

## **SPECIFICATIONS**

### **Compliance**

The bidder is required to furnish brochures and catalogues as well as technical information and data as mentioned in the bills of quantities and for the following items:-

- Aluminium sections for doors and windows
- Structural glazing
- Ironmongeries for openings and doors
- Accessories for washbasin, sink, sanitation and septic tanks
- Piping for plumbing, traps and seals and venting pipes
- Water systems pipes
- Lighting for house units and electrical appliances
- Tiling for floors and walls

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## **SECTION 1 GENERAL**

### **Article 1.1 Location of Works**

The Works are located at Albion Road, Pte. Riviere and falls within the jurisdiction of the Municipal Council of Port Louis. The location of the Works is shown on the Layout and Location Plan at the end of this Section.

### **Article 1.2 Scope of Works**

The broad scope of works to be carried out under the contract shall, *inter alia*, include:

- The construction of 12 housing units in reinforced concrete
- Finishes to house units
- Plumbing works
- Electrical works and lighting system
- Painting to house units
- Plot demarcation with chain link fencing
- Infrastructural works serving the housing units comprising; inter alia, roads, drains, water supply lines and plot connections and street lighting
- Other Ancillary Works as may be directed by the National Empowerment Foundation (NEF).

The work specified shall include all general work preparatory to execution, all matters, things, requisites and work of any kind necessary for the due and satisfactory construction, completion and maintenance of the Works to the true intent and meaning of the Drawings and this Specification and further drawings and orders that may be issued by the Project Manager from time to time; compliance by the Contractor with all Conditions of Contract whether specifically mentioned or not in the clauses of this Specification; all materials; apparatus, plant, machinery, tools, fuel, water, temporary works and roads, strutting, timbering moulds and tackle of every description, transport, offices, stores, workshops, staff and labour; the provision of proper and sufficient protective works, temporary hoarding, lighting and watching required for safety of the public and protection of the Works and adjoining lands and waterways; all measures necessary to ensure the safety of shipping, and sanitary accommodation for staff and workmen; taking and maintenance of all insurances, the payment of all wages, salaries, fees, royalties, duties or other charges arising out of the execution of the Works; the regular clearance of rubbish, reinstatement and clearing up and leaving perfect on completion.

Any error in description or in quantity or omission of items from the contract bills shall not vitiate this contract but shall be corrected accordingly.

### **Article 1.3 Datum**

All reference benchmarks required by the Contractor shall be provided by the Project Manager.

### **Article 1.4 Contract Documents**

For the purpose of carrying out the Contract, the Contractor will be supplied with one copy of the Specification, Bill of Quantities, Conditions of Contract

and the Contract Drawings. The Contractor may make additional copies but shall ensure the confidentiality of such documents.

The whole of the Works shall agree with the levels, measurements and details contained in the Drawings accompanying the Specification and with such other drawings as may from time to time be issued by the Project Manager or may be supplied by the Contractor and approved by the Consultants.

#### **Article 1.5 Standard Specifications**

For convenience, and in order to establish the necessary standards of quality, reference has been made to specifications issued by national or other widely recognized bodies.

Such specifications shall be referred to as "Standard Specifications" and shall be the latest editions of such standard specifications issued prior to the issue of the Tender Documents, together with such additions and amendments as may have been issued prior to the same date.

#### **Article 1.6 Units**

In this Specification, the Drawings, and in the Bill of Quantities, the metric system of dimensioning has been adopted.

#### **Article 1.7 Contractor's Working Area**

The Contractor shall provide and maintain on site suitable offices. He shall also provide and maintain sufficient stores, tanks and workshops for the proper storage of materials, fuel, plant and equipment.

The Contractor shall provide and maintain at its own cost a dedicated office space of an area not less than 12 m<sup>2</sup> for the exclusive use by the Employer and the Project Manager and/or their representatives. The office shall be fitted with:-

- 2 office desks
- 2 executive chairs
- 4 office chairs
- 1 cabinet for storage of drawings and documents
- A steel cupboard
- Stationery
- An air conditioning unit
- A toilet unit
- A kitchenette and pantry services for water, tea, coffee and refreshments for Employer/Project Manager and representative and serving during visit and meetings by Employer and/or delegates.
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The Contractor shall make available a helper/teaboy for the daily cleaning of this office facility.

The stores shall be of such size and construction that they shall provide adequate storage and protection of stocks of materials, fuel, spares, etc., in quantities ensuring uninterrupted progress of the work.

The workshop shall be suitably equipped for carrying out major repairs, overhaul or modification by the Contractor of all plant and equipment in or on

the works. The Contractor shall allow in his rates for all charges incurred by him for the offices and workshops.

The Contractor shall make his own arrangements with the Employer, landowners or other Contractors working in or around the site for land, which he wishes to use as access for the storage of his plant, materials and for the use of his own labour. All costs in this connection shall be borne by the Contractor.

The location of all offices and stores shall be agreed beforehand with the Project Manager and shall be such as to avoid obstruction to the Employer or nuisance to visitors.

The Contractors attention is drawn to the fact that the premises is a secured zone and access is under strict control and surveillance. The Contractor shall ensure that the workers mobilised for the project are easily identified. Workers should demonstrate exemplary behaviours while on site.

#### **Article 1.8 Survey Instruments and Chainman**

The Contractor shall provide required to the Project Manager/Employer modern and accurate survey equipment as listed below:

- 1 no. modern Total Station and tripod including two refelectors
- 4 no. ranging rods
- 2 no. staff 4 metres long graduated at 0.005m intervals
- 2 no. 50 metres fibron tape
- 2 no. 30m steel tapes
- 1 no. 5 metres steel tape
- 4 sets of Safety shoes, waterproofing jackets, raincoats, hard hats and the like

The Contractor shall also supply all other requisites necessary for checking the setting out and for measurement of the Works. The Contractor shall provide the services of two chainmen to assist the Project Manager in checking the setting out of the works whenever required.

#### **Article 1.9 Transport for Ancillary Works and Services**

The Contractor shall provide and maintain one vehicle, inclusive of driver and all running costs, for Ancillary works & Services. The vehicle shall not be more than 2 years old and shall be preferably a 4WD of a diesel powered engine type, engine capacity not less than 2700 c.c. The vehicle shall have an air-conditioning system and shall be able to accommodate three (3) occupants besides the driver. The vehicle will be more specifically required for liaison with all necessary Authorities for the smooth running of the work and also for:-

- 1) Provision of ways and means of attending sites by representatives of Employer/Project Manager for the purpose of attending meetings, witnessing tests and/or provide necessary site details such as survey and drawings.
- 2) Soils test that may be exceptionally required.
- 3) Collection of fittings made available by the relevant Authorities
- 4) Any other cognate duties as may be assigned by the Project Manager

After completion of the Contract, the above vehicle for transport facilities will be extended until all authorities have given their final clearances to the

Project and up to the handing over to the relevant authorities. The cost of providing and maintaining the vehicle shall be deemed to be covered under Item 1.4 of the BoQ.

#### **Article 1.10 Contractor's Superintendence**

With reference to the Conditions of Contract, the Agent who shall have full authority in respect of the Works and at least one of his technical assistants shall be able to speak English fluently and a reasonable proportion of foremen shall have a working knowledge of the English Language.

The Agent should be a Project Manager with a minimum of 5 years of experience in works of similar nature. Correspondence between the Contractor or the Agent and the Project Manager shall be in English.

#### **Article 1.11 Subcontractors**

Piecework workers employed or paid in gangs are deemed to be Sub-Contractors, and as such shall be subject to the requirements of the General Conditions of Contract. Individual pieceworkers directly under the control of the Contractor's supervisory staff will not be deemed to be Sub-Contractors.

#### **Article 1.12 Temporary Works and Access**

After the Contract is placed and before the Works on Site commence, the Contractor shall submit to the Consultants, drawings showing the proposed location and general arrangement of his offices, workshops, stores, quarters, access roads and other temporary works required for the proper execution of the permanent works. It will be the Contractor's responsibility to acquire sites for his offices, etc.

The Contractor shall obtain his own information with regards to access to all parts of the Site of the Works and if he wishes to make use of routes through private property then he must make all arrangements with the owners. His rates and prices are to allow for any temporary works that in his opinion would be necessary to execute the permanent works.

The condition of the surfaces of the private roads, paths or yards used or crossed by him for the purpose of the Contract shall be kept in reasonable repair during its progress, and on completion he shall put the road, paths or yards in proper repair at least equal to the original condition of the roads, paths or yards used or crossed by him and to the satisfaction of the Consultants, all at his own cost.

In general, the Contractor is to regulate the character of his transport to ensure that no undue damage is caused to any roads, tracks or properties within the area of the Works, public or otherwise. For the purpose of this project all access to and from the site shall be through the Lobin Lane which branches off the B78 road.

The Contractor shall provide and allow in his rates and prices for all temporary works or other work required in the construction of the Works.

#### **Article 1.13 Traffic Deviations, Traffic Control and Signs**

The Contractor shall be responsible for the safe and easy movement of road and pedestrians traffic, by day and night through the sections of the existing road where he is working. The Contractor shall also take all precautions and make all arrangements so that access to private properties are not impacted with the movement on Lobin Lane and the existing roads within the housing estate.

The cost of all temporary warning signs, traffic control, etc. should be priced by the Contractor in their rates. The Contractor will be responsible for all items as may be necessary for the safety and direction of the Public as required by the Laws of Mauritius or local by-laws, or as ordered by the Consultants. The Contractor shall make all necessary arrangements with the Road Development Authority and the Traffic Management and Road safety Unit of the Ministry of Public Infrastructure, Land Transport and National Development Unit with respect to traffic control and access. All such arrangement shall receive the approval of the Consultants.

Provisions and maintenance of traffic diversion will be the responsibility of the Contractor. The Contractor shall ensure that neither his own operation nor trespass by his employees shall interfere with the operation and maintenance of traffic diversions.

#### **Article 1.14 Water and Power Supplies for Use on the Works**

The Contractor shall be solely responsible for the location, procurement and maintenance of a water supply adequate in quantity to meet his obligations under the Contract.

The Contractor shall also make his own arrangement for power supplies and shall be solely responsible for the location, procurement and maintenance of a power supply, adequately to meet his obligations under the Contract.

The rates entered in the Bill of Quantities shall be deemed to include for all obligations for the location, procurement and maintenance of adequate water and power supplies and shall be deemed to include for all costs in association therewith.

#### **Article 1.15 Protection against Fires**

The Contractor is advised that at all times, it is necessary to guard against fires starting within the site or in the environs thereof, particularly as the result of the Works or from the actions of his employees. The Contractor shall have available at all times, fully functional fire-fighting equipment and shall deal with all fires howsoever caused. The contractor's staff shall be well-trained in using fire-fighting equipment on site and shall be ready to raise an alarm in case of fire. Contact number for Government Fire Services shall be conspicuously displayed and accessible to all personnel on site.

#### **Article 1.16 Health, Safety and Accidents**

The Contractor shall use his best endeavours to ensure the health, safety and welfare at work of his employees including those of his subcontractors, of the public and of all other persons on the Site. His responsibilities shall include:

- i. Wherever it is reasonably practicable copies of written safe systems of work should be provided.
- ii. Safety plans and methodologies in compliance with the requirements of the Ministry of Labour and Industrial Relations
- iii. The presentation of the Project Manager of copies of his employer's liability and public liability insurance which should provide cover for the duration of the project.
- iv. Provision and maintenance of safety and properly illuminated equipment.
- v. Fitness certificates and Consultants' certificate for all related equipment
- vi. Establishment of safe and well illuminated systems of working.
- vii. Provision and maintenance in operative conditions of all equipment necessary to render First-aid in case of accidents or other emergencies. This equipment shall be kept in readiness at all sites of the works.
- viii. Promptly report accidents arising out of or in connection with the performance of the work that caused death, personal injury or damage to property, giving full details and statements of witnesses.
- ix. A monthly report related to occupational safety, health and welfare of labour resources

**Article 1.17 Liaison with Police and Other Officials**

The Contractor shall keep in close contact with the Police and other officials of the areas concerned regarding their requirements in the control of workmen, movement of traffic, or other matters and shall provide all assistance or facilities which may be required by such officials in the executions of their duties.

The contractor shall liaise with the Black River District Council, the Police, the Ministry of Public Infrastructure, Land Transport and Shipping, the National Transport Authority, the Telecommunication Department, the Central Electricity Board, the Central Water Authority, the Road Development Authority and other related Authorities and shall comply with their requirements.

**Article 1.18 Overhead Power Line**

Where work is being carried out in the vicinity of overhead power lines, the Contractor shall be responsible for ensuring that all persons working in such areas are aware of the relatively large distance that high voltage electricity can "short" to earth.

**Article 1.19 Materials for the Works**

All materials supplied by the Contractor shall comply with the appropriate Standard Specification unless otherwise required hereinafter.

The Contractor shall, before placing any order for materials submit for the approval of the Project Manager the names of the firms from whom he proposes to obtain such materials. No materials or manufactured articles shall be ordered or obtained from any firm which the Project Manager has not previously approved in writing.



All materials shall be delivered to the site at sufficient period of time before they are required for use in the Works to enable the Project Manager to take such samples as he may wish for testing and approval. Any materials condemned as unsuitable for the Works shall be removed from the site at the Contractor's expense.

The Contractor may propose alternative material to those specified, provided that they are of equivalent quality and, subject to the Project Manager's approval, such materials may be used in the Works.

#### **Article 1.20 Programme of Works**

Within seven days (7) days after the date of Letter of Acceptance, the Contractor shall submit to the Project Manager for his approval: -

-A general programme (Programme of Works) showing the timing, order of procedure and general methods for carrying out the Works, with timing for mobilisation of equipment and plant and for purchase of important materials (Milestones).

-The organization (Organigram), staff (Staff List), labour (Labour List), equipment and plant (Plant List) proposed for the execution of the Contract. The planning shall be updated on the last week of each month.

-The layout and general arrangement of all temporary Works including site installation, he proposes to construct for the purposes of the Contract.

The Project Managers shall examine, and if necessary discuss with the Contractor on such document, prior to give his final approval before the commencement of the Works.

#### **Article 1.21 Survey and Setting Out**

The Contractor shall keep, for the duration of the contract, the services of a fully qualified and experienced surveyor. This Surveyor will provide all the centre-lines of the proposed building lines and grids together with the project boundary site and plots once the site is cleared, together with a bench mark and stations. All co-ordinates for centre lines and boundary edge and also for all the services will be submitted by the Surveyor in ACAD soft copy. The Contractor will be requested to set out all the points, that is, centre lines, road reserves and set-backs, boundary of site, buried services and utilities based on the co-ordinates submitted by Surveyor and to liaise with the land Surveyor to be appointed by the Project Manager to verify the points set out physically on site by the Contractor. Once approval is received from the Land Surveyor, the Contractor can proceed with the works.

The Contractor shall appoint and employ the necessary qualified and experienced staff to survey and set out the work accurately. The Contractor shall establish and locate all lines and levels and be responsible for the correct location of all works.

Before work commences the Contractor shall satisfy himself that existing ground levels, as indicated in the Contract drawings, are correct. Should the Contractor wish to dispute any levels he shall submit a schedule of such disputed levels of the Project Manager and existing ground levels relevant to

these levels shall not be disturbed before the Project Manager's decision as to the correct values are given. The contractor shall submit to the Project Manager a topographical survey of the site and longitudinal sections at every 20m intervals.

Where directed by the Consultants, the Contractor shall take such levels and dimensions as may be required prior to disturbance of the ground for the purpose of design and measurement and these shall be agreed between the Contractor and the Project Manager in writing before the surface is disturbed or covered up.

The cost of such surveys and the correct setting out of the Works is deemed to be included in the Contractor's rates.

#### **Article 1.22 Rates and Prices**

The rates and prices inserted by the Contractor are to be the full and inclusive value of the work described.

They are to cover all costs, expenses and general risks which may be involved together with all liabilities and obligations set forth or implied in the Specification and other documents on which the Tender is based. They must include all plant, tools, materials, transport of men and materials, insurance and labor of every description. They must also take into account the conditions referred to in the General Conditions of Contract and include the time lost due to weather, payment of guaranteed minimum and holidays with pay. The cost of any travelling time, subsistence and incentives such as overtime, etc., must be included in the rates and prices.

The quoted rates will not be subjected to any fluctuations and any adjustments. They shall be fixed rates.

Where any special risks, liabilities and obligations mentioned above or otherwise, cannot be deal with in the rates, then the price thereof is to be separately stated in an item or items provided for the purpose or added by the Tenderer. If any items are left un-priced it will be assumed that their value is included in other items and that they are not to be separately charged.

#### **Article 1.23 Faulty Works**

Any work, which fails to comply with this Specification, shall be rejected and the Contractor shall, at his own expense, make good any defects, as directed by and to the satisfaction of the Project Manager.

#### **Article 1.24 Inspections by Project Manager during Defects Liability Period**

The Project Manager will give the Contractor due notice of his intention to carry out any inspections during the Defects Liabilities Period and the Contractor shall upon receipt of such notice arrange for a responsible representative to be present at the time and dates named by the Project Manager . Any remedial or other work instructed by the Project Manager shall be executed forthwith.

#### **Article 1.25 Measurement of additional works**

In such case as the Contractor shall find it necessary to execute any works, or provide any materials which he feels entitled to claim as extras to the Bill of Quantities he shall obtain written permission from the Project Manager before commencing such work and shall make arrangements for the Works, or materials to be measured jointly with the Project Manager, and the quantities agreed. Neglect to obtain authority to commence any such work, shall entitle the Project Manager to disallow any claim for extras arising there from. The fact that joint measurement took place in no way commits the Project Manager to recognise the validity of such claim, if it is considered unjustified. The Project Manager, shall at all times, have full access to the Contractor's time books and may daily check the item of any extra works with the Contractor's timekeeper or otherwise, but the fact of his agreeing upon any time, shall in no way bind the Project Manager to value the work, other than by measurement if he thinks fit to do so.

**Article 1.26 Signboards**

Two (2) No. Signboards shall be erected by the Contractor at location to be given by the Project Manager. The signboards should be constructed as per attached drawings. Signboards should be able to resist climatic conditions throughout the duration of the contract. The signboards shall remain in place until such time the Project Manager has issued a Taking-Over Certificate to the Client. The signboards shall be made up of wooden planks, 2.5m long by 300mm wide and properly secured on 50mm diameter galvanized pipes embedded in concrete. The signboards shall be properly braced against wind loadings. The planks shall be painted white and the lettering in blue colour. A height of 100 mm should be adopted for the letterings. An example of signboard is shown in the drawings. The Contractor shall replace, within 24 hours, the signboards and/or any parts thereof should it be damaged by accident or by an act outside control. The Contractor shall maintain the signboard until the end of the Defects Liability Period. An item has been allowed in the Bill of Quantities to cover for the cost thereof.

**Article 1.27 Advertising**

The Contractor shall not erect any advertisement in any form within the Site or on adjoining ground, but shall provide a project board at the main entrances to the Site bearing suitable inscriptions including the name of the Contractor in accordance with details provided by the Project Manager.

**Article 1.28 Clearance of Site on Completion**

The Contractor is required to ensure that all debris, contractor's offices, store rooms, plants, excess material, spoil, etc. caused as a result of the works are to be removed from site on completion. Removal of and clearance is to be at the approval of the Project Manager. All septic tanks and closets shall be emptied to the satisfaction of the Project Manager and lime shall be spread on disused pits and trenches as a remedial measure. The cost of such removal is deemed to be included in the Contractor's rates under Item 1.11 of the BoQ.

**Article 1.29 Provisional Acceptance**

After completion of the Works and at least eight (8) working days before the date of provisional acceptance, the Contractor is to submit to the Project Manager the as-built drawings.

The drawings shall be supplied at the Contractor's expenses in three (3) copies, two (2) of which shall be in the form of printouts and one (1) copy on CD-R IN ACAD VERSION.

The failure to supply the as-built drawings in time shall automatically prevent the provisional acceptance.

### **Article 1.30 Progress Photographs**

The Contractor shall arrange for the taking of progress photographs including electronic copies for the different stages of construction of the Works, upon the direction of the Project Manager. The photographs will be taken at regular intervals so as to provide a historical record of the evolution of the works on site. The Contractor shall arrange to supply prints of sizes not less than 150mm by 100mm and electronic copies of each print chosen by the Project Manager for enlargement.

The number of exposures and enlargements will be as directed/ordered by the Project Manager and/or the Client. An item has been allowed in the bill of quantities.

### **Article 1.31 Protection of the Environment**

The Contractor shall comply with all regulatory and legal measures related to environmental protection, in force in Mauritius. The Contractor shall submit to the Project Manager's approval an Environmental Management Plan, together with a monitoring plan, within 14 days of possession of site.

The EMP shall include, but not limited to, the following:-

- The team organization or the staff responsible for the environmental management of the project and his CV
- A general description of the methods that the Contractor suggests to implement so as to reduce the impacts on the physical and biological environment for the whole duration of the works
- A general description of the methods that the Contractor suggests to implement so as to reduce the negative socio-economic impacts of its presence in the region, during the works duration;
- A water management plan (supply, location, quantity)
- A wastewater management plan, regarding collection and disposal from construction site and reinstatement after completion of works
- A solid waste management plan (type of waste, method of collection, method and location of storage, method and location of disposal)

An item has been allowed in the BoQ to cover costs associated with the management and protection of the environment.

### **Article 1.32 Services**

The site contains buried services in the form of water lines and cross drains. The Contractor shall clearly identify all routing of buried services during survey and setting and prior to excavations. Damage to services should be immediately reported to the Project Manager, Client and the competent authorities. Repairs to damages shall be at the expense of the contractor.

**Article 1.33 Drawings**

The tender drawings are enclosed in the bidding document and forms part of the tender.

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## **SECTION 2 – MATERIALS**

### **Article 2.1 Quality of Materials**

All materials used in the Works shall be of the qualities and kinds specified and shall be approved by the Project Manager. They shall comply with the requirements of the current amended editions, at the date of invitation to tender, of the British Standards (hereinafter abbreviated to B.S) published by the British Standards Institution, or AASHTO and ASTM Specifications as specified in the Technical Specifications. All materials may be checked both at the source and on Site and approval of any material at its source does not necessarily imply that it will be approved on site.

All materials shall be delivered on to the site in sufficient period before they are required for use in the Works, so that such samples as the Project Manager may wish are taken for testing and approval, and the Contractor shall furnish any information required by the Project Manager on the materials. Each supplier must be willing to admit the Project Manager or his representative to his premises for the purpose of obtaining the samples.

No materials of any description shall be used and no approved source of supply may be changed without prior sanction by the Project Manager.

Samples of the approved materials will be retained by the Project Manager until the completion of the Contract. The Contractor shall provide suitable labelled boxes or bags for the storage of these samples.

Materials used in the Works shall conform to the samples approved by the Project Manager.

### **Article 2.2 Approval of Source of Supply**

Before ordering any materials, the Contractor shall submit, for the approval of the Project Manager, the name of the Manufacturer of all items to be used in the Works and the source of supply of all materials to be used and the relevant Agreement Certificate. The Contractor shall ensure that the materials proposed conform to the Specification and Drawings prior to submission for approval of Project Manager.

The approval in writing of the Project Manager shall be obtained before relevant items are obtained. The information regarding the names of suppliers may be submitted at different times, as may be convenient, but no source of supply shall be changed without the Project Manager's prior approval.

Two copies of each order for materials are to be delivered to the Project Manager and if any variation from the Standard or type of materials is subsequently found necessary, it shall be approved in writing by the Project Manager.

### **Article 2.3 Defective Materials**

All materials which do not comply with the requirements of the Specification will be rejected and all such materials, whether in place or not, shall be immediately removed from the site by the Contractor at his own expense.

## **Article 2.4 Handling and Storage of Materials**

2.4.1 The Contractor shall make his own arrangements for the storage space and yards.

2.4.2 All materials for use in the Works shall be handled with due care and whenever not in immediate use, stored or stockpiled as follows or as directed by the Project Manager.

### **2.4.3 Stockpiling of Aggregates**

Approved aggregates shall be stockpiled at approved locations; prior to stockpiling, the site shall be cleaned, levelled and well drained by the Contractor, who shall if required by the Project Manager, also lay suitable hard surfacing.

Special care shall be taken to avoid segregation, contamination and mixing of different classes of aggregates. Stockpiles shall be built by layers of about 80 cm high. Material to be loaded shall be taken from the upper layer and never from the toe of the stockpile.

Coral sand for concrete shall be washed as necessary and as required by the Project Manager.

### **2.4.4 Buildings for Storage**

The siting of the buildings for storage shall be approved before construction commences. All buildings shall be adequate for the complete protection of the materials to be kept therein and precautions shall be taken against fire particularly with regard to the storage of inflammable materials.

### **2.4.5 Storage of Cement**

Cement shall be stored in well ventilated, watertight buildings with floors raised 50 cm above ground level and cement shall be within 15cm of the sides of the buildings to ensure circulation of air. Each consignment shall be kept separately and the contractor shall use the consignments in the order in which they are delivered on site. When being conveyed to the site in trucks or other vehicles, they shall be properly covered with tarpaulins or other effective waterproof coverings such as lamination. Cement, which has become unsuitable through absorption of moisture shall be rejected and removed from the site by the Contractor at his own expense.

### **2.4.6 Storage of Steel Reinforcement**

Steel reinforcement shall be stored, sheltered and supported by wooden blocks so as to prevent sagging. Bars shall be stored in separate lots according to diameter and quality.

### **2.4.7 Bulk Storage for Bitumen and Cement**

The Contractor may use bulk storage for bitumen and cement provided he can satisfy the Project Manager that the capacities are adequate.

#### 2.4.8 Top Soil

Topsoil to be used later for verges or to cover embankment slopes, landscape areas and borrow pits shall be stockpiled on well-drained ground and location to be approved by the Project Manager and Client.

### **Article 2.5 Borrow Pits and Spoil Tips**

2.5.1 The Contractor will be required to obtain naturally occurring materials for the works from sources outside the area occupied by the permanent works.

The Contractor will also be required to locate, prove and propose for the Project Manager's approval sources of fill materials and spoil tips. The approved sources for fill materials shall be designated "Borrow Pits". The fill materials proposed shall satisfy the requirements of Article 2.7.1 and 2.7.2. In case naturally occurring stones such as 'Grabbeaux' or similar materials are proposed as borrow pit material, such material shall be clean, free from dust and organic matter, besides satisfying the requirements of Articles 2.7.1 and 2.7.2 as regards maximum size and shall be subject to the approval of the Project Manager. Any material which is rejected by the Project Manager shall be immediately removed from the site and replaced at the Contractor's expense.

No additional cost shall be paid for substituted material such as 'Grabbeaux' or other in place of borrow pit material.

2.5.2 The Contractor is required to make all arrangements for land and access thereof in compliance with Clause 1.14 of the Specification.

### **Article 2.6 Boulders of Basalt**

Only clean, dense and not altered boulders of basalt shall be used for production of aggregates.

The Contractor shall submit for the approval of the Project Manager and before crushing is started the method he intends to follow for the selection of boulders of basalt conforming to these requirements.

### **Article 2.7 Materials for Embankment**

Two types of materials shall be considered:-

- Materials for construction of the main body of the embankments

- Selected materials:-

- for construction of the top 30 cm of embankment.
- for filling of holes and depressions and shaping of the surface where excavations have been carried out in soils where exists an important percentage of basaltic boulders.

2.7.1 Materials for Construction Of the Main Body Of The Embankments  
The materials shall comply with the following requirements:-

- Plasticity Index: not more than 30%
- Liquid limit: not more than 55%
- Maximum Size: 300 mm
- Swelling: not more than 3%

2.7.2 Selected Materials

The materials shall comply with the following requirements: -

- Plasticity Index: not more than 25%
- Maximum Size: 100 mm
- C.B.R. value after 4 days soaking, at 95% of the B.S Heavy Maximum Dry Density: not less than 10% (C.B.R. specimen prepared at B.S Heavy Optimum Moisture Content + 2%)
- Swelling: not more than 1%

**Article 2.8 Subgrade in Cut**

In accordance with the definition of subgrade in Article 4.18 of the Technical Specifications, the plasticity index of materials in the top 30 cm of sub-grade in cut shall not be more than 25%.

If they do not comply with this requirement, they shall be removed as directed by the Project Manager and replaced by selected materials.

**Article 2.9 Material For Surfacing Side Slopes, Verges**

Surfacing materials for side slopes and verges shall consist of approved, suitable top soil obtained from the general excavations or from other approved sources and shall be free from all sticks, roots and stones of 3 cm in greatest dimension. Top soil shall not be handled when it is so wet that it will become densely compacted during its placement.

**Article 2.10 Gabions**

Where shown on the drawings or as directed by the Project Manager, the Contractor shall excavate, trim to line and level, provide and erect gabions including providing selected rock, crushed if necessary, packed and compacted inside the gabions.

Gabions shall include gabion mattresses and gabion boxes and for the purposes of construction and method of measurement and payment, no distinction shall be made between them.

Gabions shall be "Maccaferri" boxes and / or "Reno" mattresses both with diaphragms at one metre centres, or similar approved. The maximum mesh size shall be 100 mm x 120 mm for boxes and 60 mm x 80 mm for mattresses. The wire used for the construction of gabions shall unless otherwise instructed by the Project Manager comply with the requirements below.

		Diameter (mm)	Galvanising (g/m <sup>2</sup> )
Mesh	Box	3.4	275
	Mattress	2.7	260
Binder	Box	2.2	240
	Mattress	2.2	240
Selvedge	Box	3.9	290
	Mattress	3.4	275

All wire shall be to BS 1052 having a tensile strength of not less than 40 Kg/mm<sup>2</sup>, and PVC coated.

Galvanising shall comply with the requirements of BS 443

Gabions shall be constructed to the shapes and dimensions as shown on the drawings or as directed by the Project Manager. Gabions, as constructed shall be within a tolerance of  $\pm 5\%$  on the height or width instructed and  $\pm 3\%$  on the length instructed.

