

**GOVERNMENT OF ST VINCENT AND THE GRENADINES**

**SPECIFICATIONS**

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# SECTION 1: GENERAL CLAUSES

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## 1.1 LOCATION OF SITE

*See Preambles in the General Items section on page 1 of the Bills of Quantities*

## 1.2 SCOPE OF WORKS

*See Preambles in the General Items section on page 1 of the Bills of Quantities*

## 1.3 SITE ACCESS

Access to the Site shall be via existing public roads. If it is unavoidable that the Contractor has to drive tracked vehicles along existing roads or tracks he must take all necessary precautions to prevent damage thereto. Such precautions shall not, however, relieve the Contractor of his responsibility for reinstating any damage caused to the existing roads or tracks.

## 1.4 CONTRACTOR'S AREA

The contractor is responsible for locating and proposing a suitable area of land within the geographical limits of the Site for the purpose of siting his own site offices, mess huts, stores, plant, workshops and hardstandings. The Contractor shall be responsible for all cost associated thereof.

Temporary living quarters for Contractor's staff and labour will not be allowed on this land or at any other location.

The Contractor shall be responsible for all costs in respect of temporary drainage, security fencing, temporary roads, all other necessary works, maintaining, clearing away and reinstating the area when no longer required.

The layout of the Contractor's area shall be approved by the Authorised Representative before any work is carried out therein.

Temporary structures, materials, plant or hardstandings shall not be placed outside the Contractor's area unless in the opinion of the Authorised Representative they are required for the construction of the Works. Such temporary structures, materials, plant or hardstandings shall be removed as soon as they are no longer required and any areas and/or Works disturbed shall be reinstated.

The Contractor shall note that no other land will be available for his use on Site and that if the above area is insufficient for his requirements then he shall be responsible for acquiring such additional areas of land off the Site as he may require to accommodate his needs, paying all charges and taking all responsibilities in connection therewith.

## 1.5 SANITARY ARRANGEMENTS

The Contractor shall provide on the Site where directed by the Authorised Representative, hygienic conveniences of approved design for the use of his own and sub-contractors' workmen.

The Contractor shall also provide on the Site where directed by the Authorised

Representative, suitable and separate lavatory accommodation consisting of a W.C. or chemical closet and washing facilities for the use of the Authorised Representative.

Where possible the foregoing shall be connected to an existing sewage system, otherwise the contents therefrom shall be disposed of at such place and in such manner as the Authorised Representative shall direct. Any connection (s) to an existing sewer system shall, if applicable, be subject to the approval of the relevant local Statutory Authority.

The Contractor shall maintain the foregoing in a good sanitary condition throughout the period that they are in use and he shall remove and clear away same on completion of the Works or when no longer required.

The Contractor must exercise strict supervision of all persons employed by him to avoid nuisance or contamination of the Works.

#### 1.6 SITE ELECTRICITY SUPPLY

The Contractor shall make his own arrangements for the temporary supply of any electricity required for the execution of the Works and he shall issue all notices and pay all fees, dues, charges and other costs in respect thereof.

The Contractor shall be responsible for providing and maintaining the whole of the temporary electrical installation and in relation thereto shall take all reasonable precautions to ensure the safety of every person on the Site. The Authorised Representative may require the disconnection or alteration of any parts which he considers may be dangerous.

The whole of the Contractor's temporary electrical installation shall comply with all statutory requirements in St Vincent and shall meet with the approval of St Vincent Electricity Services Ltd (VINLEC).

As soon as any part or the whole of the Contractor's temporary electrical installation is no longer required for the carrying out of the Works the Contractor shall disconnect and remove the same to the satisfaction of the Authorised Representative.

#### 1.7 SITE WATER SUPPLY

The Contractor shall make his own arrangements for an adequate supply of mains water or equivalent to cover all his requirements in connection with the execution of the Works and he shall issue all notices and pay all fees, dues, charges and other costs in respect thereof.

The Contractor shall make such temporary connections and execute such plumbing, including the provision of storage tanks as he may require to give him the requisite quantity of water at the pressure required at all times.

If the source of supply is a town's main then such temporary connections and plumbing shall be carried out to comply with the requirements of the Central Water and Sewerage Authority (CWSA).

Where mains water or equivalent is found to be too brackish for use in the Works the Contractor shall make and pay all costs for alternative arrangements to obtain a suitable acceptable supply. The Contractor will not be permitted to sink a well to obtain water supply.

All such connections and plumbing shall be carried out to comply with the requirements of CWSA.

As soon as any part or the whole of the Contractor's water supply installation is no longer required for carrying out the Works, the Contractor shall disconnect and remove the same to the satisfaction of the Authorised Representative and CWSA.

#### 1.8 SITE TELEPHONES

The Contractor shall provide such telephones as are required for his own use on Site and he shall issue all notices and pay all fees, dues, charges and other costs in respect thereof. All temporary telephone installations shall be removed on completion of the Works.

#### 1.10 REQUIREMENTS OF AUTHORISED REPRESENTATIVE

The Contractor shall provide the following for the sole use of the Authorised Representative during the period of the Works and shall maintain all in good working order at all times and replace defective items if necessary.

The Contractor shall provide all survey equipment (automatic level, theodolite, EDM, tapes etc), poles, pegs, nails, chalk, paint, paint brushes, stagings, ladders, wire ropes, moulds, templates or profiles required by the Authorised Representative for checking or measurement of the Works including leaving in position without obstruction to sighting any poles, pegs, templates or profiles used in the setting out of the Works.

The Contractor shall provide such approved labour as the Authorised Representative may require to assist him in the above work.

#### 1.11 ATTENDANCE ON AUTHORISED REPRESENTATIVE'S REPRESENTATIVE

The Contractor shall provide approved labour equal to the tasks required to give sole attendance to the Authorised Representative in the following position:-

Chainman to assist in checking the setting out, levelling or in measuring up work.

#### 1.12 ADVERTISEMENTS

The Contractor shall not display advertisements on the Site nor shall he permit advertisements to be displayed without the written consent of the Authorised Representative and he shall at all times remove advertisements displayed without such consent. Project signboards, where appropriate, shall be to a design and size agreed by the Authorised Representative and approved by the Government Planning Department.

#### 1.13 SITE WORKING CONDITIONS

Throughout the period of construction of the Works the Contractor shall maintain the whole area of his operations in a clean, tidy and safe condition by arranging his materials in an orderly manner. All rubbish, waste materials, debris, and the like shall be systematically cleared off the working areas as it accumulates and, if not removed directly off the Site, shall be temporarily deposited at general collecting points allocated by the Authorised Representative pending removal from the Site.

The working areas and the site roads shall at all times be kept clear of mud, water, silt

and other materials.

The Contractor shall clean all vehicles and plant before they leave the Site to ensure that no earth, mud or other objectionable matter is deposited by them on roads.

If earth, mud or other objectionable matter is deposited on public or private rights of way as a result of the Works, the Contractor shall provide sufficient labour, plant, equipment, etc., as is necessary and as required by the Authorised Representative to ensure that deposits are immediately removed.

The Contractor shall be responsible for minimising dust nuisance to the general public and, in particular, to owners and occupiers of property located adjacent to the Works.

All surfaces which may generate excessive quantities of windblown dust shall be sprayed frequently with water both during and after completion of construction activities.

The Contractor shall allow for cleaning down all visible surfaces of structures, removing all grease, oil, and the like, and on completion leaving everything in a sound and perfect condition free from all defects to the satisfaction of the Authorised Representative.

#### 1.14 PERMITS TO WORK

The Contractor shall make all arrangements to obtain work and residence permits for non-Vincentian staff and labour.

#### 1.15 NOISE CONTROL

All plant and equipment supplied by the Contractor for use on the Works shall be effectively "sound reduced" by means of silencers, mufflers, acoustic linings or shields, acoustic sheds or screens, etc., as necessary to fulfil the requirements of the current editions of all the Acts and Regulations applicable to noise control on construction and demolition sites.

Provided that the provisions of this clause shall not be applicable in the case of emergency work necessary for the saving of life or property or for the safety of the Works.

#### 1.16 SURVEY OF PROPERTIES, LANDS AND CROPS

The Authorised Representative shall where appropriate, arrange for surveys to be carried out in conjunction with the Contractor and owners or occupiers of the condition of all properties, lands and crops which may be affected by the Works. The Contractor shall before commencing any work, confirm in writing to the Authorised Representative that the relevant survey is a true and accurate record of the condition of all properties, lands and crops inspected.

#### 1.17 RESTRICTION ON USE OF HIGHWAYS

The Contractor shall not make use of public or private rights of way for depositing or storing plant, materials, tools or implements other than such plant, materials, tools and implements as may from time to time be required for immediate use of the Works. Plant, materials, tools, implements and temporary works shall be placed in such a way

as to cause minimum interference with the use of any right of way by the public and the Contractor shall maintain those parts of the right of way not temporarily occupied by the Works in a clean, passable and safe state at all times.

#### 1.18 TRAFFIC SAFETY MEASURES

The Contractor shall ensure that all traffic safety measures are to the satisfaction of the St Vincent Police Authorities and the Ministry of Transport and Works.

The Contractor shall not commence any work which affects the public highway until his proposed method of working has been agreed with, and confirmed in writing to the Authorised Representative and the Highways and Police Authorities and all traffic safety measures necessitated by the work are fully operational.

The Contractor shall maintain all traffic safety measures in good working order and condition at all times and shall re-position, cover or remove them as necessitated by the progress of the Works.

#### 1.19 TEMPORARY DIVERSION OF EXISTING RIGHTS OF WAY

The Contractor shall provide and maintain temporary diversion ways wherever the Works will interfere with existing public or private vehicular or pedestrian rights of way. Such diversion ways which shall be to the Authorised Representative approval, must be constructed in advance of any interference with the existing rights of way and shall be of a standard suitable in all respects for the class or classes of vehicles or pedestrians requiring to use them.

The Contractor shall remove temporary diversion ways when no longer required and shall reinstate any disturbed ground or works.

#### 1.20 EXISTING WATERCOURSES

The Contractor shall be responsible for maintaining by whatever means necessary, the flow of any existing watercourses disturbed by the Works and for reinstating them on completion of the Works.

The Contractor shall also be responsible for taking whatever measures necessary to prevent the deposition of silt or other materials in or the pollution of any watercourses within or adjoining the Site.

The above means and measures shall both be subject to the Authorised Representative's approval.

#### 1.21 PUBLIC UTILITY AND PRIVATELY OWNED SERVICES

Any information given in the Contract as to the whereabouts of Public Utility and privately owned services is believed to be correct but no warranty is given as to the accuracy or completeness of that information.

In some sections of the road CWSA and Cable and Wireless require to lay ducts and mains and to raise existing chamber covers. The Contractor shall establish with these Statutory Authorities which sections of road are thus affected. In general the ducts and mains are to be laid by these Authorities following substantial completion of the earthworks but prior to preparation of formation. The Contractor shall allow in his Programme of Works for the Authorities work such time as they may reasonably require for excavation, laying, backfilling and removal of spoil, and shall give notice of

the readiness of sections of the formation to the Authorities in a procedure to be approved by the Authorised Representative. Where appropriate the Contractor shall make provision for the Authorities to raise existing covers. The Contractor shall be responsible for ensuring that the Authorities work has been carried out in accordance with Sections 2, 3 and 4 of this Specification, and he shall notify the Authorised Representative of any deficiencies in their workmanship or materials and of any delays which will affect the satisfactory completion of his Works.

The Contractor shall contact all relevant Statutory Authorities and service owners before commencing any excavations and shall establish from their records the exact location of existing services which may affect or be affected by the construction of the Works. In addition the Contractor shall, before using mechanical plant in the vicinity of existing services, carry out full and adequate preliminary investigations by means of hand-dug trial holes, to verify the location of the existing services.

The Contractor shall make his own arrangements for any diversion or removal of existing services which he may require for his own convenience or because of his proposed method of working and shall in all cases, inform the Authorised Representative in advance of his proposals.

The Contractor shall exercise the greatest care during the construction of the Works to avoid damage to or interference with any existing services and shall be responsible for any such damage caused by him or his agents directly or arising indirectly from anything done or omitted to be done. The Contractor shall carry out all temporary works necessary to adequately support and protect any existing services.

If, in the Authorised Representative opinion, damage may be caused by the operation of mechanical plant over or adjacent to existing services, the Contractor will be required to excavate by hand in their vicinity.

#### 1.22 REMOVAL OF PUBLIC UTILITY OR PRIVATELY OWNED SERVICES, ETC.

If any Public Utility or privately owned services or other obstructions are required to be removed during the construction of the Works are not otherwise specifically catered for in the Contract, the Contractor shall draw the Authorised Representative attention to them and the Authorised Representative shall arrange for their removal by the Contractor or otherwise.

#### 1.23 PROTECTION OF EXISTING PROPERTIES

The Contractor shall take all measures necessary to protect existing properties from damage during the currency of the Contract and shall deal promptly with any complaints by the owners or occupiers of such properties.

#### 1.24 PRECAUTIONS AGAINST DAMAGE TO TREES AND SHRUBS

The Contractor shall take all precautions necessary to prevent damage or destruction of existing trees, shrubs and hedges by any cause whatsoever. No felling or cutting back of trees, shrubs or hedges on the Site shall be carried out without the written authority of the Authorised Representative. In the event of any damage to, destruction of, or any unauthorised felling or cutting back of trees, shrubs and hedges, the Authorised Representative may deduct from any monies due to the Contractor an amount equal to the cost of replacement of the damaged species and the disposal thereof, including removal of roots.

#### 1.25 CONVERSION OF METRIC AND IMPERIAL UNITS

Conversion of metric to imperial units and vice versa shall be carried out in accordance with the conversion factors in B.S. 350 Part 1 and 2 and B.S.I. Publication PD6030 and PD6031.

#### 1.26 MONTHLY CASH FLOW

The Contractor shall submit an estimate of his anticipated monthly cash flow with and based upon the programme required under the Conditions of Contract. The Contractor shall, if and when required to do so by the Authorised Representative, adjust the estimate of his anticipated monthly cash flow to accord with any revisions made in the programme.

#### 1.27 SUBSTANTIATION AND FORM OF MONTHLY STATEMENTS

##### Quantities and Valuations

Before submitting a monthly statement the Contractor shall agree with the Authorised Representative the measured and estimated quantities and the valuations to be placed upon temporary works, materials, etc. which he is entitled to claim under the terms of the Contract.

The agreed quantities and valuations shall be recorded in duplicate in writing and signed by the Contractor and the Authorised Representative. One copy will be returned to the Contractor and the other copy will be retained by the Authorised Representative.

#### 1.28 SPECIFIED FIRMS

Where considered necessary to supplement the specification in the case of work which can only be sub-contracted, a list of firms acceptable to the Authorised Representative has been given and the Contractor shall state when he submits his Tender, which firms he proposes to employ. Such work will not be the subject of a Nominated Sub-Contract and the Contractor must base his rates on the use of a firm on the specified lists.

#### 1.29 DEFINITIONS

Suitable material - material which is acceptable by the Authorised Representative for use in the Works.

Unsuitable material - any material which does not have the necessary properties to fulfil the specification requirements.

Imported material - suitable material obtained not less than 200 metres from the Site.

Optimum moisture content - the moisture content of soil at which a specified amount of compaction will produce the maximum dry density when determined in accordance with the heavy compaction test (4.5kg rammer method) of BS1377.

Maximum dry density - the dry density of soil obtained using a specified amount of compaction at the optimum moisture content when determined in accordance with the heavy compaction test (4.5 kg rammer method) of BS1377.

Sub-grade - the compacted existing ground or fill beneath formation.



Formation - the completed earthworks level shaped in accordance with the drawings in readiness to receive the sub-base.

Surfacing - the final running surface of bituminous premix material laid on the base.

### 1.30 INCLEMENT WEATHER

Construction shall be so arranged that each layer is able to drain quickly and effectively at all times. Under no circumstances shall water be allowed to pond.

The application of prime coat, and laying of surfacing shall not be carried out when the road surface is wet or when the wind is sufficiently strong to blow dust on to the exposed surfaces.

The Contractor shall be responsible for the repair and reinstatement to specification of any layer or surface damaged by inclement weather.

The Contractor shall take account in his rates of the local weather conditions which may at times affect adversely the working conditions on site.

### 1.31 TRAFFIC CONTROL

The Works shall be organised so as to cause the least possible interference with the flow of traffic.

Before commencing any work likely to cause disturbance to existing traffic movement the Contractor shall submit and obtain the approval of both the Authorised Representative and the Police Representative responsible for traffic to a programme showing the scheme of traffic management he proposes for carrying out the Works.

The approval of both the Authorised Representative and the Police Representative responsible for traffic shall also be obtained immediately before:

- i) Any major road or access is closed to traffic.
- ii) Any traffic diversion is put into operation.

