. If the binder has stripped from more than eight of the total particles tested (or more than three of the total particles tested in the case of aggregates intended for us in friction course materials), exposing any part of the aggregate the sample shall have failed the test.

5. To ensure that a fault during test has not contributed to the failure the test shall be repeated separately on each of a further 3 samples.
6. If any one of the further tests also fails, by indicating stripping in excess of the limits described in para B4, the aggregate will not be acceptable for the particular mixture, and supplies from its source shall be rejected.

APPENDIX C**STRIPPING TEST****C1 SCOPE**

1. This method shall be followed to determine the temperature of bituminous material.

C2 APPARATUS

1. For measurement of the material in a lorry, paver hopper, or in heap, the thermometer used should be 225 mm long, graduated in 5°C with an accuracy of $\pm 2^{\circ}\text{C}$, and the stem should be fully inserted into the material.
2. For measurement of the material after it has been laid, and during rolling the instrument should have a temperature sensitive element small enough to be completely surrounded by the “thin” layer of material to be rooled and the temperature sensitive element should be at mid-point of the thickness of the layer. To ensure this the stem of the thermometer should be fitted with an adjustable flange to rest on the surface of the material.
3. The thermal capacity of the thermometer should be as small as possible consistent with adequate robustness, to minimise the time required to obtain a reliable reading.

C3 CALIBRATION

1. The thermometer shall be calibrated before use, against a thermometer that complies with the requirement of related standard BS1704 over the range of temperature for which the thermometer is to be used.
2. The thermometer should also be checked at daily intervals during mixing and laying or when the accuracy of the instrument is in doubt, by immersing the temperature sensitive element in boiling water.

C4 TEST PROCEDURE

1. Before the temperature measurement are recorded and to compensate for low thermal capacity and conductivity of bituminous materials the thermometer shall first be placed in the mixture and allowed to heat up to the approximate true temperature of the material. The thermometer shall then be quickly removed from the material to an adjacent position and the first measurement recorded.
2. The temperature of material in lorries shall be taken within 30 minutes of arrival on Site.

Two measurements shall be taken at least 1 metre apart and at least 450 mm from the edge and the temperatures to be recorded shall be the average of the two readings.
3. Measurement of material in the spreader hopper shall be taken at least 450 mm from the hopper edge.
4. Where electronic type thermometers are in use for measuring the temperature of laid material at least three measurements shall be taken and the average recorded as the material temperature. Where bimetallic rotary type thermometers are in use, at least three measurements shall be taken and the average recorded as the material temperature.

At least tow thermometers should be used for the required measurements to avoid delay in rolling the material.

APPENDIX D**STRAIGHTEDGE TESTS****D1 SCOPE**

1. This method shall be followed to determine the surface accuracy of bituminous surfacing layers in Parts 5 and 6 of this Specification.

D2 APPARATUS

1. The straightedge for the tests shall be purpose made and 3 m long. It shall have a flat square edges base of metal at least 75 mm wide, along the full length of its base. The straightedge shall be fitted with lifting hand grips or handles.

D3 PROCEDURE

1. The straightedge shall be placed unsupported on the surface, anywhere in any direction, other than across the crown of a camber or across a drainage channel. The location shall be selected by the Engineer or his representative and the tests shall be carried out in his presence.
2. 20 tests shall be made for every 150 square metres laid and at least half of these tests shall be across lane joints in the case of two lane roads.
3. The Contractor shall mark with white paint all areas which fail to comply with the specified requirements.

APPENDIX E**INDEX OF RETAINED STABILITY****Related Standard MS-2****E1 SCOPE**

1. This method of test is intended to measure the loss of Marshall stability resulting from the action of water on compacted bituminous mixtures containing penetration asphalt. A numerical index of reduced stability is obtained by comparing the stability of specimens determined in accordance with usual Marshall procedures with the stability of specimens that have been immersed in water for a prescribed period.

E2 APPARATUS

1. One or more water baths with automatic controls shall be provided for immersing the specimens. Baths normally used for the Marshall Test are suitable for the tests herein prescribed.
2. A balance and water bath with suitable accessory equipment will be required for weighing the test specimens in air and in water in order to determining their densities.
3. A supply of flat transfer plates of glass or metal will be required. One of these plates will be kept under each of the specimens during the immersion period and during subsequent handling, except when weighing and testing, in order to prevent breakage or distortion of the specimens.