The alignment of the gabion shall be correct within a tolerance of 100 mm of the instructed alignment and the level of any course of gabion shall be correct to within a tolerance of 50 mm of the instructed level. In addition adjacent gabions shall not vary by more than 25 mm in line and / or level from each other.

The surface upon which gabions are to be laid shall be compacted to a minimum dry density of 95% MDD (AASHTO T99) and trimmed to the specified level or shape.

Joints in gabions shall be stitched together with 600 mm minimum lengths of binder wire, with at least one stitch per 50 mm, and each end of the wire shall be fixed with at least two turns upon itself.

Adjacent gabions shall be stitched together with binder wire along all touching edges.

Gabion boxes shall be laid with broken bond throughout to avoid continuous joints both horizontally and vertically. Pre-tensioning of gabions shall be subject to the approval of the Project Manager.

Gabions shall be hand packed with broken rock of 150 mm minimum dimension and 300 mm maximum dimension. The sides shall be packed first in the form of a wall, using the largest pieces, with the majority placed as headers with broken joints to present a neat outside face. The interior of the gabion shall be hand packed with smaller pieces. The whole interior and top layers shall be packed with smaller pieces and the top layers shall be finished off with larger pieces. The whole interior and top layers shall be packed tight and hammered into place.

The Contractor shall place filter fabric ('Terram' or similar approved) behind and below gabion faces in contact with existing or backfilled ground. The Contractor shall ensure that the filter fabric is not damaged during the

construction or backfilling around the gabion works and any damaged or torn fabric shall be replaced at the Contractor's expense. The filter fabric shall be installed in accordance with the manufacturer's instructions and the filter fabric shall not be left exposed to sunlight for more than 3 weeks.

At the back face and ends of completed gabion work, the existing soil shall be backfilled, thoroughly compacted against the sides of the gabions and finished flush with the top surface of the gabion.

On completion of gabion construction the exposed horizontal faces of the gabions shall be protected with 50 mm thick class 15 concrete to discourage vandalism.

**Article 2.11 Material for Drainage Layer**

Quality and source of supply of materials to be used for drainage layer shall be submitted to the agreement for the Project Manager:-

Coarsely crushed basalt materials or spalls can be used.

- The materials shall be clean and free from impurities and vegetable matter (not more than 1%)
- Maximum Size: not more than 100 mm
- Proportion of particles less than 2 mm: not more than 10%

**Article 2.12 Stone Aggregate Generally**

The stone for use in the works shall be obtained from approved quarries or stockpiles of basalt boulders operated by the Contractor or by an approved Sub-Contractor and consisting of hard, tough, heavy, compact basalt, or other approved rock washed before crushing if necessary, broken, screened and graded as specified hereafter, to the satisfaction of the Project Manager and free from flat, flaky, elongated, soft or decomposed pieces, excess dust and any dirt or acids or other deleterious substances.

Aggregates for different purposes are classified hereafter.

**Article 2.13 Grading Limits for Sub-Base and Granular Base**

The gradation of the materials shall be within the limiting curves given in articles 2.14 and 2.15 hereof and shall be approximately parallel to these limiting curves.

**Article 2.14 Material for Sub-Base Course**

The grading limits for crushed basalt sub base course shall be within the following limits:

NOMINAL SIZE OF SIEVE (MM)	PERCENTAGE WEIGHT PASSING
50	100
20	65-90
10	35-62
5	27-46
2	14-34
0.5	5-20

0.2	3-14
0.08	2-10

The Los Angeles Value shall not exceed 32 and the sand equivalent value shall be more than 50.

**Article 2.15 Material For base Course**

The grading of crushed basalt shall be within the following limits:-

NOMINAL SIZE OF THE SIEVE (MM)	PERCENTAGE WEIGHT PASSING
30	100
20	75 - 100
10	47 - 75
6.3	35 - 60
2	18 - 38
0.5	7 - 22
0.2	4 - 15
0.08	2 - 10

The Los Angeles value shall not exceed 30.

The Flakiness Index shall not exceed 40%.

The Sand Equivalent Value shall be more than 60.

**Article 2.16 Material For Bituminuous Course**

**2.16.1 Classes Of Aggregates**

Aggregates for bituminous course shall be obtained by mixing 3 or more classes dmm/Dmm of materials defined for each class, by the maximum size (Dmm) and minimum size (dmm) of particles.

Dimensions D and d will be chosen in the following series of sieve sizes : 2 - 6.3 - 10 - 14- 20.

Crusher run 0/20 may be used for the production of bituminous course provided that all the required specifications are satisfied.

Before the Works are started, the Contractor shall submit to the Project Manager's approval the gradation curve of reference for material of each class.

The gradation curve of reference for each class shall satisfy the following requirements: -



- Percentage by weight of material retained by sieve Dmm: not more than 10%
- All material shall pass sieve 1,25 Dmm
- Percentage by weight of material passing sieve dmm: not more than 10 %
- All material shall be retained by sieve 0,63 dmm
- Percentage by weight of material passing sieve  $\frac{[Dmm + dmm]}{2}$  : within the range 1/3 - 2/3

The total variations, by percentage, around the gradation curve of reference for each class of material such as proposed by the Contractor at the commencement of the Works shall not exceed the following values.

SIEVES (MM)	CLASSES						
	0/2	0/4	2/6,3	4/6,3	6,3/10	10/14	6.3/14
0,08	+ - 4	+ - 3					
0,20	+ - 6	+ - 4					
0,63	+ - 7	+ - 5					
1,25	+ - 7	+ - 6	0				
2,00	-10	+ - 6	+10				
2,50	0	+ - 6	+ - 6	0			
4,00		-10	+ - 7	+10			
5,00		0	-10	+ - 8	0		0
6,30			0	-10	+10		+10
8,00				0	+ - 12	0	+ - 8
10,00					-15	+10	+ - 8
12,50					0	+ - 12	+ - 8
14,00						-15	-15
18,00						0	0

According to the characteristics of the crusher plant, the Contractor may be allowed to submit for the Project Manager's approval production of classes 0/3 instead of 0/2.

Coral sand shall not be used.

Crushed basalt sand shall be used.

2.16.2 The job standard mix, such as defined in Article 5.15 of these Technical Specifications shall be within the following limits:-

i) Bituminous Base Course (Binder Course)

NOMINAL SIZE OF THE SIEVE (MM)	PERCENTAGE WEIGHT PASSING
20	100
16	80 - 100
10	60 - 80
5	40 - 60
2	25 - 40
0.5	8 - 20
0.08	6 - 8

2.16.3 Other Requirements

The Flakiness Index shall not exceed 35 %.

The Los Angeles Value shall not exceed 30.

The Sand Equivalent Value on 0/2 portion shall be more than 60.

2.16.4 Filler

Filler (portion of material passing No. 200 B. S. Sieve) shall consist of Portland Cement or dust of crushed basalt.

The Plasticity Index shall not be measurable.

Passing 0.08 mm > 80%

Passing 0.20 mm = 100%

**Article 2.17 Material for Wearing course 0/14**

2.17.1 Materials for wearing course and reshaping shall comply with the requirements of Article 2.16.1 hereof.

2.17.2 The job Standard Mix such as defined in Article 5.14 of these Technical Specifications shall be within the following limits:

NOMINAL SIZE OF THE SIEVE (MM)	PERCENTAGE WEIGHT PASSING
	<b>0/14</b>
14	100
12.5	100
10	80 - 95
5	40 - 55

2	25 - 40
0.63	15 - 30
0.080	6 -10

2.17.3 The Flakiness Index shall not exceed 25.

The Los Angeles Value shall not exceed 25.

The Sand Equivalent Value shall be more than 60.

The Percentage of particles < 0,5 mm, obtained by washing 1 kg of coarse aggregate, shall not exceed 2 %.

(1) The Los Angeles shall be measured on 6/10 and 10/14 or 6/14 materials after removal of flaky portion.

#### **Article 2.18 Material for Bituminous Surface Treatments**

Aggregates used shall be hard, tough and free from vegetable matter, dirt, lumps or ball of clay, adherent film of clay or any other matter which will prevent the adherence of the bitumen and, if required by the Project Manager, shall be mechanically washed with an adequate supply of clean water.

2.18.1 The Chippings shall comply with the following grading:-

- First Application: 10/14 mm

- Second Application: 4/6 mm

The requirements for gradation curves are given in Article 2.14.

2.18.2 The other requirements for chippings are as follows:

The Los Angeles Value shall not exceed 25

The Flakiness Index shall not exceed 20

The Proportion of particles less than 0.5 mm size shall not exceed 1%.

2.18.3 The sand used for the sealing coat will be 0/3 mm crushed basalt sand, carefully washed in order to have a portion of filler (<0.08 mm) lesser than 8%.

The Sand Equivalent Value shall exceed 75%.

#### **Article 2.19 Coloured Asphalt**

2.19.1 Type of Mix

It shall be coloured cold asphalt 0/6mm (with 2% pigment in total mix).

2.19.2 Cold Bin Settings

The asphalt should be constituted of 70% 4/6mm and 28% 0/4.

2.19.3 Bitumen Content

The percentage of bitumen by dry aggregates shall be 8.5%.

## **Article 2.20 Material for Concrete**

### **2.20.1 Coarse Aggregate**

Coarse aggregate shall consist of crushed basalt, complying with BS 882. The aggregate shall be clean, hard, free from soft, friable, porous, elongated pieces, free from impurities which may adversely affect the strength or durability of the concrete or attack the reinforcement. Aggregate shall be washed if so directed.

The aggregate shall comply with the following requirements.

Sub Class I : The combined grading of aggregates for use in reinforced concrete, where shown on the Drawings or where directed by the Project Manager, shall be uniformly graded from 20 mm down to 5 mm according to BS 882. The Flakiness index shall not exceed 35. The Los Angeles value shall not exceed 30.

Sub-Class 2 : The combined grading of aggregate for mass concrete, where shown on the Drawings or where directed by the Project Manager, shall be uniformly graded from 40 mm down to 5 mm according to BS 882. The flakiness index shall not exceed 35. The Los Angeles value shall not exceed 35.

### **2.20.2 Fine Aggregate**

Fine aggregate complying with the grading zones of BS 882 shall consist of approved sand clean from clay, organic matter, and other impurities; and it shall be washed if so directed.

The sand equivalent values shall be as follows:-

For class 25 and above concrete the sand equivalent value shall exceed 75.

For class 15 concrete the sand equivalent value shall exceed 70.

Coral sand shall not be used.

Crushed basaltic sand shall be washed.

## **Article 2.21 Manholes**

Unless otherwise particularly specified or directed, manholes shall be constructed in Grade C25 concrete. Roof slabs shall be reinforced as detailed on the drawings.

Benching and channels of manholes shall be in grade C20 concrete finished with 20mm thick cement mortar on top of the channels and benching.

Where applicable, half round pipe shall be set in the floor of the manhole to form the channel.

Where precast concrete manholes are permitted to be used they shall comply with BS 5911 and be constructed in accordance with the manufacturer's instructions. Individual rings and cover slabs shall have an approved watertight joint. Under roads and paved areas precast concrete manholes shall be surrounded with 150mm of Concrete Grade C20.

The maximum allowable lift of concrete in the construction of walls shall be 1.2m.

The cost of forming key joints as directed by the Project Manager shall be deemed to be included in the rates for concrete in manholes.

The ends of all pipes are to be properly built in and neatly finished off, and pipe sockets are to be cut off.

The tops of the chambers and shaft walls are to be level all round to give a proper bearing to the cover slabs which shall be securely bedded and pointed in cement mortar.

Manhole chambers shall be subjected to water test as directed by the Project Manager. The chambers to be tested shall be filled with water and allowed to stand full for 48 hours. They shall then be tested and deemed to be watertight if the drop in water level is not more than 12mm in a further 24 hours. Any chambers, which fail the test, shall be repaired and made watertight at the Contractor's expense and retested to the satisfaction of the Project Manager.

**Article 2.22 Filter Material**

Filter material for under drains shall consist of sand or granular material to be approved by the Project Manager.

**Article 2.23 Water**

Water shall be free from oil, acid, alkali, earth, vegetable or organic matter, or other deleterious substances in suspension or solution which may have a harmful effect on the Works. Water used for concrete, mortar shall comply with the requirements of B.S. 3148 and shall be tested if there is any doubt as to its suitability. If water is not available from a public supply, the Project Manager's approval shall be obtained regarding the source of supply and manner of its use. Contaminated water shall not be used.

**Article 2.24 Stone Work**

(a) Generally

Stone for use in masonry work shall consist of sound undecomposed basalt obtained from approved boulders and be of even texture and colour.

(b) Stone for Pitching and Stone Facing

Stone for pitching to drains, inlets and outlets, embankments and around structures shall consist of sound, undecomposed basalt with thickness not less than 15 cm and facing dimensions not less than 22 cm.

(c) Stone For Rip Rap

Stone for use as riprap shall consist of reasonably well-shaped, hard, dense, and durable rock. Separate lumps of stone shall weigh generally between 10 and 80 kg of which 80% shall be 20 kg or larger and not more than 10% less than 10 kg.

(d) Hardcore

Hardcore filling where required shall be clean hard quarry chips, clean basalt, hard broken stone or other approved material broken to 75mm gauge. All fillings shall be laid in layers not exceeding 150mm thick well

packed, rammed and blinded on top with fine stone or other approved fine material and watered to receive concrete.

#### **Article 2.25 Cement stabilised graded crushed stone sub base 0/31.5**

The graded crushed stone sub base shall be as per the requirements of road sub base in the Specifications. The Contractor shall propose a job mix formula and carry out trials. The graded crushed stone sub base shall be transported in suitable clean vehicles to prevent loss of fines and closely covered with impermeable sheeting during transit to prevent loss of moisture, and shall not be laid when its temperature exceeds 35°C.

Cement stabilised graded crushed stone sub base shall not be laid during rainfall as this will affect the moisture content and remove cement and fine material. Upon completion of compaction the surface shall be covered closely with plastic sheeting weighted down to prevent it being removed by the wind and the whole arranged to prevent loss of moisture.

Cement stabilized graded crushed stone sub base shall be laid by bob cat or by hand in a uniform layer without segregation, so that compaction shall be completed within sixty minutes of commencement of mixing. Care shall be taken to compact effectively adjacent to structures using small compaction if necessary in confined spaces. The thickness of each layer shall not exceed 200 mm and shall receive the required number of passes.

On completion of the compaction the surface shall be well cleaned, free from movement under compaction and free from compaction planes, ridges, cracks or loose material. In situ density tests shall be made on each compacted layer in accordance with BS 1924 and the next layer shall not be laid until it is at least seven days old or as instructed by the Project Manager.

The minimum 7 day compressive strength (150 mm test cubes) shall be 4.5 to 10.0 N/mm<sup>2</sup> sampled at mixing point, and the in situ dry density shall be 95% of the maximum cube dry density.

The cement content shall not in any case be less than 3%.

### **MANUFACTURED MATERIALS**

#### **Article 2.26 Cement**

##### General

The cement shall be of approved manufacture and shall be delivered in bags with seals unbroken, or if delivered in bulk, it shall be delivered in approved containers.

Test Certificates from the manufacturers or supplier shall be submitted for each consignment and shall indicate the results of the tests for compressive strength, setting time, soundness and fineness carried out in accordance with

the requirements of the relevant British Standard, but the Project Manager may require further tests to be made after the cement is delivered to the site.

If such certificates are not available, samples shall be taken from different bags or containers of the consignment, suitably packed, and sent for testing in accordance with B. S. to an approved laboratory, or where directed by the Project Manager.

The Project Manager may require further tests to be made if any cement is stored on site for a longer period than three months.

The failure of any sample to satisfy the requirement of the relevant British or other approved Standard shall entitle the Project Manager to reject the entire consignment from which it was taken.

#### Cement Received Through Importing Agents

Each consignment of cement received through importing agents shall be accompanied by a further certificate stating that no cement has been re-bagged or the percentage of re-bagging (which shall not exceed 10 % ) as the case may be.

The Contractor shall state the name of the local supplier or importing agent and the approval of the Project Manager, in writing, shall be obtained before the order of any consignment.

#### Ordinary Portland Cement

Cement shall be manufactured by an approved firm and comply in all respects with the requirements of the B.S. 12.

### **Article 2.27 Steel Reinforcement**

Steel reinforcement shall comply with the requirements of B.S. 4449 and B.S. 4461. The steel shall be free from oil, grease, dirt and paint and any loose rust shall be removed before use.

No heating except for fishtailing and no welds except in reinforcing fabric shall be made in any bar without permission in writing from the Project Manager. All bending shall be done in an approved machine with the steel cold and in accordance with B.S. 4466.

The Contractor shall supply the Project Manager with a certificate stating the origin and process of manufacture and test sheets, signed by the maker, giving the results of each of the tests applied. If and when required he shall also grant all necessary facilities to the Project Manager for the selection of test pieces and shall cause these to be prepared and submitted where directed for test. The Project Manager shall have the option of testing and approving at the works of the suppliers of all or any of the steel required under the Contract, and the Contractor shall advise the Project Manager when the whole or any of the steel is ready for test at the Works, in order to conform with the provisions of the B.S. as regards Test and Inspection.

### **Article 2.28 Mould Oil**

Mould oil shall be of an approved proprietary brand and shall be used in accordance with the Manufacturer's recommendation or as directed by the Project Manager.

### **Article 2.29 Material for Forms, Falsework and Centering**

All timber used for forms, falsework and centering shall be sound wood, well-seasoned and free from loose knots, shakes, large cracks, warping and other defects. Before use on the work, it shall be properly stacked and protected from injury from any source. Any timber, which becomes badly warped or cracked, prior to the placing of concrete shall be rejected. Forms, which are unsatisfactory in any respect, shall not be used. All shuttering for all outside surfaces above final ground level shall be either tongued and grooved or provided with a suitable lining to produce a smooth surface finish and shall be termed thin facing shuttering. Other shuttering shall be termed normal shuttering.

Irrespective of nature or position, all joints in shuttering shall be sufficiently tight to prevent leakage of liquids from concrete.

If the Contractor proposes to use steel shuttering, he shall submit to the Project Manager, dimensioned drawings of all the component parts, and give details of the manner in which it is proposed to assemble or use them. Steel shuttering will only be permitted if it is sturdy in construction and if the manner of its use is approved by the Project Manager.

Struts and props shall, where required by the Project Manager, be fitted with double hardwood wedges or other approved devices so that the moulds may be adjusted as required and eased gradually when required. Wedges shall be spiked into position and any adjusting device locked before the concrete is cast.

#### **Article 2.30 Concrete Pipes**

Concrete pipes shall comply with the requirements of B.S. 556. Where pipes are manufactured on site, all the clauses in this specification shall be applicable to the manufacture and testing of concrete pipes.

Notwithstanding any of the requirements outlined above, for routine control purposes, the cube compressive strength shall satisfy the requirements of Class 30 concrete as shown in article 3.12 of these Technical Specifications.

#### **Article 2.31 Concrete Porous Pipes**

Concrete porous pipes for French drain shall comply with the requirements of B.S. 1194.

#### **Article 2.32 Precast Concrete**

Precast kerbs, slabs, channel edging and quadrants shall comply with the requirements of B.S. 340 and with the Drawings.

Where the Contractor is permitted to carry out pre-casting on site, the precast units shall in addition to complying with the relevant B.S., be manufactured in steel moulds on a vibrating table or as directed by the Project Manager.

#### **Article 2.33 Admixtures**

Unless agreed by the Project Manager, neither admixtures nor cement containing additives shall be used.

#### **Article 2.34 Bitumen Products**

2.34.1 The following types of bitumen products will be used:-

- For the bituminous concrete, straight run bitumen penetration grade 35/50 shall be used.



- For the prime coat, cut back bitumen MC 30 shall be used.
- For the tack coat, cutback bitumen RC 3000 (or cut back 400/600) or rapid setting bitumen, emulsion (with 60% of residual bitumen) shall be used.

2.34.2 Bitumen products shall comply with AASHTO or ASTM requirements. Some of the requirements for different grades of bitumen are indicated hereunder: -

<b>GRADE</b>	<b>80/100</b>	<b>60/70</b>	<b>35/50</b>
Softening Point	1 - 51	43 - 56	47 - 60
Penetration Test	80 - 100	60 - 70	40 - 50
Density (25 C)	1 - 1,07	1 - 1,1	1 - 1,1
Flash Point	>230	>230	>250
Ductility (25 C)	>100	>80	>60
Solubility CS 2	>99,5	>99	
Loss of heating	>99,0	>99,0	>99
163 C, 5 h	>2 %	< 1%	<1%
Penetration of residue from rolling thin film over test at 25	< 1%		
100 gas % of original	> 70%	>70%	>70%

2.34.3. Emulsions shall be of the cationic type. They shall comply with the following specifications:-

- The water content shall not exceed the required nominal rate by more than 1 % of the weight of emulsions.
- The sensitivity to temperature, of the emulsion shall be such that its viscosity shall not decrease by more than 30 % if the temperature increases from 20 degree to 40 degree C.
- The emulsion shall not contain free particles likely to obstruct the sparge pipes.

Any bitumen or bitumen emulsion delivered in leaking containers or deteriorated in the containers may be rejected.

During the course of the contract, the Contractor shall, at his own expense, satisfy the Project Manager from time to time that the bitumen and bitumen products being used are in accordance with the Specification. Any laboratory testing that he arranges to satisfy this Clause shall be carried out in an approved laboratory.

#### **Article 2.35 Hydrated Lime**

Lime for stabilisation shall be Hydrated Calcium Lime (not Magnesium) and shall generally comply with B.S. 890, Class B, and with a free lime content of 50%.

The proportion of filler shall be more than 90%.

Locally manufactured limes may be proposed for the approval of the Project Manager. The Contractor shall submit with all consignments, at his own expense, the manufacturer's certificate certifying that they comply with B.S. 890, or his chemical analysis.

**Article 2.36 Precast Concrete Slabs**

Precast concrete slabs shall be "Trief" interlocking concrete blocks, type Super Trief Blocks (125 mm - (5 in )- thick with a finish) or similar.

**Article 2.37 (Glazed Vitrified Clay). Pipes and Fittings**

Clay pipes shall conform to the requirements of BS 65 and 540 or EN 598 as appropriate. The pipes shall be supplied with Type 1 sockets and supplied complete with the manufacturer's flexible joint.

**Article 2.38 Ducts For Cables**

Ducts for cables shall have a smooth internal bore without any sharp edges to the ends of the pipes, and shall be either: -

- (i) G.V.C. ducts with self-aligning flexible sleeve joints manufactured in accordance with the tolerances, permeability and strength requirements of BS 65 and 540 or EN 598 as appropriate. The internal ends of ducts shall be radiused to 3 mm minimum, or
- (ii) U.P.V.C. ducts complying with Class B or C or BS 3506 or with BS 4660.

**Article 2.39 Hand Parapets**

Hand parapets shall comply with B.S. 4360, article 7.5 of these Technical Specifications and as shown on the Drawings.

**Article 2.40 Guard Rails**

Guardrail beams shall be class A with Type 1 finish as per the requirements of AASHTO M180 and shall be approved by the Project Manager. Posts shall be as shown on the drawings.

**Article 2.41 Materials and Colour For Road Signs**

Permanent traffic signs shall be reflectorised and shall comply in all respects with GN 154 of 1970, the Contract Drawings and Section 7 of the Specifications.

The Contractor shall, at his own expense if and when required by the Project Manager, provide a manufacturer's and/or an approved laboratory's test certificate showing that the road signs comply with this Clause.

Standard colours to be used for Signs, Posts and Fittings shall be as described in the relevant BS as follows:-

Red	BS 381 C No. 537
Blue	BS 4800 No. 0-013

Yellow	BS 381 C No. 355
Grey for posts, fittings and black for signs	BS 2660 No. 9-101
Cream	BS 381 C No. 352
Black White	BS 873 C 3b and 3c

#### **Article 2.42 "Cats' Eyes " Reflectors**

The white lensed road-mounted reflectors used in the Works shall be those known as "Cats' eyes" of the pin-type such as Prismo II or similar, or an alternative complying with BS 873 Part IV previously submitted to and approved by the Project Manager.

Mounting on these reflectors shall comply in all respects with the manufacturer's instructions for use, and also with the British Department of the Environment Manual for Road systems.

Cat's eyes using the glued method of fixing will not be accepted.

#### **Article 2.43 Road Marking**

##### 2.43.1 Paint

The paint to be used for road surface marking shall be specifically manufactured for such purposes. It shall be suitable for applying by brush, low pressure spraying equipment and high pressure spraying equipment to give a chemically stable film of uniform thickness.

It shall be stored and applied in accordance with the manufacturer's instructions. Unless otherwise agreed by the Project Manager, paint shall be applied without the use of thinners or other additives.

##### Colour

##### 1. White

The colour of white markings shall when laid be approximately to BS colour No. 102 of BS 381 C.

The pigment used shall be titanium dioxide type A Anastase or type R (Rutile) complying with BS 239.

##### 2. Yellow

The colour of yellow markings shall when laid be approximately to BS colour No. 355 of BS 381 C.

##### Chlorinated Rubber Paints

1. Maximum % by weight of chlorinated rubber - 20%
2. Maximum % by volume of pigment at 20 degree C - 50%
3. Minimum colouring (prime) pigment content % by weight paint 16 % , yellow paint 10 %
4. Surface drying time determined in accordance with BS 3900 part C2, less than 5 minutes

5. Hard drying time determined in accordance with BS 3900 Part C3, less than 15 minutes
6. Adhesion to concrete or bituminous surfacings must, in the opinion of the Project Manager, be good.
7. Reflectorisation shall be surface reflectorisation.

Testing to determine drying times in accordance with BS 3900 parts C2 and C3 shall be carried out on test panels prepared in accordance with BS 3900 part A 3.

### **Reflectorisation**

#### Internal Reflectorisation

Internally reflectorised paint shall be specifically manufactured for this purpose and shall contain ballotini to the general requirements of BS 3262 part I with a luminance factor of not less than 7%, skid resistance of not less than 45, and heat stability of not less than 65%. The ballotini shall meet the following grading requirements: -

<b><u>BS TEST SIEVE</u></b>	<b><u>% PASSING</u></b>
212 micron	100
150 micron	75 - 100
75 micron	0 - 25
65 micron	0 - 10

The quantity of ballotini beads shall be between 18 and 22% by weight of total mix or such other quantity as the Project Manager shall direct.

#### Surface Reflectorisation

Surface reflectorisation shall be by application of ballotini beads to the wet paint film. The ballotini shall comply with the general requirements of BS 3262 part I and shall comply with the following grading requirements:-

<b><u>BS TEST SIEVE</u></b>	<b><u>% PASSING</u></b>
0.850 mm	100
0.600 mm	80 - 100
0.300 mm	18 - 35
0.150 mm	0 - 10
0.075 mm	0 - 2

The ballotini shall be spread on the wet paint at between 0.7 and 0.9 kg/litre of paint or at such other rate, as the Project Manager shall direct.

#### 2.43.2 Hot applied thermoplastic road marking materials

The material for hot applied thermoplastic road marking shall be in accordance with BS 3362, and suitable for spraying.

The material shall be of a type approved by the Project Manager, and if not on the current approved list, samples and technical data shall be submitted to the Project Manager at least four (4) months prior to the proposed use.

Colour

1. White

The colour of white markings shall when laid be approximately to BS colour No. 102 of BS 381 C.

The pigment used shall be titanium dioxide type A Anastase or type R (Rutile) complying with BS 239.

2. Yellow

The colour of yellow markings shall when laid be approximately to BS colour No. 355 of BS 381 C.

Composition

The thermoplastic material shall consist of light coloured aggregate, pigment and extender bound together with resin plasticised with oil as necessary, in approximately the following proportions:

Aggregate 40%, Ballotini 20%, Pigment 10%, Extender 10%, Binder 20%

Glass beads, less than 1.0 mm in diameter, dispersed in the mix (EN 1423: 1998, EN 1424: 1998)

Pigment used is Titanium Dioxide (Rutile)

Extender used is chalk or Lithophone

Binder softening point shall be 55°C

Reflectorisation shall be Internal Reflectorisation

**Article 2.44 Geotextiles**

General Characteristics

Geotextile shall be of the non-woven type having the following characteristics:

	Subgrades	French Drains
Mass per unit area	≥250 g/m <sup>2</sup>	≥200 g/m <sup>2</sup>
Tensile strength	≥20 KN/m	≥15 KN/m
Penetration load (CBR) at rupture	3 KN	2.5 KN
Elongation	≥60%	≥60%
Pore size O <sub>90</sub> (dry)	≤100 Mm	≤100 Mm
Permeability (10 cm head)	130 l/s/m <sup>2</sup>	160 l/s/m <sup>2</sup>

Geotextiles shall be delivered in rolls wrapped in a protective layer of plastic to avoid degradation from direct sunlight, ingress of dust, mud and water during storage.

#### LAYING AT SUBGRADE LEVEL

Prior to laying of geotextiles, the site will be well graded and sharp objects such as rocks, stumps of trees or bushes which might puncture or tear the fabric shall be removed. Any significant hollows or unevenness in the site should be filled.

During the rolling out into position of the geotextile, sufficient allowance shall be made in order to provide an overlap at least 500 mm between adjacent sheets. The edges of the geotextiles shall be properly weighted to maintain the position of the geotextile before covering with sub base materials or other fill. Once the geotextile is laid it shall not be trafficked until an adequate layer of fill is placed over it. Blades or buckets of construction plant must not be allowed to come in to contact with the fabric during filling operations.

For drainage applications, all sharp stones and projections shall be removed from the bottom and walls of trenches before lining of trenches with geotextiles.

The edges of the fabric shall be laid on the ground at the edges of the trench and held by small piles of aggregates.

During the filling process, no attempt shall be made to restrain the top of the fabric.

Upon completion of filling of the trenches, the free lengths of fabric shall be wrapped over the drainage layer. The overlaps shall be at least 500 mm.

#### Jointing / cutting

The minimum overlap shall be 500 mm. In applications where the geotextile is subject to tensile stress, the overlap shall be increased by 100 mm. Overlaps shall be sown or stapled as per the manufacturer's recommendations. Stitching should be at least 50 mm back from the free edges of the fabric.