Traffic flow shall be maintained on existing roads until suitable sections of the new carriageway are completed enabling it to be transferred.

### 1.34 PROTECTION OF EXISTING ROAD SURFACES

Existing or newly laid road surfaces shall be protected from damage caused by the hydraulic leg supports of plant or spillage of fuel, oil, etc.

Concrete shall not be hand mixed directly on bituminous surfaces.

Only pneumatic tyred plant shall be permitted to travel between sites on existing carriageways. Steel-wheeled rollers, tracked vehicles, etc. shall be transported on low-loaders or similar.

### 1.35 ACCESS TO PROPERTIES

Satisfactory, safe pedestrian access shall be maintained at all times to all properties fronting the roads affected by the Works.

Vehicular access to properties shall be maintained as far as practically possible and shall not be restricted beyond the end of the working day without the permission of the Authorised Representative.

#### 1.36 TRAFFIC SAFETY

All necessary traffic safety measures shall be fully operational before any work commences affecting the existing highway.

The Contractor shall provide, erect and maintain all traffic signs, lamps, barriers, traffic control signals and such other measures as may be necessary for the construction of the Works.

During the hours of darkness red warning lights or flashing lamps shall be attached to barriers surrounding any hazards to traffic, in addition to the traffic signs.

All traffic signs, lamps, barriers, etc. shall be kept clean and legible at all times and be repositioned, covered or removed as required by the progress of the Works.

#### 1.37 SITE LEVELS

All levels shown are expressed in metres and relate to St Vincent datum or as otherwise indicated on the drawings.

#### 1.38 STANDARDS

All materials shall, unless otherwise specified or authorised by the Authorised Representative in writing, be in accordance with the latest revision at the time of tender of the relevant standards. British Standards, hereafter referred to as 'BS' are applicable except that American standards are used for the surfacing, see Section 7, hereafter referred to as ASTM or AASHTO. A copy of all relevant Standards and Codes of Practices referred to in the Specification shall be provided on Site.

The Contractor may supply materials against equivalent codes to British Standards with the written permission of the Authorised Representative and shall provide a copy of all such approved codes on Site.

#### 1.39 WORKMANSHIP

Workmanship shall, unless otherwise specified, be in accordance with the appropriate current British Standards Code of Practice, hereinafter referred to by the letters 'CP' as far as applicable. The work shall be executed accurately to the dimensions, levels and profiles indicated on the drawings or as may be ordered or directed by the Authorised Representative.

#### 1.40 SAMPLES

In addition to the special provisions made hereafter as to sampling and testing of materials by particular methods, samples of materials and workmanship proposed to be employed in the execution of the Works may be called for at any time by the Authorised Representative and shall be furnished by the Contractor without delay. The samples, when approved, will be kept by the Authorised Representative. All materials or workmanship not corresponding in quality and character with the approved samples shall be rejected and removed from Site. Suitable labelled boxes for the storage of samples shall be provided by the Contractor.

#### 1.41 SAFETY PROCEDURES

The Contractor shall take all possible precautions to prevent outbreaks of fire and especially with respect to the safe storage of petroleum products, explosives and all other dangerous or hazardous goods.

The Contractor shall give every facility to the authorised safety officers of the Contracting Authority to inspect the Works as required, and shall observe and abide by any instructions given by the Authorised Representative in regard to the use of plant, equipment and temporary works whether in respect of fire hazards or general safety.

#### 1.42 NOTICE OF ACCIDENTS

In the case of any casualty or accident occurring on the Site during the carrying out of the Works or Temporary Works the Contractor shall:-

- a) Comply with all subsisting legal obligations requiring him to give Notice of such casualty or accident to any persons and supply the Authorised Representative with three copies of any Notice so given, or
- b) Where no such obligation as aforesaid subsists give Notice in writing to the Authorised Representative of such casualty or accident.

#### 1.43 NOTICE OF CARRYING OUT WORKS

The Contractor shall give the Authorised Representative due notice in writing of not less than 24 hours of his intention to set out, level, place or cast any part of the Works in order that arrangements may be made to inspect the Works intended.

#### 1.44 COPIES OF ORDERS

The Contractor and sub-contractors shall provide the Authorised Representative with copies of all orders which they may place for the supply of materials or goods required in connection with the Works.

#### 1.45 TEST CERTIFICATES

Should the Authorised Representative not inspect any materials or goods at the place of manufacture, the Contractor shall obtain Certificates of Test from the suppliers of such goods and shall send such Certificates to the Authorised Representative. Such Certificates shall certify that the materials or goods concerned have been tested in accordance with the requirements of the Specification and shall give the result 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.

#### 1.46 SETTING OUT - GENERAL

The Contractor is responsible for the accuracy of all setting out and levelling of the works.

The instruments provided by the Contractor for the proper setting out of the Works shall be maintained in good working order with valid calibration certificates at all times during the period of the Contract.

The Contractor is responsible for checking that all basic survey points are in place at the commencement of the Contract, and if any are missing, or appear to have been disturbed, the Contractor shall inform the Authorised Representative and shall carry out such operations that are necessary to re-establish the points, as directed by the Authorised Representative.

After this basic survey and setting out has been agreed by the Authorised Representative, the Contractor shall be responsible for its maintenance and re-establishment of any portion lost or destroyed.

Reference pegs and bench marks of basic points established by the Contractor shall be made of steel pins, 450 mm long and 12 mm diameter set 12 mm proud in in-situ grade 20/20 concrete blocks cast 0.25 m into the ground and at least 0.25 m in diameter. The chainage, level and other markings required by the Authorised Representative, shall be scratched or clearly marked with paint on the surface of the concrete or otherwise clearly marked to the satisfaction of the Authorised Representative.

Should the Contractor discover any error in line or level in the basic setting out, he shall at once notify the Authorised Representative who will then issue amended drawings or instructions regarding the correction of the error.

The Contractor shall establish temporary bench marks at intervals along the road not exceeding 200 metres and shall provide the Authorised Representative with a schedule of their levels.

The Contractor shall set out the road line and level and the tops of cuttings and toes of embankments at intervals of not more than 25 metres or such lesser intervals on horizontal and vertical curves as the Authorised Representative may require. Reference pegs shall be provided clear of the road and at right angles to it from which the centre-line or level can be re-established at any time. These should be maintained so long as they are needed by the Authorised Representative to check the work.

Prior to the construction of any earthworks or excavation, the levels of the existing ground shall be agreed between the Contractor and the Authorised Representative. The Contractor shall be responsible for determining the existing ground levels along the proposed alignments to the satisfaction of the Authorised Representative, following which the Authorised Representative will confirm the actual finished levels to which the road is to be constructed.

No separate payment will be made for any work in connection with the Contractor's basic and detail setting out nor any other works required by him to ensure the accurate location and construction of the Works.

#### 1.47 RESTRICTIONS IN REMOTE AREAS

In the locations where the alignment to be constructed is remote from the existing alignment of the road, work shall take place only within the confines of the new earthworks profile. Under no circumstances will plant or machinery be permitted to utilise areas outside the earthworks profile for standing access or haulage purposes.

#### 1.48 ENVIRONMENTAL MATTERS

1.49 RECORD DRAWINGS

The Contractor shall maintain, as work progresses, accurate records of changes to drawings and locations of concealed services. One extra set of drawings will be supplied for making these recordings. Upon completion of the project, the Contractor shall deliver the drawings to the Engineer with recordings neatly inked in.

1.50 PROJECT SIGN BOARDS

The Contractor shall provide, erect and maintain two (2) signboards with the layout, wording and colours as agreed with the Engineer. The minimum dimensions of the boards shall be 1.2m x 2.4m.

These signboards shall be erected at sites to be selected by the Engineer.

The signboards shall be erected within three (3) weeks of the date of commencement of the Contract. The Contractor shall remove the signboards at the end of the Defects Liability Period of Maintenance.

## SECTION 2: MATERIALS

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### 2.1 SUB GRADE MATERIALS

All materials used as fill shall pass a 200mm sieve and the material passing the 0.075mm sieve shall be less than 35% of the material passing the 2.36mm sieve.

The material passing the 0.425mm sieve shall have the following characteristics when tested in accordance with BS1377:

- i) Plasticity index to be not more than 10.
- ii) The value of the California Bearing Ratio of specimens compacted statically at the optimum moisture content and 95% of the maximum dry density, shall be greater than 8% at penetrations of 2.5mm and 5mm on both top and bottom of the specimen. The test surcharge to be used for the equivalent pavement thickness shall be designated by the Authorised Representative.

### 2.2 SUB-BASE MATERIALS

Sub-base material shall be suitable fill material complying with Clause 2.1 except that:

- i) All material shall pass the 75mm BS sieve.
- ii) The value of the California Bearing Ratio of specimens compacted statically at the optimum moisture content and 98% of the maximum dry density and soaked in water for a period of four days and shall be greater than 30% at penetrations of 2.5mm and 5mm on both top and bottom of the specimen. The test surcharge to be used for the equivalent pavement thickness shall be designated by the Authorised Representative.

The specified material in a sub-base may be substituted by any of the materials specified to be laid on it.

### 2.3 BASE MATERIALS

Base material shall consist of crushed, hard, clean, durable rock obtained from approved sources and shall be graded in accordance with the following table:-

BP Sieve Size	Percentage Passing (by Weight)
50mm (2 ins)	100
37.5mm (1 ins)	95-100
20mm (¾ ins)	60-80
10mm (½ ins)	40-60
5mm (3/16 ins)	25-40
2.36mm (No. 7)	15-30
0.600mm (No. 25)	8-22
0.075mm (No. 200)	5-12

The Plasticity Index of the material passing the 0.425mm sieve shall not exceed 6.

The Aggregate Crushing Value of material passing a 14mm sieve and retained on a 10mm sieve shall not be greater than 30.

The Flakiness Index when determined in accordance with BS 812 Part 1 shall not exceed 30%.

#### 2.4 ASPHALTIC SURFACING

The Specification for Asphaltic Surfacing is given in Section 7.

#### 2.5 PRIME COAT

The material to be used for prime coat shall be a low viscosity, medium curing cutback bitumen MC-70.

Copies of all consignment certificates stating the cutback bitumen supplied shall be submitted to the Authorised Representative for approval.

#### 2.6 PRECAST CONCRETE MANHOLES

Precast cover slabs for manholes shall comply with the requirements of BS5911, Part 1 and shall be manufactured from concrete Grade 30/20. Cover slabs shall be heavy duty.

#### 2.7 MANHOLE COVERS AND FRAMES

Manhole covers and frames shall comply with BS497, Part 1, Grade A capable of bearing wheel loads of up to 11.50 tonnes.

#### 2.8 CONCRETE BLOCKS

Concrete blocks shall comply with the requirements of Section 4. Hollow concrete blocks in manholes, catchpits, etc. shall be filled solid with concrete to the requirements of Section 4.

#### 2.9 STEP IRONS

Step irons shall be galvanised and comply with BS1247. The tail length on the general purpose pattern step iron shall be 115mm and on the precast concrete manhole pattern 50mm.

#### 2.10 PIPES FOR SURFACE WATER DRAINAGE AND DUCTS

Unplasticised polyvinylchloride (uPVC) pipes and ducts shall comply with the requirements of BS4660 or BS3506, except that Class 0 pipes shall not be used.

Concrete pipes shall comply with the requirements of BS5911, Part 1, Class L except that the pipes shall be manufactured using fully compacted, unreinforced concrete containing not less than 350kg of cement per cubic metre of concrete and having a maximum/cement ratio of 0.45. The aggregates used shall comply with the requirements of Clause 4.4.

2.11 GRANULAR PIPE BEDDING MATERIAL

The material to be used for bedding and surrounding pipes shall be aggregate either graded or single-sized in accordance with the following table:

NOMINAL PIPE SIZE mm	NOMINAL SIZE OF GRADED AGGREGATE mm	NOMINAL SIZE OF SINGLE SIZED AGGREGATE mm
110	-	10
160	14 to 5	10 or 14
225 and over	14 to 5 or 20 to 5	10, 14 or 20

2.12 SIGNS AND POSTS - GENERALLY

All traffic signs shall comply with the requirements of BS 873, Parts 1-3 and 5-7 except where the provisions of this specification supersede those of the standard.

2.13 CONSTRUCTION OF SIGNS

Materials and finishes shall be compatible so as to avoid failure or deterioration due to electrolytic action or by differential thermal expansion.

Signs shall be provided with stiffening and/or framing of aluminium section as necessary to conform with the rigidity requirements of BS873, Part 6.

The stiffening shall be so designed that the sign plate can be mounted at a minimum of two points and shall be of suitable cross section so as to accept the fixings without further drilling of the sign face.

Rivets shall be of aluminium alloy. They shall be of sufficient cross sectional area and uniform spacing to meet the structural requirements of BS873, Part 6, but in any case at a maximum of 150mm centres around the outside edge of the sign and at 300mm centres on cross braces. The centre core of all rivets shall be removed.

Any rivet brought through the sign plate shall be covered with a self coloured plastic cap to match the sign face. All rivet and holes shall be edge sealed with clear lacquer after the application of the sheeting material.

All nuts, bolts, clips and other fixings used to attach the sign plate to the post shall be manufactured from stainless steel to BS1449, Part 2, Type 316 S16 or approved equal quality. Protection washers of nylon or other approved material shall be provided where fixings are in contact with surfaces which may be damaged by overtightening.

The Contractor shall provide samples and a fully descriptive catalogue showing the fixings for the approval of the Authorised Representative before placing any orders.

2.14 TUBULAR STEEL POSTS



Posts shall be fabricated from steel to BS4360, Grade 43C to the requirements of BS4848, Part 2.

The steel shall be completely freed from scale and rust by blasting or pickling and shall be rust-proofed by an approved method prior to coating with an EVA finish.

A thickness of not less than 0.40mm of EVA finish shall be provided by a fluidized bed process. Where the EVA coating is to be applied over a galvanised finish the galvanising shall be pre-treated to ensure good coating adhesion.

Posts shall be provided with tight fitting, overlapping, weather resisting, self-coloured grey plastic caps. Steel base plates shall also be provided and may either be of the clamp-on type or the shoe and pin type with an appropriate preformed hole in the post. The plate shall be not less than 230mm square and shall be galvanised to BS729 or receive a similar approved protective coating. Anchor rods will not be accepted in lieu of base plates.

#### 2.15 SIGN PLATES

Sign plates shall be constructed from sheet aluminium or sheet aluminium alloy complying with designations 1200-H4, 6082-TF, 3103-H6 or 5251-H6 of BS1470 of minimum thickness 3.0mm for unstiffened signs and 2.0mm for stiffened signs.

The plates shall have clear cut edges and be radiused at all corners. They shall be free from warp and shall have a smooth, even finish.

The plates shall be free from dust, dirt or other loose chemical coatings, degreased and then immediately etch primed, anodised or treated with a conversion process prior to application of plastic covering.

#### 2.16 SIGN FACES

The front of the sign shall be complete covered with silk screen printed retro reflective Class 1 material complying with Table 1 and having a colorimetric performance complying with Table 4 of BS873, Part 6.

The material shall also satisfy the requirements of BS873, Part 6 with regard to photometric performance, impact resistance, bond between material and the sign plate; resistance to solvents, corrosion, weathering, water and dirt.

The Contractor shall provide such documentation as the Authorised Representative may require to show that the material meets this specification together with a Quality Control Certificate issued by the manufacturer.

The material shall be fixed to the aluminium plate with a precoated heat activated adhesive using a vacuum applicator equipped with a temperature controller. Application of the material shall be made using equipment specifically designed and manufactured for the purpose by the sheeting manufacturer and maintain according to his instructions.

When applied to the aluminium, the reflective sheeting shall give the appearance of a

continuous retro reflective surface under any angle of observation.

All joints shall be overlapped by not less than 6mm. No butt joints shall be permitted and in horizontal joints the overlap shall be from the top. The use of joints shall be kept to a minimum.

Each sign shall have its face suitably protected to prevent damage during storage, transit and installation. Modifications to sign faces shall only be carried out under factory conditions.

The rear of the sign faces shall be stove-enamelled grey for a stoving cycle of 30 minutes in an electrically heated oven at a temperature of 120°C.

## 2.17 MATERIALS TESTING EQUIPMENT

It will be necessary for the materials which are to be incorporated in the permanent works to be tested to ascertain their suitability.

The following table describes the testing requirements for the road construction materials and concrete:

### Test No. Description of Test

BS1377	Moisture content	Liquid Limit Plastic Limit Particle Size Distribution Dry Density/moisture content (Proctor 4.5kg) Dry Density on site by sand replacement California Bearing Ratio Aggregate Crushing Value
BS812		Flakiness Index
BS1881		Concrete Cube Strength Concrete slump

The tests required for the Asphaltic Concrete Surfacing are described in Section 7.