E3 TEST SPECIMENS

1. At least eight standard Marshall specimens 101.6 mm in diameter and 63.5 +/- 30 mm in height shall be prepared for each test. Preparation of the specimens shall be in accordance with standard Marshall Method procedure as described in MS-2.

E4 DETERMINATION OF SPECIFIC GRAVITY OF TEST SPECIMENS

1. In determining specific gravity of the test specimens according to AASHTO T-166 and T-275.
 - (i) Obtain the weight of each specimen in air and in water. The latter should be done as rapidly as possible to minimize absorption.
 - (ii) Calculate the specific gravity of each test specimen as follows:

$$\text{Special gravity} = \frac{A}{B - C}$$

where A = weight in grams of specimen in air
 B = weight on grams of saturated surface dry specimen.
 C = weight in grams of specimen in water

E5 PROCEDURE

1. Sort each set of eight test specimens into two groups of four specimens so that the average specific gravity of the specimens in group 1 is essentially the same as for group 2. Test the specimens in group 1 as outlined in the Asphalt Institute Marshall Method of Mix Design
2. Immerse the group 2 specimens in water for 24 hours at the temperatures specified below, then test immediately for stability and flow.

| <u>Type Bitumen</u> | <u>Marshall Stability Test Temp.</u> |
|---------------------|--|
| Penetration | 60 ± 0.2 C |

E6 CALCULATION

- The numerical index of resistance of bituminous mixtures to the detrimental effect of water shall be expressed as the percentage of the original stability that is retained after the immersion period. It shall be calculated as follows:

$$\text{Index of retained stability} = \frac{S2}{S1} \times 100$$

where S1 = Marshall stability of group 1 (average)

S2 = Marshall stability of group 2 (average)

E7 REQUIREMENT FOR ACCEPTANCE

- Mixes showing index of retained stability of less than 75 shall be rejected or an approved method of processing the aggregate or of treating the asphalt shall be required to increase the index of retained strength to a minimum of 75.

AMENDMENTS, November 2001

The Standard Specification for Road and Civil Works, March 2000 Edition is amended as follows:

In **Clause 104**, Paragraphs 4 to 8, are renumbered as Paragraphs 5 to 9, and Paragraph 4 is added to read "EN" means European Norm.

In **Clause 106**, Paragraph 1, line 7, the word "reulting" is amended to read "resulting".

In **Clause 126**, add Sub-Clause 4 as follows:

"4. The Contractor shall provide the Engineer as evidence for the addition of the hydrated lime filler required by Clause 532 of the Specification, the original invoices for the purchase of hydrated lime filler corresponding to the required quantities to be used. However, this shall not relieve the Contractor of his obligations for the provision of hydrated lime filler resulting from the provisions of Clause 532 of the Specification".

In **Clause 132**, paragraph 3, at the end of the paragraph replace the full stop with a comma and add the following: "and take all necessary measures to comply with the requirements of law 89(I)/96 for Safety and health at Work".

In **Clause 209**, Paragraph 2, in line 2, add the phrase "except as provided for in Clause 208" after the word "Works".

In **Clause 211**, Paragraph 3, line 4, the word "ditvches" is amended to read "ditches".

In **Clause 304**, Paragraph 2, line 1, the word "on" is amended to read "or". Also in paragraph 3, line 2, the phrase "at it remains" is amended to read "as they remain".

In **Clause 401**, Paragraph 2, the phrase "Unless otherwise shown requirements of CYS99" is deleted and replaced by the following: "Unless otherwise shown on the drawings subbase and shoulder material Type 2 shall consist of naturally occurring sandy gravels, havarochiakkilo, crushed stone or other materials directed or approved by the Engineer".

Also in Table 4/1 item (iii) under "shoulder material" the phrase "6 min" is added next to the phrase "13 max".

In **Clause 402**, Paragraph 4, line 3, the word "real" is amended to read "rear".

In **Clause 404**, Paragraph 2, line 1, the phrase "crushed stone" is amended to read "waterbound". Also in Paragraph 3, line 4, the word "had" is amended to read "have".