#### **Article 2.45 Cast Iron Gully**

Cast iron gully shall of Grade A type and shall comply with the requirements of B.S. 497.

#### **Article 2.46 Polystyrene**

The board shall be formed of polystyrene base resin in an extrusion process and shall be homogeneous and essentially unicellular. It shall conform to the requirements of ASTM 11230.

## **SECTION 3 - TESTING**

### INDEX

#### ARTICLE NO

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- 3.2 PROVISION AND OPERATION OF LABORATORY
- 3.3 ADDITIONAL TESTS
- 3.4 INSPECTION AND TESTING OF MANUFACTURED MATERIALS
- 3.5 TESTS ON SUSPECT MATERIALS AND WORKMANSHIP
- 3.6 LOCATION OF MATERIALS
- 3.7 SAMPLING OF MATERIALS
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- 3.10 TESTS FOR WATER PURITY
- 3.11 TEST FOR MANUFACTURED MATERIALS
- 3.12 GENERAL CONTROL AND TESTS DURING CONSTRUCTION
- 3.13 FREQUENCY OF TESTS
- 3.14 FREQUENCY FOR OTHER MANUFACTURED MATERIALS

3.15 ALTERATION IN FREQUENCY OF TESTS

3.16 APPARATUS OF THE LABORATORY

3.17 CONTROL OF SURFACES



## SECTION 3 - TESTING

### Article 3.1 General

The Contractor shall carry out on the Site tests for selection and control of materials and workmanship in accordance with the Technical Specifications and as instructed by the Project Manager. Such instructions shall in no way affect the responsibility of the Contractor to ensure that all materials and workmanship are in accordance with the Contract.

### Article 3.2 Provision And Operation Of Laboratory

#### 3.2.1 General

Permission to commence any major construction operations shall not be given by the Project Manager until the Contractor provides sufficient proof that it has set up a laboratory in full working order, suitably equipped and staffed.

#### 3.2.2 Laboratory

The Contractor may opt to provide, equip, and maintain a laboratory equipped to carry out all tests required for the selection of materials, design of mixes, control of materials and workmanship, in compliance with the requirements of these Technical Specifications. The laboratory could be located in the Contractor's yard and place of business. The Contractor may further appoint a laboratory agency for that purpose. The Contractor shall also appoint and employ qualified laboratory technicians for the duration of the Contract and adequate semi-skilled and unskilled labour. The Contractor shall ensure that at all times during the currency of the Contract, he has sufficient quantity of apparatus, equipment, chemicals and other materials, and is adequately staffed to carry out any and all of the tests by the methods described hereunder, and at the speed and in volume required by the progress of the works, and the Project Manager's instructions.

All tests shall be carried out by the Contractor's technicians, but the Project Manager shall be allowed free access at all times to the Laboratory and testing facilities. The Laboratory shall be under the direct control and supervision of the Project Manager.

The Contractor shall provide and maintain all labour, tools and equipment that may be required for the digging of trial pits and collection of samples in connection with all tests.

All tests to be performed shall be in accordance with Standard Specifications of the B.S., LCPC, AASHTO and ASTM as specified in these Technical Specifications.

All tests including crushing of concrete cubes shall be carried out in the site laboratory. The execution of tests in any other laboratory, outside the site will not be permitted, except as otherwise provided under Article 3.2.6 and Article 3.5

The Contractor shall provide and maintain all essential services including lighting, clean water and sinks with adequate drainage facilities. The

Contractor shall provide such work benches, tables and chairs as required by the Project Manager.

The Contractor shall maintain the building in a clean and tidy condition and shall be responsible for the security of the building and its contents at all times.

#### 3.2.3 Design Of Mixes

The Contractor shall carry out tests to establish proper proportions and characteristics of mixes as described in Parts VI and VII of these Technical Specifications.

#### 3.2.4 Tests Of Materials

The Contractor shall carry out tests to ensure that all materials to be used in the Works are in accordance with the Technical Specifications.

#### 3.2.5 Tests on Workmanship

The Contractor shall carry out tests at the frequencies specified herein, or as directed by the Project Manager to ensure that all workmanship is in accordance with the Technical Specifications.

#### 3.2.6 Tests Carried Out By A Nominated Testing Authority

Whenever the facilities of the Contractor's laboratory are determined to be inadequate by the Project Manager to carry out control tests on materials or workmanship, such tests shall be carried out at the Contractor's expense by any other testing laboratory which shall be nominated by the Project Manager, and the Contractor shall be fully responsible for any delays in the testing or work which may ensue.

#### 3.2.7 Test Results

All samples and records shall be preserved for as long as the Project Manager may direct and they shall be kept and labelled in an orderly fashion to his satisfaction. The results of all tests shall be entered on standard forms, samples of which will be provided by the Project Manager and two legible copies of each completed form shall be delivered to him with the minimum of delay. No material shall be incorporated in or rejected from the Works until the results of all relevant tests have been approved.

### **Article 3.3 Additional Tests**

In addition to the tests required under other articles hereof, the Project Manager shall have power to order independent tests of all materials to be carried out by some person appointed by him at such place as he may determine and from the result of such tests there shall be no appeal. No payment shall be made for these additional tests and the costs thereof shall be deemed to be included in other rates and prices.

#### **Article 3.4 Inspection and Testing of Manufactured Materials**

Whenever considered desirable by the Project Manager, inspectors may be sent to the factory to test the materials or to supervise their manufacture. Materials shall be tested before leaving the factory as well as after delivery to the site and the Project Manager shall be at liberty to reject materials notwithstanding the preliminary test at the factory. Should the Project Manager not decide to send an inspector to the manufacturer's works, the Contractor shall obtain from the manufacturer certificate of test, proof sheets, mill sheets etc. showing that the materials have been tested in accordance with the requirements of these Specifications relating thereto and shall provide adequate means of identifying the materials on site with the corresponding certificates etc..., but neither the omission of the Project Manager to send an inspector nor the production of the manufacturer's certificate of test shall affect the liberty of the Project Manager to order further tests on samples selected from the materials delivered to the site and to reject after delivery materials found to be unsuitable or not in accordance with these Technical Specifications.

#### **Article 3.5 Tests on Suspect Materials and Workmanship**

Where so directed, tests other than the tests specified herein, shall be carried out on the completed works or portions thereof at any time until the final handing over certificate has been issued. Where there is any doubt that the work has not been carried out in accordance with the provisions of the contract or the Project Manager's instructions, such tests shall be carried out jointly by the Project Manager and the Contractor, or at the request of either party, by an independent Testing Authority which shall be nominated by the Project Manager.

#### **Article 3.6 Location of Materials**

The Contractor shall be responsible for locating all naturally occurring materials to be used in the works.

The Contractor shall open up trial pits and carry out tests, to locate materials suitable for use in the works, all as directed. The frequency of the trial pits shall be at the discretion of the Project Manager.

#### **Article 3.7 Sampling of Materials**

##### **3.7.1 General**

Samples of materials to be tested shall be carried out in accordance with the methods hereinafter described, or as referred to in the appropriate method of testing. In all other cases, the method shall be as directed.

##### **3.7.2 Trial Pits**

Trial pits, dug by hands, shall have a minimum plan area of 1 metre by 1 metre.

Samples shall not be taken from the spoil of the trial pit but shall be obtained from equal increments taken from each face of the pit, each

increment being a representative sample of the material taken from any single horizon. The four increments so obtained shall be thoroughly mixed by turning over three times and then quartered or riffled down to the size required for testing.

### 3.7.3 Stockpiles

The surface material of the stockpile shall be removed before sampling. At least twelve equal portions shall be taken from different parts of the stockpile, and thoroughly mixed by hand before being quartered down or riffled down to the size required for testing.

## **Article 3.8 Testing of Naturally Occurring Materials**

### 3.8.1 Preparation of Disturbed Samples for Testing

The preparation of disturbed samples for testing shall be carried out in accordance with the procedure given in B. S. 1377.

### 3.8.2. Tests on Naturally Occurring Materials

The tests shown below shall be conducted in accordance with the relevant British Standard or

Moisture Content	: B. S. 1377 Test 1A
Speedy Moisture Content	: as directed by the Project Manager
Liquid Limit	: B. S. 1377 Test 2A or 2 B
Plastic Limit	: B. S. 1377 Test 3
Plasticity Index	: B. S. 1377 Test 4
Specific Gravity	: B. S. 812
Bulk Density	: B. S. 812
Particle Size Distribution	: B. S. 1377, Test 7A
Particle size analysis by Hydrometer method	: B.S 1377 Test 7D
(If required at the discretion of Project Manager)	
Sand Equivalent	: AASHTO T 176

All sieving shall be done by the wet method. Dry sieving may only be carried out with the specific permission of the Project Manager.

### 3.8.3 Compaction Tests

The tests shall be carried out in accordance with B. S. 1377 test 13.

### 3.8.4 California Bearing Ratio Test

The test shall be carried out in accordance with B. S. 1377 test 1 dynamic compaction method 1.

All C.B.R. Specimen shall be prepared at B. S. Heavy Optimum Moisture Content and at B. S. Heavy Optimum Moisture Content + 2%.

All C.B.R. tests on un-stabilised soils are to be carried out after 4 days soaking.

### **Article 3.9 Testing of Aggregates**

#### **3.9.1 Sampling of Aggregates**

The sampling of aggregates shall be carried out in accordance with the procedure given in B. S. 812 Section 1.

#### **3.9.2 Tests on Aggregates**

Sieve Analysis	:	B. S. 812
Amount passing No. 200	:	B. S. 812
B.S. Sieve		
Flakiness Index Test	:	B. S. 812
Specific Gravity	:	B. S. 812
Bulk Density	:	B. S. 812
Los Angeles Abrasion Test	:	AASHTO Designation T 96-49
Sand Equivalent Test	:	AASHTO T 176
Moisture Content	:	B. S. 812
Speedy Moisture Content	:	as directed by the Project Manager

### **Article 3.10 Tests for Water Purity**

The tests shown below shall be conducted in accordance with the relevant British Standard 3148.

### **Article 3.11 Tests for Manufactured Materials**

Each batch of cement delivered to site must be accompanied by a Manufacturer's Certificate giving results of tests proving its compliance with the requirements of BS 12 or BS 4027 as appropriate. The tests shall be carried out in accordance with BS 12 together with the tests for determining the percentage of alkali in the Cement expressed as Na<sub>2</sub>O.

In addition to the above the Project Manager may order that any cement which has been stored on site for more than one month shall be tested in accordance with BS 12, and used only when it meets the design requirement.

Further, the Project Manager may require the Contractor to take samples from cement bins or bagged cement and to carry out the following tests:

### 3.11.1 Ordinary and Rapid Hardening Portland Cement

<u>TEST</u>	<u>BRITISH STANDARD</u>
Compressive Strength Test	: B.S.4550 Part 3 Section 3.4
Consistency of Standard Cement Paste	: B.S. 4550 Part 3 Section 3.5
Initial and Final Setting	: B.S. 4550 Part 3 Section 3.6
Soundness Test	: B.S. 4550 Part 3 Section 3.7
Fineness Test	B.S. 4550 Part 3 Section 3.3

### 3.11.2 Bituminous Materials

Sampling Bituminous Materials	: AASHTO T 40
Penetration Test	: AASHTO T 49
Softening Point	: AASHTO T 53
Ductility Test	: AASHTO T 51
Viscosity	: AASHTO T 201/T 59
Solubility Test	: AASHTO T 44
Distillation	: AASHTO T 78
Residue from Distillation	: AASHTO T 59
Flash Point	: AASHTO T 48/T 79

### 3.11.3 Tests on Steel Bars and Wire

All reinforcement shall be supplied with a manufacturer's test certificate showing that it has been tested and found to comply with the relevant standards BS 4449, 4482, 4461, 4483, 2691, and 4360. If required by the Project Manager, the Contractor shall provide samples free of charge for testing at an approved laboratory. No payment shall be made for these tests and the costs thereof shall be deemed to be included in other rates and prices.

## **Article 3.12 General Control and Tests During Construction**

### **3.12.1 Description**

The Contractor shall be responsible for the quality of all materials to be included in the permanent works.

The Project Manager or his representative shall inspect the materials and works from time to time during and after construction and get the quality of the materials and Works tested by himself, by his Testing and Quality Control Units or by any other agency deemed fit by him generally as per the requirements stipulated in the Specifications. Additional tests may also be conducted where, in the opinion of the Project Manager, need for such tests exists, in the absence of clear indications and frequency of tests for any item procedures and tests as directed by the Project Manager shall be followed.

The Contractor shall provide necessary co-operation and assistance in obtaining the samples for tests and carrying out the field tests as required by the Project Manager from time to time. This shall include provision of labour, attendant and assistance necessary in connection with the tests.

For the work of embankment, subgrade and pavement, construction of subsequent layer of same or other layer over the finished layer shall be done after obtaining permission from the Project Manager.

Similar permission from the Project Manager shall be obtained in respect of other items of work prior to proceeding with the next stage of construction.

For cement, bitumen, mild steel deformed bars, high tensile steel, pre-stressing materials, bearings, and similar other materials essential tests are to be carried out at the manufacturers' plants or at laboratories other than the site laboratory. The Contractor shall also furnish the test certificates to the Project Manager. For testing of cement concrete at site during construction, arrangement for supply of samples, sampling, testing and supply of test results shall be made by the Contractor as per the frequency and number of tests as stipulated in these Specifications or as approved by the Project Manager.

The method of sampling and testing of materials shall be as required under relevant clauses stipulated in these Specifications or as approved by the Project Manager.

Where the Project Manager consider that for the interest of the quality on materials or workmanship, modifications, if any, are necessary, such shall be carried out as per direction of the Project Manager by the Contractor at his own expenses.

### **3.12.2 Field Moisture Content Test**

This test shall be carried out in accordance with B. S. 1377, Part 2, Test 1 or by using a Speedy Moisture Tester as directed by the Project

Manager. When using the latter method it must be noted that the instrument requires calibration for each type of material being tested.

To improve the accuracy of the instrument, at least six small ball bearings should be placed in the Speedy Tester and these will assist in breaking up the soil, so allowing the calcium carbide to react with the moisture more readily.

### 3.12.3 In-Situ Dry Density Control

The test shall be carried out using the sand-cone method or the rubber-balloon method or nuclear density and/or moisture method as directed by the Project Manager.

In case the nuclear densiometer is used, at each test location the average of four readings taken at positions rotated by 90° will be used. A check/comparison test using the sand replacement method (sand cone or the rubber balloon test methods) will be carried out at a 50 test interval. Initial calibration of the instrument will be done by carrying out at least fifty tests in parallel with the sand replacement method for each different material encountered. The check tests will be used to update the initial calibration of the instrument. The instrument shall have a valid calibration certificate before the initial site calibration mentioned above is carried out.

### 3.12.4 Measurement of Deflection under a 8.2 Ton Axle Load

This test shall be carried out using the Benkleman beam along the centerline and at offsets of 2.5 m, from the centre line and at each profile and half profiles intervals on both sides on each layer in the construction of pavement construction layers on embankment, main body of the embankment, sub grade in cut and fill, the carriageway i.e. strengthening layers and finished level or as directed by the Project Manager.

### 3.12.5 Bituminous Concrete and Road Base

Sampling of Bituminous Mixture	: AASHTO T 41
Bulk Density	: as directed by the Project Manager
Bitumen Content	: AASHTO T 58
Marshall	: ASTM D 1559
Duriez/LCPC	: .Mode operateiro LCPC

The samples for Marshall tests shall be compacted with 50 blows on each face.

### 3.12.6 Surface Treatment

As directed by the Project Manager



### 3.12.7 Concrete

Sampling	: B. S. 1881
Slump Test	: B. S. 1881
Compressive Strength Test	: B.S. 1881
Indirect Tensile Strength	: B. S. 1881
Compressive Strength of Concrete Pipes	: B. S. 556

### **Article 3.13 Frequency of Tests**

The frequency of tests for soils and aggregates, steel, bituminous materials, water, reinforcement, cement, and of quality control test outside shall be as shown in the tables.

### **Article 3.14 Frequency for Other Manufactured Materials**

For all other manufactured materials, the frequency of testing shall be as indicated in the relevant British or other approved Standards, or as directed by the Project Manager.

### **Article 3.15 Alteration in Frequency of Tests**

Notwithstanding any provision in these Technical Specifications as to the frequency of tests, the Project Manager shall be empowered to alter the number, type or nature of such tests, as may in his opinion, be necessary for the proper execution of the works. The Project Manager shall be at liberty to increase the frequency of testing, and repeat tests which, in his opinion, are unsatisfactory and vary the nature and type of test.

### **Article 3.16 Apparatus of the Laboratory**

With reference to article 3.2.2, the laboratory shall be equipped to carry out at least the following tests:-

- Sieve Analysis
- Atterberg Limits
- Proctor
- Specific Gravity
- Moisture Content
- Bulk Density
- Sand Equivalent
- Field Moisture Content
- In-Situ Dry Density (Rubber balloon or sand-cone method or nucleo gamma densometer method)
- Slump for fresh concrete
- Measures of Deflections using a Benkelman Beam
- Measure of Temperature (0 – 400 °C)

- All other necessary tests may be carried out by Nominated Testing Authority.

**Article 3.17 Control of Surfaces**

The Contractor shall provide straight edges, templates for checking the finish of the surfaces. They shall be maintained in good condition during all the works.

## **4.0 Site clearance**

### **Article 4.1 General**

The locus in question forms part of the vast extent of land owned by the Employer. It is actually a bare piece of land. There are already 59 housing units on the site out of which 12 are occupied by the victims of the flood of 2013. The Contractor shall remove all grass and bush covering the site where the permanent works would be implemented.

### **Article 4.2 Demolition**

No demolition works have to be performed.

### **Article 4.3 Clearance of land**

Clearing of site shall mean the clearing of the ground surface of all grass covers, bushes and flowers, hedges, shrubs, stumps, loose boulders and other materials and disposal to approved dumping sites. It include grubbing and removal of organic/vegetative soil. Top soil and excavated materials shall be stored as directed for subsequent use elsewhere in the yard or as directed by the Project Manager/Employer.

### **Article 4.4 Cutting of trees**

The site does not have any trees that require any specific clearance prior to cutting.

### **Article 4.5 Working in water**

The excavation works to foundations and sub-structure shall be kept free from water at all times. The Contractor shall keep pumps and equipment readily available on site to pump water from pits and excavated portions.

The Contractor shall clean all excavated portions from damp silts and clays as a result of exposure to rainfall. The Contractor shall also take precautions against slips and cave-ins that may result in over-excavated pits. Reinstatement of the excavated portions shall be at the expense of the Contractor.

## **5 Earthwork/Excavation Specification**

### **Article 5.1 General**

The extent of the earthworks is defined on the Project Manager's bulk earthworks drawings

The Contractor is deemed to have visited the site and to have carried out trial pits at his own expense to ascertain the nature of the soil conditions prior to tendering as no claim will be entertained on account of the soil being of a different nature from that which he allowed in his prices.

The Contractor shall also collect the necessary information on the structures or facilities which could be affected by the Works, particularly underground, notify their owners and take all useful precautions for the protection of such structures and facilities. The Contractor shall be responsible for the removal, reconstruction or repair of any damage caused during excavation and bulk earthworks to the satisfaction of the Project Manager.

### **Article 5.2 Setting Out**

All dimensions and levels on the drawings are shown in metres. The levels shown on the various drawings relate to Ordinance Datum unless otherwise stated. These shall be used by the Contractor to establish a benchmark on site and to obtain the levels shown on the drawings.

Details of all grid lines, setting out stations, benchmarks and profiles shall be recorded on the site setting out drawing and retained on site throughout the contract and handed over to the Project Manager on completion.

### **Article 5.3 Programme of Works**

The Contractor shall submit for approval by the Project Manager a Programme of Works prior to start of works.

The Project Manager shall have the right to direct the Contractor as to the length or location of portions of earthworks which can be started at any one time.

### **Article 5.4 Standard Specification**

Except where otherwise specified all imported materials shall conform to the requirements of the relevant and latest British Standards and Codes of Practice.

### **Article 5.5 Method of Excavation**

If required by the Project Manager, the Contractor shall submit his proposed method of excavation including details of necessary supports for the excavations to the Project Manager for his written approval.

#### **Article 5.6 Excavation of Unsound Material**

If the Contractor encounters any unsound material in the formation, he shall immediately inform the Project Manager who will instruct the Contractor in writing as to whether or not the said material shall be treated as sound or unsound. Unsound material shall be removed and disposed of to the satisfaction of the Project Manager, the voids so formed shall be filled with Concrete Grade 10 in the formations to structures, and with the same material as that which comprises the fill in the formation to embankments.

#### **Article 5.7 Earthwork in Rock**

Rock shall be interpreted as meaning natural bedrock of un-weathered and undecomposed basalt, which can only be dislodged by wedges and sledge hammers or pneumatic tools, and boulders and blocks of other material exceeding 0.5 cu.m, in size, which cannot be fractured except by mechanical means.

Weathered and decomposed basalt shall not be classified as rocks for the purpose of works measurement.

Unless classified by the Project Manager as rock in accordance with the above definition, the excavation material shall be deemed to be soft material.

#### **Article 5.8 Use of Explosives**

The Contractor shall not use any explosives for the purpose of the excavation of the Works without the prior approval of the Project Manager. Rock excavation shall normally be carried out by the use of wedges and sledge hammers or pneumatic tools. The non-approval by the Project Manager of blasting as a means of excavation in rock shall not entitle the Contractor to any extension of time or any adjustment of the tender sum.

#### **Article 5.9 Support of Excavation**

The Excavations shall be supported at the Contractor's expense as may be necessary to protect persons, property, traffic or the Works or to prevent caving and harmful subsidence. Supports shall not be removed until in the opinion of the Project Manager the permanent formwork is sufficiently far advanced to permit such removal. The Contractor shall submit his proposals for such supports to the Project Manager if required.

The Project Manager shall have the right to order the proper support of excavation whenever he considers the installation of the support to be necessary and his decision shall be final. If in the opinion of the Project Manager the support proposed is insufficient then the Project Manager may order the provision of stronger support which shall be provided to the satisfaction of the Project Manager.

#### **Article 5.10 Slips, Falls and Excess Excavation**

Slips and falls of material from the sides of excavation and embankments shall be prevented.

In the event of slips or falls occurring in the excavations and where excavations are

made in excess of the dimensions of the permanent works, the voids so formed shall be filled as specified below. When such voids, in the opinion of the Project Manager may affect the stability of the ground for support of the Works or of the adjacent structures and services, they shall be filled solid with concrete Grade 10. In other cases, they shall be filled with selected excavated material placed and compacted to the approval of the Project Manager.

#### **Article 5.11 Excavations to be kept dry**

All excavations shall be kept free from water at the Contractor's expense so that the Works can be constructed in dry conditions.

The destination and method of disposal of water from the excavations shall be subject to the approval of the Project Manager. Care must be taken especially if ground de-watering equipment is used, that lowering of the ground water table causes no damage to adjoining property.

#### **Article 5.12 Topsoil Storage**

All surface material which in the opinion of the Project Manager is suitable for reuse shall be kept separate from the general excavation material as directed by the Project Manager.

Topsoil shall be stacked in spoil heaps not more than 1250 mm high. Weed growth on topsoil heaps shall be controlled by mechanical or approved chemical means, to prevent soil becoming polluted with weed seeds.

#### **Article 5.13 Care of Excavation Material**

All excavated material shall be filled in such a manner that it does not endanger the Works or any building, structure or property or obstruct roads, pavements and driveways or cause undue obstruction to traffic.

#### **Article 5.14 Material for Backfill and Imported Backfill Material**

The material used for backfill in the Works and the imported backfill, if any shall be subject to the approval of the Project Manager.

In the event where it is necessary to import backfill material, the Contractor shall submit to the Project Manager all relevant information concerning the borrow area and the proposed method of transport of the borrowed material together with samples of the proposed material for approval. The imported backfill material shall be selected material free from lumps of clay, large stones or rock and pebbles.

Selected fill material shall pass a sieve of 10 mm aperture and shall not contain any stone or material greater than 100 mm in size.

#### **Article 5.15 Borrow Areas**

The Contractor shall select the sites from which he shall import material for the purpose of the Works and shall obtain the Project Manager's approval pursuant to Clause 5.14 hereto.

#### **Article 5.16 Rockfill Specifications**

Material for rockfill shall be dense basalt, natural or crushed, with individual particles not exceeding 100 mm.

The fill shall be compacted in layers not exceeding 150 mm to form a dense mass free of voids.

Compaction shall be carried out mechanically by several passes of an 8 - 10 ton roller until no further settlement is observed.

Places inaccessible to the roller shall be compacted by means of a mechanical tamper.

#### **Article 5.17 Compaction of Backfill**

All backfill material shall be placed in layers not exceeding 150 mm and then mechanically rammed.

The Contractor shall, if necessary, water the fill material prior to or during compaction so that its moisture content lies within a range of 2% optimum Proctor values suitable for the fill material and the adopted method of compaction.

Unless otherwise specified, the standard compaction requirement shall be 95% maximum dry density as defined by the modified Proctor test. One test of the backfilling material in place shall be carried out free of charge by the Contractor for at least every 200 cu.m. of backfilling or when ordered by the Project Manager.

The testing of this material shall comprise grading tests for grain size distribution, modified Proctor compaction tests and sand replacement density tests carried out in accordance with BS 1377.

#### **Article 5.18 Scarification**

The Contractor shall scarify to a depth of 150 mm the ground where compaction of fill is specified. He shall ensure that no vegetation remains in the area to be covered by the embankment and shall, if necessary, bring the moisture content of the scarified surface material to its optimum value before placing and compacting the fill thereon.

#### **Article 5.19 Finish of Embankment**

Except where otherwise specified or ordered by the Project Manager, the tops and side slopes of fill placed in embankments shall be neatly trimmed equal to the best practicable finish which in the opinion of the Project Manager can be obtained by the skilled use of the earth moving equipment used in the placing and compacting of the fill.

Where precise lines and levels of embankments are not specified or ordered by the Project Manager, the Contractor shall construct embankments in straight lines between smooth curves to give a pleasing appearance. The tops of embankments

shall be finished reasonably level and even.

#### **Article 5.20 Allowance for Settlement**

Due allowance shall be made for consolidation and settlement of fill, compacted fill and formations so that levels of the finished surfaces at the end of the period of maintenance are not less than those specified or ordered by the Project Manager.

If at any time during the construction period or the period of maintenance any damage of the surface of the formation has occurred as a result of settlement, the Contractor shall promptly carry out at his own expense all necessary repairs and reinstatement which may be required as a result of such damage.

#### **Article 5.21 Disposal of Material**

All rock, unsuitable materials and all excavated materials not required for the Works shall be transported and disposed of away from the Site. The locations proposed for disposing or storing the rock, unsuitable or excess excavated materials, whether temporarily or permanently, shall be subject to the approval of the Project Manager.

#### **Article 5.22 Safeguarding of Excavations**

The Contractor or his agent or representative appointed in writing shall be deemed to be and shall be both the "excavator" and "a person competent to inspect bracing and shoring".

Should the depth of an excavation or the nature of the material excavated render the sides of the excavation liable to movement that might endanger the Works or the workmen engaged on the excavation, the sides of the excavation shall be supported by suitable timber or other sheeting adequately strutted and braced, all being properly assembled and having sufficient strength and stiffness to prevent movement in the materials supported, or, alternatively, the Contractor may, subject to the approval of the Project Manager, so reduce the slope of the excavated face

or faces that any danger to the Works or the said workmen is removed.

The Contractor shall make good any fall of rock or earth due to rain, flooding, insufficient timbering or other cause, and shall fill in at his own expense any cavities so formed as directed or using approved means.

Without relieving the Contractor in any way of his responsibility, the Project Manager may order additional lateral support for, or the sloping or reduction of the slope of, the sides of any excavation.

During the progress of each excavation, the Contractor shall report to the Project Manager the presence of bedding planes inclined towards the excavation, seepage water and any other feature that may affect the stability of the excavation, as soon as the presence of such feature or features is known.

All timbering and sheeting shall be removed from the excavation before the completion of the work, unless the written permission of the Project Manager allowing



any portion to remain is obtained.

## **Article 5.23 Existing Services**

### **5.23.1 Detection, location and exposure**

The drawings show the position of existing services based on the best information available. The Contractor shall verify the position of all services and all other obstacles and existing works on the Site. Manholes, valve boxes and the like will be regarded as known services. Before commencing construction in any particular area, the Contractor shall verify the positions of services and report to the Project Manager any that are missing.

### **5.23.2 Protection of cables**

The Contractor shall advise the Project Manager at least 7 days in advance of the actual date on which he proposes to excavate near any cable. He shall not use mechanical equipment to excavate within 3 m of the estimated position of any cable and shall, if necessary, expose the cable by means of hand excavation carried out under proper supervision. When so instructed, the Contractor shall backfill such cable trenches with approved material to the compaction density ordered.

### **5.23.3 Negligence**

Where a service is damaged because of the Contractor's negligence, the penalty payable by the Contractor shall be as specified in the project specification and he shall make good such damage or bear the cost of the repairs, as specified.

## **Article 5.24 Reinstatement and maintenance of roads**

The Contractor shall reinstate and maintain the surfaces of all roadways through which trenches or other excavations have been made. Should any subsidence occur to the site of such trench or other excavation, the Contractor shall immediately restore the road surface to its correct level.

Where immediate restoration is impracticable, the Contractor shall provide barricading, lighting and other safeguards until restoration is complete.