## 2.18 SAFETY FENCES

### a) Untensioned Corrugated Beam Safety Fence

Corrugated beams shall be of mild steel and not less than 300mm in depth and shall be so formed that the traffic face has a central trough at least 75mm deep. When the section is freely supported over a span of 3000mm with the road face uppermost and centrally loaded with a point load of 1000kg, the deflection measured at the centre of the span shall not exceed 40mm.

The beam sections shall be straight, except where described otherwise in the contract documentation, and 3800mm long. Adjacent beams shall be joined by minimum 300mm lap joints using bolts, nuts and washers manufactured in accordance with BS970 : 080 M 40 (Normalised). The bolt heads shall be such as to present no appreciable projection to traffic.

Beam sections to suit curves of less than 45 metres radius shall be shop-curved.

b) Safety Fences - Posts

Posts for untensioned corrugated beam safety fences shall be manufactured from 152 x 75mm x 17.88 Kg/metre channel complying with BS4, Part 1 and shall be drilled with 19mm diameter holes to take the specified bolts for fixing the beams.

Posts for tensioned corrugated beam safety fences shall be manufactured from 5mm mild steel plate in accordance with BS4360 Grade 43A formed into Z section 100 x 32mm x 6 Kg/metre.

c) Pre-treatment of Safety Fence Components

All steel parts shall be galvanised after fabrication in accordance with BS729.

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## SECTION 3: WORKMANSHIP

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### 3.1 EARTHWORKS - GENERAL

Unsuitable material shall be removed from the Site to a tip provided by the Contractor and approved by the Authorised Representative.

No excavated suitable material shall be removed from the Site without the approval of the Authorised Representative unless it is surplus to the requirements of the Works. Should the Contractor be permitted to remove suitable material to suit his operational procedure then he shall make good any consequent deficit of fill material arising therefrom. Excavated topsoil shall be stockpiled on the Site for re-use in the Works.

Where the excavation reveals a combination of suitable and unsuitable material the excavation shall, unless otherwise agreed with the Authorised Representative, be carried out in such a manner that the suitable materials are excavated separately for use in the Works without contamination by the unsuitable material.

The hauling of excavated material to areas of fill shall proceed only when sufficient spreading and compacting plant are operating at the place of deposition to ensure compliance with the requirements of Clause 3.4. No plant shall leave the site without the approval of the Authorised Representative.

### 3.2 EXCAVATION OF FOUNDATION PITS AND TRENCHES

All trenches and pits under roads shall, where possible, be excavated, backfilled and compacted before road construction commences.

The sides of the excavation shall be adequately supported at all times and, except where otherwise described in the contract documentation, be vertical.

Trenches and pits shall be kept free of water. In tidal and high water table areas the excavation shall be kept free from standing water at all times during construction. Proposals for the insertion of membranes or use of filter media shall be submitted to the Authorised Representative for approval prior to implementation.

The bottom of all excavations shall be formed to the lines and levels shown on the drawings. Any pockets of soft soil or loose rock in the bottom of pits and trenches shall be removed and the resulting cavities and any large fissures filled with suitable material compacted in accordance with Clause 3.4.

Except where otherwise described in the contract documentation backfilling shall consist of suitable material compacted in accordance with Clause 3.4 using vibrating plate compactors, vibrating rollers or other mechanical plant approved for the purpose.

The full width of the compaction plant shall fit inside the surface area of the backfilling with sufficient space to permit adequate compaction. Under no circumstances shall compaction be carried out with plant straddling backfilled and existing surfaces.

Any excavation greater than the net volume required for the Works, or additional excavation at or below the bottom of foundations to remove material which has been allowed to become unsuitable, shall be made up with suitable compacted fill material complying with the requirements of Clauses 2.1 and 3.4.

### 3.3 EXCAVATION OF TRENCHES FOR PIPES OR DUCTS

Trenches for pipes or ducts shall be excavated in accordance with Clause 3.2 to the levels and gradients indicated elsewhere in the contract documentation and within the limits specified in the following table:

NOMINAL DIAMETER mm	MINIMUM WIDTH mm	MAXIMUM WIDTH mm
100	430	630
150	490	690
200	560	760

The maximum and minimum widths shall apply from the bottom of the trench to 300mm above the crown of the pipe or duct.

Trench supports and sheeting shall be outside the minimum width but within the maximum width.

### 3.4 COMPACTION OF FILL MATERIAL

All fill material used in earthworks shall be compacted to the specification by plant approved for the purpose by the Authorised Representative. Earthmoving equipment shall not be accepted as compaction plant.

The Contractor shall submit to the Authorised Representative for approval his proposals for the compaction of each type of material to be used in the embankments, detailing the type of plant, number of passes and maximum loose depth of layer.

Compaction trials for each main type of material shall be carried out on areas, size approximately 50 x 10 metres. The Contractor shall carry out any laboratory tests necessary to satisfy the Authorised Representative that the specified compaction requirements can be achieved adopting the methods he proposes, and the work shall not commence until the Authorised Representative has approved the type of compaction for the materials concerned.

All fill shall be placed in loose layers within the effective range of compaction of the approved plant; however, the maximum permissible loose layer thickness shall be limited to 200mm irrespective of plant type.

Rollers shall be correctly ballasted at all times during rolling with tyre pressures, where applicable, as specified by the manufacturer and shall not have leaking ballast tanks or leaks of any description.

The fill material shall be watered and mixed as necessary to ensure that prior to compaction the moisture content of the whole layer is  $\pm 3\%$  of the optimum moisture

content. Compaction of each layer shall continue until a density of at least 95% of the maximum dry density has been achieved.

No layer shall be covered by the next layer until it has been tested, inspected and approved by the Authorised Representative.

The Contractor shall be responsible for reinstatement to the satisfaction of the Authorised Representative of any layer damaged or disturbed after compaction and approval, by any means or cause, prior to placing the next layer.

### 3.5 COMPACTION OF SUB-GRADE

Unless otherwise directed by the Authorised Representative, the sub-grade shall be scarified, broken up, watered and compacted to ensure that the top 150mm complies with the requirements of Clause 3.4.

### 3.6 PREPARATION OF FORMATION

Preparation and surface treatment of the formation shall be carried out after all duct and pipe installations in the sub-grade have been completed. The surface shall then be shaped and rolled by a minimum of 4 passes of a smooth-wheeled roller having a mass per metre width of 4400-6000kg.

The formation shall be regulated and trimmed to the levels shown elsewhere in the contract documentation.

### 3.7 COMPACTION OF SUB-BASE

The material shall be compacted in accordance with Clause 3.4 except that compaction shall continue until a density of at least 98% of the maximum dry density has been achieved.

The material shall be spread so that after compaction the total thickness is as specified.

### 3.8 SOFT SPOTS

Any soft spots, irregularities or depressions that develop in the surface of any layer of the sub-grade or sub-base, shall either be corrected by loosening the surfaces of such areas and adding further materials, or by removing the material in such areas and replacing with further approved material, as the Authorised Representative may decide, and recompacting in accordance with Clause 3.4 so that the surface is smooth and uniform and follows the profile of the finished formation.

In the event of "heave" occurring during compaction, caused either by excessive build-up of pore water pressure or the ground water table being sufficiently high to affect construction techniques, either of the following procedures shall be adopted subject to the approval of the Authorised Representative:

- i) Sufficient time shall be allowed to elapse enabling the excess pore water to dissipate prior to further construction or compaction being carried out.
- ii) The affected material shall be removed and approved alternative

construction layers substituted.

### 3.9 RECTIFICATION OF FORMATION LEVEL

Any surface area of the formation which is too high shall be graded off, scarified and recompacted to the full depth of the affected layer in accordance with Clause 3.4.

Any surface area of the formation which is too low shall be scarified and corrected by the addition of suitable material of the same classification and moisture content or other approved material laid and compacted in accordance with Clause 3.4.

The Contractor shall carry out additional testing if required by the Authorised Representative to ensure that the standard of compaction is satisfactory through the full depth of layer.

### 3.10 RECTIFICATION OF SUB-BASE

Where the sub-base consists of unbound material, the top 75mm shall be scarified, re-shaped with material added or removed as necessary and recompacted to the specified requirement.

The area treated shall not be less than 30 metres long and 2 metres wide or such area determined by the Authorised Representative as necessary to obtain compliance with the specification.

The Contractor shall carry out additional testing if required by the Authorised Representative to ensure that the standard of compaction is satisfactory through the full depth of layer.

### 3.11 LAYING AND COMPACTION OF BASE

The material shall be kept wet during transporting and spreading in order to minimise segregation.

The material shall be spread so that after compaction the total thickness is 175mm.

The material shall be compacted in accordance with Clause 3.4 except that compaction shall continue until a density of at least 100% of the maximum dry density has been achieved.

### 3.12 CLEAN SURFACES

Immediately prior to the application of the prime coat all loose and objectionable material shall be removed from the surface to be treated by brushes.

Adjacent surfaces and kerbing shall be protected during spraying operations.

### 3.13 APPLICATION OF PRIME COAT

Before laying the surfacing the surface of the base shall be primed. The prime coat shall be applied by a mechanical spraying tank or pressure hand spraying equipment at the recommended temperature for the product at a rate of 0.9 Litres/sq metre or as directed by the Authorised Representative.

The prime coat shall be evenly sprayed so as to avoid ponding in hollows and in the event that ponding does occur the excess material shall be removed immediately. Sufficient time shall be allowed after application to ensure that the prime coat dries completely before surfacing begins. During this period traffic shall not be allowed on the surface and temporary diversions and additional protection shall be provided as necessary.

3.14 HORIZONTAL ALIGNMENT

Horizontal alignment shall be determined from one edge of the pavement surface as shown on the Drawings. The edge of the pavement as constructed and all other parallel alignments shall be correct within a tolerance of  $\pm 13$ mm therefrom.

3.15 SURFACE LEVELS OF PAVEMENT COURSES

The designed levels of the various pavement courses shall be determined from the true finished road surface calculated from the carriageway vertical profile and crossfalls shown on the drawings or as modified by the Authorised Representative.

The vertical depth below the true finished road surface of any point on the constructed surface of the formation or pavement courses shall be within the appropriate tolerances stated in the following table:

SURFACE	TOLERANCE FROM DESIGNED LEVEL mm
Formation	+ 15 - 25
Sub-base	+ 10 - 20
Base	+ 5 - 10
Surfacing	$\pm 6$
Kerbs	$\pm 3$

For checking compliance with the Table the measurement of surface levels shall be taken at points to be selected by the Authorised Representative at 10 metre centres longitudinally and at 2 metre centres transversely. At junctions the grid point spacing shall be determined by the Authorised Representative.

In any length of pavement, compliance with the Table 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 5mm more than the tolerance for the layer concerned.

All longitudinal profile devices such as pegs, pins and profile boards shall be set to the true plan lines with a maximum tolerance of  $\pm 3$ mm measured over a maximum length



of 8 metres.

3.16 RECTIFICATION OF BASE

The levels shall be checked and where the tolerances are exceeded rectification shall be carried out in accordance with Clause 3.10.

3.17 TESTING

Testing and sampling of sub-grade, sub-base and base shall be carried out whenever the Authorised Representative so directs and at least at the minimum frequency shown in the following table:

Minimum Frequency of Testing: Sub-Grade, Sub-Base, Base

TYPE OF TEST	SUB-GRADE m <sup>2</sup>	SUB-BASE m <sup>2</sup>	BASE m <sup>2</sup>
BS 1377			
Classification test (See following Table)	2000	1200	500
Heavy compaction (4.5kg rammer method)	1800	1500	1500
Insitu dry density	600	500	500
BS 812			
Particle size and shape	-	-	1200
Flakiness index	-	-	1200

Following testing for approval purposes aggregate properties shall be verified during the course of construction at such regular intervals as the Authorised Representative may direct and whenever the source of aggregate varies tests shall be carried out according to the following schedule:

Specification for Tests to be carried out in the Contractor's Laboratory

STANDARD	DESCRIPTION
BS 1377	Preparation of disturbed soil samples for testing.  Determination of moisture content (standard method - maximum temperature 80°C)  Determination of liquid limit  Determination of plastic limit  Determination of plasticity index  Determination of particle size distribution by:- a) Wet sieving method - Standard method b) Dry sieving - Subsidiary method
	Determination of the dry density/moisture content relationship using heavy compaction test (4.5kg rammer method)  Determination insitu of the dry density of soil on the site using sand replacement method suitable for fine - medium - and coarse grained soil (large pouring cylinder method).  Determination of the California Bearing Ratio
BS 812	<b>PART 1</b> Determination of particle size and shape  Determination of flakiness index
BS 812	<b>PART 3</b> Determination of Aggregate Crushing Value

3.18 ADJUSTMENT OF EXISTING MANHOLE AND OTHER ACCESS COVERS

Manhole covers, inspection covers, valve boxes and all other access covers together with their frames are collectively referred to as "covers" in this Clause.

The height of existing covers in the new carriageways or footways shall be adjusted to the new levels of the areas surrounding them.

The existing covers shall be carefully removed, cleaned and stored for reuse.

The Contractor shall examine all existing covers prior to removal and shall inform the

Authorised Representative of those which are damaged. The Contractor shall be responsible for the replacement of any cover which in the opinion of the Authorised Representative has been damaged by mishandling.

The height of the existing concrete cover slab shall be adjusted by the formation of a concrete plinth where the level is slightly low, and the entire slab surface shall be raised using concrete where the level is substantially low, as directed by the Authorised Representative.

Where the level of the existing concrete cover slab is too high it shall be removed and the walls of the chamber demolished and made good. A new cover slab shall be provided in accordance with Clause 2.6 and the existing frame shall be solidly bedded in mortar.

### 3.19 LAYING PIPELINES - GENERALLY

The Contractor shall provide an approved traveller and sight rails which are securely positioned either vertically above the pipeline or immediately adjacent thereto. Not less than three sight rails shall be erected on each length of pipeline of the same gradient and alignment.

Only one type of pipe shall be used within any individual drain run between manholes, soakaways and gullies.

Gully connections shall be laid to straight lines and even gradients.

Before being laid each pipe shall be carefully brushed out and inspected for soundness.

Pipes shall be laid singly, straight to line and true to gradient on a solid and even foundation for the full length of the barrel with sockets, if any, facing up the gradient.

During construction all open ends of pipes shall be temporarily sealed to prevent the entry of dirt, water, etc.

### 3.20 LAYING DUCTS

Pipes for ducts shall be joined so that no silt, grout or surround material is able to enter. Pipes with push-fit joints shall have a register to ensure that the joint is fully pushed home.

Each duct shall be laid with a stranded polypropylene draw rope, the ends of which shall be made fast. The ends of the ducts shall be sealed with removable stoppers before backfilling commences.

The Contractor shall provide approved concrete marker pads to indicate the position of the ducts set in the ground in 300 x 300 x 300mm concrete. The marker pads shall be on both sides of the carriageway in positions to be agreed with the Authorised Representative.

### 3.21 MANHOLES/INSPECTION CHAMBERS

Manholes, catchpits, inspection chambers and draw pits are collectively referred to as

"chambers" in this Clause.

Notwithstanding the type of pipeline, the joints on inlet and outlet pipes nearest the manhole shall be flexible. The pipe laying shall be so organised that the joint is formed approximately 750mm from the inner face of the chamber.

Foundation chambers shall be of concrete according to Section 4.

Hollow blockwork shall comply with the requirements of Section 4 and shall be filled solid with concrete.

All chambers shall be watertight on completion.

Benching shall be formed in concrete to a height not lower than the soffit of the outlet pipe and shall slope upwards at 1:10 to the chamber walls. Within three hours of casting, the top surface of the benching shall receive a 12mm mortar rendering, finished smooth with a steel trowel.

Where the depth of invert of the chamber exceeds 900mm below cover level, step irons shall be built-in at 300mm vertical centres staggered 300mm horizontally. The top of the first steps iron shall be located at a distance not greater than 600mm below the cover level.

### 3.22 BEDDING AND FIXING COVERS AND FRAMES

An upstand of one or two courses of solid precast concrete blocks in mortar shall, if necessary, be constructed below the frames which shall be set to the profile of the surrounding areas. The frame shall be laid in a mortar bed carried out the edges of the frame and splayed back at 45° to the frame upstand.

Surfaces between the frames and covers shall be greased.

Two sets of keys shall be delivered to the Authorised Representative for each type of keyway in the covers included in the contract.

Unless otherwise instructed the pipeline shall be tested in complete lengths between chambers and manholes before it is covered. The Authorised Representative may require further tests after backfilling.

### 3.23 ERECTION OF CORRUGATED BEAM SAFETY FENCE

The fencing shall be erected to show a flowing alignment and so that the whole assembly presents no sharp edges or projections to traffic. Lap joints shall be made in the direction of the adjacent traffic.