In **Clause 501**

(a), Paragraph 5 is deleted and replaced by the following:

"Coarse and fine aggregate from each supply source shall be separately tested for soundness in accordance with ASTM-C88 ($\text{Na}_2\text{SO}_4/\text{MgSO}_4$) and if the loss exceeds 10%/15% for the fine and 12%/18% for the coarse aggregate respectively from that source shall be rejected".

(b) In Paragraph 6, first line, after the word "aggregates" add the phrase "from each supply source".

(c) In Table 5/1, the data referring to Aggregate Soundness are deleted.

Clause 502, Paragraph 2, is deleted and replaced by the following:

2. The type of filler to be used shall be either hydrated lime in accordance with CYS 65, crushed limestone in accordance with CYS 99, or crushed diabase (as specified in Clause 532).

In **Clause 513**, Paragraph 1, Table 5/3 add below the data for the 40/50 Pen Bitumen, the following corresponding data for the 60/70 Pen Bitumen:

| | | | | | | |
|-----------|-----|-----|-----|-----|-----|-----|
| 60/70 Pen | | | | | | |
| Bitumen | 150 | 170 | 145 | 165 | 145 | 165 |

In **Clause 519**, Paragraph 2, line 2, "Appendix E" is amended to read "Appendix C".

In **Clause 520**, paragraph 1, line 6, the phrase "according to the Engineer" is replaced by the phrase "in accordance with the Engineer's instructions".

In **Clause 525**, Paragraph 3, line 2, the word "Arising" is amended to "arising" and the word "Debris" is added in front of it.

In **Clause 531**, table 5/6, the subnote is deleted and replaced by the following: "The material passing the 75 micron BS 410 sieve shall include hydrated lime, or hydrated lime and crushed limestone as specified in Clause 532".

In **Clause 532**, paragraph 1, lines 1, 2 and 5, and paragraph 2, lines 1 and 2, insert the word "hydrated" before the word "lime".

In **Clause 552** renumber Paragraph 1 as paragraph 4 and add Paragraph 1, 2 and 3 as follows:

- "1. The surface of areas to be paved shall be checked for uniformity to the lines and grades and tolerance specified in the Contract. All loose and foreign matter or free water shall be removed by brooming or blowing with compressed air.
2. Surfaces of kerbs, gutters, vertical faces on bridges and all other structures which shall be in contact with the asphalt concrete shall be given a thin even coating of tack coat. Care shall be taken to prevent any coating on any exposed surface.

3. Prior to spraying the prime coat, the cleaned surface of the base shall be given a light application of water and allowed to dry to a surface dry condition before the bituminous material is applied."

Add new **Clause 553** "POLYMER MODIFIED ASPHALT" as follows, and the corresponding Index title:

"553 POLYMER MODIFIED ASPHALT"

Polymer modified asphalt shall be used where required by the Contract. The polymer modified binder must be type approved in the country of origin and must have a proven performance record. Before using the polymer, the Contractor must submit satisfactory evidence that the product satisfies the Specification and the requirements of Appendix 500/1 and obtain the Engineer's approval."

In **Clause 601**, Table 6/1, the data referring to Aggregate Soundness are deleted.

In **Clause 707**, Table 7/1 is amended as follows:

TABLE 7/1

DESIGNED CONCRETE MIXES

| Class Designation | Max. Size of Aggregate mm | Min. Cement Content in Concrete kg/cu.m | Min. Compressive strength 28 days after mixing | |
|----------------------|---------------------------------|--|--|-------------------------------|
| | | | Preliminary Trial N/sq.mm. | Works Test N/sq. mm. |
| C40 | 20 | 400 | 55 | 40 |
| C35 | 20 | 375 | 50 | 35 |
| C30 | 20 | 350 | 43 | 30 |
| C25 | 20 | 325 | 38 | 25 |
| C20 | 20 | 300 | 33 | 20 |
| C15 | 40 | 220 | 25 | 15 |
| C10 | 40 | 180 | 17 | 10 |

In **Clause 717**, Paragraph 6, line 2, the word "thirty" is replaced by the word "fifty".