## **Article 5.25 Tolerances**

### **5.25.1 Positions, dimensions, levels, etc.**

The work shall be finished to Degree of Accuracy II and the permissible deviations (PD) shall be within the limits given below:

	Permissible deviation PD		
Degree of Accuracy	III	II	I
	III	II	I

	mm	mm	mm
<i>Excavations for structural foundations Position on plan</i>			
PD in plan of any point measured from the nearest grid line	+ 50	+ 35	+ 25
<i>Dimensions on plan</i>			
PD from the design dimensions	+ 75	+ 50	+ 25
<i>Foundation Level (i.e. level of underside of concrete except floor slab)</i>			
PD in level of surface of excavation trimmed to receive Concrete	+ 75	+ 50	+ 25
<i>Level</i>			
PD from designed level with reference to the nearest transferred bench-mark of any floor slab	+ 20	+ 15	+ 10
<i>Terraces and embankments</i>			
<i>Position of top edge of terrace*</i>			
PD from designated position of any point, measured from nearest grid line	+ 450	+ 300	+ 150
<i>Alignment of top edge of terrace*</i>			
PD from a line joining any two points 30 m apart on top edge of terrace	+ 200	+ 100	+ 150
<i>Finished levels</i>			
PD from designated levels with reference to nearest transferred bench mark			
Slopes of top surfaces	Nil	Nil	Nil
<i>Project Specifications</i>			
PD from direction of slope % % %	20	10	5
PD form rate of fall:			
1 in 100 to 1 in 300			
1 in 400 and flatter	10	5	2

\*Subject to the breaking between intersecting slopes being acceptably straight.

5.25.2 Moisture content and density

The permissible deviations from OMC and density shall, except where otherwise specified, be as given below, appropriate to the degree of accuracy specified for a particular class of work.

		Permissible Deviation		
		Degree of Accuracy		
		III	II	I
		%	%	%
OMC in field during compaction		+2 -2	+1 -2	+0 -2
Specified density	+ no top limit -0	+ no top limit -0	2 - 0	+

## 6.0 Concrete Specifications

### Article 6.1 General

#### 6.1.1 Code of Practice

The references in brackets included in certain clause headings in this specification are to numbers of clauses or sub-clauses of British Standard BS8110:1997: Part1. The recommendations of any clause or sub-clause so referred to are requirements of this specification.

#### 6.1.2 Definitions

The following definitions and abbreviations are used and have the following meanings:

BS	-	British Standard
CP	-	British Standard Code of Practice
The Works	-	The whole of the Works envisaged by this Contract including the works of nominated Sub-contractors or Suppliers, Local Authority and Public Undertakings unless specifically stated otherwise
The Work subsequent to the statement	-	That part of the Works dependent upon or
"Directed"	-	directed by the Project Manager
"Inspected"	-	inspected by the Project Manager
"Submitted" or examination "Submit"	-	submitted to or submit to the Project Manager for
"Agreed" or "Agreement"	-	agreed by or agreement of the Project Manager
"Accepted" or Manager in writing "Acceptance"	-	accepted or acceptance by the Project
"Approval" or Manager in writing "Approval"	-	approved by or approval of the Project
Formwork Props	-	Props that are part of the formwork and are necessary to support newly cast concrete until it is strong enough to carry its own weight.

## Specifications

Concrete Grade	-	The characteristic strength
"Testing approved by Authority"	-	An organisation nominated by the contractor and the Project Manager fully equipped to carry out all tests and checks required by this specification
"Required" -		required by the terms of this specification or any other contract document
Characteristic 5% of the Strength	-	That value of strength below which no more than works test results for each concrete grade will fail
Designed Mixes -		Any concrete mix where the specified constituents are individually proportioned and purposely combined to achieve the characteristic strength or other specified requirements of the concrete
Satisfactory	-	to the satisfaction of the Project Manager

### 6.1.3 Approvals

Approval by or of the Project Manager shall have the following limitations:

- a) Any approval given in respect to samples of materials, workmanship or methods of construction submitted in accordance with the requirements of the Specification, shall not be interpreted as denoting any degree of satisfaction with the materials used in, or the execution of the Works.
- b) Any approval given in respect of shop drawings or scheme called for by the Specification or proposed by the Contractor is only for conformance with the design concept and information given in the Contract Documents.

### 6.1.4 Notice for Approvals

The Contractor shall agree with the Project Manager, whose decision shall be final, reasonable times for an acceptance or approval before the related work commences.

### 6.1.5 Responsibility

No approval or acceptance by the Project Manager shall relieve the Contractor of his responsibility under the Contract.

#### 6.1.6 Rates

The Contractor's rates for all measured items relating to the concrete works and tests shall include for carrying out the works in accordance with all the terms and requirements of this specification.

#### 6.1.7 Variations

No variations to this Specification may be made unless approved by the Project Manager.

#### 6.1.8 Defective Work

Where, in the opinion of the Project Manager, any of the finished Works or the materials or workmanship in any part of the Works fails to comply with this Specification, that part of the Works will not be accepted and may be classed as defective.

All work classed as defective shall be cut out and removed from the Works and replaced or otherwise dealt with in an approved manner.

Any special tests not specifically covered by this Specification that are proposed by the Contractor as a result of failure to comply with this specification shall be at the contractor's expense. The Contractor shall be responsible for any consequential costs or delays.

The results of these tests will not necessarily be accepted as proof of adequate materials or workmanship.

#### 6.1.9 Currency of Documents

Unless otherwise directed all publications are the latest edition including any amendments, current ten days before the date fixed for the return of Tenders.

### **Article 6.2 Materials**

#### 6.2.1 General

Concrete shall be made with cement, aggregate and water. No other ingredients shall be used without approval from the Project Manager.

##### 6.2.1.1 Reinforced Concrete

The reinforced concrete works have been designed generally in accordance with the recommendations contained in BS 8110:1997 and the contractor shall comply with the recommendations contained therein unless specifically excluded or modified hereafter.

##### 6.2.1.2 Unreinforced Concrete

Unreinforced concrete shall comply with all the relevant requirements of this Specification.

#### 6.2.2 Cement

##### 6.2.2.1 General

All cements used for concrete work shall comply with the relevant British Standards. The cement types given below are acceptable for use in the works; however the proportion of extender in factory blended cements shall conform to the requirements of Table 1. On no account shall masonry cements be used for concrete work, even if the strength designations are the same as for common cements.

All cement shall be delivered to the site in sealed containers or bulk cement Lorries of suitable design.

Table 1: Acceptable cement types:

Conform to:		
PC	Portland Cement	BS 12: 1996
PBFC	Portland Blast furnace Cement	BS 146: 2002
SRPC	Sulphate-resisting Portland Cement	BS 4027: 1996
PPFAC 1996	Portland Pulverized-fuel Ash Cement	BS 6588:

### 6.2.3 Aggregates

#### 6.2.3.1 General

Aggregate shall comply with BS812: 1996.

#### 6.2.3.2 Uniformity

The Contractor shall obtain an undertaking from the suppliers of both fine and coarse aggregate of the quality and type selected that sufficient supplies are available to complete the contract.

#### 6.2.3.3 Water

Water shall be clean and free from harmful matter. When so directed the Contractor shall arrange for tests of the water to be carried out in accordance with BS 3148: 1980 and BS 2690: Part 6 when directed.

### 6.2.4 Admixtures

#### 6.2.4.1 General

Admixture may be permitted in designed mixes provided the details of the admixture and the associated mix design and trial results are approved. Calcium chloride and admixtures containing calcium chloride will not be permitted.

### 6.2.5 Concrete

#### 6.2.5.1 Concrete Mixes

Designed mixes shall be used for each grade of concrete listed in the table below and shall be in accordance with BS5328: 1997 except that the Contractor shall obtain approval for any change in sources of material and change in content.

Concrete Type	Classification	Cement Type	Extender Type	Grade N/mm <sup>2</sup>	Max Coarse Aggregate size (mm)	Min Cement Content Kg/m <sup>3</sup>	Max. Water/Cement Ratio
Normal Reinforced Concrete	C 20	PC	-	20	12 20	260 290	0.6
	C 25	PC	-	25	12 20	280 310	0.55
	C 30	PC	-	30	12 20	300 330	0.5
	C35	PC	-	35	12 20	330	0.45
	C 40	PC	-	40	12 20	330	0.45
	Water Retaining Concrete	WC 35	PC	-	35		
WC 40		PC	-	40			0.45

For structural concrete the maximum cement content should not exceed 450 Kg/m<sup>3</sup>

For watertight construction the maximum cement content should not exceed 400 Kg/m<sup>3</sup>

Frequency of sampling:

On first 40 batches : 10 samples  
On remainder : 1 sample per 20 m<sup>3</sup>

#### 6.2.5.2 Trial Mixes

Result of all preliminary tests shall be submitted as soon as they are available and before concrete work starts on site. When tested, the concrete should meet the appropriate requirement specified in BS 5328:1: 1997.

#### 6.2.5.3 Redetermination of Mix Proportions

Mix proportions may be adjusted in accordance with BS 5328:1997, but changes of current margin shall be subject to approval.

#### 6.2.5.4 Ready-Mixed Concrete

Ready-mixed concrete may be used, subject to approval. It shall be produced at an approved depot. The concrete shall comply with BS 5328: 1997, with the specification.



All delivery notes shall be retained by the Contractor and made available for inspection throughout the duration of the Contract.

If at any time the Project Manager is not satisfied that the ready-mixed concrete complies with this Specification he may alter the frequency of the sampling.

#### 6.2.5.5 Chloride Content

The chloride content in steel reinforced concrete at the time of placing shall not be greater than 0.10% by mass of cement.

Primary and/or routine testing may be required depending on the choice of aggregate and/or mixture.

#### 6.2.6 Reinforcement

##### 6.2.6.1 Types of Reinforcement

The types of reinforcement bars will be identified on the Schedules by prefixes to the bar mark numbers.

The prefixes have the following meanings:

R Plain round hot rolled mild steel bars with a characteristic strength of 250N/mm<sup>2</sup> and complying with BS 4449: 2005/SANS 920: 2005

Y Type 2 deformed high yield steel bars complying with BS 4449: 2005/ SANS 920: 2005 with a characteristic strength of 450N/mm<sup>2</sup> for diameters up to and including 16mm, and 450N/mm<sup>2</sup> for diameters exceeding 16mm

Steel fabric shall comply with BS 4483: 2005/ SANS 1024: 2006, and shall be delivered to site in flat sheets.

##### 6.2.6.2 Water Retaining Structures:

Minimum concrete cover from external surfaces, contraction joint surfaces and waterstops to all steel reinforcement shall be 50mm unless shown otherwise on the drawings or as given in the Particular Specifications and maintenance of this minimum cover during casting and concrete shall be strictly enforced. Concrete which is cast with insufficient cover to the reinforcement shall be demolished and re-cast at the Contractor's cost. Tying wire may not encroach on the specified minimum cover by more than a single strand thickness.

Cover blocks used to ensure the cover to reinforcement shall be made of cement mortar. They shall be dense and have a minimum 28 day crushing strength of 50 MPa, and shall be cured in water for at least 14 days before being used. Steeldale cover blocks or similar approved proprietary items may be used - site made blocks will not be permitted. Spacer blocks made of plastic will be permitted upon agreement with the Project Manager.

#### 6.2.6.3 Rust Staining

Concrete surfaces which will be exposed to view the finished Works shall be protected from staining due to rusting of projecting reinforcement either by coating the reinforcement with cement or by another approved method.

#### 6.2.6.4 Dowel Bars

The following grouts may be used for dowel bars:

Vertical dowels:

Hilti HIT-HY 150  
ABE Epidermix 395  
Sikadur 31

Pro-struct 618/632

Horizontal dowels:

Hilti HIT-HY 150  
ABE Epidermix 396  
Sikadur 31

Pro-struct 617

Vertical dowels upside down (unless noted otherwise):

Sikadur 31

Pro-struct 617

### Article 6.3 Concreting

#### 6.3.1 Final Preparation and Inspection

Before each concrete pour the Contractor shall give notice as directed so that an inspection may be made before the concrete is placed.

#### 6.3.2 Mixing

The volume of mixed materials in each batch shall comply with the mixer manufacturer's written recommendations. The mixing shall conform to the requirements of BS 5328: 1997.

#### 6.3.3 Transporting

Runs or gangways for concrete transporters and main runs for foot traffic shall not be supported or allowed to bear on the fixed reinforcement.

#### 6.3.4 Placing

Concrete shall be placed continuously up to construction joints while, in the opinion of the Project Manager, it is still sufficiently plastic for adequate compaction.

#### 6.3.5 Compacting

Unless otherwise specified all structural concrete shall be compacted by mechanical vibrators of appropriate type.

The Contractor shall submit details of the type, size and number of vibrators to be used in the Works. Whenever concrete is being vibrated at least one spare vibrator of each type in use shall be available in case of breakdown.

Compaction shall start as soon as there is sufficient concrete within the formwork to immerse the vibrator and vibration shall continue during the placing operations so that at no time shall there be a large volume of un-compacted concrete in the formwork.

Starter sections of walls, columns, etc., shall be cast and compacted in such a way that their strength and other characteristics are at least equal to those specified for the whole member.

#### 6.3.6 Cleaning

All equipment used for mixing, transporting, placing and compacting concrete shall be thoroughly cleaned before changing from one type of aggregate or cement to another and whenever mixing ceases.

#### 6.3.7 Curing

Concrete shall be cured by covering it as soon as practicable after casting with a layer of sand, hessian or other approved material kept constantly wet during the curing period, or by other approved method.

#### 6.3.8 Concrete in Hot Weather

On exposed concrete surfaces in high sun temperatures and/or strong drying wind conditions the Contractor shall use a curing method which also shields the concrete and this shall be placed in position no later than half an hour after final tamping. If the surface exhibits cracking while the concrete is still plastic then it shall be re-tamped to close the cracks.

Any formwork made of metal, concrete or other material of high thermal capacity shall be cooled with water before the concrete is placed against it.

#### 6.3.9 Striking of Formwork

##### 6.3.9.1 General

Before any formwork is removed the Contractor shall ensure that the concrete has attained sufficient strength for striking to proceed.

The structure shall not be distorted, damaged or overloaded in any way by the removal of the formwork. The responsibility for the safe removal of any part of the formwork or props shall rest with the Contractor.

##### 6.3.9.2 Minimum Striking Period

The minimum periods before removing formwork to structural members shall be established in accordance with Clause (6.2.6.3) of BS 8110 except that Table 3 in this Specification shall be used in place of Table 6.2 of BS 8110. The earlier striking of forms (but not props) may be approved if the Contractor can show that this can be done without damage to the concrete.

The making and testing of cubes to establish the period before striking shall be at the Contractor's expense.

The Contractor's method of measuring the surface temperature of the concrete shall be submitted for the Project Manager's approval.

Members	Minimum period before striking Temperature of Concrete in degrees Centigrade Note less than 16 °C
Beam sides, walls and columns	12 hrs.
Slab soffits (formwork props undisturbed)	4 days
Formwork props to slabs	10 days
Beam soffits (formwork props undisturbed)	10 days
Formwork props to beams	14 days

Permission to strike formwork on the basis of the strength of specially cast cubes will be withdrawn if the Project Manager is not satisfied that the strength of the cube is representative of the strength of the concrete.

Notwithstanding the above, formwork props shall remain in position for at least 3 days.

### 6.3.10 Treatment of Cast concrete

Unless otherwise directed no treatment of any kind, other than that required for curing the concrete, shall be applied to the concrete after removal of the forms until it has been inspected. The Contractor's methods of making good any defects are to be subject to approval in each case.

### 6.3.11 Concrete Finishes

#### 6.3.11.1 General

Unless otherwise indicated on the drawings, formed concrete finishes shall comply with those set out in Table 3, as applicable and are in accordance with BS 8110-1.

Appropriate forms must be used to achieve the required finish. Protective measures must be taken to protect off-shutter concrete surfaces from damage during construction. These measures must be deemed to be satisfactory by the Project Manager.

#### 6.3.11.2 Formed Concrete Finishes

Finishes Class A & B in Table below shall comply with BS 8110-1.

Concrete unexposed to viewing (rendered with plaster/skim at a later stage) is to have a Class A finish, except where the basic as on the sides of foundations. Class A finish is acceptable in locations such as the inside of fire escapes, plant rooms, columns, walls etc.

Concrete which is intended to be exposed to viewing is to have Class B finish. Such concrete elements will be shown on the architectural and structural drawings.

Class	Description	Type of Finish
Basic	Basic	No particular requirement other than to ensure compliance with the clauses of the specification. Only applicable to items such as the sides of foundations.
A	Standard	This finish is obtained using properly designed formwork or moulds of timber, plywood, plastics, concrete or steel Small blemishes caused by entrapped air or water may be accepted but the surface should be free from voids, honeycombing and other blemishes.
B	Fairface	This finish can only be obtained with the use of

high quality concrete and formwork. This concrete should be thoroughly compacted and all surfaces should be true, with clean arises. Only very minor surface blemishes should occur with no staining or discolouration from the release agent. The joints in the shutters are to be in a grid pattern approved by the Project Manager. The use of ferrules and through bolts will be permitted, subject to the Project Manager's approval.

- General: Blemishes such as segregation, honeycombing, water scour, discolouration from leakage or cracking from plastic settlement should be prevented.
- Blowholes: No more than five blowholes of a diameter greater than 5mm shall be allowed in any surface area of 1m<sup>2</sup>.
- Colour Variation: Any colour variation within a construction panel or between adjacent panels, shall not be greater than that shown in quality benchmark panels for this project, or as agreed upon with the Project Manager.
- Lips, Steps & Abrupt changes in Surface: Notwithstanding the general tolerances given elsewhere in this document, all surfaces shall be dimensionally accurate within the following limits:
  - a) Straightness or bow of a wall, column or beam: 3mm maximum deviation from a 3m straight edge held in contact with the surface.
  - b) Steps or misalignment at board, panel or construction joint: 1mm deviation.
  - c) Roundness of circular columns: 2mm permissible deviation from a true semi-circular template held in contact with the surface.
  - d) Variation in a width of joints between precast concrete panels shall be within 5mm tolerance for any one joint.

#### 6.3.12 Trial Panels

In order to ensure that specified formed finishes can be obtained by the method of construction proposed and to provide a standard by which the finishes in the Works can be assessed trial panels shall be cast on site. These panels shall be approved before similar construction is begun in the Works.

The trial panels shall employ the materials, plant and concrete mix proposed for the Works. They shall be at least one storey height and 1m wide. They shall be of similar thickness and similarly reinforced to the elements they represent and shall incorporate all features which may contribute to the final appearance of the work, i.e.

- horizontal and vertical construction joints horizontal and vertical panel joints
- arises and chamfers
- tie bolts or other fixing devices
- means of maintaining concrete cover to reinforcement
- release agent and
- any other feature

### 6.3.13 Surface Beds and screeds

It is the contractor's responsibility to ensure that 500mm of good quality granular fill, approved by the Project Manager, is compacted to 98% MOD AASHTO beneath all surface beds in layers not exceeding 150mm unless notified otherwise.

All surface beds to have a minimum thickness 250 micron DPC below them with adequate laps and turned up to the full depth of surface bed as bond breaker against all block walls on all sides.

Isolation joints to be provided around all concrete columns, walls and around block walls.

Saw-cut joints are to be done as soon as concrete is firm enough not to damage the edges - usually between 6 to 16 hours. Panels to be cut as per structural drawings.

Contractor to take the necessary measures at saw cut joints with regard to tiling joints. Contractor to refer to architectural tiling layout where necessary.

Saw-cut joints to be repeated in the finishes.

## 6.4 Performance and tests

### 6.4.1 General

For all cement and reinforcement delivered to the site the Contractor shall obtain a copy of the manufacturer's certificates of tests carried out at the frequency and using the methods specified in the relevant British Standards.

Certificates for reinforcement shall be accompanied by details of the manufacturer's identification marks rolled into each brand of bar supplied.

### 6.4.2 Testing Facilities

At the commencement of the contract the Contractor shall nominate a Testing Authority for the approval of the Project Manager. The Testing Authority will be fully equipped to carry out all the tests and checks required by this Specification.

### 6.4.3 Testing of Aggregates

#### 6.4.3.1 General

All sampling and testing of aggregates shall be carried out in accordance with BS 812.

#### 6.4.3.2 Preliminary Tests

As soon as the sources of supply of aggregates have been approved the Contractor shall arrange for the following tests to be carried out:

- a) Sieve analyses
- b) Tests for clay, silt and dust content
- c) Tests for salt content

The results of these tests shall be submitted for approval as soon as they are available.

Tests (a) and (b), with tests of the moisture content of each aggregate, shall be carried out on the samples used for each trial mix.

#### 6.4.3.3 Works Tests

The Contractor shall carry out such tests on the aggregate as are necessary for the production of the specified concrete.

#### 6.4.4 Testing of Concrete

##### 6.4.4.1 General

The sampling of works concrete from designed mixes shall be in accordance with 6.4.2 of BS8110:1997 except that samples shall be taken at the mixer or at the point of casting as directed. The frequency of sampling shall be not less than specified in Table 1. In special circumstances an increased rate of sampling may be directed.

At least one sample shall be taken on each day that concrete of that grade is used.

The workability of each sample shall be checked and shall be within the limits given in 6.3.5.2 of BS8110:1997 relative to the value determined for the trial mix.

##### 6.4.4.2 Salts

Tests for salt content of hardened concrete specimens shall be made in accordance with BS 1881: Part 124: 1997.

#### 6.4.5 Ready-Mixed Concrete

Samples of concrete shall be taken in accordance with the requirements of this Specification at the point and time of delivery.

The concrete shall be sampled and tested in accordance with Clause 9 or 15 of BS 5328:1997 and this specification at least once a day for each mix delivered for the first five days on which that mix is delivered and thereafter as directed.

In accordance with Clause 14.4 of BS 5328: 1997 samples of each mix shall be taken at the mixer at least once on every day when concrete of that mix is delivered.

For each sample workability tests shall be carried out and two cubes shall be made, one for test at 7 days and the other for test at 28 days. The results of these tests shall be submitted weekly, with copies of typical manufacturer's certificates for each type of cement used.



#### 6.4.6 Test failure of Works Concrete

The concrete from designed mixes shall comply with the requirements of 6.4.2 of BS8110:1997. Any concrete which does not comply with these requirements will not be accepted.

#### 6.4.7 Batching Plant

##### 6.4.7.1 General

The method of batching the materials and the accuracy of the equipment used shall be such as to satisfy the recommendations of BS 5328: 1997 and clause 6.3.4 of BS8110:1997.

##### 6.4.7.2 Recalibration

Recalibration of the measuring equipment by the manufacturer or his agent shall be undertaken at intervals of not more than 3 months.

##### 6.4.7.3 Mixing Plant

Weigh-batching plant shall be checked weekly or as directed by the Project Manager. The checking shall be carried out with approved weights provided by the Contractor for this purpose.

The water gauging equipment shall be inspected and checked weekly.

If any fault in the mixing plant or water-gauging equipment is detected by these checks or otherwise the fault shall be rectified to the satisfaction of the Project Manager before any further use is made of the equipment.

#### 6.4.8 Setting Out and Tolerances

Tolerances to comply with BS 5606:1990 (or SANS1200)

##### 6.4.8.1 Structural Members

Unless otherwise directed by the Project Manager structural members shall be set out from the references and constructed such that the dimension between any two points on the structure as built or between any point on the structure and any reference shall agree with the required dimension, whether shown on or calculated from the Drawings, within the degree of accuracy indicated in Table 4.

Maximum deviation in mm from required dimension

Position of Member	Maximum			
	Up to 2m	2m to 10m	10m to 30m	Add for each additional 30m
Foundation	10	20	30	5
Superstructure	6	10	20	2.5

The figures given in table above apply to such variables as:-

- Position of plan of any point from nearest grid line.
- Plumb.
- Cross section and other linear dimensions of member.
- Clear dimension between members.
- Bow and camber other than design camber.
- Twist (the distance of any corner from a plane containing the other three corners)
- Squareness of corners (the longer two adjacent sides shall be taken as the base line). Deviation is related to the length of the shorter side.
- Level (measured from the nearest datum).

The Contractor shall advise and consult the Project Manager when the above tolerances are exceeded.

#### 6.4.8.2 Dimensions of Completed Work

The Contractor shall keep records in an approved form of the dimensions of all work as constructed.

These records shall be available for inspection at any time and shall be submitted immediately after completion of each section as directed.

#### 6.4.9 Defective Work

##### 6.4.9.1 Materials and Workmanship

Where any part of the finished Works or materials or workmanship in any part of the works fails to comply with this Specification, that part will not be accepted and may be classed as defective.

All work classed as defective shall be cut and removed from the works or otherwise dealt with in an approved manner.

##### 6.4.9.2 Watertight Construction

In construction specified in the Drawings as watertight, any leaks or damp patches shall be repaired in accordance with CP 102 or as approved at the expense of the contractor.

#### 6.4.9.3 Water bars

Where water-bars are incorporated in construction joints they shall be of approved material and make and design. Water-bars shall be joined in an approved manner.

Before commencing the work the Contractor shall obtain the Project Manager's approval of the methods to be used to support and maintain the water-bars in the correct locations while the concrete is placed.

#### 6.4.10 Load Tests

Test procedures and standards of acceptance will be as directed in accordance with the design.

Where the results of such tests indicate that any part of the Works does not comply with this specification that part of the Works will be classed as defective work.

### 6.5 Reference standards and specifications

- BS 12 : Specification for Portland Cements
- BS 146: Specification for Portland-blast furnace cement
- BS 812: Testing Aggregates
- BS 1881 : Testing Concrete
- BS 2690: Part 6: Methods of testing Water used in industry;  
Chloride and sulphate.
- BS 3148 : Methods of test for water for making concrete  
including notes on the suitability of the water)
- BS 4449 : Specification for carbon steel bars for the  
SANS 920 reinforcement of concrete.
- BS 4483/ : Specification for steel fabric for the reinforcement  
SANS 1024 of concrete
- BS 5328 : Concrete
- BS 8110:1997: Part 1: Code Practice for design & Construction
- CP 102: Code of Practice for protection of buildings against water from the ground.

## Section 7.0 Blockwork Specification

### Article 7.1 General

Concrete blocks shall be provided from an approved source and shall be vibrated and pressed concrete blocks of standard sizes. The source of procurement shall be communicated to the Project Manager. The Project Manager may request for samples. Blocks to be used on site shall have passed the curing period which is not less than 4 weeks from date of production. Blocks shall be marked.

### Article 7.2 Requirements

Concrete blocks shall conform to the following requirements:

		Requirements
Strength	Average of 12 blocks	450 lbs/sq.in. based on gross area.
	Lowest individual block	350 lbs/sq.in. based on gross area.
Drying Shrinkage		For 3 No. specimens, the drying shrinkage shall not exceed 0.04%.
Moisture Movement		Moisture movement shall not exceed 0.3%.
Manufacturer's Certificate		The Contractor shall supply a certificate from the Supplier for each consignment of blocks received on site to the effect that the blocks comply with the specified requirements.

### Article 7.3 Mortar for joints

#### 7.3.1 Mortar Mix principle

Mortar to be used for all blockwork shall be composed of 1 part of Portland Cement and 4 parts of sand with an approved plasticiser mixed in the proportions as recommended by the manufacturer.

#### 7.3.2 Mortar Mixing

All mortar constituents shall be thoroughly dry mixed in mechanical mixers with water and plasticiser added in required quantity until proper consistency is achieved and a homogeneous mix is obtained.

All mortar must be used within thirty minutes of mixing. No partially or wholly set mortar will be allowed to be used or re-mixed.

### 7.3.3 Bedding and Jointing

All blocks shall have been soaked and maintained wet prior to being bedded and jointed to avoid absorption of water from the mortar.

All joints shall be a minimum of 1/2" in thick and shall be raked out 1/2" where surfaces of walling are to be rendered.

### 7.3.4 Laying of Blocks

All walls throughout the works shall be carried up evenly in courses, no part being allowed to be carried up more than 3 feet (90 cm) higher at any one time.

All blocks shall be laid such that all horizontal joints are level and all vertical joints plumb. Out of plumb blockwork panels shall be removed and constructed anew at the contractor's cost. The contractor shall provide a methodology for that purpose.

All fresh mortar joints shall be protected from drying out in sunny/windy weather and washing away in heavy rainfall. A one-day protection period shall be deemed acceptable.

The Contractor shall ensure that newly erected walls are not subject to lateral loads dislocating the joints. Should this occur, the Project Manager shall be entitled to order complete removal of blocks in the zone affected and reconstruction of the said zone to his satisfaction.

No blockwork shall be opened up to allow passage through of scaffolding or any item of temporary work.

Blockwork shall be tied to the reinforced concrete structure as per the Project Manager's instructions.

## **Section 8.0 Rendering and screed**

### **Article 8.1 General**

All surfaces to receive rendering and screed shall be cleaned free of dirt and deleterious materials. All joints to blockwork shall be cleaned and excess mortar from block joints cut and hacked neat to surface. The purpose of rendering is to cover all joints arising of blockwork and to present an aesthetic finish to the building. The Contractor shall ensure that the shade and texture of rendering is not changed during the course of the exercise.

It is advisable to moist the surfaces with clean water prior to rendering.

Concrete floors and concrete surfaces shall be hacked in order to increase the bondage. All hacked surfaces shall be cleaned and washed before screed is applied. A cement paste/glue shall be applied to all surfaces receiving the rendering and/or screed.

### **Article 8.2 Materials**

#### **8.2.1 Cement**

Cement shall be of OPC and shall comply with the requirements of BS 12 or any latest specifications. Cement shall be supplied in bags and properly stored as described previously.

#### **8.2.2 Sand/fines**

Sand for rendering shall comply with the requirements of BS 1199. The use of coral sand will be permitted but Contractor shall seek environmental clearances if so required. Coral sand shall be sieved and washed so that the salt content is negligible.

#### **8.3.3 Admixtures/plasticisers**

Plasticisers shall be allowed and shall comply with the requirements of BS 5075 or ASTM C494 and subject to the Project Manager's approval. Plasticisers shall be added at the expense of the Contractor.

#### **8.3.4 Design mix**

The Contractor shall prepare a mix in the cement:sand ratio of 1:4. A sample application shall be made on a dedicated location directed by the Project Manager/Employer and over a size of 1m x 1m. Internal and external surfaces shall have the same design mix.