In the case of tensioned corrugated beam safety fencing, the tensioning of the joints shall be carried out strictly in accordance with the manufacturer's instructions.

Post foundations shall be concrete Grade 30/20 350mm diameter or 310mm square and 950mm deep overall and shall not protrude more than 75mm above the surrounding ground level. The length of post in the foundation shall not be less than 780mm.

The horizontal alignment of the fences shall not depart from the road alignment by more than  $\pm 30$ mm, nor deviate in any two successive section lengths from the straight or required radius by more than 10mm.

Except at ramps, the steel beams shall be mounted at an overall height of 720mm above the edge of the adjacent carriageway or hard shoulder, or if the fence is located more than 1500mm from the edge of the carriageway or hard shoulder, above the surface vertically beneath the fence face within a tolerance of  $\pm 30$ mm. In addition the deviation from the straight shall not exceed  $\pm 5$ mm in any two successive section lengths.

No site drilling or cutting of beams and posts shall be permitted without the approval of the Authorised Representative. Under no circumstances shall flame cutting equipment be used for cutting beams and forming holes.

## **SECTION 4: CONCRETE WORK**

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### **4.1 GENERAL**

The Contractor shall submit to the Authorised Representative for approval all details of all materials which he proposes to use in the concrete including the names of manufacturers or suppliers and sources of supply.

Materials or sources of materials shall not subsequently be changed unless it can be demonstrated that such change will not be to the detriment of the properties of the concrete.

Certificates for tests referred to in this Specification shall be provided by the Contractor.

Materials shall not be used in the permanent works until trial mixes have been concluded and the Authorised Representative's approval has been given in writing.

In obtaining approval for any specific source of supply, the Contractor shall satisfy the Authorised Representative that it is of adequate capacity without any further changes or additions being required which could lead to a change in quality of work.

### **4.2 CEMENT**

Cement shall be approved Portland cement type I complying with ASTM C150 (or B.S.12).

The source of supply of cement shall be subject to the Authorised Representative's approval and the Contractor shall furnish the Manufacturer's test certificates and proof that the required Standard Specification has been complied with, together with a note of the date of manufacture, certified by an independent agency in the country of origin. Supplies of cement shall be obtained from one specific source unless otherwise agreed by the Authorised Representative.

All cement shall be fresh and shall be delivered either in unbroken water resistant bags containing approximately 50kg cement, or bulk containers specifically designed for the purpose, bearing the manufacture's name and the date of manufacture.

Cement shall be stored off the ground in a suitable dry shed or in a self-clearing silo and shall be protected against deterioration.

Cement which has deteriorated in any way shall not be used.

Consignments of cement shall be used in order of delivery. Any cement which has been stored on site for more than two months shall be re-tested for moisture content, soundness and setting time before being used in any part of the Works, and copies of the test reports shall be deposited with the Authorised Representative and his consent obtained to use the cement. Any cement which fails to pass the test shall not be used.

### **4.3 ADMIXTURES**

Use of admixtures shall be permitted in the concrete for permanent works, subject to the approval of the Authorised Representative as described below. Concrete may be made using a water reducing set retarding admixture conforming to the requirements of BS 5075 or ASTM C494, Type D. Formulations shall be available to provide varied setting times relating to conditions of climate and the Contractor's site requirements at a constant dosage rate as recommended by the manufacturer.

Except where the use of admixtures is specifically directed, admixtures will only be permitted if the Contractor demonstrates to the satisfaction of the Authorised Representative that they do not lead to a reduction in strength, additional shrinkage or bleeding or any other undesirable effects. The Contractor shall demonstrate the action of an admixture by means of trial mixes.

If the use of the admixtures is permitted they shall be used strictly in accordance with the manufacturer's instructions and any method statement agreed with the Authorised Representative after site trials have been carried out.

Admixtures containing calcium chloride or chloride salt must not be used under any circumstances. They shall not contain chloride ions in excess of 2% by weight of the admixture or 0.03% by weight of the cement content of the concrete mix.

Admixtures shall comply with one of the following British Standards as appropriate:

BS 1014 "Pigments for Portland Cement, BS 4887 or BS 5075 "Concrete Admixtures".

The equipment and method of introducing and controlling the quantity of admixtures shall be subject to the Authorised Representative's approval.

In all cases the Contractor shall record the following information:

- (a) the quantity to be used, in ml per kg of cement and ml per cubic metre of concrete for liquid products and in kg per 50kg of cement and kg per cubic metre of concrete for solid products;
- (b) the detrimental effects caused by adding a greater or lesser quantity;
- (c) the chemical name(s) of the main active ingredient(s);
- (d) whether or not the admixture leads to the entrainment of air.

#### 4.4 AGGREGATES

Aggregates shall be to BS 882 "Aggregates from natural sources for concrete", shall be hard, durable and clean and shall not be chemically reactive. They shall not contain any deleterious material in sufficient quantity to adversely affect the strength at any age or the durability of the concrete or to cause corrosion of reinforcement.

The grading and shape of aggregates shall be such that a concrete can be produced with the specified proportions and consistency and which will readily work into position without segregation and without the use of excessive water and which can readily be compacted into a dense impervious mass. Separate fine and coarse aggregates shall be used and in general these shall conform to BS 882. All-in aggregates shall not be used in the Works unless specifically authorised by the Authorised Representative.

The Contractor shall, when required by the Authorised Representative, send samples of

the fine and coarse aggregates to a laboratory to be nominated by the Authorised Representative, and obtain reports stating the suitability of each sample of the aggregate and verify its compliance with this Specification. Copies of the report shall be forwarded to the Authorised Representative.

No aggregates shall be used in the Works without the approval of the Authorised Representative. Samples of the approved fine and coarse aggregates which the Contractor proposes to use for the concrete shall be deposited with the Authorised Representative and all aggregates used in the Works shall be equal to such samples. Further samples shall be submitted to the Authorised Representative as and when called for. The sample of fine aggregate shall be 25kg in weight and that of the coarse aggregate shall be 50kg in weight.

The Contractor's attention is drawn to the need to maintain a consistent aggregate quality and he will be expected to undertake adequate testing to ensure that the quality does not vary significantly. The results of such testing shall be reported to the Authorised Representative. The Contractor's procedure and frequency of testing shall be to the approval of the Authorised Representative.

The following tests as described in BS 812 shall be carried out as appropriate on both fine and coarse aggregates:

Determination of Particle Size and Shape - Sieve Analysis  
Determination of Flakiness Index and Elongation Index  
Determination of Ten Percent Fines Value

The flakiness index and elongation index when determined in accordance with BS 812 Part 105 for each of the predominant size fractions in each single sized coarse aggregate, shall not exceed 20% and 25% by weight respectively. Fine aggregate shall not contain appreciable amounts of flaky and/or elongated material.

When tested in accordance with BS 812: Part 4 the total acid-soluble chloride salt content for the aggregates shall not exceed the following figures:

Fine Aggregate-0.06% by weight  
Coarse Aggregate-0.03% by weight

The acid soluble sulphate salt content for the aggregates, when tested in accordance with BS 812: Part 118, shall not exceed 0.25% by weight for both fine and coarse aggregates.

Notwithstanding the above figures every effort shall be made to obtain aggregates with as low a chloride and sulphate content as possible.

The shell content (as calcium carbonate) as a percentage by weight of dry single size aggregates shall not exceed 20% for 5mm to 10mm and 8% over 10mm.

All aggregates which are to be used in the Works shall have negligible alkaline reactivity. The water absorption of aggregate shall not exceed 2.5%.

a) Fine Aggregate

The fine aggregate shall be from an approved source and shall be sharp and



free from clay, organic matter and other impurities. The gradation of fine aggregate shall be in accordance with gradings C M or F of BS 882 Table 5 and the percentage by weight passing the sieve No. 50 shall not exceed 30%. The percentage passing the sieve No. 200 shall not exceed 3% and the sand equivalent shall be not less than 50%.

The clay, silt and fine dust content shall not exceed the appropriate percentage stated in BS 882 : Table 6 by volume when using the field setting test given in BS 812 or such other equivalent test as agreed with the Authorised Representative.

The amount of hollow shells, which are likely to form voids, present in material retained on a BS No. 7 sieve determined by direct visual separation, shall not exceed 3% by weight of the entire sample.

b) Coarse Aggregate

When the coarse aggregate is obtained by combining aggregates of different screen sizes the respective quantities of the various sizes of coarse aggregates shall be premixed by the supplier at the pit and loaded into vehicles from one hopper for transportation to the batching plant and stored separately until weighed for batching. The method of mixing the respective sizes to obtain the required sizes of coarse aggregate shall be to the Authorised Representative's approval.

Under no circumstances shall the mixing of different sizes of coarse aggregates be done by loading the vehicles at the pit with calculated amounts of each respective size from individual hoppers.

The coarse aggregate shall be from an approved source, shall be clean, free from shell, sand, clay, mica shale, quarry refuse, dust, organic matter and other impurities. The stone shall not be thin or flaky.

The amount of material passing a BS No. 200 (75 micron) sieve in each size of the single-sized coarse aggregate, determined in accordance with BS 812 (Decantation Method) shall not exceed 1% by weight.

The Aggregate Impact Value, determined in accordance with BS 812 and using standard 14mm to 10mm test sizes, shall not exceed 30 except where specified minimum compressive strength or characteristic strength of the concrete is 50 N/mm<sup>2</sup> or higher in which case the AIV shall not exceed 25.

#### 4.5 STORAGE AND DELIVERY OF AGGREGATES

Coarse and fine aggregates shall be delivered to the Site or to the mixing plant by means that prevent contamination due to environmental effects, if necessary in covered containers, and shall be stored separately. Care shall be exercised in the handling and storage of the aggregates to prevent the segregation of the various particles and to prevent contamination from deleterious materials.

Stockpiles shall be formed in bins or bags of suitable concrete foundations and to falls to allow drainage and shall be sheltered from the sun and wind blown dust. All storage

areas and bins and hoppers shall be regularly emptied and cleaned to remove any accumulated contaminants. The Contractor shall at all times maintain, to the satisfaction of the Authorised Representative, on site or at the mixing plant, sufficient quantities of each type of aggregate to ensure continuity of work.

#### 4.6 WASHING OF AGGREGATES

At the sole discretion of and with the written consent of the Authorised Representative and subject to the Conditions of Contract, water may be made available for the washing of aggregates so as to allow them to comply with the requirements of the Specification.

#### 4.7 WATER

Water which is to be used for mixing concrete, curing concrete and any other operation affecting steel or formwork which could subsequently come into contact with fresh concrete shall at all times comply with the requirements of BS 3148. It shall be fresh, clean, potable and free from any substances that may be deleterious to concrete or steel. The pH of water used in concrete work shall be not less than 5.0 and not more than 8.0.

Under no circumstances shall sea water or river water be used for mixing or curing concrete.

The Contractor shall avoid water being contaminated by earthy, vegetable or organic matter, acid or alkaline substances, substances or other deleterious matter in solution or suspension which, in the opinion of the Authorised Representative, will impair the strength or durability of the concrete.

The water shall enter the mixers at as low a temperature as possible. Every effort shall be made to protect water pipes and tanks from the sun, e.g. by burying, shading, insulation or painting white.

Where flaked or crushed ice is added to the water for concreting it shall be stored in such a manner as to prevent thawing and refreezing into larger pieces.

#### 4.8 REINFORCEMENT

Mild steel reinforcement (designated with the letter "R") shall conform to BS 4449 with a specified characteristic strength of 250 MN/m<sup>2</sup>. High yield reinforcement (designated with the letter "T") shall conform to BS 4449 with a specified characteristic strength of 460 MN/m<sup>2</sup>. The bars shall be deformed type 2. Mesh fabric reinforcement shall comply with the requirements of BS 4483.

The Contractor shall supply the Authorised Representative with a certificate stating the process of manufacture and test sheet signed by the maker of the reinforcement giving the results of mechanical tests applicable to that type of reinforcement. The chemical analysis of the reinforcement shall also be provided.

The Contractor shall obtain the manufacturer's certificates for each delivery of reinforcement which he shall retain as record documents. These certificates shall state that the reinforcement complies with and has been tested at the frequency specified in the appropriate British Standard Specification. The chemical analysis reported in the manufacturer's certificate shall include the nitrogen content.

If required test specimens from the reinforcement delivered on site shall be taken by the Contractor and sent for testing as directed by the Authorised Representative, and no reinforcement shall be used in the Works until such testing has been carried out and the reinforcement approved in writing by the Authorised Representative.

Reinforcement intended for use in the Works shall be delivered clean and free from dust, mill scale, oil and grease and shall be stored on or near the site in a dry weatherproof building of adequate size. The reinforcement shall at all times (in store, during cutting and bending and prior to fixing) be kept on racks or supports of sufficient height to keep the bars clear of the ground and suitably placed to prevent excessive deflection of the bars.

The reinforcement shall be inspected prior to fixing and all rust, mill scale, oil, grease, paint, retardants or preservatives and harmful other matter removed to the satisfaction of the Authorised Representative by wire brushing or, if necessary grit blasting down to bare metal. Placing of concrete shall be carried out as soon as is practicable after fixing of reinforcement.

Immediately prior to placing concrete all reinforcement shall be washed liberally with water of equal quality to that used for mixing the concrete to remove wind blown dust, salts or other contaminants. Excess water shall be removed from the forms prior to placing the concrete.

#### 4.9 BENDING OF REINFORCEMENT

The Authorised Representative will prepare and provide copies of all necessary Bending Lists. These are to assist the Contractor in the correct bending and placing of the reinforcement, but shall not relieve him of his responsibility for the correct placing of the reinforcement in accordance with the Drawings. The Contractor shall check the Bending Lists against the Drawings and shall bring any discrepancies to the notice of the Authorised Representative before the steel to which the list refers is cut or bent.

All reinforcement is to be cut and bent in accordance with BS 8666 and exactly as shown on the Bending Lists and no departure from the details shown thereon is to be made without the Authorised Representative's permission in writing.

Unless otherwise specified on the bending schedules the minimum mandrel diameter to be used in the bending of reinforcement rods shall be 4 times the diameter of the bar for mild steel reinforcement and 6 times the diameter of the bar for high yield reinforcement.

Straight portions of reinforcement shall be true and without kinks and bends and shall be kept in the correct plane.

Reinforcement shall be bent cold by hand or power operated machines producing a gradual and even bending section.

Bending shall be completed before the steel is fixed in position. Reinforcement shall not be re-bent unless a method statement has been approved by the Authorised Representative.

Procedures for heating, welding and bending of bars on Site shall be submitted to the

Authorised Representative.

Bending and subsequent straightening of reinforcing bars projecting from existing concrete shall be carried out as follows:

- a) Unless otherwise noted on Drawings, the minimum distance from an existing concrete surface to the beginning of a bend, and the minimum inside diameter of the bend shall be:

Bar Size	Min. Distance from surface to beginning of bend	Min. Inside diameter
10mm to 25mm	3 Bar Diameters	6 Bar Diameters
32mm Over	4	8
32mm	5	10

- b) Bars of 10mm to 16mm diameter inclusive may be bent once without heating; heating is required for subsequent straightening or bending.

Bars 20mm to 32mm inclusive may be bent once and subsequently straightened; heating is required in all cases.

Bars having a diameter greater than 32mm may be bent only with the approval of the Authorised Representative; heating is required in all cases.

- c) Heat shall be applied as uniformly as possible over a length of bar equal to 10 bar diameters. The centre of the heated length shall be at the middle of the arc of the completed bend. The bar temperature shall not exceed 350°C. The temperature shall be maintained constant during bending or straightening operations. Temperature measuring crayons or a contact pyrometer shall be used to determine the temperature. Care shall be taken to prevent quenching of heated bars either by application of water or by a high volume of air.
- d) Straightened bars shall be visually inspected before and after straightening to determine whether they are cracked or otherwise damaged. A request for inspection is to be submitted to the Authorised Representative.

Bars not exceeding 32mm in diameter not projecting from concrete may be bent without heating in accordance with this Section providing no local section is rebent or straightened, and the area of the bend is inspected for cracks. A request for inspection is to be submitted to the Authorised Representative.

Reinforcement shall not be cut using ox-acetylene or electric equipment.

#### 4.10 WELDING OF REINFORCEMENT

Welding of reinforcement shall be permitted only when specifically authorised by the Authorised Representative. All welding shall be carried out by fully trained and experienced workmen capable of carrying out vertical and overhand as well as downhand welding to the satisfaction of the Authorised Representative.

The type of electrode to be used shall be to the approval of the Authorised Representative. The slag shall be such that in making the vertical run the metal lies reasonably flat and free from overhanging folds.

Suitable provision shall be made to prevent distortion of the reinforcement. Bars to be butt welded shall be held in a suitable jig sufficiently rigid to prevent movement during welding and cooling.