In **Clause 723**, Paragraphs numbers 1 to 22 are renumbered as 3 to 24. In the renumbered paragraphs, 3 line 1, 4 line 1, and 8 line 3, the phrase "Section 1" is replaced by the phrase "Section 100". Also in the renumbered paragraphs 5 line 2, 16 line 5 and 17 line 2, the phrase "Section 8" is replaced by the phrase "Section 700".

In **Clause 801**, Table 8/1 under the heading "Concrete Pipes", line 1, insert the word "be" between the words "shall" and "non-reinforced". Also under the heading "Filter Drains" line 2, the unit "sq.m." is amended to "sq.mm.". Under the heading "Pipes for Service Ducts" paragraph 2, line 4, insert the word "after" between the words "immediately" and "it".

In **Clause 802**, paragraph 2, line 4, the phrase "Grade 5 concrete" is amended to read "Grade 7.5 concrete".

In **Clause 807**, paragraph 14, line 3, the phrase "Special Requirements" is changed to "Special Provisions".

In **Clause 808**, paragraph 2, line 2, the phrase "CYS 183 Part 2" is changed to "CYS EN 124". In line 3, add the sentence "They shall be bedded on cement mortar 1:3" after the word "Contract".

In **Clause 901** paragraph 1 is deleted and replaced by the following:

1. Pre cast concrete kerbs, channels, edgings and quadrants shall be hydraulically pressed complying with CYS 283 and shall be manufactured to the dimensions shown on the drawings. They shall be laid and bedded in accordance with BS 7263 Part 2 with wide joints, and to the tolerances stated on the drawings.

In **Clause 904**, Sub-Clauses 2 and 4 are deleted and Sub-Clause 3 is renumbered as Sub-Clause 2. At the end of the second line of sub-clause 1, add the following: "They shall be laid bedded and jointed in accordance with BS 7263 and as shown on the drawings".

In **Clause 907**, paragraph 1 line 1, the word "of" is deleted.

In **Clause 1002**, paragraph 1, line 1, the word "Departmental" is changed to "Departments".

In **Clause 1005**, paragraph 1, line 1, the word "if" is changed to "of", and in line 4 the phrase "clause 804" is amended to read "Clause 802". Also in paragraph 4, line 7, the phrase "Clause 802" is amended to read "Clause 805".

In **Clause 1006**, paragraph 1, line 4, the phrase "Appendix 1001/1" is amended to read "Appendix 1000/1", and in line 10, the word "they" is deleted. In paragraph 7, line 1, the word "chamber" is amended to read "chambers". In paragraph 8, line 2, the phrase "Clause 810" is changed to "Clause 809".

In **Clause 1007**, paragraph 1, line 7, add the word "ordinary" in front of the word "sand", and the phrase "nominal size not exceeding 2 mm, free of organic or foreign matter" after the word sand.

In **Clause 1102**, under the sub-heading "Materials", line 2, replace the words "Section 900" by the words "Section 700".

In **Clause 1108**, paragraph 1, line 8, replace "Clause 905" by "Clause 1106".

In **Clause 1203**, paragraph 8, line 3, the word "earth" is replaced by the word "earthing".

In **Clause 1301**, paragraph 2, line 3, the phrase "3 m solid with 9 m gap" is replaced by the phrase "as shown on the drawings".

In **Clause 1304**, paragraph 1, line 1, the number "200" is replaced by the number "300". Also in paragraph 2, line 1, add the word "shapes," after the word "arrows".

In **Clause 1307**, paragraph 1, in the last line, replace the word "won" by the word "own".

In **Clause 1311**, paragraph 4, line 4, replace the word "give" by the word "given".

In **Clause 1312**, paragraph 3, line 4, a full stop is placed after the word "years" and in line 5 the phrase "has been obtained" is deleted.

In **Clause 1401**, paragraph 1, line 5, add the phrase "or by a Nominated Sub-Contractor" after the word "Department".

In **Clause 1402**, last line, add the phrase "/Nominated Sub- Contractor" after the word "EMS".

In **Clause 1403**, paragraph 1, line 5, add the phrase "/Nominated Sub-Contractor" after the word "EMS".

In **Clause 1501**, paragraph 1, the second sentence is deleted.

In **Clause 1701**, paragraph 1, line 4, replace the words "Clause 10.3" by the phrase "Clause 1703 of this Specification".