#### **8.3.5 Finish**

Rendering shall be applied with wooden float and shall have a neat finish of even thickness. The surface will be checked with a wooden plank having a true face. The Project Manager may direct the removal and replacement of the rendering in case the surface is uneven and/or the gaps between the surface and the plank are excessive.

The finish shall be of sponge type and the thickness shall not be less than 12mm.

#### **8.3.6 Tyrolean finish**

The surface receiving the tyrolean finish shall be prepared with an initial coat of rendering and of thickness not less than 10mm. Tyrolean shall be applied with the appropriate equipment and a sample shall be made first prior to full application. The Project Manager shall direct the Contractor accordingly.

#### 8.3.7 Arises

Arises shall be formed to beams, columns, edges of slabs, holes and cuts in slabs, holes and apertures to receive panels and the like. Vertical and horizontal arises shall be of neat and aesthetically acceptable type of finish but shall be robust and strong to withstand cracks.

#### 8.3.8 Shrinkages

The Contractor shall take due care especially during hot conditions where water is lost easily from the render and leaving cracks behind. The Contractor shall take reasonable steps to keep the render and arises under moist conditions. Covering of surfaces with moist cloth/covers to prevent rapid depletion of water shall be subject to the Project Manager's approval. Where shrinkage cracks are observed the Contractor shall carry out remedial works to the satisfaction of the Project Manager.

## **Section 9.0 Painting**

### **Article 9.1 General**

Paint shall comply with the requirements of MS 3 or any other standards acceptable to the Project Manager and Employer. The Contractor shall submit to the Project Managers' approval the source of procurement and brand name of the paint he intends to use prior to place an order.

Paints shall be supplied in sealed containers having an expiry date. Paint which have not been used prior to expiry date shall be removed immediately from site and discarded in a manner acceptable to the local authority. Such disposal shall be at the expense of the Contractor.

The paint to be ordered shall be in compliance with the colour schemes approved by the Project Manager/Employer and similar to the existing housing units on site. All painting shall be carried out by skilled labour. The contractor shall provide all tools and equipment required for that purpose. Moreover the contractor shall provide all protective equipment for its labour force involved in painting.

### **Article 9.2 Sample paint**

The contractor shall paint a sample area 1m x 1m on a wall surface as directed by the Project Manager/Employer. The Project Manager/Employer will approve the sample and will direct the Contractor to proceed accordingly. Painting shall be carried out in the following manner:-

- Preparation and cleaning of surface. Surface shall be free from dust, dirt, grease and all deleterious materials. Cracks shall be properly filled with approved fillers.
- Application of a sealing coat
- Application of an undercoat
- Application of finishing coat.

The Contractor shall ensure that painting is carried out under conducive meteorological conditions.

### **Article 9.3 Painting to different materials**

#### **9.3.1 Painting to blockwork**

All rendering surfaces shall be prepared and washed to clean them free of dust prior to receive the sealing coat. Internal surfaces shall be painted in one sealing coat and two finishing coats. The emulsion paint type shall be agreed with the Employer prior to procurement.

External surfaces to blockwork shall be prepared as above and paint applied in the following order:-

- One seal coat
- One undercoat and
- Two finishing coats

#### **9.3.2 Painting to timber**

Timber shall be cleaned and prepared prior to application of paint. All cracks and knots shall be sealed prior to application of sealing coat. Two layers of



undercoat and one final layer of finish coat shall be applied. All painting shall be of gloss enamel type.

Contractor shall ensure that all latches, handles and ironmongeries are removed prior to painting.

#### 9.3.3 Painting on steel structure

The Contractor shall thoroughly clean the metal surfaces and all mill scales, rust patches, sharp edges, dirt and grease are removed before painting. All bolts, nuts and washers shall be cleaned prior to application of paint. Steel purlins and sheeting rails shall be painted in the same manner as structural steel.

Additives and thinners added to paint shall receive prior approval from the Project Manager before use.

#### 9.3.4 Painting to non-galvanised metal surface

All metal surface shall be cleaned and free from dirt and scales. All welding surface and bead shall be cleaned from the black scales and polished to a neat surface texture. A first coat of red lead primer shall be applied to the whole metal surface. This coat shall be followed by a second primer coating after fixation to position. The third and final coat shall be of gloss enamel paint.

All paint shall comply with the requirements of BS 4800.

#### 9.3.5 Painting to galvanised metal surface

The surface of galvanised metal shall be treated in a manner that the dirt and scales are removed completely.

- The initial surface treatment shall be of etching primer.
- The second application shall be of a lead based primer as approved by the Project Manager
- The finish coating shall be made in two application of high gloss enamel paint.
- The interval of application between two successive coats shall not be less than 24h.

#### 9.3.6 After completion

Once painting activity is completed the Contractor shall mobilised unskilled labour for the general cleaning of marks, stains and paint sprays and drops left over surfaces. Such activity shall not commence before 24h of last application of paint. The Project Manager shall inspect all cleaning works and provide his approval accordingly.

#### 9.3.7 Colour scheme

Colour of paint shall be approved by the Project Manager/Employer prior to final application.

### **Article 9.4 Varnish**

Wherever specified and/or directed the Contractor shall apply varnish to timber and wooden surfaces. The surfaces receiving varnish shall be prepared to a smooth finish and cleaned from dirt, dust and the like. Varnish type and source of procurement shall meet the Project Manager's approval

prior to placing of order. The varnish shall be of gloss type unless directed otherwise.

## **Section 10.0 Aluminium Openings**

### **Article 10.1 General**

Windows and doors openings shall comply with the schedules provided in the drawings and/or as directed by the Project Manager/Employer. The Contractor shall submit information on the source of procurement of the aluminium frames and glazing.

### **Article 10.2 Shop drawings**

#### 10.2.1 Design

The Contractor shall submit the following:-

Manufacturing drawings and specifications of materials intended to be used for the fabrication of openings

A detailed design (shop drawings) including design notes/calculations carried out and certified by a registered professional civil/structural engineer. As a guide the design wind speed shall be taken as 280 km/h. The design shall incorporate and compensate for expansion and contraction, deflection, distortion and other incidental as a result of operation. All design and materials specifications shall comply with the requirements of BS 8118 Part 1- 1991- Use of Structural Aluminium - Code of Practice for design. Glass panels to be used in the openings shall comply with the requirements of BS 6262-3: 2005 – Glazing for Buildings. Wind load designs shall comply with the requirements of CP 3 Chapter V, Part 2: 1972 Wind Load.

All design notes and drawings shall be submitted to the Project Manager in 3 sets hard copies. The Contractor shall not place any order prior to having received the approval on the designs submitted. Therefore the Contractor is advised to submit the design notes and drawings at latest 6 weeks from order to commence.

The contractor shall submit full details of assembly, brackets, connections pieces and the like as well as brochures and catalogues that contain sufficient information for the Project Manager/Employer to give their approval.

The Project Manager may request for samples of aluminium sections and glass intended for use for approval.

#### 10.2.2 Materials

Materials to be used for the fabrication shall comply with the following:

- Extruded aluminium sections 6063-T5
- Sheet hand plates
- Steel sections
- Toughened glass complying with the requirements of BS 952
- Approved sealants and joints
- Colour as per scheme provided
- Finish to Project Manager/Employer's choice

The Contractor shall provide a warranty of 3 years on all openings and materials used for the fabrication.

### 10.2.3 Opening fabrication

The openings shall comprise, inter alia, of:-

- All assembly accessories that will render them watertight and resistant to cyclonic gusts
- Maintain dimensions as per schedules provided
- Brackets and supports for the stability of the openings
- Be of type (sliding or hinged) as specified in the schedules
- Be easily maintained
- Providing for removable frame buttons at concealed closers
- Assembly of fittings in the factory
- All hardware

The above is a non-exhaustive list and the Project Manager/Employer reserves the right to seek additional information on the fabrication.

### 10.2.4 Delivery to site and placement to position

#### 10.2.4.1 Delivery

Finished products shall be delivered to site by batches. They shall be protected to prevent damage. The delivery and storage shall be the sole responsibility of the Contractor. Any damage and scratch to openings arising out of the delivery, storage and fixing shall be immediately removed from site and replaced in a reasonable time frame.

The openings shall be stored on site in dedicated storage areas. Such areas shall not have direct sunlight and shall be weatherproof.

#### 10.2.4.2 Placement to position

Openings shall be placed as per schedules. Appropriate drainage shall be allowed for condensed water especially at cill positions. Such Gap shall not exceed 8mm.

Proper tolerances shall be incorporated in the operable components.

Damp proof materials such as asphaltic paint shall be applied on the metal pieces at concrete interface.

Openings shall not cause any noise, vibration, screech, rattling and the like during operations.

All frames for openings to be sealed in position by rubber based gasket products. Sealants applied by gun method to be approved by the Project Manager. Excess sealant materials to be removed immediately after application.

All doors and windows shall have stoppers as directed by the Project Manager/Employer

Glazing to openings shall be as per approved thickness, hard, tempered and robust. It shall bear no cracks, scratches or marks.

#### 10.2.4.3 Testing and handing over

The Contractor shall perform tests on all opening to demonstrate performance against air and water ingress. The following standards provide guidelines for the tests:- BS 4873, BS 5368, BS 4315.

### **Article 10.3 Warranty**

The Contractor shall provide a Warranty Certificate for all the openings fixed in the housing units for a period of 3 years. All faulty parts and/or malfunctioning of the system shall be replaced within a period of 1 from the day of notification by the Employer. In case this is not carried out the Employer may seek other alternative and would pass on the charges to the Contractor.

The cost of materials, design, installation, fixing, handling, transportation, storage, warranty and the like shall be deemed to be covered on the rates inserted in the BoQ.

## Section 11.0 Electrical works

### Y60 CONDUIT AND CABLE TRUNKING

#### Article 11.1 GENERAL

##### 11.1.1 STANDARDS:

Conduit and cable trunking shall be provided in accordance with the relevant British Standards and in particular the requirements of BS 7671 Requirements for Electrical Installations (The IEE Wiring regulations).

#### Article 11.2 PRODUCTS/MATERIALS

Type of packing - Type A; unpacked.

Type of sheath - Low smoke and fume material.

Fittings material - Brass adaptors to BS 731 Part 1.

#### Article 11.3 CONDUIT - NON-METALLIC RIGID:

Material - Insulating conduit to BS 4607 Part 1.

Connections: Slip joints shall not be used. Expansion couplings with solvent solution shall be used.

#### Article 11.4 CONDUIT - NON-METALLIC FLEXIBLE AND PLIABLE:

Material: Insulating conduit to BS 4607 Part 1

Method of connection - Threadable conduit.

Connections: Plastic adaptors and bushes shall be used

Male adaptors shall be used to connect flexible conduit to motors and any other equipment having a threaded entry.

Female adaptors and externally screwed bushes shall be used to connect flexible conduit to trunking and equipment not having a threaded entry.

#### Article 11.5 CONDUIT FITTINGS AND ACCESSORIES - INSULATING TO BS 4607:

Conduit fittings and adaptable boxes Factory made bends, inspection bends or inspection couplers shall **not** be used. Boxes and connections to suit size of conduit and method of jointing shall be used. Heavy gauge, high impact rigid PVC conduit fittings shall be used.

All boxes shall be provided for supporting luminaires or other heavy devices with metal brackets or insert clips to provide a support independent of the box.

Boxes shall be provided for flexible conduit, accessories and luminaires connection with a brass earthing terminal and/or steel circular earthing ring.

Conduit fixing saddles - Spacer bar or hospital.

Plugs - Spout entry plug.

#### Article 11.6 CABLE TRUNKING AND FITTINGS:

Comply with BS 4678. Trunking of each type from one manufacturer shall be used.

#### Article 11.7 SERVICE OUTLET BOXES:

Service Outlet boxes and junction boxes constructed from sheet steel with same finish as trunking shall be provided. Continuity and segregation of compartments shall be maintained through boxes and fit flyovers where necessary.

Service outlet boxes shall be provided with separate and segregated access to outlets associated with each wiring compartment. Cable guard or grommet shall be fitted to each section.

Spigots shall be incorporated on boxes for connection to trunking.

Frames shall be made adjustable on each corner, recess lids as indicated on drawings.

Frame and lids shall be manufactured for service outlet boxes and junction boxes of cast metal, and suitable to accept type of floor covering.

#### *Outlet plates*

Outlet plates shall be provided for each low voltage compartment equipped with socket outlets as scheduled or indicated on the drawings.

Outlet plates shall be provided for each extra low voltage compartment equipped with items as scheduled or indicated on the drawings.

Blank outlet plates shall be provided for any unused compartments.

#### **Article 11.8 PVC SURFACE TRUNKING - GENERAL PURPOSE:**

Trunking to comply with BS 4678 Part 4

Mechanical properties, trunking for medium mechanical stress Temperature tolerances - BS 4678 Part 4, Table 1.

Resistance against ingress of solid objects

Protected against dripping water (1PX2)

Resistance against corrosive or polluting substances

Medium protection.

#### *Fittings*

Fittings from same manufacturer as trunking shall be used.

'snap-on' covers shall be used. Trunking fittings and accessories suitable for jointing by solvent welding shall be used.

Proprietary cable retaining clips at 500 mm maximum intervals on trunking that exceeds 1.8 m in length shall be used. Where junctions occur ensure first clip shall not be more than 300 mm from junctions.

#### **Article 11.9 PVC SURFACE TRUNKING - SKIRTING TRUNKING:**

Trunking to comply with BS 4678 Part 4

Mechanical properties, trunking for medium mechanical stress.

Temperature tolerances - BS 4678 Part 4, Table 1.

Resistance against ingress of solid objects

Protected against ingress of solid objects greater than 1.0 mm (IP4X).

Resistance to ingress of water

Protected against dripping water (IPX2).

Resistance against corrosive or polluting substances

Low protection.

#### *Fittings*

Fittings from same manufacturer as trunking shall be used.

'Snap-on' covers shall be used. Trunking fittings and accessories suitable for jointing by solvent welding shall be used.

Proprietary cable retaining clips at 500 mm maximum intervals on trunking that exceeds 1.8 m in length shall be used. Where junctions occur it shall be ensured first that clip is not more than 300 mm from junctions.

#### **Article 11.20 SEPARATE OR MULTI-COMPARTMENT TRUNKING:**

Separate trunking or multi-compartment trunking shall be used for segregation of services. It shall be ensured that steel partitions have a provision for connecting a circuit protective conductor.

Separation of wiring shall be provided for circuits as required by BS 7671 and as indicated on the schedules or drawings.

#### **Article 11.21 PROPRIETARY SUPPORTS AND FIXINGS:**

Proprietary suspension systems comprising channel sections with return lips and compatible fixing accessories made of material to BS 2994 or BS 4848 and/or slotted angles to BS 4345 shall be provided.

### **Article 11.22 CONDUIT SUPPORTS AND FIXINGS:**

It shall be ensured that support components for Class 4 conduit have the same finishing method as the conduit carried out after manufacture. It shall be ensured that components in direct contact with conduit match profile of conduit.

It shall be ensured that all steel components such as studding, bolts and steel screws, bolts, nuts and washers are either cadmium plated or zinc electroplated to BS 3382 after manufacture. Metal fixing components likely to deteriorate and/or cause damage through electrolytic action shall not be used.

### **Article 11.3 GENERAL WORKMANSHIP**

#### **11.3.1 GENERAL:**

It will be ensured that entire system is electrically and/or mechanically continuous, conformed to BS 7671.

*Fire barriers:* Comply with the requirements of BS 7671 wherever the conduit or trunking passes through the perimeter of a fire compartment (wall, floor or ceiling).

*Appearance:* Conduit, trunking and ducting shall be arranged to present neat appearance, parallel with other service runs and lines of building construction, except where in screed or in-situ concrete. Plumb vertical runs shall be ensured

#### *Cable installation*

Cable in conduit, trunking or equipment enclosures shall be installed only when completely erected throughout its length.

Framework of partitions or similar shall not be used unless indicated.

#### *Building expansion and settlement*

Provision shall be made in conduit and trunking at expansion and settlement joints to allow for movement of building structure. Circular through or adaptable boxes not more than 300 mm either side of expansion or settlement joints for conduit crossing shall be provided.

Boxes shall be joined with flexible steel conduit type A or conduits arranged to form a telescopic joint and cover overall with PVC sleeve to provide minimum degree of protection of IP44 or purpose made telescopic joint protected by a PVC sleeve to at least IP44.

*Quality:* Conduit shall be cut clean and square with axis. Any burrs prior to erection shall be removed.

Site shall form 90° in conduit wherever practical or use circular or adaptable boxes. Bends and sets cold with a bending machine shall be constructed. Heat shall be applied when forming sets or bends.

Bending tools complying with British Standards appropriate to conduit material shall be used.

It shall be ensured that no indentation or reduction in cross sectional area occurs during installation.

Correct tools shall be used to assemble conduit. It shall be ensured that no tool marks or damage to components occurs.

#### **11.3.2 LAYOUT:**

It shall be ensured the maximum circuit lengths and groupings of cables indicated are not exceeded.

#### *Conduit sizing*

Where dimensions are not indicated trunking and conduit sizes shall be selected in accordance with Appendix A of Guidance Note 1 Selection and Erection published by the IEE.

#### **11.3.3 SPACING:**

Conduit, trunking and equipment shall be installed clear of other services. Distance from surface of any thermal insulation shall be measured. Instances shall be notified where minimum clearance cannot be achieved and bond items concerned. Minimum general spacings between conduits, trunking and equipment and



: insulated steam services - 300 mm  
: other services excluding steam - 150 mm  
: above central heating radiators - 1000 mm  
: ensure separation is in accordance with Appendix K of Guidance Note I Selection and  
Erection published by the IEE.

#### **11.3.4 CONDENSATION PREVENTION:**

Conduit and trunking systems shall be installed to ensure internal condensation would not affect operation of associated circuits. Drainage points shall be provided in accordance with BS 7671.

Where conduit passes through external wall between two areas of different ambient temperatures or in other locations likely to cause condensation, a conduit or adaptable box shall be installed. After wiring box shall be filled with inert, permanently plastic compound with high insulation value.

#### **11.3.5 EQUIPMENT CONNECTIONS:**

Where surface mounted equipment is installed in connection with concealed conduit work, concealed conduit shall be terminated at flush mounted conduit or adaptable box. Back of equipment, bush for back entry and mount equipment shall be drilled to conceal back box.

Fixed equipment shall be connected via conduit box located adjacent to termination point, using either solid or flexible conduit as indicated for final connection to equipment terminations.

Conduit box shall be used as cable change point to facilitate changed wiring locally to adjacent equipment.

Trunking shall be connected to equipment by specially fabricated connectors or by couplers and externally screwed brass bushes.

#### **11.3.6 CLEANING BEFORE WIRING:**

Inside of conduits and trunking shall be cleaned with swabs immediately before wiring.

All components shall be inspected and any foreign matter shall be removed, shall fit temporary plugs to open ends of conduit and trunking to prevent ingress of water and solid material.

#### **11.3.7 WIRING:**

When wiring, BS 7671: 2008 shall be complied with.

Circuits shall be segregated as indicated.

It shall be ensured that draw wires be left within empty conduits for use of specialist installers. Draw wires comprising nylon tapes with fitted eyelets shall be used.

It shall be ensured that system is installed for concealed conduit to enable re-wiring to be carried out from boxes for fittings or accessories only. Draw-in boxes will only be permitted with prior permission in writing.

Tallow or any other substances to facilitate drawing-in of cables shall not be used.

#### **11.3.8 BUILDERS WORK:**

It shall be ensured that conduit is not concealed until work has been inspected and approved.

Permission shall be obtained before horizontally chasing walls.

It shall be ensured that conduit and fittings buried in concrete or behind plaster are protected against corrosion or electrolytic action prior to rendering.

It shall be ensured that conduit concealed in wall is covered by plaster and/or rendering to minimum depth of 12 mm.

## **Article 11.4 WORKMANSHIP FOR CONDUIT**

### **11.4.1 DRAW-IN BOXES:**

Draw-in boxes shall be provided in conduit at maximum intervals of 10 metres or after bends and/or sets totalling 180 degrees.

### **11.4.2 INSTALLATION OF CAST IN OR BURIED CONDUIT:**

It shall be ensured that cast-in conduits are firmly secured to reinforcing steelwork and that accessory and/or conduit boxes are secured so that they do not move during subsequent building operations.

It shall be ensured that there is no blockage when shuttering is removed.

It shall be checked that there is no mechanical damage to conduit in floor screed prior to screeding.

Temporary protection shall be provided to conduits until screeds are laid.

It shall be ensured that minimum amount of cross-overs occur dependent upon screed depth. Draw boxes in floors shall not be installed.

Conduits shall not be installed: In screeds in areas indicated, Within site blinding, In main structural slabs unless prior permission in writing is obtained.

### **11.4.3 CONDUIT BOXES:**

It shall be ensured that wherever conduit boxes are cast in the face of the box, the boxes must be flushed with the face of the concrete or plaster. Circular conduit boxes shall be fitted with extension rings to ensure a flush face with plaster or concrete or where terminal blocks are to be accommodated.

It shall be ensured that fixing holes are countersunk where material thickness allows or use round head screws to prevent damage to cables and remove burrs before cables are drawn in.

A minimum of two screws fixing for standard circular conduit boxes and four screws for large conduit boxes and adaptable boxes up to 150 mm x 100 mm shall be used.

Back outlet boxes shall be used where surface conduits pass through walls, to outside accessories or lighting points.

Switch boxes and socket boxes using counter-sunk steel screws shall be secured where provision is made for them or if not use round head screws. Plug inserts shall be used and finally grout in position prior to plastering or screeding.

### **11.4.4 FIXING CONDUIT:**

Support conduit in accordance with Appendix I of Guidance Note I Selection and Erection published by the IEE.

It shall be ensured that conduit is not under mechanical stress. Conduit boxes shall be fixed independently of conduit. Allowance shall be made for any additional mechanical loading supported by conduit boxes.

Where protection is specified as IP44 or greater it shall be ensured that fixings of conduit boxes are suitable to maintain degree of protection.

The following methods of fixing conduit shall be used:-

#### **LOCATION TYPE OF FIXING**

Floor screeds Saddles or crampets

Buried in plaster or render Crampets or saddles

Above false ceilings Saddles

Surface Saddles

### **11.4.5 FLEXIBLE AND PLIABLE CONDUIT:**

Flexible conduit shall be used for final connections to motors, other equipment subject to vibration or adjustment and to thermostats, motorised valves and similar items mounted in pipelines or ducts.

Sufficient length shall be used between equipment and circular through box at end of conduit run (minimum 450 mm) to allow necessary full range of withdrawal, adjustment or movement.

Solid type adapters shall be used to terminate flexible conduit.

Covered flexible conduit shall be used where installed externally, exposed to weather or in any position where ingress of moisture or condensation may occur.

#### **11.4.6 NON-METALLIC CONDUIT:**

Manufacturer's instructions for bending, setting and jointing of conduit shall be complied with. Plastic conduit shall be used only where indicated.

Conduit shall not be installed when ambient working temperature is or will be below -5°C or above 60°C.

Solvents recommended shall be used by manufacturer of conduit when using solvent welded joints and it shall be ensured that spigots enter full depth of sockets. Hold joints rigid and in position until weld sets. Excess solvent shall be removed before surface damage occurs.

Slip joints shall be used as necessary, but not exceeding 6 metres on straight lengths to allow for expansion and contraction over temperature variation as indicated. Semi-mastic adhesive shall be used where expansion joints are formed.

Where fittings do not have shaped or smooth conduit entries shall be connected with male bushes and external couplings.

It shall be ensured that special care is taken to prevent mechanical damage or warping to conduit where mechanical loads are imposed on conduit system, e.g. lighting fittings.

#### **11.4.7 UNDERGROUND INSTALLATION:**

Where buried below ground, use Class 4 conduit. Any buried conduit boxes unless prior permission in writing has been obtained. Conduit shall be wrapped with PVC self-adhesive tape, half lapped. Taping

150 mm shall be extended beyond point where conduit leaves ground.

Circular through conduit boxes shall be installed at the end of the tape. Conduit boxes shall be filled after cable installation with inert, permanently plastic compound with high insulation value, and wrap in PVC self-adhesive tape.

### **11.5 WORKMANSHIP FOR TRUNKING**

#### **11.5.1 MANUFACTURE OF TRUNKING:**

Measurements shall be taken on site before producing drawings for manufacture of trunking.

#### **11.5.2 ACCESS:**

Trunking shall be arranged to allow access to wiring. Covers on top or sides of trunking shall be located. Access shall be arranged so that covers are not on a continuous face and cables can be laid in throughout the length of the trunking. It shall be notified where either condition cannot be achieved.

#### **11.5.3 FIXING TRUNKING:**

It shall be ensured that trunking is independently fixed and supported from building fabric. Approval shall be obtained for proposed fixings/supports.

Trunking shall be supported in accordance with the manufacturers' requirements and/or Guidance Note 1 Selection and Erection published by the IEE.

Two fixings minimum shall be used per standard length.

### **11.6 HV/LV CABLES AND WIRING**

#### **11.6.1 GENERAL**

##### **11.6.1.1 CABLE MANUFACTURE:**

New cables, delivered to site with seals intact, manufactured not more than one year prior to delivery, labelled with manufacturer's name, size, description, BS number, classification, length, grade and date of manufacture shall be used.

**1.6.1.2 CABLE CERTIFICATION MARKING:**

All types of cable shall be marked with CENELEC cable certification marking or if included in British Approvals Service for Electric Cables (BASEC) in accordance with BASEC regulations.

**11.7 PRODUCT/MATERIALS**

**11.7.1 STANDARD ORDINARY FLEXIBLE WIRES - SINGLE CORE:**

Standard - BS 6004, Table 1 (c); BS 6500, Table 19.

**11.7.2 STANDARD LSF FLEXIBLE WIRES - SINGLE CORE**

Standard - BS 7211, Tables 3(b) and 4(b).

**11.7.3 STANDARD HEAT RESISTING (95oC OR MORE) FLEXIBLE WIRES - SINGLE CORE:**

Standard

BS 6004, Table 8(b); BS 6007, Tables 6, 7(c) and 8(b); BS 6141, Tables 4 and 5.

**11.7.4 STANDARD ORDINARY FLEXIBLE CORDS - MULTI-CORE**

Standard

BS 6007, Table 3 and Table 4; BS 6141, Tables 8, 10 and 15; BS 6500, Tables 6, 8, 16 and 18.

**11.7.5 STANDARD WIRES FOR CONDUIT AND TRUNKING, PVC INSULATED:**

Standard - BS 6004, Tables 1(a) and 2.

Mechanical protection - Conduit and trunking.

**11.7.6 STANDARD WIRES FOR CONDUIT AND TRUNKING, LSF INSULATED:**

Standard - BS 7211, Tables 3(a) and 4(a).

Mechanical protection - Conduit and trunking.

**11.7.7 STANDARD WIRES FOR CONDUIT AND TRUNKING, 90°C PVC INSULATED:**

Standard - BS 6004, Tables 8(a) and 9.

Mechanical protection - Conduit and trunking.

**11.8 Earthing**

All electrical circuit shall be earthed. Contractor to provide all materials for that purpose.

**11.8 Shop drawings & As-built drawings**

A typical design for power supply to the housing unit is attached in the drawings. Positions of switches, sockets light sources have been placed indicatively. The Contractor shall submit to the Project Manager 3 sets of detailed drawings and design notes for all electrical works to be incorporated in the housing unit. The shop drawings shall be submitted not later than 21 days from order to commence. The electrical circuit shall start just after the meter provided by the Central Electricity Board.

As-built drawings shall be submitted in 3 hard copies and 1 ACAD (2010 version) not later than 15 days from the date of Practical Completion.

**11.9 Testing and Commissioning**

After completion of the works the Contractor shall carry out all testing of the circuits and certified by a Registered Professional Engineer (Electrical). The CEB would be called to carry out the final connection once the testing is completed.

## SECTION 12 - SITE CLEARANCE AND EARTHWORKS- ROADWORKS

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## **SECTION 12 - SITE CLEARANCE AND EARTHWORKS-ROADWORKS**

### **Article 12.1 - Mass Diagram**

As required by Article 1.12, the Contractor shall prepare a mass diagram showing in as much detail as the Engineer may consider necessary the programmed movement of the earth for measurement purposes. The programme for earthworks shall be submitted for the approval of the Engineer before the commencement of the Works. Such approval shall not be deemed to relieve the Contractor of any of his responsibilities under the Contract. The Contractor shall before preparing his earthworks programme, carry out such soil testing as necessary to determine the suitability of materials for use in the Works.

### **Article 12.2 - Existing Structures and Services**

The site does not have any structures nor any buried services on the road alignment. However, Contractors shall excavate trial pits at regular intervals to ascertain themselves on sub-soil conditions. These would be construed as preparatory works and shall be at the expense of the Contractor.

### **Article 12.3 - Demolition And Dismantling**

The Engineer must be given 7 days' notice of any proposal to demolish or dismantle all or any part of the existing structure on the Site, which is necessary for the completion of the Works.

The Contractor shall give the Engineer an explanation of the method and order of demolition and the steps taken to ensure the safety and stability of any remaining structure affected thereby.

The approval of the Engineer shall not relieve the Contractor from his responsibility for injury, loss, inconvenience and annoyance to persons, damage to animals, property and Works consequent on the demolition and dismantling.

### **Article 12.4 - Demolition of Masonry, Concrete, and Reinforced Concrete Structures**

Demolition of existing masonry, concrete, reinforced concrete structure shall be carried out in accordance with the Contractor's methodology as approved and directed by the Engineer.

The Works as directed by the Engineer shall include: -

- Demolition (reinforcement shall be cut off close to concrete)
- Removal of material
- Loading, carting away & disposal of material at an approved location as directed by the Engineer
- Filling under embankment of all inspection pits and openings made in connection with the removal of these structures to the original ground or to the lines and levels as directed by the Engineer, to be levelled with an approved material compacted to a density at least equal to that of the surrounding ground or as directed by the Engineer.