#### 4.11 PLACING OF REINFORCEMENT

The number, size, form and position of all steel bars, links, stirrups and other members of the reinforcement shall be in exact accordance with the Working Drawings. To prevent displacement before or during concreting the bars shall be secured one to the other and steel supports shall be provided between layers of reinforcement. They shall be fixed by means of 1.2mm diameter stainless steel wire for exposed surfaces throughout bridge decks and structures, elsewhere soft annealed mild steel wire of 1.6mm thickness or proprietary ties to the approval of the Authorised Representative may be used. The end of tying wire shall be bent inwards away from the concrete faces.

Spacer blocks shall be used to ensure the correct cover to reinforcement. The distance between spacers shall be sufficient to ensure that the correct cover is maintained throughout the length of the reinforcement. Spacers are to be purpose made cement mortar blocks of a thickness corresponding to the necessary cover. Such blocks, which shall be to the approval of the Authorised Representative, shall not exceed 50mm in length or breadth, and shall be composed of one part cement to two parts fine aggregate. Stainless Steel tying wire shall be embedded into one face of the blocks.

No other material whatsoever shall be used to keep the reinforcement in the shuttering, except that in certain cases the Contractor may, with the approval of the Authorised Representative, use plastic spacer blocks of an approved design.

Immediately before concrete is placed around it, reinforcement shall be free from mud, oil, paint, retarder, release agent, loose rust, loose mill scale, grease or any other substance that can be shown to have an adverse chemical affect on the steel or concrete, or reduce the bond.

#### 4.12 COVER TO REINFORCEMENT

Concrete cover to all reinforcement shall in no case be less than 35mm unless shown otherwise on the Drawings.

#### 4.13 CONCRETE

The Contractor shall design the proportion of each concrete mix in accordance with the recommendations of BS 5328 to obtain concrete of a homogeneous structure which can be worked into the corners and angles of the formwork and around reinforcement without segregation of the material or excessive bleeding of free water at the surface and shall also, on striking of formwork present a uniform face free from honeycombing and crazing. When hardened, the concrete shall have the required strength, maximum density and low porosity.

The final proportions of cement aggregates and water shall be such that the weight of cement used is the least amount which will produce concrete complying with the Specification.

Evidence shall be submitted to the Authorised Representative for each class of concrete showing that the intended workability, the proposed mix proportions and manufacturing method will produce concrete of the required quality.

The classes of concrete mix that shall be used in the Works are set out in Table 4.1:

**Table 4.1 : Grades of Concrete**

Class	Grade	Section of the Works and Application
50/20	C50	Prestressed concrete
40/20	C40	Structural concrete, (Bridge Deck Slabs)
30/20	C30	Mass concrete foundations, Saddles and Backing to arches and retaining walls, Kerbing, footways and drain crossings
30/10	C30	Parapet Posts and Beams, Service Bay Cover Slabs
7.5/20	C7.5P	Blinding

The Contractor shall submit the following data and obtain the Authorised Representative's approval before using any concrete mix to the Works:

1. Nature and source of all materials.
2. Full details of tests on trial mixes.
3. Proposed quantities of each ingredient per cubic metre of compacted concrete.

The required characteristic cube crushing strengths, cement type, minimum cement content, maximum water ratio and nominal maximum aggregate size for each class are shown in Table 4.2. The initial design mix shall have a preliminary target mean strength of at least 15 N/mm<sup>2</sup> greater than the specified minimum cube strength.

**Table 4.2: Mix Requirements & Strength Grades**

Class of Concrete	Nominal Maximum Agg. Size	Maximum Water Cement Ratio by Weight	Cement Type	Minimum Cement Content in Concrete kg/m <sup>3</sup>	Minimum Compressive Works Cube Strength N/mm <sup>2</sup>	
					7 Day	28 Day
50/20	20	0.42	Portland Type I to ASTM C150	400	30	50
40/20	20	0.42	Portland Type I to ASTM	400	27	40

			C150			
30/20	20	0.45	Portland Type I to ASTM C150	425	20	30
30/10	10	0.45	Portland Type I to ASTM C150	425	20	30
7.5/20	20	0.60	Portland Type I to ASTM C150	200	5	7.5

The preliminary and works cube strengths detailed above are for concrete cured within the standard curing temperature range specified in BS 1881. Where actual curing temperatures are higher than within the standard range, cube strengths to be achieved will be correspondingly higher. The Authorised Representative will determine the increases in cube strengths to be achieved with increases in mean curing temperatures.

#### 4.14 TRIAL MIXES AND WORKABILITY

Trial mixes shall be produced under full scale production conditions using representative samples of cement and aggregates. Three separate batches shall be produced each on a separate day. The workability of each batch shall be determined and at least 6 cubes shall be made for each batch, three for test at 7 days and three for test at 28 days.

The trial mix proportions will be accepted if the average strength of the nine cubes tested at 28 days is not less than 3.5N/mm<sup>2</sup> below the target mean strength. The trial mix may be approved on the basis of 7 day results provided the Authorised Representative is satisfied at the likely rate of gain of strength from 7 to 28 days. If the range of the strength of the three cube results in any one batch should exceed 15% of the average of that batch the trial mixes shall be repeated.

The Contractor shall take suitable precautions to ensure that the approved mix proportions are maintained in the concrete that is actually deposited in the Works. The Authorised Representative may require additional trial mixes to be made if any significant changes are made in the materials or in the proportions of materials used.

The quantity of water used in mixing the concrete shall be controlled by an approved water measuring device and shall be sufficient, but not more than sufficient, to produce a dense concrete of adequate workability for the different parts of the Works. The water content of the mix shall be maintained within the limits of  $\pm 5$  litre/m<sup>3</sup> of the quantity determined by the trial water content of aggregate. The Contractor is to maintain on Site a suitable apparatus for checking the water content of the aggregate as and when directed by the Authorised Representative.

Concrete will only be accepted for placement if its workability is within the following limits at the time of placement.

Slump test  $\pm 1/3$ rd of the trial mix mean  
or 25mm whichever is the lesser value

Compacting Factor  $\pm 0.03$  of the trial mix mean.

The slump of the concrete will be determined from samples taken from the mixed concrete just before the concrete is placed in the work. The slump tests and/or compacting factor tests shall be carried out in accordance with BS 1881.

#### 4.15 PRODUCTION AND DELIVERY

Batching - The proportions of cement and aggregate in the concrete shall be measured by weigh-batching. The weigh-batching plant shall be of a type approved by the Authorised Representative and the Authorised Representative shall be satisfied that the method of use by the Contractor will accurately control the quantities of materials. The equipment shall have an automatic system that records the amount of each constituent material in each batch.

Cement shall be weighed on a separate weighing device to that used for the aggregates. Alternatively, the cement may be measured by using a whole number of bags in each mix (split, damaged or partly full bags shall not be used).

Each ingredient shall be measured to an accuracy of better than plus or minus 2.0%.

The amount of water shall be measured by volume or by weight. The measuring equipment shall be to the approval of the Authorised Representative.

Separate containers and measuring devices shall be used for admixtures.

The scales of all weigh batching plant and all liquid dispensers shall be zeroed daily and calibrated at intervals not exceeding one week. The Contractor shall provide all weights, materials and labour for calibration and tests and shall retain all certificates as record documents.

Mixing - Concrete shall be mixed using a batch type mixer/s of a design approved by the Authorised Representative. Mixing shall continue until there is a uniform distribution of the materials and the mass is uniform in colour and consistency. The minimum mixing time shall be not less than that recommended by the manufacturer of the equipment and must be agreed with the Authorised Representative.

The mixer shall have mechanical/electrical controls to ensure that concrete cannot be discharged until the required mixing time has elapsed and that the entire batch is discharged before the mixer is recharged.

The method of releasing the water into the mixer shall be such that the full measured quantity is discharged in one operation and the flow is stopped automatically by a valve or siphon arrangement only when the full quantity of water has been released. Arrangements which allow the discharge of partial quantities of mixing at the discretion of the mixer driver will not be permitted.

The amount of concrete mixed in any one batch shall not exceed the rated capacity of



the mixer.

The whole of the mixed batch shall be removed from the mixer before materials for a fresh batch enter the drum.

The Contractor shall ensure that the mixing efficiency of the equipment is not impaired by the build-up of cement and mortar on the mixing drum blades. On cessation of work, including all stoppages exceeding 15 minutes, the mixer and all handling plant shall be washed out with clean water.

The first batch of a production run shall contain 15% less coarse aggregate in order to compensate for the coating of the interior of the mixer.

Transporting - The concrete shall be discharged from the mixer and transported to the Works by means that shall be approved by the Authorised Representative and which shall prevent contamination, segregation or loss of ingredients, and ensure that the concrete is of the required workability at the point and time of placing.

Concrete that has been mixed remote from the Works shall be transported in truck mixers or agitators. The concrete shall be continually agitated during transportation and until discharge. Mixing and transportation of such concrete shall be in accordance with BS 5328.

Truck mixers shall comply with BS 4251 and the mixing performance when tested in accordance with BS 3963 shall be within the limits of Table 5 of BS 1305.

The drum of the truck agitator or truck mixer shall be completely clean and empty before it is filled with concrete. Trucks shall not be loaded in excess of the manufacturer's rated capacity, which shall be displayed on the vehicle in terms of volume of mixed concrete. Trucks shall be discharged within one hour after the introduction of the water to the cement unless a longer time is authorised by the Authorised Representative.

Transit mixer trucks shall have their drums painted with heat reflective paint or covered with hessian which is to be kept wet to achieve evaporative cooling.

The concrete shall be placed in the form as soon as possible after mixing before the initial set of the concrete has started. The Authorised Representative will from time to time specify the maximum time between the mixing of the concrete and its placement in the form and no concrete shall be placed in the Works after this period has elapsed.

The Contractor's attention is drawn to the need to ensure that every precaution is taken to minimise the loss of workability of the concrete during transit. Concrete shall be transported from the mixer to the forms as quickly as conditions will allow and the work shall be streamlined and co-ordinated so that delays are eliminated. Also the temperature of the concrete shall be kept as low as possible, see Clause 4.23.

When the loss of slump cannot be adequately offset by the above measures the Contractor may compensate for the anticipated slump loss by increasing the amount of water used to initially mix the concrete but this shall be within the limits of the specified water cement ratio and subject to a maximum slump increase of 25mm. No additional water shall be added to the concrete after it has been discharged from the mixer.

Should the haul distances and climatic conditions make it impossible to avoid a slump loss greater than 25mm the Contractor may, with the written approval of the Authorised Representative, withhold all the additional water required until the concrete arrives on Site. The Authorised Representative may withdraw his permission or impose additional conditions at any time.

Only sufficient water to adjust the mix to the specified slump, within the limits of the specified maximum water cement ratio shall be used, and the truck mixer shall make 20 - 30 revolutions at mixing speed to incorporate the water into the mass of the concrete.

Under no circumstances shall water be added if the initial set of the concrete has taken place.

Each consignment of concrete shall be accompanied by a docket giving the class of concrete and the time when the mixing water was added. When it has been agreed that extra water can be added to site the docket shall indicate the maximum amount of water that can be added.

#### 4.16 READY MIXED CONCRETE

The supply and delivery of Ready Mixed concrete shall comply with the recommendations of BS 5328 and all relevant provisions of this Specification.

Prior to obtaining concrete from a ready-mixed supplier the Contractor shall submit the following information:

- Ready Mixed Concrete Supplier
- Location of Plant
- Details of suppliers of all materials to be included in the concrete, including relevant test certificates
- Standard Deviation (strength) currently achieved by Plant (N/mm<sup>2</sup>)
- Design Standard Deviation (strength) (N/mm<sup>2</sup>)
- Target Mean Strength (N/mm<sup>2</sup>)
- Total chloride and sulphate ion content of concrete (%)
- Total equivalent alkali content of concrete (Kg/m<sup>3</sup>)

The Contractor shall arrange for the supplier to provide the facilities stated in Clause 13.1 of BS 5328.

A ticket shall accompany each delivery and shall contain the following information:

- Name or number of ready-mixed concrete depot
- Serial number of ticket
- Date
- Registration number of delivery vehicle
- Name of purchaser
- Name and location of project
- Concrete mix designation
- Cement content
- Free water/cementitious material ratio
- Workability
- Type of cement
- Nominal maximum size of aggregate

Type name and quantity of admixtures, if included  
Quantity of concrete in cubic metres  
Time of loading

Tickets shall be retained as record documents by the Contractor.

No water shall be added to the mix after it has left the ready mixed concrete plant. Each delivery shall be treated at the Site for workability.

#### 4.17 PLACING

Every delivery of concrete to the Site must be sampled and checked for workability by the slump or compaction factor method prior to discharge into the Works. The Authorised Representative will generally require to witness these tests. Concrete outside the workability limits will be rejected. Also, the concrete shall be rejected and not placed in the Works if the initial set has taken place in any part of the batch or if the Authorised Representative considers it to be otherwise in an unsuitable condition.

The Contractor shall discuss and agree with the Authorised Representative all details of his proposed method of placing and curing the concrete before commencing work. If required, the Contractor shall be prepared to demonstrate or otherwise prove to the Authorised Representative the adequacy and effectiveness of his proposed method.

Concrete shall not be placed in the Works unless the Authorised Representative is present and the fixing of all form work and reinforcement has been completed and approved by the Authorised Representative. All surfaces shall be free of standing water.

The concrete shall be deposited as nearly as possible in its final position, and shall be placed in such a manner as to avoid segregation to the concrete and displacement of the reinforcement, waterbars or formwork.

The concrete shall be consolidated (compacted) by high frequency mechanical vibrators approved by the Authorised Representative, in such a manner as to obtain complete compaction without segregation or excessive laitance or the formation of "cold" joints. Particular attention shall be made to ensure that concrete is thoroughly worked into the corners of the formwork and around all reinforcement, waterbars and pipes.

Contact between the vibrators and reinforcement or formwork shall be avoided and on no account shall vibration be used for the purpose of distributing concrete horizontally.

Vibrators shall operate at a frequency of not less than 5,000 cycles per minute.

#### 4.18 BLINDING LAYER

All horizontal or sloping surfaces of reinforced concrete that bear on the ground shall be protected by a layer of blinding concrete 75mm thick.

The Contractor shall place the blinding layer of concrete in such a way, and at such a time, as to ensure that the exposed surface of the ground on which the blinding layer of concrete is to be placed does not deteriorate after excavation through exposure to weather, traffic or other reasons and the method of securing this shall be to the satisfaction of the Authorised Representative.

#### 4.19 CURING

All concrete shall be adequately cured and protected from the harmful effects of sunshine, drying winds, rain or running water.

The Contractor shall be aware of the importance of adequately curing the concrete, particularly during the early stages of hardening.

All exposed surfaces shall be protected immediately on completion of placing and compaction of the concrete. Curing shall be such as to ensure full hydration of the concrete and shall be carried out by keeping all exposed surfaces on the concrete moist by means of wet hessian or similar absorbent material, and ponding. The surface of the concrete shall be protected by application of an approved curing membrane until the concrete has set sufficiently to take the weight of coverings.

All shuttering shall be loosened as soon as possible and provision made for curing water to run down inside them.

Timber formwork covering the concrete shall be covered and moistened with water at frequent intervals to keep it from drying out during the curing period. Metal formwork exposed to the sun must be shaded from its direct rays, painted white or otherwise protected during the curing period.

The wet curing shall continue for a minimum of 14 days. Exposed surfaces shall be protected against contamination by atmospheric chlorides until 28 days after the concrete was placed.

Throughout the curing period all the exposed surfaces shall be adequately protected from excessive heat gain from the sun by tenting or reflective covering.

All concrete shall be protected from anything which may interfere with the process of setting or cause damage before the concrete has set.

#### 4.20 SEPARATION MEMBRANE

A separation membrane shall be used between concrete surface slabs and the sub-base.

Separation membranes shall be impermeable plastic sheets 125 microns thick laid flat without creases. Where an overlap of plastic sheets is necessary this shall be at least 300mm. There shall be no standing water on or under the membrane when the concrete is placed upon it.

#### 4.21 CARRIAGEWAY JOINTS

Joints shall be formed in a straight line at right angles to the horizontal axis of the carriageway or footway.

The spacing of joints shall be at 5 metre intervals for carriageways and 10 metres for footways.

Joints shall be formed of wood of 15mm thickness placed vertically to the full depth of the slab.

Emergency joints in the event of mechanical breakdown may be provided at a position which is not less than 2.5 metres from the previously constructed transverse joint where no adjacent concrete has been laid.

End of day joints, other than emergency joints, shall be at normal joint locations.

#### 4.22 CARRIAGEWAY FINISH

After the final regulation of the surface of the slab and before the application of the curing membrane the surface of concrete slabs to be used as running surfaces shall be brush-textured in a direction at right angles to the longitudinal axis of the carriageway.

The brushed surface texture shall be applied evenly across the slab in one direction by the use of a wire brush not less than 450mm wide.

Texture depth shall be not less than 0.75mm for an average of 10 measurements with no one measurement less than 0.65mm.

#### 4.23 CONCRETING IN HOT WEATHER

In general the recommendations ACI 305 "Recommended Practices for Hot Weather Concreting" and ACI 308 "Recommended Practice for Curing Concrete" shall be followed.

The temperature of the concrete at the time of placing shall not exceed 30°C.

Every effort shall be made by the Contractor to keep the temperature of the concrete at the time of placing as low as possible. If the temperature of the concrete is likely to exceed 24°C at placing the Authorised Representative will expect the Contractor to take special measures to control the temperature.

The concrete making plant, mixers, pipelines, pumps and chutes, etc, shall be shaded and/or painted white. The pump lines and other surfaces shall be kept damp by spraying with water.

Where the aggregate stockpiles are kept moist by water sprays the Contractor shall control these with great care to ensure a constant moisture content of the aggregate at all times and demonstrate his ability to do so to the Authorised Representative's satisfaction.

In a prevailing arid wind, temporary wind breaks shall be provided. The Contractor shall provide and use ample water supply hose and fog nozzles.

Suitable means shall be provided to avoid premature stiffening of concrete placed in contact with hot, dry surfaces. Surfaces, including reinforcement against which concrete is to be placed, shall be shielded from the direct rays of the sun and shall be sprayed with water (using a fog spray) to cool and moisten the surfaces and the surrounding air.

The Contractor shall take all necessary precautions and measures to ensure that the concrete is adequately compacted and cured.

#### 4.24 TESTING

Samples of concrete being placed in the Works shall be taken and 150mm test cubes made, in metal moulds, as and when directed by the Authorised Representative's Representative. In general the Authorised Representative will require 3 No. cubes to be made from each concrete pour. The slump test and/or compacting factor test will be required for each set of test cubes.

The Authorised Representative's Representative will require to witness the moulding of cubes.

The method of making, storing and testing of work cubes shall comply with BS 1881.

The Contractor shall ensure that every precaution is taken during hot weather to take samples and form cubes as quickly as possible and to then immediately protect the cubes from drying and temperature rise by placing them in damp conditions.

The cubes shall be transferred to standard moist curing conditions in a laboratory after a day. During the transfer they shall be protected and handled carefully.

The Contractor shall submit for approval of the Authorised Representative details of his proposed arrangement for carrying out regular crushing tests. The Authorised Representative will require to witness all testing done by the Contractor.

Reports of all tests shall be supplied to the Authorised Representative within 24 hours of the cubes being tested. Unless otherwise directed by the Authorised Representative, 1no. cube shall be crushed at 7 days and the remaining 2 No. crushed at 28 days.

The Contractor shall keep on the Site and make available to the Authorised Representative on request full details of the section of concrete to which any particular test cube is related. All test cubes shall be adequately marked for identification.

Concrete shall be assumed to have achieved its characteristic strength when, at 28 days:

- a) the average strength determined from any group of four consecutive test results exceeds the characteristic strength by:  $3\text{N/mm}^2$  for concrete having a characteristic strength of  $20\text{N/mm}^2$  and above,  $2\text{N/mm}^2$  for concrete having a characteristic strength of less than  $20\text{N/mm}^2$ .
- b) the strength determined from any test result is not less than the characteristic strength minus  $3\text{N/mm}^2$  for concrete having a characteristic strength of  $20\text{N/mm}^2$  and above and  $2\text{N/mm}^2$  for concrete having a characteristic strength less than  $20\text{N/mm}^2$ .

The quantity of concrete represented by any group of four consecutive test results shall include the batches from which the first and last samples were taken together with all intervening batches. A test result failing to comply with Clause (b) above shall represent only the batch from which the sample was taken.

The Contractor shall prepare and test at his own expense additional concrete cubes

where he requires to demonstrate to the Authorised Representative that a concrete element has achieved a particular compressive strength after a period other than specified for routine tests. Such cubes shall be cured under the same conditions as the related element.

Where the concrete is proved unsuitable by the above criteria the Contractor shall remove the related concrete and replace it by new concrete of the specified strength to the entire satisfaction of the Authorised Representative. The Authorised Representative may reconsider the suitability of any particular section of concrete if additional tests on the hardened concrete in the structure are favourable.

When so required by the Authorised Representative the Contractor shall drill cylindrical cores from concrete in the Works and shall supply to the Authorised Representative fully detailed reports thereon with photographs all in accordance with the procedure specified in BS 1881. Testing of cores shall be carried out by an approved laboratory.

The Contractor shall be responsible for the cost of cutting and testing cores where these are required to satisfy the Authorised Representative that concrete complies with the Specification.

Samples from each class of concrete in production shall be tested for potential alkali-aggregate reaction by casting into prisms of dimensions not less than 200 x 75 x 75mm. For each concrete mix to be tested one prism shall be made using mix constituents and proportions identical to those used in the Works and a second prism made from concrete with its alkali content artificially raised to 6kg/m<sup>3</sup> equivalent sodium oxide by the addition of potassium hydroxide. The prisms shall be fitted with measuring points such that change in length can be measured at intervals during storage in conditions of 100% R.H and 38 ± 1 °C.

Sample storage and measurement shall be as described in clause 11 of draft BS 812 Part 123.

In the event that the expansion of the prisms exceeds 0.05%, the Authorised Representative shall immediately be informed.

As an alternative to the prism test specified above, the Contractor may perform mortar-bar tests to ASTM C227-81.

#### 4.25 FORMWORK

Formwork shall be to BS 8110 and Technical Report 13 of the Concrete Society and the Institution of Structural Engineers.

The formwork shall be in every way adapted to the structure and to the required finish of the concrete. It shall, unless otherwise stated, be made either of sound and seasoned timber wrought and of sufficient thickness, or of treated plywood or other approved material suitably supported.

The formwork shall be fixed in perfect alignment and securely braced so as to be able to withstand deflection, displacement or movement of any kind, the weight and pressure of the moist concrete and the weight and movements of men, materials and plant.

The supporting struts to formwork shall be adjusted and fixed in position by suitable

means and where necessary placed on timber bearers to prevent them from sinking into the ground or from causing injury to finished work.

Where it is necessary to use spacers or ties through a wall for supporting the shutter above, such spacers or ties shall be of approved pattern. The holes left in the concrete shall be neatly pointed with an approved expanding grout as soon as the formwork is stripped.

Concrete shall not be placed against vertical or inclined blinded earth faces in lieu of formwork without the approval of the Authorised Representative.

Before any concrete is placed all formwork shall be carefully examined and cleaned out, and the inside face shall be treated with an approved mould oil, which must not come into contact with the reinforcement or be allowed to collect in the bottom of the formwork. Upon every occasion on which the formwork is stripped it shall be thoroughly cleaned and oiled, if necessary, before re-use.

The responsibility for the removal of any formwork after concreting rests with the Contractor. Formwork shall be removed without causing damage or excessive deflection to the concrete.

Nevertheless the Authorised Representative will specify the minimum time which must elapse between pouring concrete and removal of formwork, which will not be less than that required for the concrete to achieve a minimum compressive strength of 10N/mm<sup>2</sup> or twice the stress to which the member will be subject at the time of striking, whichever is the greater.

The work of removing such formwork or supports shall be carried out under the personal supervision of a competent Foreman in the Contractor's employment. The Contractor shall be responsible for any injury to the work and any damage caused by or arising from the moving or striking of formwork or supports.

The Contractor shall submit to the Authorised Representative, if required, his formwork design calculations.

Formwork and supports shall resist all loads to which they will be subjected without detriment to the finished concrete.

Where the finished surface of concrete is at a slope greater than 35° a top shutter shall be used.

A 25mm x 25mm chamfer shall be formed on all arises exposed in the finished work except where otherwise indicated by the Authorised Representative.

Joints, including those in form linings and between forms and completed work, shall be constructed to prevent loss of grout.

Formwork shall be in good condition, clean and free of concrete remnants. Portions of shutters at the level of each lift shall be removable to ensure a through clearing out of any rubbish.

Release agents shall be applied to formwork surfaces in contact with concrete using the minimum quantity necessary to obtain a clean release.



Any liquid applied to the formwork surfaces in contact with concrete shall be compatible with any finish to be applied to the concrete and shall not contaminate the reinforcement, embedded items or hardened concrete.

No metal part of any fixing device for securing forms shall remain within the concrete cover shown on the Drawings.

#### 4.26 EMBEDDED ARTICLES

Special care shall be taken to ensure that articles to be embedded are securely fixed in the correct position and templates and other temporary supports shall be provided as necessary.

Items to be embedded in concrete shall be clean and free from oil or foreign matter than would weaken the bond of the concrete to these items.

The Contractor shall accurately and securely install in the formwork all required inserts, anchors, joint elements, bolts, sleeves and any other items as required.

#### 4.27 SURFACE FINISH

##### i) Quality

The Contractor's attention is drawn to the extreme importance of producing concrete work having maximum possible durability. In this regard the Contractor shall pay particular attention to ensuring that the surface finish to concrete work shall, by appropriate reduction of porosity, adequately reduce the potential ingress of corrosion inducing elements.

A smooth true surface is required to all exposed surfaces of the concrete work. Such surfaces shall be perfectly true and free from all imperfections and every endeavour must be made to obviate the necessity for surface treatment of the concrete after the removal of moulds. For this purpose the shuttering used for such surfaces shall be wrought and thickened boards of a properly seasoned timber accurately and closely fixed together or lined, laminated plywood shuttering or other approved material. Before the shuttering is removed it shall be tapped on its exterior surface with a light hammer or power operated vibrator in order as far as possible to obviate the necessity for surface treatment after removal of the shuttering. Directly after the shuttering has been removed, all broken corners and such parts of the surface where the face has been removed, shall be made good with suitable cement mortar to bring same to the general level of the surrounding surface. All exposed surfaces shall be thoroughly rubbed down, if necessary with power operated carborundum grinders, to obtain alignment of the surface. All arises shall be formed with a 50mm chamfer unless otherwise shown.

All fins and work out of true which cannot be rectified by rubbing down must be tooled off with power operated machines, together with any surfaces which are in any way defective, and made true by rubbing in cement mortar with a wood float; the mortar shall be composed of one part Portland cement to two parts of approved fine sharp sand.

##### ii) Formed Surfaces – Class of Finish

Formwork shall be capable of producing the following finishes where required in the

works:

Class F1 finish. As struck, no extra requirement. For buried concrete.

Class F2 finish. The irregularities in the finish shall be no greater than those obtained from the use of wrought thickened square edged boards arranged in a uniform pattern. The finish is intended to be left as struck but imperfections such as fins and surface discolouration shall be made good. For general structural concrete.

Class F3 finish. This finish is for bridge decks. The resulting finish shall be smooth and of uniform texture and appearance. The formwork lining shall leave no stain on the concrete and shall be so joined and fixed to its backing that it imparts no blemishes. It shall be of the same type and obtained from only one source throughout any one structure. The Contractor shall make good any blemishes and imperfections, such as discolouration and fins in the finish.

Permanently exposed concrete surfaces to all classes of finish other than F1 shall be protected from rust marks and stains of all kinds.

### iii) Unformed Surfaces – Classes of Finish

Class U1 finish. For buried concrete. The concrete shall be levelled and screed to produce a uniform surface to the profile shown on the drawings. No further work shall be applied to the surface unless it is used as a first stage for another class of finish.

Class U2 finish. For general concrete. After the concrete has hardened sufficiently, the Class U1 finish shall be floated by hand or machine sufficiently only to produce a uniform surface free from screed marks.

Class U3 finish. For structural concrete and bridge decks. When the moisture has disappeared and the concrete has hardened sufficiently to prevent laitance from being worked to the surface, a Class U1 finish shall be steel-trowelled under firm pressure to produce a dense, smooth uniform surface free from trowel marks.

Class U4 finish. This is for bridge decks that are to receive waterproofing systems. The concrete shall be levelled and screed to produce a uniform surface. When the concrete has sufficiently hardened and the bleed water evaporated the surface shall be trowelled to produce a hard dense surface free from screed marks and exposed aggregate. Finally the surface shall be lightly textured with a wooden float or equivalent/ The finish shall not deviate from the required profile by more than 10mm over a 3 m gauge length or have any abrupt irregularities more than 3 mm.

## 4.28 CUTTING CONCRETE

No concrete or steel in the reinforced concrete work shall be cut in any way without the permission of the Authorised Representative in writing.

## 4.29 FAULTY WORKS

The Contractor shall at his own expense remove and reconstruct any portions of the work which, in the opinion of the Authorised Representative, give evidence before or

after the removal of the formwork that the concrete was of sufficiently compacted in the formwork or that any bars of the reinforcement have been omitted, incorrectly placed or displaced, or that the formwork has been incorrectly positioned or displaced, or which given any evidence of fault, defect or injury from any cause whatsoever which may, in the opinion of the Authorised Representative, prejudicially affect the strength, durability, water tightness or alignment of the work.

#### 4.30 JOINTS IN STRUCTURES

The Contractor shall submit details of the type and location of all construction joints he wishes to make to the Authorised Representative's Representative. In the case of the principal items of concrete work, these proposals will be regarded as major Temporary Works and sufficient Drawings, etc. covering the whole structure must be submitted in advance of the start of the work to enable the complete concreting plan to be accepted.

In addition to the foregoing, the Authorised Representative's Representative shall be empowered to require the inclusion of construction joints not previously intended by the Contractor; such instructions will be issued in time for inclusion with the associated formwork.

All construction joints will normally be required to be keyed or toothed and four clear days allowed between adjacent pours.

The whole surface of concrete which has set shall unless otherwise shown on the Drawings have been thoroughly roughened and cleaned of all loose and foreign matter and laitance before further concrete is placed. Wherever practicable, as at horizontal joints, laitance shall be removed whilst the concrete is still green so as to expose the tops of the larger aggregate particles without undue erosion of the mortar. Where concrete already deposited has set but not set hard, laitance shall be removed and the surface roughened by wire brushing and washing, care being taken not to disturb the underlying mass. Where the concrete first poured has set hard, any skin or laitance shall be removed and the surface roughened by hammering with an approved pattern power operated "bush" hammer followed by wire brushing to remove all loose particles. When carrying out this method of preparation, care shall be taken to avoid breaking off the arises of the joint face or shattering or loosening exposed particles of coarse aggregate.

Immediately before depositing fresh concrete, the face of the joint shall be thoroughly washed after which the excess water shall be removed. The fresh concrete shall be forced hard on to set faces of concrete by means of compacting and vibrating tools.

Free joints to allow for expansion, contraction or shrinkage shall be formed at positions appropriate to the design of the structure.

Joint fillers and sealing compounds shall be of approved manufacture, and used in accordance with the makers' instructions as appropriate to the type of joint, vertical, inclined or horizontal. Sealing compounds shall be two part polysulphide unless otherwise agreed by the Authorised Representative.

#### 4.31 TOLERANCES

Positive tolerances given in Table 4.3 are the measurements by which the concrete is

permitted to exceed the stated dimensions. Negative tolerances are the measurements by which the concrete can be short of the stated dimensions. Departure from alignment is the permissible deviation from the centre line horizontal or vertical face or edge of the concrete.

No reduction shall be permitted in the cover to reinforcement because of a specified negative tolerance in a concrete section.

Abrupt changes of surface alignment of concrete such as may occur at badly made construction joints will be allowed even though the concrete surfaces are within the permissible tolerances.

**Table 4.3 Tolerances**

Structure Surface / Alignment	Tolerance	
	Concrete Placed in Dry (mm)	
Concrete in structures against which backfill is placed	+25	-5
Concrete in structures not backfilled	+10	-5
Upper surfaces of concrete	+5	-5
Cross-sectional dimensions of concrete members	+5	-5
Departure from alignment of precast units	+10	-10
Overall plan dimensions of precast units	+10	-10
Position of embedded items	+5	-5
Departure from alignment in roads and paved areas	+10	-10
Top surfaces of roads and paved areas	+5	-5

4.32 **PRECAST CONCRETE**

The manufacture of precast concrete components shall be in accordance with the recommendations contained in BS 8110.

The moulds of all precast concrete works shall be to the accurate dimensions and shapes as shown on the drawings and shall be of sound construction to the Authorised Representative's satisfaction. Moulds shall be thoroughly cleaned before each casting. Exposed faces shall be trowelled smooth or otherwise prepared to the Authorised Representative's satisfaction.

The standard of workmanship and the quality of materials used in the manufacture of all

precast components shall comply with the relevant clauses of this Specification.

Tests to verify that the completed precast components comply in all respects with this Specification may be called for by the Authorised Representative at any time.