## **Article 12.5 - Site Clearance**

Clearing site shall consist of clearing the ground of trees, bush, hedges, fences, shrubs, stumps, rubbish, loose boulders, piles of boulders and other objectionable material excluding soil and rock, including disposal from areas shown on the Drawings or as directed by the Engineer, and shall include the grubbing up of all root and backfilling with approved materials of all cavities caused by the clearing to a density at least equal to that of the surrounding ground. Clearing shall also include removal of hard surface, remnants of old structures, damaged concrete, remediation works to disused septic tanks, pits, ditches, man-made canals all in conformity with inventory made during handing-over of site. The Contractor shall acquaint himself of present site conditions while preparing his offer.

The Works include the loading, carriage and disposal of all materials to tip as directed by the Engineer.

## **Article 12.6 - Cutting of trees**

Trees defined as having a girth of 1,000 mm, measured 1,000 mm from the ground shall be cut by the Forestry Service or by owners, at the request of Engineers. Otherwise, this work shall be carried out by the Contractor and paid under day work schedule. The Contractor must seek the approval of the Forestry Service prior to the removal of any trees.

The removal of stumps and roots of such trees as defined above, is included in the works. Holes left by the removal of stumps and roots shall be backfilled and compacted to 90% B.S. Heavy Compaction with approved materials up to the top of the sub-grade level or as directed by the Engineer.

## **Article 12.7 - Ownership Of Materials**

Materials, components and other items which the Contractor has demolished, dismantled or otherwise removed in compliance with the Contract shall remain the property of Employer unless and until the Contractor is informed in writing by the Engineer that ownership of all or any of the materials, components and other items belong to a third party.

## **Article 12.8 - Classification Of Excavated Materials**

### **12.8.1 Topsoil**

Topsoil shall consist of a material containing vegetable root system existing in a thin layer on the natural ground surface complying with Article 2.9 of these Technical Specifications.

### **12.8.2 Approved Material**

Approved material shall consist of all material complying with Articles 2.7 and 2.8 of these Technical Specifications or which, in the opinion of the Engineer, is suitable for incorporation in the construction.

### **12.8.3 " Rock"**

Rock is defined as all materials, which in the opinion of the Engineer, require blasting or the use of metal wedges and sledgehammers, or the use of compressed air drilling for their removal and which cannot be extracted by ripping with a tractor of at least 300 brake HP with a single, rear mounted, heavy duty ripper. Tractor shall be in good order, operating weight forty (40) tones, operated by qualified operator.

#### 12.8.4 Power Of The Engineer

Should any difference of opinion arise between the Contractor and the Engineer, as to the classification of the material, the Engineer's decision shall be final.

### **Article 12.9- Removal Of Top Soil**

Where embankment/subgrade will be constructed on natural ground, removal of topsoil depth shall be directed by the Engineer, shall be stripped after clearing and grubbing. In the fill areas containing humus or other deleterious materials harmful to the stability of road, the Engineer may order for a depth greater than 300 mm within the area designated. The stripped area shall be compacted as per Article 4.26. The stripped materials shall be stockpiled for use on the surfaces before turfing and surplus material shall be disposed off as directed by the Engineer to a site identified by the Contractor and approved by the Engineer at any distance from the work site.

Where the removal of topsoil has not been specifically directed, any top soil excavated shall be deemed to be part of the general excavation.

### **Article 12.10- Dewatering**

During construction of the roadway and parking lots, the roadbed shall be maintained in such a condition that it is well drained at all times. In order that the embankment, subgrade, sub-base and/or base may not be subject to wetting, during or after construction, the Contractor shall at all times, and especially at an early stage of the work be required to provide adequate drainage by scheduling ditch work and outlet construction so as to prevent such wetting. The Contractor shall clean and trim all such drainage ditches from time to time during the work or when directed by the Engineer, so that there may be a free water flow throughout the whole period of work. The Contractor shall immediately repair damage attributable to wetting through failure to provide such measures.

No separate payment shall be made for this work as these are deemed to be included in the relevant items of the Bill of Quantities.

### **Article 12.11 - Excavation**

12.11.1 "Excavation" shall consist in the loosening, digging, loading, hauling and disposal of normal, soft, rippable, loose, unsuitable and boulders materials to the lines, levels, slopes and widths shown on the Drawings or as directed by the Engineer. It shall include compaction, finishing and shaping of all surfaces formed by such excavations in accordance with these Technical Specifications.

The Contractor shall take special care for the saving of all suitable excavated materials for embankment or subgrade construction.

- 12.11.2 Removal of existing structures, site clearance, removal of topsoil and removal of unsatisfactory material shall be carried out in proper sequence so that one operation does not interfere with another. Sufficient time shall be allowed between each operation for any measurement required by the Engineer to be carried out and the Contractor shall not proceed with any other operation until such time as any measurement has been agreed and approved.
- 12.11.3 Where a firm foundation is not encountered at the bottom of the excavation due to presence of soft, spongy or other unstable material, the Contractor shall, at his own expense, remove such unstable material and replace with approved material thoroughly compacted to a density not less than 95% B. S. Heavy Maximum Dry Density.
- 12.11.4 All excavations shall be carried out in such a manner that the back slopes are neatly trimmed to the lines shown on the Drawings or as directed by the Engineer.
- 12.11.5 Where excavation reveals a combination of suitable and unsuitable materials, the Contractor shall, wherever the Engineer considers it practicable and so directs, carry out the excavation in such manner that the suitable materials are excavated separately for use in the works without contamination by the unsuitable material.
- 12.11.6 In wet weather clay cuttings shall not be excavated and shall not be taken down to less than 25 cm above final level of the subgrade.
- 12.11.7 The Contractor shall take all necessary precautions to prevent slips and falls to the sides of the excavation, but if any should occur, the Contractor shall remove, at his own expense, all such fallen or displaced materials and replace if required with suitable material compacted to a density not less than that of the adjoining ground at his own expense.

#### **Article 12.12 - Road Excavations**

Road excavations will be carried out in order to cart away unsuitable materials from existing pavement to widen carriageway or shoulder or adjust level of existing road.

They shall consist in excavation of any material from pavement or subgrade to such a depth as shown on the Drawings or as directed by the Engineer.

The works include:

- Dismantling and removal of existing cats eyes
- Scarifying, loosening and digging asphaltic material from the carriageway shoulder or verge

- Loading, carting away and disposal of all materials in spoil tips, temporary stockpiles or in subgrade of new pavement as directed by the Engineer
  - Shaping and Compaction of the bottom of the excavation to 95% B.S. Heavy Compaction or as directed by the Engineer.
- Excavation in any other material except bituminous materials shall be paid as normal excavation.

#### **Article 12.13 - Borrow Pits**

12.13.1 Before opening of any borrow pits for the removal of material for forming embankments, the Contractor shall submit his proposals for the carrying out of the work, in writing, for the Engineer's approval.

The proposals shall state the location of the proposed borrow-pit, the thickness of topsoil or unsuitable material to be removed, the depth of suitable material to be excavated, the type or types of material to be secured and the areas for stockpiling top soil to be reused to cover the borrow pit area. Any modification that the Engineer may require shall be made by the Contractor.

The approval of the borrow pit area by the Engineer shall not relieve the Contractor of his obligations to ensure that all the material used as fill is as approved by the Engineer.

The Contractor may be required to mix the materials excavated by bulldozing into stockpiles and face loading by shovel into lorries.

12.13.2 The Contractor shall be responsible for the access to any borrow pits, quarries or stockpiles.

Any cost, rent royalties or fees which can arise in connection with access to such areas shall be borne by the Contractor and are assumed to be included in Bill No. 1 and Bill No. 2.

12.13.3 On completion of the excavation of borrow pit material, the Contractor shall leave the borrow pit in a tidy condition, top soil being replaced to cover completely the borrow pit area as directed by the Engineer. Where borrow pits are required to be drained, the Contractor shall do so at his own expense and in a manner as approved by the Engineer.

#### **Article 12.14 - Use Of Explosives**

Blasting is strictly forbidden.

#### **Article 12.15 - Preparation Prior To Embankment Construction**

12.15.1 The construction of embankment shall not commence until the work under Articles 12.1 to 12.10 of these Technical Specifications has been completed as directed.

If after topsoil stripping the ground is considered unacceptable by the Engineer, the Contractor shall excavate to such depths as required and dispose of the material to spoil tips as directed.

12.15.2 The Contractor shall execute all works necessary to drain the natural ground prior to forming of the embankment. Should any subsequent embankment filling be adversely affected through lack of such drainage, the Contractor shall remove and replace it at his own expense.

12.5.3 Prior to placing fill material in embankments, the Contractor shall compact the top 30 cm of the natural ground in accordance with Article 4.17 and Article 4.20.

#### **Article 12.16 - Proof Rolling Section**

Before commencing any embankment construction, the contractor shall, at his own expense, carry out compaction trials by establishing proof rolling sections. The purposes of these trials are to determine, for each main type of materials to be used in embankment, subgrade, sub base, base and bituminous courses, the proper compaction plant to be used, the number of passes and the thickness of loose material for each layer, in order to achieve the required degree of compaction and a minimum value for the deflection under a 8.2 tons axle load.

The trial stretch shall be of such length and width as directed by the Engineer, and in no case shall be less than one lane in width and 100 m in length.

The Contractor shall submit to the Engineer for approval a procedure for carrying out these compaction trials, supplemented by any necessary laboratory and in-situ tests.

These trials and tests shall be completed before the Works with the corresponding materials will be allowed to commence.

No payment shall be made for these trials and the costs thereof shall be deemed to be included in the other rates and prices.

#### **Article 12.17 – Preparation of Natural Ground**

The natural ground or the surface of an earth/gravel road after removal of top soil as per Article 4.9 on which the embankment / subgrade is to be constructed shall be prepared in accordance with the following requirements:

When an existing earth/gravel road, referred to as natural ground on which subgrade is to be constructed falls below within 0.3 m of the subgrade level, and if existing material is suitable for subgrade, the natural ground shall be prepared as subgrade preparation in earth cut as per Article 4.18.

When the natural ground or an existing earth / gravel road, referred to as natural ground on which the embankment is beyond 0.3 m of the subgrade level and existing material is suitable for construction of embankment, the natural ground shall be prepared as embankment by loosening and re-compacting the existing natural ground to a depth of 300 mm or as directed by Engineer, before placing new embankment and subgrade layers.

#### **Article 12.18 - Construction Of Embankment**

12.18.1 All fill material shall be supplied from the general excavation wherever possible, or from approval borrow pits or quarries.

12.18.2 No material shall be deposited until the ground shall have been prepared in accordance with Article 4.15 and approved by the Engineer.

The material shall be neatly and evenly spread over the area of the embankment to such an extent that the embankment is composed of fully compacted material for the widths required in uniform horizontal layers in accordance with Articles 4.16. The layers shall be kept shaped and trimmed and levelled by approved equipment. The surface of the layers shall at all times be maintained to such camber or cross falls as will shed water and prevent water stagnation. No subsequent layers shall be placed until each layer has been properly shaped, compacted and approved by the Engineer. If before the approval of a layer, damages, if any, such as cracking, rutting, corrugations, potholes, softening, erosion etc, are caused to the lower layer for any reasons whatsoever, such damages shall be made good by the Contractor at his own cost to the satisfaction of the Engineer before placing of materials for overlying layer. The methods employed for making good of damages as above shall include scarification with recompaction or reconstruction using new materials, as directed by the Engineer. Embankments shall be formed according to the Drawings or as directed by the Engineer. Side slopes shown on the Drawings are indicative only of the expected slope required for the material used and may be altered to suit the requirements of the material where directed by the Engineer.

12.18.3 Compaction shall not proceed until the moisture content of the material has been adjusted in accordance with Article 4.26. Any adjustments involving the incorporation of additional moisture shall be carried out by approved plant and shall be so arranged that the required moisture content shall be uniform throughout the layer to be compacted and shall remain uniform during compaction. The removal of excess moisture content shall be carried out by spreading out the material for aeration by mechanical means and remixing it at regular intervals. Should circumstances arise when the removal of excess moisture cannot be achieved, work on the compaction of the material shall be suspended until the conditions of weather and drainage are such as permit the required moisture content to be attained. The contractor's attention is drawn to the fact that no claim for extension of time and / or additional costs will be entertained for any stoppage of work arising for the conditions of weather and drainage preventing the drying of the material and it will be assumed that the contractor's rates and prices shall provide for such stoppages.

The contractor may opt to use imported fill from borrow pits to replace any material with an excess moisture content in order to avoid stoppage of the work. However the cost of such

replacement shall be borne entirely by the contractor, unless same has been specifically ordered by the Engineer.

Where soft area has resulted from negligence on the part of the Contractor, it shall be removed and replaced with suitable material at his own expense.

Watering and compaction plant shall be approved by the Engineer prior to the commencement of the Work but such approval shall not relieve the Contractor of his responsibility to provide suitable and adequate plant for the construction of the works.

#### 12.18.4 Rock Embankment and Boulders Embankment

The embankment shall be built in layers not exceeding 50 cm in thickness of loose material. Top 150 mm of rock fill embankment shall be well-graded granular material (crusher run), having maximum size of particle of 100 mm. This will act as top of sub-grade. There should be a minimum of 175 mm thick sub-base cushion over the rock fill.

The Contractor shall take special care to minimise segregation of material during handling and placing.

Compaction shall be carried out as follows: -

First pass : Using a pressure-type roller

Following passes : Using a vibrating roller with a out-of-balance weight of 10 tons at least, or other approved plant.

Compaction control shall be carried out by survey method (levelling) or as directed by the Engineer.

The interstices between the lumps shall be filled with smaller lumps, aggregates and sand as directed by the Engineer. Compaction shall be as directed by the Engineer.

Each layer shall be approved by the Engineer.

#### **Article 12.19 - Subgrade**

The subgrade is defined as the surface on which the sub-base is placed or on which the base is placed and where no sub-base is required as shown on the Drawings or as directed by the Engineer.

The subgrade, once it has been finally shaped and compacted and approved by the Engineer, shall be protected from damage and kept well drained at all times. Storage or stockpiling of plant or materials on the finished subgrade shall not be permitted.

Where the subgrade is damaged by the Contractor's own vehicles or vehicle belonging to the general public or by rain or from any other cause,

then the damaged or deformed material shall be dug out and shall be replaced with approved compacted material at the Contractor's expense.

#### **Article 12.20 Embankment against Sloping Ground**

When embankment is to be placed and compacted on hill sides, or new embankment is to be compacted against existing embankment, where the slopes are steeper than 4:1 (H:V), continuous horizontal benches each at least 300 mm wide shall be cut into the old slope for ensuring adequate bond with the fresh embankment/subgrade material to be added. The material obtained from cutting of benches could be utilised in the widening of the embankment/subgrade. However, when the existing slope against which the fresh material is to be placed is flatter than 4:1 the slope surface may only be scarified instead of resorting to benching.

Where the width of the widened portions is insufficient to permit the use of usual wider rollers, compaction shall be carried out with the help of tandem rollers, small vibratory rollers, mechanical tampers or other approved equipment. Benching of slopes shall be considered incidental to the work and shall not be measured separately.

#### **Article 12.21 Embankment and Subgrade around Structures**

To avoid interference with the construction of abutments, wing walls or return walls of culvert/bridge structures, the Contractor shall, at points to be determined by the Engineer suspend work on embankments forming approaches to such structures until such time as the construction of the latter is sufficiently advanced to permit the completion of approaches without the risk of interference or damage to the structures.

Unless directed otherwise, the filling around culverts, bridges and other structures up to distance of twice the height of the road from the back of the abutment shall be carried out independent of the work on the main embankment. The fill material shall not be placed against any abutment or wing wall unless permission has been given by the Engineer but in any case not until the concrete or masonry has been in position for 14 days. The embankment and subgrade shall be brought up simultaneously in equal layers on each side of the structure to avoid displacement and unequal pressure. The sequence of the work in this regard shall be approved by the Engineer.

Where it may be impracticable to use power rollers or other heavy equipment, the compaction shall be carried out by mechanical tampers or other methods approved by the Engineer. Care shall be taken to see that the compaction equipment does not hit or come too close to any structural member so as to cause any damage to them or excessive pressure against the structure. Payment shall not be measured separately and deemed to be included in other rates and prices.

#### **Article 12.22 Construction of High Embankments and Embankments on Soft Foundation**

Where the embankment exceeds 6 metre in height or where directed by the Engineer, the embankment shall be constructed in stages as instructed by the Engineer. The subgrade layer, that is the top 500 mm of the embankment, shall be constructed only after the Engineer is satisfied



that the embankment is stable and no more consolidation settlement is expected to take place.

On soft foundations, such as in marshy areas, the embankment work shall be given priority in construction operation so that sufficient time is available for the ground to consolidate prior to application of the pavement layers. For such cases, the Project Manager may order surcharging of embankments by the addition of fill to such levels as determined by him for effecting quick consolidation of sub-strata. The surcharge shall be removed only when the Project Manager is satisfied that no more settlement is possible. Removal of the surcharge shall be to a level 500 mm below the subgrade level. The stripped embankment surface shall be scarified to an average depth of 100 mm and compacted to the designated density. Only after this operation the subgrade layer shall be constructed. The surcharge fill shall be deemed as if additional embankment has been constructed and measured accordingly. Removal of the surcharge and re-compacting the surface of the stripped embankment shall be considered incidental to the work and shall not be measured separately.

#### **Article 12.23 Subgrade Preparation in Earth Cuts**

The objective of this operation is to ensure that the subgrade and its foundation comprise suitable material and specified density, that it is compacted to the specification limits and that it is levelled, shaped and made to a condition fit for receiving subsequent pavement layers.

For this purpose, the material in earth cut to be used as subgrade shall be tested for conformity to Article 3.8.2. If found suitable, the surface shall be loosened to a depth of 200 mm or as directed by the Project Manager, the moisture content adjusted, shaped to the specified levels and cross-fall, and compacted to the density specified in Article 4.26.2 considering top 500 mm as subgrade.

If the material is found unsuitable, the same shall be sub-excavated to a depth of 500 mm below subgrade level or as ordered by the Project Manager, replaced by suitable material and compacted to the specified degree.

Where a strata of boulder mixed with soil is met with, the same shall be sub-excavated to a depth of 500 mm or as directed by the Project Manager and replaced by suitable subgrade material.

#### **Article 12.24 Subgrade Preparation in Rock Cuts**

The rock cut for subgrade shall be made true to the designated line and levels in the drawing. The gaps/holes and unevenness so created in the process of rock cutting shall be made up to the required depth through levelling, shaping and compaction of crushed stones conforming to sub-base quality as per Article 2.14.

#### **Article 12.25 - Tolerances**

- 12.25.1 The finished subgrade shall be properly shaped and compacted to a smooth surface which shall not show any departure from the required cross section greater than within the range -2 cm to +2 cm at any point. When measured with

a 3 meters straight edge, deflections shall not be greater than 2 cm.

If for two consecutive working days, more than 10% of the measurements do not comply with these requirements, the Work shall be stopped in order to examine and improve the methods and equipment used and if necessary substitutes any defective equipment.

- 12.25.2 The deflections measured under 8.2 tons axle load shall not exceed the maximum value determined during the proof rolling section as described in Article 4.16 hereof.

### **Article 12.26 - Compaction Of Earthworks**

12.26.1 The moisture content of fill material of natural ground during compaction shall never exceed B. S. Heavy Optimum Moisture Content (OMC) for the densities specified in Article 4.26.2 hereof of more than 2%.

- 12.26.2 The compaction requirements are as follows:-

(Heavy Maximum Dry Density: H.M.D.D.)

- (a) Compaction of the top 30 cm of natural ground under the embankment: not less than 90% B.S.H.M.D.D.
- (b) Compaction of the top 30 cm of cuts under the pavement structure: not less than 95% B.S.H.M.D.D.
- (c) Compaction of embankment except for the top 30 cm: not less than 90% B.S.H.M.D.D.
- (d) Compaction of the top 30 cm of the embankment other than rock or boulder embankment: not less than 95% B.S.H.M.D.D.

### **Article 12.27- Side Slopes**

The Contractor shall construct at his own expense temporary kerbs and downspouts to protect the embankment's side slopes from erosion due to surface water.

All side slopes shall be neatly trimmed and the finished slopes shall not vary by more than 5 cm from the required cross section. Steep slopes in cuttings shall be cleared of all loose and insecure fragments.

All excess material including accumulation, at the foot of side slopes of embankments, of boulders, lumps or other rubbish shall be taken to tip.

No sharp change in the inclination shall be left, edges being rounded off to provide gradual change and discourage erosion.

Any slips or falls of materials shall be removed and the faces re-trimmed in accordance with this Article at the Contractor's expense.

The side slopes given on the Drawings whether for cut or for embankment are subject to variation by the Project Manager according to the nature of the soil.

## **Article 12.28 - Earthworks for structures**

### **12.28.1 Excavation**

Foundation excavation shall include the removal of all material, of whatever nature, necessary for the construction of the foundations and sub-structures in accordance with the plans or as directed by the Project Manager.

It shall include the construction of all cribs, cofferdams, dewatering, etc., which may be necessary for the excavation of the work. It shall also include the subsequent removal of cofferdams and cribs and the placement of necessary backfill as specified. It shall also include stock-piling of the suitable excavated material for return as backfill and compaction as specified, and the disposing of excavated material that is not required for backfill, in a manner or in locations so as not to affect the waterway of the channel and be unsightly.

All sub-structures, where practicable, shall be constructed in open excavation and, where necessary the excavation shall be shored, braced, or protected by cofferdams in accordance with approved methods.

Foundation excavation shall be classified according to Clause 4.8 of the Specification. Separate measurement and payment shall be made of each class of material respectively.

Excavations shall be kept free from water. The bottom of the excavation shall be thoroughly cleaned of loose material, mud and water and carefully trimmed and shaped to the correct levels and dimensions and, after approval in writing by the Project Manager, the Contractor shall lay a blinding layer of concrete Class 15 to receive the concrete floor or footing, tamped to a smooth finish, providing all forms and screeds and any sump holes for drainage and pumping. Any pockets of soft soil in the bottoms shall be removed and replaced with Class 15 concrete. The Contractor shall make good with Class 15 concrete any additional excavation below the bottom of the foundations to remove material that the Contractor allows to become unsuitable, the cost of which shall be borne by the Contractor.

Pumping from the interior of any foundation enclosure shall be done in such a manner as to preclude the possibility of the movement of water through any fresh concrete. No pumping will be permitted during the placing of concrete, or for a period of at least 24 hours thereafter, unless it is to be done from a suitable sump separated from the concrete work by approved means. Pumping to dewater a sealed cofferdam shall not commence until the seal has set sufficiently to withstand the hydrostatic pressure.

### **12.28.2 Cofferdams**

#### **(i) General**

Cofferdams for foundation construction shall be carried to adequate depths and heights, be designed and constructed to

the Project Manager's satisfaction and be made as watertight as is necessary for proper performance of the work that must be done inside them. In general, the interior dimension of cofferdams shall be such as to give sufficient clearance for the construction of forms and the inspection of their exteriors, and to permit pumping outside of the forms. Cofferdams that are tilted or moved laterally during construction shall be righted, reset or enlarged so as to provide necessary clearance.

When conditions are encountered which, in the opinion of the Project Manager, render it impracticable to dewater the foundation before placing concrete he may require the construction of a concrete foundation seal of such dimensions as may be necessary. The foundation shall be then pumped out and the balance of the concrete placed in the dry. During the placing of a foundation seal, the elevation of the water inside the cofferdam shall be controlled to prevent any flow through the seal and if the cofferdam is to remain in place, it shall be vented or ported at low water level.

(ii) Protection of concrete

Cofferdams shall be constructed so as to protect fresh concrete against damage from water, from any source whatsoever.

No timber or bracing shall be left in cofferdams in such a way as to extend into the sub-structure, without written permission from the Project Manager.

(iii) Drawings required

For sub-structure work, the Contractor shall submit drawings showing his proposed method of cofferdam construction and other details. Such drawings shall be approved by the Project Manager before construction is commenced.

The drawings shall be submitted at least 2 weeks in advance of the time the Contractor intends to commence the construction of the cofferdam. Such approval shall not relieve the Contractor of his responsibility for the safety and adequacy of the structure so approved.

(iv) Removal on completion

Unless otherwise provided, cofferdams or cribs, with all sheeting and bracing, shall be removed after the completion of the sub-structure, care being taken not to disturb or otherwise injure the completed structure.

### 12.28.3 Backfill to structures

Up to the rock line, materials for foundation fill shall consist of lean concrete of Class 15 and as required by the Project Manager.

Above the rock line, all materials used for backfill shall be crusher run 0/31.5 stabilised with cement to produce compressive strength at seven days of 150 mm cubes of not less than 8 N/mm<sup>2</sup> and not greater than 10 N/mm<sup>2</sup>.

All spaces excavated and not occupied by abutments, or other permanent work shall be backfilled with approved material up to the surface of the surrounding ground, with a sufficient allowance for settlement. All backfill material shall be placed in horizontal, uniform layers not exceeding 200 mm in thickness, and not less than 75mm after compaction, and shall be brought up uniformly and simultaneously on all sides of the structure. Each layer of backfill shall be compacted to a density of not less than 95% B.S. Heavy Compaction.

For filling to structures above existing ground level, the Contractor shall so arrange his programme for the construction of structures and earthworks that the filling behind and around any structure is carried but concurrently with, and as part of, the earthwork operation.

#### 12.28.4 Cement stabilised fill to earth retaining structures

All materials used for compaction against earth retaining structures shall be of a quality acceptable to the Project Manager, free from large lumps, wood or other extraneous matter. Granular fill shall consist of well-graded crusher 0/31.5 stabilised with cement to produce a compressive strength of between 8 and 10 N/mm<sup>2</sup> at 7 days on cubes of 150 mm.

The fill behind abutments, wing-walls and culverts shall be deposited in well-compacted horizontal layers not exceeding 200 mm in thickness and not less than 75 mm in thickness after compaction and shall be brought up uniformly and simultaneously on all sides of the structure. Each layer of the backfill shall be compacted to a density of not less than 90% of B.S. Heavy Compaction. The material to a depth of 1500 mm below the soffit of the approved slab or finished road level shall be compacted to 95% B.S. Heavy Compaction, and shall consist of a graded crushed stone of a similar quality as the road sub base.

No backfill shall be placed against any abutment, wing-wall or culvert until permission has been given by the Project Manager and not until the concrete has been in place 14 days or until the cubes results show the specified strength, whichever is the later.

The material shall not contain more than 0.2 % of sulphate ions as determined by B.S. 1377 unless special precautions to the approval of the Project Manager are taken to protect the concrete.

#### 12.28.5 Mixing of Backfill Material

The cement stabilised crusher run material to be used for backfilling to structures and earth retaining structures may be mixed in place or in a plant.

Mixing in Place

The Constructional Plant and method shall include:

- (a) A cement spreader or approved method which will spread cement uniformly on to the material and provides the required proportion of cement per cent by weight to provide

the specified compressive strength with a tolerance of plus or minus 0.5 per cent.

- (b) A rotary mixer fitted with tines and capable of mixing the cement uniformly into the material for the full depth of the layer in a single pass. The mixer shall be capable of adjustment to control the depth of processing and shall be equipped with a water spray bar. The spray bar shall be regulated to spray water onto the material at a predetermined rate fixed in relation to the speed of travel of the mixer and providing the required proportion of water per cent by weight, with a tolerance of plus or minus 1.0 per cent. Alternatively a bowser which is similarly equipped may be used.

The first pass of the mixer shall be made to mix in the cement without adding water, one or more further passes shall be made, mixing in the required amount of water.

Each pass of the mixer shall overlap the adjacent pass at longitudinal joints by at least 100 mm and at traverse joints by 1.0 metre.

#### Plant Mixing

The mixing plant shall be capable of producing uniformly mixed material having the required proportion of cement per cent by weight to achieve the specified compressive strength with a tolerance of plus or minus 0.5 per cent and the required proportion of water per cent by weight with a tolerance of 1.0 per cent.

Twin shaft paddle mixers or gyratory pan mixers shall be used for material containing more than 50 per cent of particles passing a 5.0 mm sieve and for material containing more than 6.0 per cent of particles passing 0.15 mm sieve.

#### Quality Control

Test cubes shall be made cured and tested at the rate of one group of three cubes for every 1000m<sup>2</sup> of base laid. The average strength of each group of three shall not be less than the strength specified.

#### 12.28.6 Measurement and payment for earthworks for structures

The unit of measurement for earthworks shall be cubic metre. The volume paid for will be as indicated below.

Where the structure excavation is performed within road excavation, the quantity of excavation to be paid shall be the actual number of cubic metre of in situ material excavated within a volume banded by vertical planes parallel to the neat lines of the footing of the structure and the planes of the bottom and side slopes of the road excavation. No extra payment will be made for working space, the cost of which is deemed to be included in the excavation rates.

Where the structure excavation is performed in new road embankment the quantity of excavation to be paid shall be the actual quantity of cubic metres of in situ material excavated prior to

the embankment construction within a volume banded by vertical planes parallel to neat lines of the footing or structure (no allowance will be made for working space) and the lower limit shall be the level of the road subgrade while the upper limit shall be the original ground stripped of topsoil.

Where bulk excavation is performed to new lines and levels the quantity of excavation to be paid as a difference between the designed finished levels and the original natural ground level carried out during joint survey at commencement of works.

In case of independent footings the quantity of additional excavation to be paid shall be the actual number of cubic metres of in situ material excavated within a volume banded by vertical planes banded by neat lines of the footing, with no allowance for working space, and the planes of the bottom of the footing foundation and the road subgrade.

For raft foundation, the quantity of additional excavation to be paid shall be as for independent foundations but the planes of the bottom shall be the foundation of the raft.

No allowance shall be made for structure excavation where road excavation cannot be executed prior to the structure excavation.

The Contractor will be paid separately for each class of material excavated as specified in Clause 12.8 and for excavation to any depth.

## SECTION 13 - ROAD WORKS

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## SECTION 13 - ROAD WORKS

### Article 13.1 - General

#### 13.1.1 Terminology

- Subgrade Surface or Formation Level on embankments and in cuttings shall be the surface level of the earthworks after completion of the earthworks.
- The subgrade shall be the material immediately underneath the subgrade surface.
- The pavement shall be formed by the materials laid above formation level. It shall comprise the subbase where required, the stone road base or the bituminous base course and the wearing course. The finished level shall be the surface of final layer of the pavement.
- On drawings or in Technical Specifications hereof
  - "bituminous Concrete" applies for a hot premix bituminous concrete used for wearing course
  - "bituminous Base" applies for a open graded base course bituminous concrete
  - "crusher run" applies for a graded crushed stone material used for sub base or road base with grading between 0 and 213 mm (0/213) or 0 and 130 mm (0/130)
- Bituminous Surface Treatment applies for a film of bituminous binder covered by a layer of nominal single sized stone chippings.
- A sealing coat composed of a film of bituminous binder covered with a layer of fine aggregate shall complete double bituminous surface treatment on carriageways.

#### 13.1.2 Works To Be Executed

The roadworks and parking lots shall consist of the following operations:-

- (a) Preparation of subgrade surface
- (b) Construction of crushed stone sub base
- (c) Construction of crushed stone
- (d) Construction of bituminous concrete wearing course
- (e) Construction of shoulder or footpath
- (f) Application of a surface treatment
- (g) Construction of verges and slopes of embankment and top soiling
- (h) strengthening of existing pavements on site boundaries

The pavement structure is defined on typical cross sections and layout plan and longitudinal profiles.

It is specified that no layer shall be laid until the underlying layer has been inspected and approved by the Engineer.

#### 13.1.3 Programme To Be Furnished

The Contractor shall submit to the Engineer for his approval the programme and drawings specified in Article 1.10 of T.S.

It is advisable to complete drainage works before starting road/pavement works on a section.

The method of construction of the pavement shall be such that a subsequent layer shall be placed as soon as possible after the results of the tests and measurements (density, deflection etc...) carried out on the laid layer have been found as specified or as directed by the Engineer.

#### 13.1.4 Typical Cross Section

- The typical cross sections shown on Drawings shall be applied on cross sections levelled as specified in Article 1.11 and to be approved by the Engineer.
- Some adaptations are to be foreseen, particularly the theoretical camber fixed at 2.13% in alignment which may vary between 2.13 and 3%. Nevertheless in alignment and for the same cross section, the camber on each half of the carriageway shall not differ by more than 0.13%.
- The nominal thickness specified on typical cross sections and on plan and longitudinal profiles are deemed to be the minimal thickness of material to be laid down.

#### **Article 13.2 - Preparation Of Subgrade Surface For Existing Road**

The subgrade surface shall be cleaned of all foreign matter; and any loose material, potholes, ruts, corrugations, and other defects which may have appeared shall be corrected; if directed by the Engineer, the Contractor shall scarify, water, grade and re-compact the subgrade to line and level. No payment shall be made for preparation of subgrade surface and the costs thereof shall be deemed included in the other rates and prices.

#### **Article 13.3 - Precautions during Rains**

Adequate measures shall be taken by the Contractor during period of rains to protect all work by providing drainage of all exposed surfaces. No placing of layer shall be permitted until the surface, on which the layer is to be laid, is dry.

#### **Article 13.4 - Proof Rolling Sections**

Before commencing any pavement work, the Contractor shall carry out compaction trials by establishing proof rolling sections. The purposes of these trials are to determine the proper compaction plant to be used (including number of rollers, wheel load, inflation pressure of tyres, rolling patterns, speed of rollers, distance between the asphalt paver and the

compaction plants), the number of passes, the thickness of loose material for each layer, the temperature for spreading in order to achieve the required thickness of compacted material, the required density and a minimum value for the deflection under a 8.2 tons axle load.

The Contractor shall submit to the Engineer for approval a procedure for carrying out these compaction trials supplemented by any necessary laboratory and in-situ tests.

These trials and tests shall be completed before works with the corresponding materials will be allowed to commence.

The results of these trials such as defined above shall be submitted to the Engineer for his approval; such approval shall not relieve the Contractor of any of his duties and responsibilities under the Contract.

No payment shall be made for these trials and the costs thereof shall be deemed included in the other rates and prices.

#### **Article 13.5 - Drainage Layer**

Drainage layer materials shall be placed as shown on typical cross section or where required by the Engineer. The materials shall be spread on subgrade surface with a grader and compacted with vibrating roller or heavy self-propelled tyred roller. Depending on the type of the materials, compaction requirements and method of compaction shall be specified in accordance with results of proof rolling sections. Drainage layer in shoulders or as backfilling of masonry or drainage structures shall be hand-placed and compacted with hand-propelled vibrating roller.

#### **Article 13.6 - Crushed Stone Sub Base and Base Construction**

The crushed stone sub base and base materials (crusher run) shall comply with the requirements of Articles 2.11, 2.12, 2.13 and 2.14 of these Technical Specifications and shall be provided and laid to the lines, levels and cross section shown on the Drawings or as directed by the Engineer. The crushed stone sub base as well as the base course shall be placed in layers over the entire formation. The thickness of one layer shall never be less than ten (10) cm and more than twenty (20) cm for base material and less than twelve (12) cm and more than twenty five (213) cm for sub base.

Spreading of the approved material shall be carried out by plant or vehicles designed or equipped with suitable devices capable of depositing the material in a continuous uniform layer of the correct thickness, width, shaping, and surface tolerances.

The paver shall be capable of spreading the material to a thickness sufficient to provide a compacted layer of at least 20 cm over a width of at least 3.20 m.

During spreading of material, precautions shall be taken to avoid segregation. If segregation occurs, the Contractor shall remix the material by a method to be approved by the Engineer.

Where the addition of fine is necessary, it shall be thoroughly mixed in with the aggregate before the introduction of any water that might be required.

Where it is necessary to add water to adjust the moisture content, the water shall be added by an approved mechanical sprinkler and mixed into the full depth of the loose material by means of a harrow or other mixing equipment approved by the Engineer.

Compaction of crusher run layer shall be carried out only after the construction of edge concrete kerbs provided for retaining the material has been completed.

Equipment for compacting shall be composed of vibrating rollers with W/L ratio greater than 20 kg/cm and heavy tyred roller of more than 2.13 T by wheel.

The thickness of the processed layer shall be checked continuously at all stages of the construction to ensure that the thickness of the final compacted layers is at all points within the tolerances specified in Article 13.113.

### **Article 13.7 - Compaction Requirements For Sub Base And Base Courses**

The moisture content of the material shall be continuously checked before and during rolling and shall be in the range of -2% to + 2% of O.M.C. (O.M.C. Optimum Moisture Content)

The layers shall be compacted to a minimum density of 913% of B.S. Heavy Compaction for sub base and 98% of B. S. Heavy Compaction for base. These requirements must be fulfilled for 90% of measurements.

Compaction shall continue until: -

- (i) The specified density is achieved when measured with a Nucleo-Gamma densometre type Troxler or any other method as approved by the Engineer.

AND

- (ii) The compacted pavement layer contains not more than 113% voids for road base, or 20% voids for sub base, voids being air voids and voids filled with water.

All rolling shall be longitudinal and shall commence at the outer edges except that on super- elevated curves, rolling may progress from the lower to the higher edge.

The surface of the material shall on completion of compaction, be well closed, free from movement under the compaction plant and free from compaction planes, ridges, cracks or loose material. All loose, segregated or otherwise defective areas shall be dug out and made good with new material to the full thickness of the layer and re-compacted all at the Contractor's expense.

### **Article 13.8 - Tolerances For Crushed Stone Sub Base And Base Course**

#### **13.8.1 Surfaces**

The finished surfaces of crushed stone sub base and base shall not show any departure from the required cross sections exceeding 1.13 cm (113 mm). When measured with a 3 metres

straight edge, deformations shall not be greater than 1.13 cm (113 mm).

If the departures are greater than these tolerances, the Contractor shall at his own expense scarify, reshape, add water, if necessary, and compact such areas.

If for two consecutive working days more than 10% of the measurements do not comply with these requirements, the work shall be stopped in order to examine and improve the methods and equipment and if necessary substitute any defective equipment.

#### 13.8.2 Deflection Measurement Under A 8.2 Ton Axle Load

More than 90% of deflections measured on a length corresponding to a day's work shall be within the limit specified by the Engineer in accordance with the results of proof rolling sections.

If on a limited area localised in a homogeneous section (in regard of geotechnical conditions and strengthening solutions carried out) the characteristic deflections ( $D + 20 *$ ) exceed the average level of deflections in this section by more than 213%, additional compaction shall be required. If, in the opinion of the Engineer, no significant improvement is obtained, excavation shall be ordered in order to replace the subgrade or sub base materials, at the own cost of the Contractor.

### **Article 13.9 - Shoulder Construction**

The construction of shoulders and crushed stone footpath shall in all respects be the same as for sub base and base courses, except for compaction requirements which shall be fixed to 913% B. S. Heavy Compaction. Where crushed stone base (and sub base) is provided, construction and especially compaction of shoulder layers shall be carried out at the same time as the corresponding works on the carriageway. Where bituminous base course and wearing course are provided, the laying and first compaction of shoulder material shall be made before the construction of the bituminous courses.

### **Article 13.10- Preparation Of Crushed Stone Base For Prime Coat**

The surface shall be thoroughly brushed by mechanical brooms and all loose sand, dust, dirt and other unsuitable material shall be removed, to the approval of the Engineer.

The finished base surface shall be true to line, grade and cross section as specified in Article 13.8. The base shall be in the condition of compaction and finishing as specified. Prime coat shall be applied when the surface to be treated is dry. The prime coat shall not be applied on dust or when the weather is rainy.

### **Article 13.11 - Application of Prime Coat**

13.11.1 On completion of the preparation of the base and approval of the surface by the Engineer, the prime coat of MC 30 or other approved binder as required in Article 2.31, shall be

applied immediately by means of a pressure distributor at the rate of spread of 1.2 Kg/m<sup>2</sup>.

The rate and number of application shall be such that the prime penetrates at least 1.13 cm the base course and dries to a uniform matt surface in 24 hours.

The area to be primed shall extend to the whole width of the base course, including shoulders to be covered by the wearing course.

The nozzles of the distributor shall be checked prior to spraying.

The base surface where too closely knit may be slightly moistened by a mechanical sprinkler.

During spraying of binder all elements such as, culvert head walls, kerbs and the like which are liable to be disfigured by splashing of bitumen shall be protected and any such feature which is accidentally marred by bitumen shall be cleaned off with a suitable solvent or made good.

Any areas insufficiently covered shall be re-sprayed by spray lance to the satisfaction of the Engineer.

Where the prime coat does not completely penetrate into the base, the excess should be blotted with sand or single sized aggregate 4/6.

The prime shall be completely cured before spreading asphaltic concrete or placing of paving slabs.

The prime coat shall be left undisturbed for a period of at least 24 hours, and shall not be opened to traffic until it has penetrated and cured sufficiently so that it will not be picked up by the wheels of passing vehicles. The Contractor shall maintain the prime coat until the next course is applied. Care shall be taken that the application of bituminous material is not in excess of the specified amounts and any excess shall be blotted. All areas inaccessible to the distributor shall be sprayed manually using the device for hand spraying from the distributor.

13.11.2 Where required by the Engineer, or in order to protect the base surface under traffic, the prime coat shall be covered with sand or single sized aggregate 4/6 at the rate of 6 litre/m<sup>2</sup>.

#### **Article 13.12 - Tack Coat**

A tack coat shall be applied between the existing bituminous surface and the bituminous concrete base course or wearing course. The tack coat may also be ordered by the Engineer between the bituminous base course and wearing course.

The surface to be tacked shall be swept clean of all loose particles and dust immediately prior to the application of the tack coat, at the rate of 0.600 Kg/m<sup>2</sup> of RC 2130 or 0.300 Kg/m<sup>2</sup> of residual bitumen from bitumen emulsion.

#### **Article 13.13 - Surface Treatment**

Following spraying and curing of prime coat, a surface treatment shall be applied where specified on drawings.

### 13.13.1 Average Rates

The rate of application of binder and chippings shall be determined on site according to type of binder and chippings. The following table gives the average rates upon which bill prices have to be based: -

	CUTBACK RC 2130 KG/M SQ	CHIPPINGS Litre / M <sup>2</sup>		
		2/4	4/6	10/14
Single Surface Treatment	1.0		8.0	
Double Surface Treatment				
1st Layer	1.3		6.0	
2nd Layer	1.2			11.0

### 13.13.1 Spraying Binder

The binder RC 2130 or equivalent shall be sprayed mechanically by means of a pressure distributor after road base has been cleaned as specified for priming.

The distributor shall be such that the spraying is uniform on an adjustable width. The spraying pressure shall be uniform whatever the running speed may be. A competent foreman shall continuously supervise the spraying of binder.

All road furniture shall be protected.

### 13.13.2 Spreading Chippings

Chippings shall be spread mechanically immediately after the binder has been applied. A maximum delay of 13 minutes shall be authorised.

10/12 ton self-propelled tyred roller shall be exclusively used. They shall make 3 to 13 passes, subject to approval of the Engineer.



### 13.13.3 Completion

When the surface dressing has been completed, all surplus material shall be swept away by mechanical brooms.

The rates shall be checked everyday for each layer of binder and chippings in cross section as well as in longitudinal direction. Nowhere the departure from the required rate shall exceed 10%.

## Article 13.14 - Bituminous Concrete Base Course And Wearing Course

### 13.14.1 Mix Design

The Contractor shall carry out trial mixes to determine the job mix formulae (gradation of aggregates, precise proportions of bitumen and aggregates) at least 30 days before production of bituminous mixes are started and as soon as possible after commencement of aggregate production.

The study shall permit to check that, in spite of the normal fluctuations of a well-adjusted plant, the performances of the materials satisfy the requirement of these Technical Specifications.

The Contractor shall submit for the approval of the Engineer full details of his proposed aggregates grading and bitumen content together with details of the mix design and results of test carried out at ranges of bitumen contents from below the proposed bituminous content to above. Specimens at each bitumen content shall be made in quadruplicate.

The approved laboratory design mix shall be confirmed by full-scale plant trials using the full range of bitumen contents. The approved plant trial mix shall be termed the Job Standard Mix.

### 13.14.2 Mix Requirements

The Job Standard Mix shall be determined by the Contractor in conformity with the following requirements.

---

		<b>Base Course</b>	<b>Wearing Course</b>
Bitumen Content	(%)	4.3 – 13.0	6.0 – 6.13
Marshall Stability	(kN)	Min. 7.0	Min. 9.0
Flow	(mm)	1 - 4	1 - 4
Air Voids	(%)	3 – 13	3.13 – 4.13
Voids in Mineral Aggregate	(%)	16 - 20	16 - 20
Voids filled with Bitumen	(%)	70 – 81.3	71.3 - 82

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The gradation and quality of aggregates and filler shall satisfy the requirements defined in Articles 2.14 and 2.113.

#### 13.14.3 Working Mix

The Contractor shall maintain the composition of the working mix within the following tolerances from the Job Standard Mix.

- (1) Bitumen: 13% (five per cent) of the specified weight of bitumen
- (2) Filler: 1.13% (one and a half per cent) by weight of total mix
- (3) Aggregate retained on 13.00 mm B. S. Sieve: 7% by weight of total mix
- (4) Aggregate passing 13.00 mm B. S. Sieve but retained on 713 micron B.S. Sieve : 13% by weight of total mix

The bituminous concrete shall be checked every day, 2 bitumen extraction shall be carried out. For Marshall test, at least 6 samples shall be taken as specified in Part III of T.S.

The Contractor shall not be allowed to modify the setting of the asphalt plant after production is started without informing the Engineer.

#### 13.14.4 Asphalt Plant

The nominal capacity of the asphalt plant shall be at least 60 t/h when moisture content of aggregates is equal to 3%.

There shall always be sufficiently large stockpiles of all required sizes of aggregates to prevent delays because of low quantities.

The asphalt batch plant or continuous asphalt plant shall be submitted to the Engineer for approval: the storage tank shall be of sufficient capacity to keep the plant supplied with due allowance for delays in delivery; the bins for storage of aggregates shall be such that contamination is prevented; the plant shall be equipped with gauges, thermometers, mechanical, electrical, luminous, resonant devices and systems, timers in order to adjust, measure and control with a precision compatible with the Job Standard Mix approved by the Engineer.

The plant shall be operated under skilled supervision and maintained in a satisfactory working condition.

The Contractor shall keep accurate records of proportions and temperature of material incorporated, plant operation performed, tests performed, at all times.

The new "TSM" type or equivalent asphalt plant shall comply with special requirements as specified in "Complements Pour Utilisation Des T.S.E." Direction Des Routes Et De La Circulation

#### 13.14.5 Control Of Mixing And Asphalt Plant

The temperature of the binder at the time of mixing shall be in the range of 1413 C to 11313 C. The temperature of the bitumen shall never exceed 170 C.

The temperature of heated bitumen shall be kept within a range of 10°C around the required temperature for mixing.

The mixing time shall not be less than that recommended by the plant manufacturer, or such longer time as may be required to ensure adequate coating of aggregate and uniform distribution of the bitumen through the mix as directed by the Engineer. The plant shall not be operated at a higher speed than the manufacturer's rated capacity. The plant shall be such that the mineral filler shall be kept dry and be separately stored and weighed. It shall be possible to introduce the filler separately into the mixer if required by the Engineer. All aggregates on leaving the drier shall have a moisture content of less than 1 % by the mass.

The frequency for checking the precision of the components of the asphalt plant for delivery of materials (adjustable gates, gradation control unit, metering pump, scales etc...) shall be as specified in the following table which applies to traditional asphalt plant.

#### 13.14.6 Transport

The mixed materials shall be transported from the asphalt plant to the site of the work in trucks having clean, tight, smooth bodies, which shall be treated to prevent adhesion of the mixture. Soapy water or lubricating oil but not in excess may be used for coating the bodies but gasoline, kerosene or other solvent shall not be used for this purpose.

The bodies of the trucks shall be covered and insulated to maintain the heat loss within the requirements.

#### 13.14.7 Laying

The bituminous concrete shall not be laid when the base is wet, when there are pools and during rainfall. The surface shall be kept thoroughly clean, free from dust and foreign matter, using mechanical broom or blown off by compressed air. The bituminous concrete binder course as well as the wearing course shall be placed in one layer, except where reshaping work is provided. The temperature of the mix at delivery of the plant shall be approximately 140 C.

The bituminous concrete shall be spread and tamped by a self-propelled paver operated by a fully-trained and experienced man. The paver shall be capable of laying to a width of 4 meters.

The screed unit shall be adjusted before laying is started in order to produce a compacted layer with the required thickness as shown on the Drawings or as directed by the Engineer. During laying the screed unit shall be blocked; in other words adjustment of the thickness during laying using the so-called floating action of the screed unit shall not be authorised.

The mixed material shall be supplied continuously to the machine and laid as soon as possible after delivery.

The speed of paver shall be adjusted to that of the asphalt plant and hauling capacities so that the paving operation is maintained as continuously as possible during the work.

The temperatures of mixes measured in the receiving hopper of the asphalt paver shall not be lower than 130 C.

Mixes which have a lower temperature shall be discarded.

Transverse joints in the wearing course shall be offset at least 1300 mm from those in the base course. Longitudinal joints shall be offset at least 1130 mm. At transverse joints between existing compacted asphalt and newly laid asphalt, the edge of the existing asphalt along the joint shall be neatly cut away in straight lines over a sufficient width to ensure that the full specified thickness of new asphalt is placed. The exposed edge in the existing work shall, if directed, be painted with hot bitumen or emulsion immediately in advance of placing the new work.

When the asphalt layers are laid in half widths, the longitudinal joints between them shall, if directed, be treated similarly to the transverse joints.

Cold joints shall be neatly cut away in straight lines except that they have been compacted to the required rate by means of a special equipment (lateral wheel). They shall be painted with hot bitumen or emulsion. The Contractor shall organise his work so that there are no exposed longitudinal joints left at the end of any day's work.

Before opening to traffic, new layer shall be linked up with the existing one by means of a chamfered edge with a slope not exceeding 8%. Before carrying on the layer this chamfered edge shall be cut away.

#### 13.14.8 Compaction

The attention of the Contractor is drawn to Article 13.7. The roller operators shall be fully-trained and experienced men. An indicative composition of compaction equipment is :

- A heavy self-propelled tyred roller (> 3T/Wheel)
- A smooth wheeled (vibrating) roller (10T)

Rollers shall not stand on newly laid materials while there is a risk that the material will be deformed thereby. When the bituminous concrete is spread in areas that are inaccessible to the rollers, compaction shall be obtained by hot hand compactors.

During initial breakdown rolling and finish rolling, no vibratory compaction shall be resorted to. The exact pattern of rolling shall be established after trial compaction as approved by the Engineer. Any displacement occurring as a result of reversing of the direction of a roller or from any other cause shall be corrected at once as specified and/or removed and made good. The rollers shall not be permitted to stand on pavement freshly rolled. Necessary precautions shall be taken to prevent dropping of oil, grease, petrol or other foreign matter on the pavement either when the rollers are operating or standing.

The wheels of roller shall be kept moist to prevent the mix from adhering to them. But in no case shall fuel/lubricating oil nor excessive water poured on the wheels. Rolling shall commence longitudinally from edges and proceed towards the centre, except that on superelevated and unidirectional cambered portions, where it shall progress from the lower to upper edge parallel to the centre line of the pavement. The roller shall proceed on the fresh material with rear or fixed wheel leading so as to minimise the pushing of the mix and each pass of the roller shall overlap the proceeding by one half of the width of the rear wheel.

The layers shall be compacted while the mixed materials temperature is within 113 C to 130 C.

#### 13.14.9 Control of Compaction

The density of the material of each layer shall be in conformity with the following requirements:

- The density shall be more than 97% of the density determined by the Marshall test, and more than 100% of the LCPC density.
- Densities measured by "Troxler" type apparatus shall be gauged with densities measured on drilled core-samples. If for two consecutive working days, more than 10% (ten per cent) of the measurements do not comply with these requirements, the work shall be stopped in order to examine and improve the methods and equipment used and if necessary substitute any defective equipment.
- Deflection measurements shall be carried out and requirements of Article 13.8.2 apply for bituminous concrete courses.

#### 13.14.10 Tolerances

When measured with a 3 metres straight edge, deflection shall not be greater than 0.8 cm for bituminous base course and 0.13 cm for wearing course.

The thickness for each layer shall be controlled on the samples taken for control of compaction. The tolerances shall be within the range -10%, +20% of the thickness defined on the Drawings or as directed by the Engineer.

If for two consecutive working days, more than 10% (ten per cent) of the measurements do not comply with these requirements, the work shall be stopped in order to examine and improve the methods and equipment used and if necessary substitute any defective equipment.

In any case for each working day, the average of all results shall be at least equal to the required thickness.

#### **Article 13.15 - Grassing, Topsoiling and Landscaping**

13.15.1 After completion of bituminous surfacing, the verges, central median and the slopes of cuttings and embankments shall be planted with indigenous grass suitable for this particular use.

The Contractor shall plant springs of grass at approximately 20 cm centres.

Topsoil shall be obtained from material resulting from site clearance or from spoil tips or from natural ground in close proximity to the works. It shall be lightly compacted.

Planting shall preferably be carried out at the beginning of a rainy season, but where this is not possible, the grass shall be kept watered. Grassing and landscaping shall be paid under the corresponding Items of Bill No.3

13.15.2 Landscaping shall be made by means of loose boulders, decorative bushes and trees, as directed by the Engineer.

The bushes and trees shall be supplied and planted by specialists sub contractors.

#### **Article 13.16 – Concrete Surfaces of footpaths and sidewalks**

13.16.1 Footpaths shall be of concrete having minimum strength of 213 Mpa, minimum 2613 kg cement content, a maximum 0.1313 water: cement ratio, 60mm  $\pm$  20 mm initial slump, normal setting plasticizing admixture to a final 110 mm  $\pm$  20 mm slump, 20 mm aggregate. The amount of colour pigments added to a concrete mixture shall not be more than 7 % of the mass of the concrete but 13 % may be needed. The amount required depends on the type of pigment and colour desired. To maintain uniform colour, proportioning of all materials must be carefully controlled by mass.

To prevent streaking, the dry cement and colour pigment must be thoroughly blended before they are added to the mix. Mixing shall be longer than normal to ensure uniformity. Use of admixtures may be required for dispersal of pigment. All admixtures shall be normal setting and non-retarding.

13.16.2 Trial mixes shall be assessed and refined until the concrete satisfies the requirements for strength, durability, colour

and finishability. These are required to establish the mix proportions for a concrete to satisfy:

- Strength class,
- Maximum water: cement ratio,
- Nominal aggregate size,
- Chloride content class,
- Consistence class,
- Cement type (Ordinary Portland Cement),
- colouring agent to be used (red oxide).

The sources of the constituent materials shall not be changed without further trial mixes and prior to approval of Engineer. All equipment for the manufacture, transport, compaction and finishing shall be cleaned immediately prior to the production of the coloured concrete. The mixing process shall be sufficient to ensure effective dispersal of the pigment.

13.16.3 Contraction joints at a spacing to produce approximately square sections shall be provided.

13.16.4 Curing shall commence as soon as possible. Apply one coat of curing compound evenly across the entire surface at the manufacturer's recommended coverage rate. Curing compound shall be clear, non-yellowing, acrylic sealer with a minimum solids content of 20%. Curing compound shall be submitted for approval of Engineer. Concrete surface finish shall be brush finish to  $\pm 13$  mm tolerances.

## SECTION 14- DRAINAGE

### INDEX

#### ARTICLE NO

- 14.1 GENERAL
- 14.2 DRAINAGE PROGRAMME
- 14.3 DRAINAGE EXCAVATION
- 14.4 TIMBERING AND SHORING OF EXCAVATIONS
- 14.5 TRENCHES AND HOLES EXCAVATION AND BACKFILLING
- 14.6 LINED TRAPEZOIDAL DITCH
- 14.7 UNLINED TRAPEZOIDAL DITCH
- 14.8 REINFORCED CONCRETE TRAPEZOIDAL DRAIN
- 14.8 PIPE CULVERTS
- 14.9 BOX CULVERTS
- 14.10 GULLIES AND MANHOLES
- 14.11 MASONRY WORKS
- 14.12 RIP RAP
- 14.13 RAINWATER DOWNSPOUTS
- 14.14 CATCHPITS



## **SECTION 14 - DRAINAGE**

### **Article 14.1 - General**

The present section includes the construction of:

- Drains
  
- Pipe and box culverts including head works, wing walls and cover slabs
  
- Gullies and Manholes
  
- Retaining walls, paving slabs
  
- Masonry works (including retaining walls, stone facing, rainwater downspout, etc.)
  
- Riprap

### **Article 14.2 - Drainage programme**

The Contractor shall submit to the Project Manager for his approval immediately after the signature of the Contract a carefully prepared programme for the drainage works which shall allow for completion of all drainage systems necessary for drainage during construction, before works are started.

### **Article 14.3 - Drainage Excavation**

The Contractor shall excavate all drainage systems to the lines, levels, and slopes and dimensions shown on the Drawings or as directed by the Project Manager.

Excavation for drainage systems shall be carried out in accordance with the requirements of the section "Earthworks" of these Technical Specifications.

Should excavations be executed to greater depth or dimensions than necessary through the incidence of boulders or through other causes, the Contractor shall backfill and make good, with approved materials thoroughly compacted, to the correct level and dimensions and to the approval of the Project Manager.

The material excavated for drainage systems shall be, if suitable, set aside for use as backfill and if unsuitable or in excess, run to spoil tips.

#### **Article 14.4 - Timbering and Shoring of Excavations**

The sides of excavations such as trenches, holes shall, where required, be timbered and shored to the satisfaction of the Project Manager. The Contractor shall remain liable for any damage or injury consequent upon removal of timbering or shoring.

Where directed by the Project Manager the timbering and shoring shall be left in excavations and measured and paid for except if, in the Project Manager's opinion, the necessity for leaving the timber in has arisen from carelessness or neglect on the part of the Contractor.

#### **Article 14.5 - Trenches and Holes Excavation and Backfilling**

14.5.1 The trenches and holes excavations shall be of sizes sufficient to enable the bottom to be compacted as required, the bed to be laid, the pipes and concrete to be placed accurately and proper backfilling and ramming to be carried out.

14.5.2 Where required the bottom of such excavations shall be compacted to 95% B.S.H.M.D.D.

14.5.3 Where rock is met at level of the intended bottom of the trench or hole, it shall be cut to a depth of 20 cm below this level and replaced with sand, granular material or other material to the approval of the Project Manager.

14.5.4 Trenches and holes shall be kept free from water until any works such as concrete or joints therein are sufficiently set; the Contractor shall construct any temporary drains that the Project Manager may deem necessary.

14.5.5 Where seepage of water occurs in trenches or holes, bedding and backfilling shall be carried out using sand, granular material or crushed stones or other material as directed by the Project Manager.

14.5.6 Material for backfilling shall be to the approval of the Project Manager and shall be deposited in layers not exceeding 15 cm of loose material, compacted with power rammers, the moisture content of the material being adjusted to facilitate thorough compaction. The density of each compacted layer shall not be less than 95% of B.S.H.M.D.D.

#### **Article 14.6 - Lined trapezoidal ditch**

Lined trapezoidal ditches shall be built in masonry to the cross-section as shown in the drawing or as directed by the Project Manager, and the invert level shall be finished to a steady longitudinal gradient not less than 0.5% and the fall shall be in all cases towards a culvert.

#### **Article 14.7 - Unlined trapezoidal ditch**

Unlined trapezoidal ditches shall be constructed to the cross section as shown on the drawing or as directed by the Project Manager.

The invert level shall be finished to a steady longitudinal gradient of not less than 1% and the fall shall be in all cases towards a culvert.

#### **Article 14.8 – Reinforced concrete trapezoidal drain**

Reinforced concrete trapezoidal drain shall be constructed to lines and levels as shown in the drawings. The concrete grade shall not be of Grade 25 and shall have a fair face finish. Reinforcement shall comply with the requirements of MS 10. Cover to main reinforcement bars shall be 25mm.