The Contractor shall notify the Authorised Representative before precast concrete work is commenced and shall allow the Authorised Representative every facility to visit the pre-casting yard.

Detailed records of mixes, cubes, curing methods, dates of manufacture, etc., shall be kept and submitted to the Authorised Representative within 7 days of manufacture.

All precast members shall be marked with an unique reference to the Authorised Representative's approval.

The Contractor shall be fully responsible for supplying adequate lifting points and any additional reinforcement and equipment as necessary to ensure the safe handling, transport and erection of the precast members.

Holes left in the precast units to facilitate lifting shall be neatly pointed with an approved expanding grout as soon as the planks are finally positioned.

Stacking of precast units shall be properly carried out after curing in a separate area set aside for that purpose and so arranged that the units may be removed and used in the order in which they were cast.

No units may be placed in the Works until such time after casting as agreed with the Authorised Representative.

The Authorised Representative will accept no responsibility for damage to units which occurs during handling, storage, transporting or placing, and shall order the Contractor to remove and replace such damaged units at the Contractor's own expense.

Generally the external faces of precast units which will be visible after their inclusion in the Works shall be finished with a fair face equivalent to that described in Clause 4.27. The surface of precast units which will act as bearing surfaces for further precast units shall be given a steel trowel or equal approved finish. All other internal surfaces of precast units shall have surfaces prepared as construction joints as described in Clause 4.30.

No structural connections shall be made until the Authorised Representative's approval has been given.

Levelling devices shall only be released or removed with the Authorised Representative's approval.

At all stages of construction, precast concrete units and other concrete associated therewith shall be properly protected to prevent damage to permanently exposed concrete surfaces, especially arises and decorative features.

All precast concrete elements manufactured off site shall be subject to inspection by the Authorised Representative's Representative prior to dispatch to the Site. The Contractor

shall provide adequate notice to the Authorised Representative's Representative to permit such inspection. Damaged concrete elements shall not be dispatched to the Site and elements which sustain damage during transportation shall be removed from the Site and replaced at the Contractor's expense. The same provision shall apply to precast elements damaged prior to or during erection into the Works or thereafter. Only minor repairs will be permitted to be carried out to precast elements at the Site at the discretion of the Authorised Representative and following his approval of a detailed method statement for the work.

#### 4.33 METHOD STATEMENT

Not less than 28 days before the commencement of concrete works the Contractor shall provide a full and detailed method statement for concrete works to the Authorised Representative for approval. The Method Statement shall cover all aspects of concrete works including the following:

- a) Sources of all materials for use in concrete mixes with test certificates and results.
- b) Details of proposed concrete mix designs and programme for trial mix production.
- c) Methods of storage of materials and production, delivery and quality control.
- d) Arrangements for carrying out cube and other tests.
- e) Methods of placing of concrete.
- f) Falsework, formwork and methods of achieving specified finishes including proposals for trial panels.
- g) Details for production of precast concrete, where appropriate.

#### 4.34 BEDDING OF PRECAST UNITS

Precast concrete units shall be bedded in cement mortar composed of one part cement to three parts sand.

Sand for mortar shall be naturally occurring sand or consist of crushed rock or gravel or a combination thereof. It shall be clean hard and free from impurities to BS 1199 and 1200 and in accordance with Clause 5.04. Sand shall be well graded from 4.3mm down in accordance with Table 1 of BS 1199 and 1200.

Mortar plasticiser is used shall be to the approval of the Authorised Representative, shall comply with BS 4887 and shall be used in the proportions and manner recommended by the manufacturer.

The water content of mortar shall be just sufficient to ensure a dense mortar with adequate workability, when trowelled or worked into place. Mortar that has begun to harden shall not be used in any part of the Works.

All materials shall be accurately gauged by gauge boxes and mechanically mixed and used within 30 minutes of first mixing. Re-tempering of mortar will not be permitted.

Gauge boxes and mixers shall be kept clean.

Mortar joints shall be pointed with a neat flush joint as the work proceeds. Joints shall be protected from the harmful effects of the environment for a minimum of three days after completion.

Joints between or around precast members which are cast into the Works shall be carefully sealed using an approved tape or other means as approved by the Authorised Representative to ensure there is no grout loss during concreting.

#### 4.35 CONCRETE SIDEWALKS AND DRIVEWAYS

Fresh concrete in sidewalks and driveways shall be struck off and compacted until a layer of mortar has been brought to the surface. The surface shall be finished to grade and cross-section with a float, trowelled smooth and finished with a broom. The float shall not be less than 3m in length and not less than 150mm in width. Concrete adjacent to expansion joints shall be finished with a edger tool. Brooming shall be transverse to the line of traffic and if water is necessary, it shall be applied to the surface immediately in advance of brooming.

The surface of sidewalks shall be marked into uniform sized rectangles of not less than 1.0sqm nor more than 2sqm with a scoring tool which will leave the edges rounded, and a 100mm wide surface along the edges smooth. Such marking shall be done after brooming and before the concrete has hardened.

Expansion joints 6mm wide shall be constructed at all returns and opposite the joints in adjacent kerb. Where the kerb is not adjacent, expansion joints shall be constructed at intervals of 20m. Expansion joints shall be filled with a bituminous type filler conforming to the provisions of AASHO M33.

The surface shall not vary more than 6mm from a 3m straightedge, except at grade changes, and the finished surface shall be free from blemishes. Concrete sidewalks and driveways shall be cured as provided in Specification Clause 4.19.

#### 4.36 PRESTRESSED CONCRETE

(e)

- a) Prestressing wire shall comply to BS 5896:1980 "specification for high tensile steel wire and strand for the prestressing of concrete."
- (f)
- b) The contractor shall design and propose a safe method of handling, lifting and placing of precast prestressed concrete units and submit this for the approval of the Authorised Representative.

**SECTION 5: MASONRY**

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5.1 RUBBLE MASONRY WORKS – RETAINING WALLS

a) Stone

Stone for rubble masonry shall be hard, sound and durable. It shall be free from segregation, seams, cracks and other defects tending to destroy its resistance to weather. It shall be free from rounded, worn or weathered surfaces or any coatings tending to destroy the bond with the mortar.

Individual stones shall have a thickness of less than 200mm and a width of not less than one and one-half (1 1/2) times the thickness. Stones shall increase in thickness from the top to the bottom of the wall. The stone shall be roughly squared on joints, beds and faces. Selected stones, roughly squared and pitched to line shall be used at all angles and ends of walls.

All shaping and dressing of stone shall be done before the stone is laid in the wall and no dressing or hammering which will loosen the stone after it is placed will be permitted.

Headers shall hold in the heart of the wall the same size as shown in face and shall extend into the wall not less than 450mm beyond the face stones. They shall occupy not less than one-fifth (1/5) of the face area of the wall and shall be evenly distributed. Headers in walls 0.6m or less in thickness shall extend entirely through the wall.

b) Sand

Sand shall consist of hard, strong, durable, uncoated mineral or rock particles, free from injurious amounts of organic or other deleterious substances. It shall be uniformly graded from fine to coarse within the following limits.

Passing No.	8 sieve	100%
Passing No.	50 sieve	15% - 40%
Passing No.	100 sieve	0% - 10%

c) Mixing Mortar

Mortar shall be composed of one (1) part Portland cement and quarter (1/4) part Lime and three (3) parts of sand. 1: 1/4: 3 mix (Cement: Lime: Sand). It shall have a mean 28 day compressive strength of 11 N/mm2.

Mortar shall be machine mixed in an approved mixer for a period of not less than one and one-half (1 1/2) minutes.  
Mortar shall be used within 45 minutes after mixing. Re-tempering of mortar will not be permitted.

d) Laying Stones

The masonry shall be laid to line and in courses roughly levelled up. The bottom



or foundation courses shall be composed of large selected stones and all courses shall be laid with bearing beds parallel to the natural bedding planes of the foundation strata.

Each stone shall be cleaned and thoroughly saturated with water before being set and the bed which is to receive it shall be cleaned and well moistened.

All stones shall be bedded in freshly laid mortar. The mortar joint shall be full and the stones carefully settled in place before the mortar has set. Joints and beds shall have an average thickness of not more than 25mm.

Wherever possible, the face joints shall be properly pointed before the mortar becomes set. Joints which cannot be so pointed shall be prepared for pointing by raking them out to a depth of 50mm before the mortar has set. The face surfaces of stone shall not be smeared with the mortar forced out of the joints or that used in pointing.

The vertical joints in each course shall break joints with those in adjoining courses at least 150mm. In no case shall a vertical joint be so located as to corner directly above or below a header.

In case any stone is moved or the joint broken, the stone shall be taken, the mortar thoroughly cleaned from bed and joints and the stone reset in fresh mortar.

The same standard of workmanship and materials shall be maintained in building the heart of the wall as elsewhere. The walls shall be laid true to the lines staked out on the ground for the top and toe of the wall, and shall present a surface true to the inclined plane for which the lines were staked.

e) Pointing

Joints not pointed at the time the stones are laid shall be thoroughly wet with clean water and filled with mortar. The mortar shall be well driven into the joints and finished with an approved pointing tool. The wall shall be kept wet while pointing is being done and in hot or dry weather, the pointed masonry shall be protected from the sun and kept wet for a period of at least three (3) days after completion.

After the pointing is completed and the mortar set, the wall shall be thoroughly cleaned and left in a neat and workmanlike condition.

## SECTION VII: GABION BASKETS AND MATTRESSES

<b>(7.1) GABION BASKETS 6'-0" x 3'-0" x 3'-0" HIGH</b>		
<b>7.1.1</b>	DIMENSIONS:	3'W x 3'H x 6'L
<b>7.1.2</b>	NO. OF CELLS:	2 equally-sized cells per basket
<b>(7.2) GABION MATTRESSES 6'-0" X 9'-0" X 1'-0" HIGH</b>		
<b>7.2.1</b>	DIMENSIONS:	6'W x 1'H x 9'L
<b>7.2.2</b>	NO. OF CELLS:	<b>3</b> equally-sized cells per mattress
<b>7.3</b>	CAPACITY:	approximately <b>2</b> cubic yards per Gabion basket and mattresses. All conforming to ASTM A975-97 – specification for Double-Twisted Hexagonal Mesh gabions or other equivalent internationally recognized standard Weight of Zinc coating is to be determined by ASTM A-90 or other equivalent internationally recognized standard
<b>7.4</b>	WIRE SPECIFICATIONS:	<b>PVC-coated, galvanized</b> , 8x10 mesh, hexagonal, double-twisted
<b>7.5</b>	TENSILE STRENGTH OF WIRE MESH PARALLEL TO TWIST:	At least 3500 lbs/ft
<b>7.6</b>	TENSILE STRENGTH OF WIRE MESH PERPENDICULAR TO TWIST:	1500lbs/ft
<b>7.7</b>	CONNECTION TO SELVEDGES:	1400lbs/ft
<b>7.8</b>	PANEL TO PANEL:	1400 lbs/ft
<b>7.9</b>	PUNCH STRENGTH OF MESH;	6000lbs/ft
<b>7.1</b>	TENSILE STRENGTH OF WIRE:	from 54,000 – through 70,000 psi soft temper in accordance with ASTM A641-92
<b>7.11</b>	MESH OPENING:	Hex. Non. Approximately 3 ¼" x 4 ½" (8 cm x 10cm)
<b>7.12</b>	WIRE FOR NETTING (MESH WIRE):	At least 0.120 inches diameter with zinc coating of at least 0.85 oz per sq.ft.
<b>7.13</b>	WIRE FOR SELVEDGES:	At least 0.153 inches diameter with zinc coating of least 0.90 oz per sq.ft.
<b>7.14</b>	WIRE FOR BINDING (LACING WIRE):	At least 0.091 inches diameter with zinc coating of at least 0.90 oz per sq.ft.
<b>7.15</b>	TOLERANCES:	All gabion and mattress dimensions shall be within a tolerance limit of plus or minus 5% of the manufacturer's stated dimensions
<b>7.16</b>	COLOUR:	Any
<b>7.17</b>	OTHER:	Mattresses must be supplied with lids

## 7.18 GENERAL

Gabion: A retaining wall system designed for mass gravity retaining wall applications. Gabion units are delivered flat packed ready for site assembly, where they are filled with rock and stacked on one another to form flexible, permeable, monolithic structures such as retaining walls and channel linings.

## 7.19 STONE FILLING

Stone filling for gabions shall consist of hard durable rock free from weathered or decomposed parts. The minimum dimension of each stone shall not be less than half its maximum dimension. For mattresses the stone shall be 150 to 80mm, for baskets the stone shall be 200mm to 100mm. The stone shall be obtained from a source approved by the Project Manager. No stone shall be smaller than the size of the gabion mesh. In carrying out the filling, selected pieces of stone of elongated shape shall be placed with their flatter and elongated faces in contact with the mesh wherever possible.

## 7.20 CONSTRUCTION

- 1) For complete installation instructions or for special assembly details consult manufacturer's installation instructions.  
The empty gabions shall be placed to line and level as shown on the Drawings or as directed by the Project Manager and then stretched so that the gabions retain their shape on being filled. Diaphragms shall be provided at not more than 1 meter intervals for baskets and not more than 600mm intervals for mattresses. The gabions shall be filled with approved stone as specified above, either by hand or using mechanical equipment as approved by the Project Manager. No basket or mattress forming part of an intended continuous line of gabions shall be completely filled until an adjacent basket or mattress has been half filled, unless otherwise directed, in order not to cause displacements from bulging during filling.
- 2) For baskets at least two horizontal connecting wires shall be tied between front and back of the gabion in each 1 meter compartment, at a height of 330mm and 660mm from the bottom as the stone fill reaches these levels. Additional tie wires shall be provided if necessary and in no case shall the gabion basket bulge by more than 40mm. Where a continuous line of gabions is required, adjacent gabions shall be securely tied together at the top and bottom of the gabions with tying wire.
- 3) Particular care shall be taken to ensure tightness of mesh, well packed filling with minimum voids and secure lacing.
- 4) The gabions shall be filled to a level just sufficient to require the lid to be forced into place with a bar. The lid and all joints between basket and between diaphragms and basket shall each be tied down with a continuous running wire.
- 5) Where gabions are to be shaped, the shape shall be formed by folding the mesh internally and tying it with a continuous running wire.
- 6) All tying wire shall be galvanised, PVC coated and of the same gauge as the gabion mesh wire specified above.

# SECTION VIII - GEOTEXTILES (GEOMATERIALS)

## 8.1 GENERAL

1) Scope of Work

The Contractor shall place all geomaterials in the areas shown on the drawings and as instructed by the Project Manager and in accordance with the following specification.

2) Contractor's Obligations

The Contractor shall be fully responsible for the supply of all equipment, materials and services and for the complete co-ordination of all the activities for the successful installation of the geomaterial foundation. The Contractor shall bear full and sole responsibility for the supply, installation and performance of the geomaterial supplied by him.

3) Consent

a) The Contractor shall submit geomaterial samples and data sheets to the Project Manager for inspection and review, and shall not proceed with procurement of any geomaterial or equipment until the consent of the Project Manager is given. Samples of approved geomaterial shall be retained on Site for reference throughout the construction period.

b) The Project Manager may instruct tests to be carried out on the geomaterial to demonstrate its compliance with this Specification. An independent certificated laboratory approved by the Project Manager shall carry out the tests. Notwithstanding the foregoing, the Project Manager may require observe tests on the proposed material prior to approval of the laboratory being granted.

c) The Contractor shall permit the Project Manager to take random samples of geomaterials from the Site for further check tests at all times.

4) Testing

Tests to check the properties of the geomaterial shall comply with the methods of testing set out in the following standards or acceptable equivalent standards:

<b>BS EN ISO 10319</b>	Geotextiles- Wide-width Tensile Test
<b>BS EN ISO 12236</b>	Geotextiles and Geotextile-related Products- Static Puncture Test (CBR Test)
<b>BS EN 918</b>	Geotextiles and Geotextile-related Products- Dynamic Perforation Test (Cone Drop Test)
<b>BS EN 964 &amp; BS EN ISO 9863</b>	Geotextiles and Geotextile -related Products, Determination of Thickness at Specified Pressures
<b>BS 2471</b>	Methods of Test for Textiles - Woven Fabrics – Mass per Unit Length and Mass per Unit Area

<b>ASTM D4533</b>	Test Method for Trapezoid Tearing Strength of Geotextiles.
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5) Ordering

The geomaterials shall be ordered in advance of the site trials and in good time for incorporation into the Works.

6) Delivery and Storage

All geomaterials shall be delivered to site in the wrapping applied by the manufacturer or, as a minimum, 50 micron black Polyethylene wrapping. Any damage to the wrapping shall be repaired immediately by the Contractor at his own cost. The rolls shall be stored in a well-aired area and protected from direct sunlight. The wrapping shall only be removed immediately prior to use. Each roll shall have an individual roll number and have a roll label with the following details:

- a) Name and address of manufacturer
- b) Roll number
- c) Name and type of product
- d) Length and width of the roll
- e) Unit weight
- f) Raw materials
- g) Method of manufacture

7) Handling

The geomaterial shall be handled with due care, following all of the manufacturer's recommendations such that it is undamaged for incorporation into the Works. All damage, including physical damage, or where the geomaterial has been exposed to chemical contamination, shall be reported to the Project Manager. The Project Manager shall have the power to instruct the removal of the damaged or contaminated portion of the geomaterial or in cases of severe damage or contamination, the rejection of the entire roll.

8) Method Statement

- a) Thirty (30) days prior to commencement of the installation of the geomaterial in the Works and before any site trials are carried out, the Contractor shall submit to the Project Manager for his consent, a method statement for the successful installation of the geomaterial and its incorporation into the Works. The method statement shall list all plant, labour, methods, activities and sequencing of operations required for laying the geomaterial.
- b) Any alternative method to that previously approved shall be subject to the consent of the Project Manager. Notwithstanding the above, the Project Manager's consent to the Method Statement shall not absolve the Contractor of his duties or obligations under the Contract.

9) Site Trials

- a) Prior to commencement of full-scale installation of the geomaterial, the Contractor shall demonstrate his working method described in the Method Statement by conducting a site trial in the presence of the Project Manager. The trial shall consist of laying a minimum of 20m of geomaterial and the full layer of rip-rap. The site trial may be conducted on the Site and be incorporated in the Works at the discretion of the Project Manager and following a successful trial.

- b) Providing that upon completion of the trial, the work and working method are acceptable to the Project Manager they shall be designated the "standard" for the installation of geomaterial and the Method Statement shall be modified to suit the results of the Site trial. All subsequent work shall comply with the established "Standard."
- c) The Contractor may submit revisions to the approved "standard" but shall not modify his working methods until additional trials have been conducted in the presence of the Project Manager and the Project Manager's consent has been given.

#### 10) Preparation for Installation

The Contractor shall notify the Project Manager whenever installation of the geomaterial foundation is to be carried out. The Contractor shall also permit and afford all facilities for the Project Manager to inspect the laying of the geomaterial and placement of the bedding layer. The Contractor shall replace or repair any geomaterial damaged during installation and shall remove and replace any bedding stones that do not conform to Specification.

#### 11) Installation Above Water

- a) The installation of the geomaterial foundation shall be carried out by experienced personnel with suitable equipment, to the "Standard" established during the Site Trials. The geomaterial shall be laid in such a manner as not to damage the geomaterial or unduly disturb the formation.
- b) The formation to receive the geomaterial foundation shall be free from debris and material greater than 100mm in size. The formation shall be generally free of any mounds or hollows and shall not exceed a gradient of 2% different from that shown on the Drawings. The Contractor shall not proceed with the installation of the geomaterial until the Project Manager has granted specific consent for the sections concerned.
- c) The geomaterial shall be laid on the prepared formation without wrinkles, gaps, folds, slack, stressing or deformation. The geomaterial shall be laid line to line and to the level of the formation and there shall be no gaps or voids under the geomaterial or bulges in the surface and to the tolerances in formation above. The Contractor shall follow the manufacturer's recommendations for overlapping or sewing of the geomaterial, subject to the consent of the Project Manager and following a successful Site Trial.

#### 12) Installation Under Water

- a) Experienced personnel shall carry out the installation of the geomaterial foundation with suitable equipment to the "Standard" established during the Site Trials. The geomaterial shall be laid in such a manner as not to damage the geomaterial or unduly disturb the formation.
- b) The formation to receive the geomaterial foundation shall be free from debris and material greater than 100mm in size. The formation shall be generally free of any mounds or hollows and shall not exceed a gradient of 2% different from that shown on the Drawings. The Contractor shall not proceed with the installation for the geomaterial

until the Project Manager has inspected the formation and the Project Manager has granted specific consent for the sections concerned.

- c) The geomaterial shall be laid on the prepared formation without wrinkles, gaps, folds, slack, stressing or deformation. The geomaterial shall be laid line to line and to the level of the formation and there shall be no gaps or voids under the geomaterial or bulges in the surface and to the tolerances in formation above. The Contractor shall follow the manufacturer's recommendations for overlapping or sewing of the geomaterial, subject to the consent of the Project Manager and following a successful Site Trial.
- d) The Contractor shall secure the geotextile to the river bed by the method agreed in the Site Trial and place a 0.5 metre thick layer of the rip-rap material onto the geomaterial as soon as possible after sufficient geomaterial has been laid, subject to the consent of the Project Manager.

## 8.2 GEOMATERIAL TYPE 1

- 1) Location  
To be placed under all imported stone bed protection
- 2) Type 1: Needle-punched Geofabric

	The main functions of a geotextile used beneath Rip-rap are filtration and separation. The geotextile shall be manufactured under factory production control guidelines set out within EN 13253; Geotextiles and geotextile related products – characteristics required for use in erosion control works (coastal protection, bank revetments). The manufacturer must be able to supply accompanying CE documentation upon request. The functional characteristics and relevant test methods to this specific condition of use are identified below.
	The geotextile shall have the following properties:

<b>2.1 Physical Properties:</b>				
Polymer type:	Prime quality virgin polypropylene fibre containing 1% carbon black by weight.			
Fabric construction:	Needle punched nonwoven fabric manufactured from mechanically entangled staple fibre.			
	<b>Approved test method</b>	<b>s</b>	<b>e</b>	<b>Allowable tolerance to 95% confidence limits</b>
Thickness @ 2kPa:	EN ISO 9863-1: 2005	m	0.3	n/a*
<b>2.2 Mechanical Properties:</b>				
Static puncture strength (CBR)	EN ISO 12236	N		-10%
Push-through displacement	EN ISO 12236	m	78	n/a*
Tensile strength	EN ISO 10319	m	15	-10%
Tensile extension	EN ISO 10319	%	0	+/-30%
Cone drop perforation hole diameter	BS EN 13433	mm		+3mm
<b>2.3 Filtration Properties:</b>				

Water flow normal to the plane of the geotextile @50mm head	EN ISO 11058	<sup>2</sup>		-30%
Characteristic opening size: 90% finer [O90]	EN ISO 12956	m		+/-30□□
<i>* Indicates property not used for quality control as part of harmonised testing within EN 13253</i>				

<b>2.4 Durability (according to annex B: EN 13253):</b>			
Resistance to weathering (UV) @ 50MJ/m2 radiant exposure	EN 12224	Retained Strength	>80%
Resistance to Oxidation (150 years)	EN 12225	Retained Strength after 84 days	>80%
Microbiological Resistance	EN 12225	Retained Strength	>80%
Resistance to liquids	EN 14030	Retained Strength	>80%
<i>* Durability test data can be supplied by the manufacturer – test frequency must not exceed 3 years.</i>			

3	<p>Geotextiles shall be delivered to site in packaging, which will protect the product from damage during handling, storage. Packaging must be suitable to protect the product from UV degradation. Product must be kept in appropriate packaging until such time that it is required for installation.</p> <p>The geotextile shall be clearly and indelibly marked with the product name along the edge of the roll at regular intervals no greater than 5mts. The labelling shall clearly identify the product supplied in accordance with EN ISO 10320: Geotextile and Geotextile related products – Identification on site.</p>
4	The geotextile manufacturer shall provide production test certificates on mechanical properties at the rate of one set of tests per 6,000m2 delivered to site and a minimum of one set per contract. Test methods employed shall be in accordance above specification and the reporting laboratory should be accredited by UKAS to carry out the required tests. Certificates relevant to a batch of geotextile shall be furnished to the Project Manager prior to that batch of Geotextile being incorporated in the works.
5	The rolls of geotextile shall be stored on level ground and stacked not more than five rolls high and no other materials shall be stacked on top of the geotextiles.
6	The geotextile shall be laid and installed in the positions and to the line and levels described on the drawings. Construction plant must not operate directly on the geotextile.
7	Joints shall be formed by overlapping by a minimum of 1metre. A reduction in overlap to 0.3m may be considered by the Project Manager where the sub-layer is firm and above water level.
8	<p>On site quality control should be performed in accordance with CEN/TR 15019.</p> <p>a) Test specimens should be taken every 30,000 m2 , with a minimum of 1 test above 1000 m2</p> <p>b) For sampling EN 963 should be applied, i.e. samples should be taken not less than 5m from the end of the roll in machine direction and over the whole width in the cross machine direction. The location of the sample should be described exactly.</p> <p>c) For evaluation of conformance, statistical procedure should be used in line with section 5.2 of CEN/TR 15019: 2004.</p>
9	<p>The following definitions shall apply when considering test results:</p> <p>a) A set of test results shall be those results derived from specimens cut from one sample.</p> <p>b) The mean value for any set of test results shall be the arithmetic mean of that set of results.</p>



	c) The characteristic value is the value below which not more than 5% of the test results may be expected to fall. This represents the value at 1.645 standard deviations below the mean value.
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3) Type 2: Geogrid

Tensar geogrid SS40 or similar approved. Technical specification and installation details are to be obtained from the manufacturer.

# SECTION IX - RIP-RAP ROCK-FILL, ROCK-FILL, SLOPE PROTECTION, OPEN CHANNELS AND GABION STONE

## 9.1 GENERAL

### 1) Scope of Works

The extent of the rip-rap and filter fabric is shown on the Drawings

### 2) Definition of Terms:

The following definitions apply in this Specification.

- a) Filter Layers - Geotextile or rock used as separation layer between materials of different gradings
- b) Rip-Rap Stone(s) - Generally smaller pieces of rock used en masse as in the core or surface layer
- c) Rock Material - Collective term for rocks and stones

### 3) Method Statement

Within two (2) weeks of the Works Commencement Date, or such other period as may be agreed, the Contractor shall submit to the Project Manager for consent, full details of the proposed construction methods for the structure(s).

The details shall include, but not be limited to:-

- a) Proposed additional site investigation works, if any.
- b) Proposed source(s) of Stone and including documentation showing that the proposed materials from each quarry or quarry face comply with the specification, and evidence that the source(s) can supply the required quantity at the required rates.
- c) Details of geotextile - see Specification 1400.
- d) Method statement for quarrying, grading, sorting, stacking, inspection, weighing and transportation of the rock materials. The Contractor shall give his proposals for sampling and testing stone and for ensuring compliance with the requirements of this Specification. Details shall include the sampling rate and size of sample and shall take into account such factors as the number of quarries or quarry faces, overall quantity, rate of delivery to Site, methods of stockpiling and handling and rate of placing.
- e) Method statement for handling, stockpiling and disposal of non-compliant rock materials.
- f) Method statement for the construction of the structure(s) including, but not limited to:
  - i. Drawings showing design details and construction sequence
  - ii. Proposed plant and labour resources
  - iii. Method of placing the filter fabric and stone
  - iv. Sequence of construction
  - v. Construction programme
  - vi. Setting out control, inspection and survey procedures
  - vii. Monitoring of rockfill displacements along slopes
- g) Health and Safety considerations

## 9.2 ROCK MATERIAL

### 1) Physical Properties of Rock Materials

- a) Quality of Stone used in rip-rap construction shall conform to the specified requirements when tested as specified in this Section. Visual examination of the quarry, including examination of the blast samples, suitable tests and service records shall be required to determine the acceptability of the stone.
- b) Stone will be required to satisfy EITHER BS 812 OR ASTM as follows:

#### *BS812:*

Quarried stone shall comply with requirements (i)-(v) below when tested in accordance with BS 812 and requirement (vi) below when tested in accordance with Appendix D of BS 6349: Part 1.

- i. Saturated surface dry density not less than 2650 kg/cubic metre;
- ii. Water absorption not more than 3 per cent by weight;
- iii. Aggregate impact value less than 30 per cent
- iv. Ten per cent fines value not less than 240kN;
- v. Aggregate abrasion value less than 8 per cent
- vi. Soundness value less than 18 per cent after 5 cycles in magnesium sulphate solution using a coarse aggregate sample.

#### *ASTM:*

To ensure the required quality, stone shall conform to the specific gravity, absorption, durability and wetting and drying tests as follows:

<b>TEST</b>	<b>TEST METHOD</b>	<b>REQUIREMENT</b>
Apparent Specific Gravity	ASTM C 127	2.65 min.
Absorption	ASTM C 127	2.0% max.
Durability	ASTM C 535	50% max. after 2400 revs.
Sulfate Soundness	ASTM D 5240	10% max. after 5 cycles(magnesium sulphate)

The size and quantity of test specimens used for the tests listed above shall conform to the requirements of ASTM D 4992

### 2) Quality Control

- a) Contractor may be required to provide representative samples of the proposed stone materials from each stone source. The samples shall consist of sufficient individual pieces to allow reviewing of stone quality and gradation. In no case shall the sample be less than 110 pounds (50 kg).
- b) The Contractor shall undertake sampling and testing for each quarry, quarry face or other source each month for the tests set out in Clause 2402 01 (iii), (iv), (v) and (vi).

Notwithstanding the above, samples for each source of rock material shall be carried out weekly, commencing at the start of production, until it can be demonstrated that the source is consistently producing the required gradings.

- c) In addition, the Contractor shall undertake additional sampling and testing when circumstances so dictate or as instructed by the Project Manager.
  - d) Any rock in non-compliance shall be rejected and removed from the Site by the Contractor.
- 3) Cracks, Laminations etc.  
Individual rocks shall be free from cracks, laminations and cleavage planes, weathered material and solution cavities. All rocks shall be free of all remains of quarry blasting materials.
- 4) Length to Thickness Ratio  
No more than 50% of the stones shall have a length to thickness ratio (L/d) greater than 2, and no rock shall have an L/d ratio greater than 3, where the length, L, is defined as the greatest distance between any two points on the rock, (i.e. diametrically opposite corners of a cuboidal block), and the thickness, d, the minimum distance between two parallel straight lines through which the rock can just pass.
- 5) Grading for all Rock  
The grading for all rock shall be in accordance with the size distribution described in the table below (these are equivalent cubic dimensions):

		W [mm]	SPEC GRAV [kN/m <sup>3</sup> ]		%AGE FOR GENERAL SLOPE PROTECTION (NOT EDGE DETAILS)
0		100	26	6	5
00		200	26	21	20
35		235	26	24	40

### 9.3 TRANSPORTING AND PLACING

#### 1) *Transporting and Depositing Rock Materials*

The Contractor shall supply and transport rock material by land or sea, or a combination of both, and deposit it by means of marine or land operated plant. The Contractor shall take all precautions and provide all means necessary to ensure that the various classes of rock material are deposited in the position and to the profiles indicated on the Drawings. The rock materials shall be placed using techniques to achieve a dense fill with no segregation and no contamination from river bed deposits.

#### 2) *Placing of rock*

The rock shall be stockpiled adjacent to its designated position in the Permanent Works. The rock shall be carefully placed using land-based plant from the end of the partially completed structure, taking care not to damage or disturb the filter fabric. Following placing the surfaces shall be carefully trimmed to the required profile.

No placing of rock shall proceed before a complete handling trial has been conducted to the satisfaction of the Project Manager. One trial shall be undertaken and shall be made on the correct profile and shall be of adequate size to represent the actual placing conditions. These trials shall be used to demonstrate that the design porosity and specified interlocking requirements are met. If successful and subject to the consent of the Project Manager, the trial may be incorporated into the Works.

The Contractor shall give the Project Manager 14 days' notice of the trial. The units shall be placed in a single layer in deliberately varying attitudes. Adjacent units shall not normally have similar attitudes (At most, 2 adjacent blocks may be orientated in the same way).

3) *Sequence of Placing*

The geotextile foundation and first construction layer shall be laid in accordance with Specification 1400 of this Specification.

4) *Grading of Rock to be Maintained*

The grading of rock shall be correctly maintained and to this end the Contractor shall take all actions necessary to remove any rocks that may have been displaced by wave or other action and washed, or swept or otherwise moved into voids of previously placed rip-rap, before any further placing necessary to complete the sections.

5) *Survey Equipment*

The Contractor shall provide and operate all necessary equipment required for progress surveying of the structure(s). This shall include but not be limited to suitable optical/electronic survey equipment for above water surveys and in shallow water conditions.

6) *Construction Survey*

During the progress of construction, the Contractor shall survey the river bed immediately ahead of the rip-rap construction at regular intervals as dictated by construction needs and as directed by the Project Manager. All survey records shall be provided to the Project Manager. The Contractor and the Project Manager shall jointly inspect and agree the completed profile of each layer of the structure(s), at 10 meter longitudinal intervals, or as and when directed by the Project Manager. No surface shall be covered by a subsequent layer, until there is available a certificate based on the above inspection and/or survey signed by both the Contractor and the Project Manager indicating the satisfactory completion of the 10 metre unit of construction.