#### **Article 14.9 - Pipe Culverts**

Pipe culverts shall be placed after cleaning their inside. Any damaged pipe shall be rejected.

Pipes shall be embedded in class 20 concrete to the line and level as shown on the drawings or as directed by the Project Manager.

The method, tools for placing the pipes, joints to be used shall be to the approval of the Project Manager.

A properly fitted plug shall be well secured at the end of each pipe already laid and shall be removed only when the next pipe line is being laid or on completion of the pipe line or culvert.

Where required by the Project Manager, bedding shall curve upward along the culvert to correct for expected settlement and to ensure tightness in the lower half of the joints.

The flow line of the pipes shall be within a range of 0.5 cm of the specified level shown on the drawings or as directed by the Project Manager.

Backfilling shall be brought up evenly on both sides of the pipe. Special care shall be taken to compact thoroughly the material under the haunches of the pipe and to ensure that backfilling material is in intimate contact with the pipe.

Jointed pipes shall be tested as directed by the Project Manager.

Masonry works shall comply with the requirements of Article 14.11 and the end of all pipes shall be neatly built into the walls and finished with cement mortar.

No separate payment shall be made for excavation of pipe culverts and the cost thereof shall be deemed to be included in the rate for provision and laying of the pipe.

#### **Article 14.10 - Box Culverts**

Box culverts shall be built to the lines, levels and dimensions shown on the drawings or as directed by the Project Manager. The base shall rest on firm soil and if the nature of the soil encountered requires the foundation to be lowered, the extra depth excavated shall be filled up with class 15 concrete containing 25% of plums.

The bottom of the excavation shall be filled with class 15 blinding concrete.

The top of the base slab shall be finished smooth to a steady gradient and the fall shall be as directed by the Project Manager. The base slab and the cut-off walls shall be executed in class 30 concrete.

The supporting walls and the wing walls shall be built with class 30 concrete. All exposed surfaces shall have a smooth off shutter finish and construction joints shall be rubbed down to a smooth finish. The supporting walls and the wing walls may be built in masonry at the option of the contractor.

The top of the supporting walls shall be finished smooth to a perfectly level surface (by a layer of concrete in the case of masonry walls) so that no rocking of the precast apron slabs occurs once the latter is fixed in position.

The apron slabs shall be cast to have a smooth off shutter finish to the dimensions and levels given in the drawings or as directed by the Project Manager in class 30 concrete. These slabs may be cast *in-situ* or precast at the option of the contractor. If they are precast, they shall, in all respects, comply with the requirements for precast concrete given in Article 6.12.

#### **Article 14.10 - Gullies and Manholes**

Gullies and Manholes shall be built to the lines, levels, dimensions, and details given in the drawings or as directed by the Project Manager. The bottom of the excavation shall be blinded with class 15 concrete. The base slab and the walls shall be built with class 30 concrete. The internal surfaces shall be of off-shutter finish with the construction joints rubbed down to make a uniform level surface. The top edge of the wall shall be carefully finished smooth and level so that no rocking of the precast cover slabs occurs.

#### **Article 14.11 - Masonry Works**

The stones for masonry works shall be in accordance with the requirements of Article 2.24 and the mortar for laying the stone and for pointing shall be as specified in Article 7.3.

The masonry shall be laid to line and in courses roughly levelled up. The bottom courses shall be composed of large selected stones to be approved by the Project Manager and all courses shall be laid with bearing beds parallel to the natural beds of the material.

Each stone shall be cleaned and thoroughly saturated with water before being set and the bed which is to receive it shall be clean and well moistened. All stones shall be well bedded in freshly made mortar. The mortar joints shall be full and the stones carefully settled in place before the mortar has set.

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 racking them out to a depth of 5 cm before the mortar has set.

The face surfaces of stones shall not be smeared with the mortar forced of the joints or that used in pointing.

Vertical joints in each course shall break with those adjoining courses at least 15 cm. In no cases shall a vertical joint be so located as to occur directly above or below a header.

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

Joints not pointed at the time the stone is 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 four days after completion. After the pointing is completed and the mortar has set, the wall shall be thoroughly cleaned and left in a neat condition.

#### **Article 14.12 - Riprap**

The stones for riprap shall be as specified in Article 2.24. They shall be laid with closed joints from the bottom of the slope of the embankment or existing ground, upward, the larger stones being laid at the bottom.

#### **Article 14.13 - Rainwater Downspouts**

The stones for rainwater downspouts shall be as specified in Article 2.24. They shall be laid and bedded in class 15 concrete to the lines, levels and dimensions given in drawings or as directed by the Project Manager.

#### **Article 14.14 – Catchpits**

Catchpits shall be built at locations shown on drawings and as directed by the Project Manager. Catchpits shall have a silt trap 300mm below invert level of drain.

## SECTION 15 - ROAD FURNITURE AND MISCELLANEOUS

### INDEX

#### ARTICLE NO

15.1 ROAD MARKING PAINT

15.2 CATS' EYES

15.3 TRAFFIC SIGNS

15.4 GUARD RAILS

15.5 PEDESTRIAN HAND RAILS

15.6 MILESTONES AND BOLLARDS

15.7 PRECAST KERBS, CHANNELS, EDGINGS AND QUADRANTS

15.8 IN SITU KERBS

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## SECTION 15 - ROAD EQUIPMENT AND MISCELLANEOUS

### Article 15.1 - Road Marking Paint

15.1.1 Paint shall comply with Article 2.43 of T. S. The setting out of lines and symbols shall be made by the Contractor according to Typical Drawings. For junction and roundabout, the contractor shall submit to the agreement of Project Manager working drawing at least fifteen days before starting works.

15.1.2 Prior to application, the road surface shall be thoroughly cleaned of dust, dirt and all loose material. Painting on wet surface is forbidden.

15.1.3 The application of paint shall preferably be done by a purpose made machine, but the Project Manager may approve brushing. All application shall be strictly adhered.

The spraying rate for cold paint will vary with the roughness of the surface, but shall be such to give continuous coverage. Immediately after application of the cold paint, ballotinis shall be spread on top.

The minimum dry film thickness and the rate of ballotinis shall be in accordance with the manufacturer's instructions. The guarantee period of products shall be at least twelve months.

Warning signs shall be erected when painting is in progress and traffic shall not be allowed to pass over wet paint. Any painting disfigured by traffic, or any painting not to the satisfaction of the Project Manager, shall be wiped out and repainted at the Contractor's expense.

### Article 15.2 - Cats' Eyes

The two way cats' eyes shall comply with requirements specified in Article 2.39. They shall be fixed in accordance with manufacturer's instructions for use, according to the paint center line pattern.

### Article 15.3 - Traffic Signs

15.3.1 All traffic signs shall comply with the "GN 154 of 1990 for Traffic Signs". Height or diameter of signs are given on Typical Drawing. Locations of traffic signs shall be specified by the Project Manager.

15.3.2 All posts shall be GI.

When the sign has been assembled the complete sign, including the post, shall receive one coat of rust protective primer as specified followed by two coats of grey paint of an approved manufacture.

15.3.3 The foundation of posts shall be of Class 15 concrete. The volume of foundation shall be not less than 1.25 m<sup>3</sup>. The post shall be surrounded at sides and bottom by a minimum of 150 mm of concrete. The top of the foundation shall be set to the design level with a tolerance of 2 cm.

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15.3.4 The sign plates shall be manufactured from Aluminium alloy sheet of at least 3 mm thickness (11 gauges). The sign plates are to be stiffened and the stiffening may be in the form of a flange at least 15 mm deep on all edges, or by means of Aluminium sections.

Material for fixing, such as brackets, sockets, caps, clips, screws, bolts, nuts and washers shall be to the Project Manager's approval. Brass or copper will not be allowed for use in contact with Aluminium.

The supplier's shall confirm the following:

The reflective Project Manager Grade sheeting used on road signs shall consist of spherical lens elements embedded beneath the surface, and shall have a protected, pre-coated adhesive backing which shall be tack free, heat activated for mechanical vacuum heat application or a pull off film which shall be pressure sensitive for manual application .

The reflective sheeting shall be sufficiently flexible so as to permit application over and conformance to a moderate embossed surface. It shall show no damage when bent 90° over a 50 mm diameter mandrill.

The sheeting shall be solvent resistant so as to be capable of withstanding cleaning with petrol, diesel fuel, mineral spirits, turpentine and methanol.

The sheet shall show no cracking or reduction in reflection after being subjected to the dropping of a 25 mm diameter steel ball from a height of 2 meters onto its surface.

The adhesive shall permit the reflective sheeting to adhere securely within 48 hours after application at temperatures of up to 95°C.

The reflective material shall be weather resistant and, following cleaning, shall show no definite fading, darkening, cracking, blistering or peeling and not less than 155 of the specified wet or dry minimum brightness values when exposed either to an accelerated weathering period of 12 hours or a natural exposure of 2 years, in accordance with an approved testing procedure



The minimum reflective brightness values of the retro-reflective sheeting as compared to Magnesium Oxide (MgO) shall be:-

COLOUR	ANGLE OF INCIDENCE	ANGLE OF DIVERGENCE	REFLECTIVE VALUE COMPARED WITH MgO
Red	-4 <sup>0</sup>	0.5 <sup>0</sup>	15
	20 <sup>0</sup>	0.5 <sup>0</sup>	10
	50 <sup>0</sup>	0.5 <sup>0</sup>	3
White	-4 <sup>0</sup>	0.5 <sup>0</sup>	155
	20 <sup>0</sup>	0.5 <sup>0</sup>	150
	50 <sup>0</sup>	0.5 <sup>0</sup>	150
Yellow	-4 <sup>0</sup>	0.5 <sup>0</sup>	45
	20 <sup>0</sup>	0.5 <sup>0</sup>	35
	50 <sup>0</sup>	0.5 <sup>0</sup>	10
Blue	-4 <sup>0</sup>	0.5 <sup>0</sup>	6
	20 <sup>0</sup>	0.5 <sup>0</sup>	4.5
	50 <sup>0</sup>	0.5 <sup>0</sup>	0.5

The brightness of the reflective sheeting when totally wet by rain, shall be not less than 90% of the values.

A *warranty certificate* for the reflective sheeting is to be obtained from the Local Supplier of the road signs and submitted to the Project Manager.

Standard colours to be used for signs, posts and fittings shall be as described in the relevant BS as follows:-

Red

BS 381C No. 5315

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Blue BS 4800 No. 0.013

Grey for post fittings and

Back of signs BS 2660 No. 9-101

Black and White BS 8153 CB & 3C

Rust inhibitive paint shall comply with BS 2523: Lead Based Priming Paints.

#### **Article 15.4 – Guard Rails**

Guardrails shall be installed as shown on the Drawings or as directed by the Project Manager. The posts shall be spaced a standard interval of 3.8 metres. Posts shall be plumbed. The top of the post shall be set to the design level with a tolerance of 2 cm.

#### **Article 15.5 - Pedestrian Handrails**

Pedestrian handrails shall be provided as shown on Typical Drawing. Individual panels supplied shall take into account horizontal and vertical alignment of the ground where hand railing is to be located, and the change in direction of the hand railing at road junctions.

Support posts for the panels shall be fixed in the ground as shown on the Drawings.

#### **Article 15.6- Bollards**

Bollards shall be precast with Class 25 concrete to the dimensions shown in the Drawings or as directed by the Project Manager and shall in all respects comply with the requirements for precast concrete as per Article 8.12. They shall be bedded in Class 15 concrete.

Bollards shall be painted as directed by the Project Manager.

#### **Article 15.7 - Precast Concrete Kerbs, Channels, Edgings and Quadrants**

15.7.1 Precast concrete kerbs, edgings and quadrants shall comply with Article 2.32 of the Technical Specifications and shall be laid and bedded in a layer of mortar not less than 10 mm thick on a Class 15 concrete foundation. Kerbs shall be backed with Class 15 concrete.

15.7.2 All precast kerbs shall be butt jointed and all joints shall be mortared.

15.7.3 For radii of 12 m or less, kerbs of appropriate radius shall be used.

15.7.4 Any unit of kerb, channel edging and quadrant deviating more than 3 mm in 3 m from line and level shall be made good by lifting and relaying.

#### **Article 15.8 - In situ kerbs**

15.8.1 The kerbs shall be compacted with regular sides, edges, arises and chamfers finished to a surface free from blowholes and dragging and shall be impervious.

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15.8.2 The surface regularity of the top of the kerbs shall comply with the tolerances for the wearing course as specified in this Specification. The horizontal alignment shall not deviate from that shown on the Drawings by more than 3 mm in 3 m.

15.8.3 The concrete shall comply with relevant clause of Section 6 of this specification and shall be Class 30.

The exposed surfaces of kerbs shall be cured by treating with an approved aluminised curing compound immediately after laying, unless other methods of curing are approved by the Project Manager.

15.8.4 Kerbs shall remain firmly secure on the surface on which they are laid and shall be cast at least one week prior to the laying of the layer they are to contain. They shall be cut and moulded whilst green to form expansion and contraction joints. The joints shall then be filled.

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SECTION 16 – WATER WORKS

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ARTICLE NO

16.1 HDPE PIPES

16.2 TOOLS AND EQUIPMENTS FOR POLYETHYLENE PIPES.

16.3 HANDLING AND STORAGE

16.4 PIPE JOINTING AND TESTING

16.5 VALVES AND CHAMBERS

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## SECTION 16 WATER WORKS

### **Article 16.1 HDPE PIPE. (High Density Polyethylene Pipes) Technical data**

#### **ALL PIPES AND FITTINGS TO BE PN 16**

High-density polyethylene pipes (HDPE) shall be manufactured in accordance with ISO1614 ISO 3607 and ISO 1167 DIN 16075. AFNOR NFT 54-072 or equivalent to the approval of the Consultant and shall have a normal pressure rating of 10 bars at +20°C. The pipes shall be constructed with polyethylene having a minimum density of 0.941g/cm<sup>3</sup> including 20 to 25% of carbon black required for U.V stabilization and a maximum melt flow index of 10g / 10 min.

Recycled materials shall not be used in their manufacture.

The pipes shall be suitable for joining by means of electro-fusion joints and/or mechanical joints. The connections and fittings shall have a normal pressure rating identical to the polyethylene pipe on which they are installed they shall fit the same pipe exactly. Pipes up to 110mm diameter to be supplied in coils having a maximum length of 50m. Pipes greater than 110mm diameter to be supplied in a maximum length of 16m.

The pipes shall be of black colour and with either blue strip.

#### **Low Density Polyethylene Pipes**

Low density polyethylene (LDPE) pipes shall be manufactured in accordance with DIN 16072, DIN 16073 and AFNOR T54-043 or equivalent and shall have a nominal pressure rating of 6 bars at a temperature of +20°C. The low-density polyethylene pipes shall be joined with assembled joints as specified.

The pipes shall be made of low-density polyethylene, as specified in AFNOR T 53-020, to which shall be added only those anti-oxidants and pigments (carbon blank) necessary for the manufacture and use of pipe of this Specification. Reworked materials shall not be used.

The pipes shall be supplied in coils having a maximum length of 100m. The pipes shall be coiled at a temperature inferior to 30°C and the minimum permissible ratio between the radius of coiling and the external diameter of the pipe shall be 15.

#### **Polyethylene Fittings**

Polyethylene fittings to be supplied shall be of the electro-fusion types and shall be as described below:

#### **Polyethylene Electro-fusion Fittings**

- 1. Polyethylene electro-fusion fittings shall have embedded heating coils with contact terminals or shall alternatively be supplied with electro-fusion couplers

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- 2. The fittings shall have deep insertion length with a wide fusion zone and a cold zone in the centre. They shall also have fusion indicators.
  - 3. The fittings shall be made of high density polyethylene and be of black colour to withstand 16 bars test pressure i.e. a nominal 10 bars pressure. They shall also have high tensile and compressive strengths with a density of approximately 0.936 to 0.95 g/cm<sup>3</sup> at 23<sup>o</sup>C. Their melt index shall be within the range of 0.4 to 1.3 gm/10 min.
  - 4. The fittings shall have a bar code label, which can be read by the want of the electro-fusion equipment. They shall be compatible for electro-fusion with HDPE pipes with melt index groups 003 to 050 and shall be electro-fused at any safety electro-fusion voltage within the range of 16 volt to 416 volt to suit the electro-fusion welding equipment owned by the Authority.
  - 5. Tapping tees shall be suitable for electro-fusion on live mains with a metal threaded drive cutter of limited cutting depth to protect the opposite pipe wall from damage. The cutter shall also allow the disc cut from the pipe wall to be retained in the cutter and shall not produce debris while cutting through the pipe wall.
  - 6. Electro-fusion tapping tees and branching saddles shall comprise a lower half and upper half under and over the pipe bolted together prior to electro-fusion.

### **Electro-fusion Type Flanged Adaptors**

Electro-fusion type flange adaptors shall be of polyethylene and shall have to be able to be safely electro-fused with electro-fusion couplers. Length of the adaptors shall therefore be sufficient to allow proper fusion widths.

The flange adaptors shall be compatible with the steel flange as specified.

### **Polyethylene Adaptor and Reducing Connector**

P.E adaptor and reducing connector shall be of mechanical type. The P.E adaptor and reducing connector shall comprise of a high grade polymer body and nut, actual split ring and insert and a nitrile rubber O-ring.

### **Transition Fittings – Polyethylene/Other Pipe Connections**

The Polyethylene side shall have integral heating coil or provided with long and with electro-fusion couplers. Electro-fusion safety voltage specifications shall apply. The metal sides shall be manufactured as per specifications of the relevant pipe connector.

The transition fittings shall be a monolithic product guaranteed to axial bursting and internal pressure tightness.

### **Steel Flange**

The Steel flange shall be compatible with the P.E flange adaptors as specified.

Drilling comply with BS 4504 –Table 16/11 or alternative approved standard Rating and test pressure of the steel flanges shall be not less than 15 bars.

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The steel flange shall be supplied complete with rubber joints, bolts and nuts which shall be block hexagonal and flat washers to BS 4190 or alternative approved standard.

### **PVC Saddle**

The saddle shall be of UPVC supplied with bolts, nuts, sealing ring and all accessories to make a complete connection. The saddle shall be suitable for mounting on High Density Polyethylene Pipe.

The tapping shall be internally threaded to the nominal diameter given for the ferrule as specified.

### **PTFE Tape**

The PTFE Tape shall be made of 100% fluoro-carbon and be chemically inert and non-contaminating seal and shall be supplied in 10 metres length.

Dimensions shall be 0.075mm x 12.0mm

### **HDPE Tappings Tees Saddles**

The saddles shall be supplied in two parts with anti-corrosion bolts and nuts for tight clamping on the HDPE pipes.

The saddles shall be fitted with integral heating coil to enable electro-fusion jointing. Electro-fusion safety voltage specifications shall apply.

The saddles shall be supplied complete with the tapping device, appropriate key including all fittings/couplers for connection with 20mm LDPE service pipes or otherwise as directed by the Project Manager. These fittings/couplers for connection shall also be fitted with heating coil to enable electro-fusion jointing.

The tapping shall be internally threaded to the nominal diameter given for the ferrule as specified.

### **Article 16.2: Tools and Equipment for Polyethylene Pipework**

The Contractor shall have be equipped with appropriate electro-fusion equipment for use with electrofused joints and fittings for HDPE pipes. The equipment shall consist of:

- (a) Cutting/reaming equipment
- (b) Electro-fusion equipment with controller supplied by a portable generating set delivering a minimum power of 3.5 Kw
- (c) alignment equipment

### **Electro-fusion Welding Equipment and Mobile Generator**

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- 1. The equipment shall have a computer aided command system for automatic control and monitoring of the power supply and including a built-in earth leakage circuit breaker.
  - 2. The equipment shall offer to the user simplicity of operation with push button system and liquid crystal display. The electronic component shall be housed in a waterproof compartment.
  - 3. The equipment shall also provide and include for bar code system reading of welding data for fully automatic electro-fusion.
  - 4. The equipment shall also provide and include for the following:
    - i) Heavy duty output cables, welding cables with both universal and X-plugs, series welding cables
    - ii) Primary heavy duty cable and connectors to fit generating set and welding equipment
    - iii) Light pen for bar codes reading.
  - 5. The mobile generator shall be fused with minimum 16 Amps and be compatible for use with the electro-fusion welding equipment as specified above.
  - 6. Facility for recording and printing of technical fusion parameters for each fusion shall be provided.

### **Clamping Tool**

Clamping tool for restraining movement of polyethylene pipes and some P.E fittings of 20 to 63mm diameter complete with pipe adaptors or inserts of the full range of diameters for the two clamps shall be used.

The clamping tools shall allow easy operation in a narrow trenching environment

### **Pipe Restraining Clamp**

The clamp shall be used for PE and some PE fittings of diameters ranging from 63mm to 160mm, complete with all adaptors or inserts of the full range of diameters.

The clamp shall allow easy operation in a narrow trenching environment

### **Pipe Cutter**

An appropriate pipe cutter as per manufacturer's instructions shall be used for cutting polyethylene pipes of diameter ranges:-

- i) 20 to 63 mm
- ii) 63 to 160 mm



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## **Article 16.3: Handling & Storage**

### **Off-Loading**

When off-loading or lifting standard pipe bundles of 12 metre length support slings (or fork centres on fork-lift trucks) should ideally be not less than 4m nor greater than 6m spaced equidistant about the centre of the pipe bundle.

When lifting by crane non-metallic slings or ropes must be used. Hooks must never be inserted in pipe ends.

Individual pipes may be handled in the same way.

Pipes must never be thrown from delivered vehicles or slid from the tailboard of a moving flat-bed wagon.

Where pipes are delivered to site loose, off loading may be achieved more easily by using skid timbers, rope slings and manpower.

Coils of pipe are easily handled manually or by fork-lift truck, depending on pipe diameter and coil length. Coils must not be rolled from delivered vehicles or along the ground.

All precautions must be taken to prevent damage to the outer surface of the pipe. Pipes or fittings with surface defects penetrating the wall to a depth exceeding 10% should be put aside.

### **Transportation**

The following general rules should be followed when transporting pipes within storage depots, between depots and site and most particularly, at and around the construction site.

For transporting bundled loose pipes the vehicles should be provided with a flat bed, free from nails or other projections, which may cause damage. Special care must be taken to prevent slippage or excessive bowing of the pipes and extra protection given at all sharp edges.

Pipes and fittings should not be positioned near or adjacent to exhaust systems or other heat sources.

### **Storage**

All pipe stacks should be made on sufficiently firm, flat ground cleared of all large stone/sharp objects and any other item that may cause damage to bottom layer of pipes to support the weight of pipes and any necessary lifting equipment. The maximum stacking heights should not exceed 3 metres.

Coils should be stored horizontally, Maximum stack heights should not exceed for

- 50 mm diameter – 16 coils high

- 
- 63 mm diameter – 4 coils high
  - 90 mm diameter – 2 coils high

Loose pipes should be stored in pyramid form to a maximum height of one metre and with the bottom layer fully restrained against lateral displacements.

The bottom layer of pipes should be laid on timber battens at one metre centre.

Fittings should be stored under cover on racking and the manufacturer's protective wrapping or carbons kept intact until time of installation.

All special tools and equipment associated with the jointing of HDPE pipes and fittings should be stored separately and securely until they are required for use. The heating faces of fusion tools should not be kept in a position where the surfaces could be scratched or otherwise damaged and those tools incorporating cutting edges should be protected from damage that could cause poor joint preparation.

## **Article 16.4: Pipe Jointing and Testing**

### **Pipe Cutting**

The cut must be at right angles to the axis of the pipe. A.P.E pipe cutter or a saw with teeth suitable for cutting plastic can be used for this purpose.

### **Fusion Zone**

Mark out the depth of insertion (or fusion zone) i.e. the distance between the coupler edge and central register. In the case of slide-over couplers, the distance between the edge and the middle of the coupler. In the case of tapping fittings, the surface covered by the upper section.

### **Removal of Oxide Layer**

Prior to jointing, a scraper or a peeler should be used to remove (at least 0.1 mm) all traces of the oxide layer, which had been formed on the surface of the spigot pipes and fittings. Filing or grinding are not allowed as impurities could be ground in. A check line is drawn with a greasy pencil on the fusion zone to ensure that the oxide layer has been completely removed.

### **Deburring the Inside and Outside Edges**

A scraper blade is ideal to remove burrs and shavings.

### **Correcting Ovalised Pipes**

During storage, PE pipes lose their circular form. The areas of the pipe affected at the fusion zone must be corrected with a surrounding clamp during fusion of the pipe and can be removed as soon as the fusion time has elapsed.

### **Cleaning of Fusion Zone**

Directly prior to join the surfaces and internal faces of the fitting have to be cleaned with an acetone based cleaning agent and then wiped clean with an absorbent, lint free and non-dyed disposable paper towel. Then mark the insertion depth, which has been removed when scraping and cleaning.

### **Inserting the Fittings**

The contract terminals of the fitting for connection to the fusion plug must remain accessible. The fitting should slide on without having to use force. If necessary the spigot surfaces can be scrapped off again to permit the insertion end more freely as far as the marker line of the insertion depth.

### Alignment of the Pipes

The pipes' ends for fusion must be in a straight alignment. Also the couplers must be able to be turned after fitting to the pipe ends. If necessary, the pipe has to be secured against sagging. Pipes must not be subjected to bending stress or be left to support their own weight in the fitting. A connection point which is stressed will result in inadmissible flow of molten material when welding and under worst-case conditions will lead to a defective connection.

### Fusion

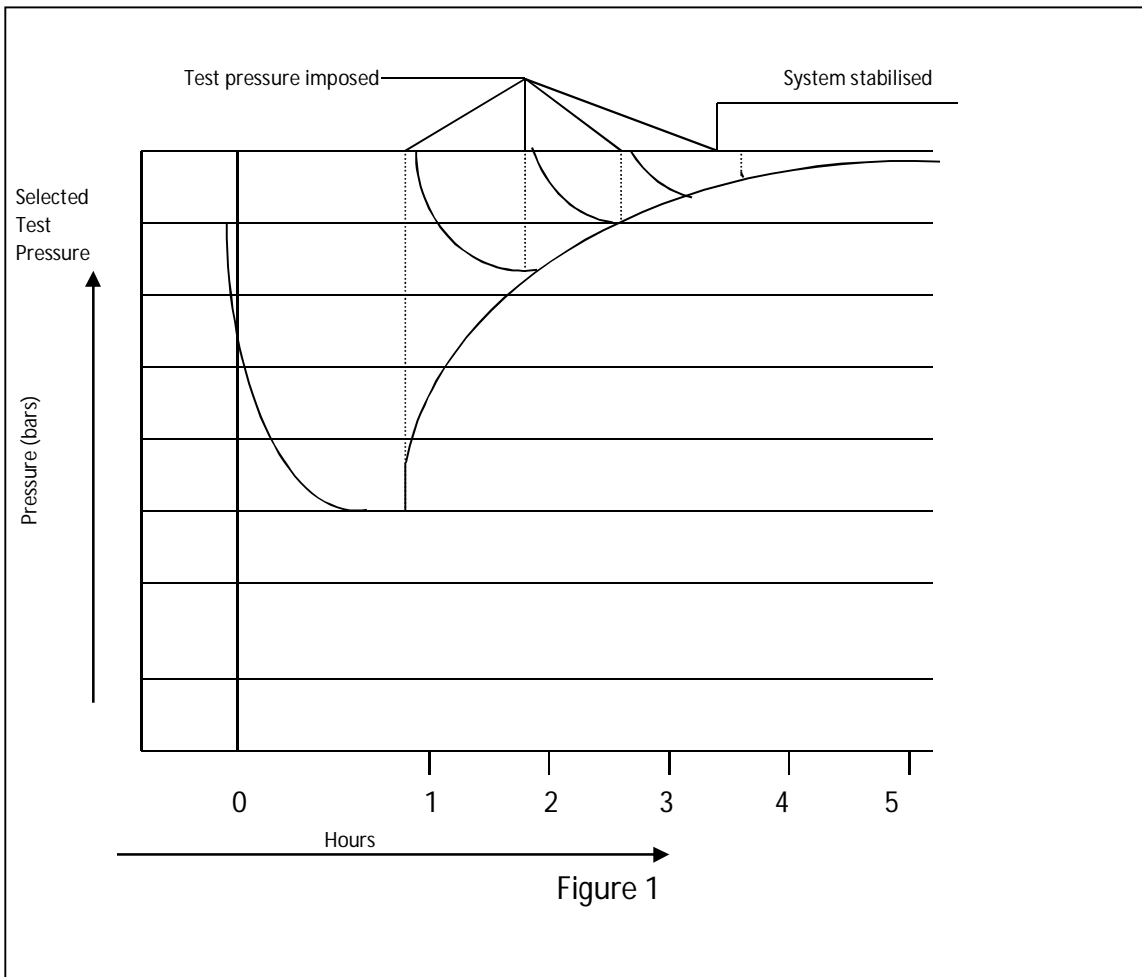
Before fusion, the seat of the insertion ends of the pipes in the fitting must be rechecked against movement. The suitable fusion equipment, as approved by the Project Manager, must be used. The joint assembly must not be moved or disturbed until the full cooling time has elapsed as specified.

### Hydrostatic Pressure Testing For High Density Polyethylene Pipes.

All joints must be left opened during testing. The pressure test should be carried out at ambient temperature and should not exceed the rated pressure of the pipe or 1.5 times the maximum static head on the main, whichever is greater.

The selected test pressure applicable to the system is maintained by additional pumping, if necessary, at 1 hour intervals for 3 to 4 consecutive hours. After the 1<sup>st</sup> hour the decay in pressure may attain 2.5 to 3.0 bars at the test gauge.

The test procedure can only begin after the pressure in the system stabilises at the selected test pressure (See figure 1).



The system is deemed to be considered as such if the decay in pressure for two consecutive readings at one hour intervals is equal to or less than 0.2 bars at the test gauge.

### **Type 1 – Pressure Test**

This test is suitable for short lengths of small diameter main where there is no residual air in the test section.

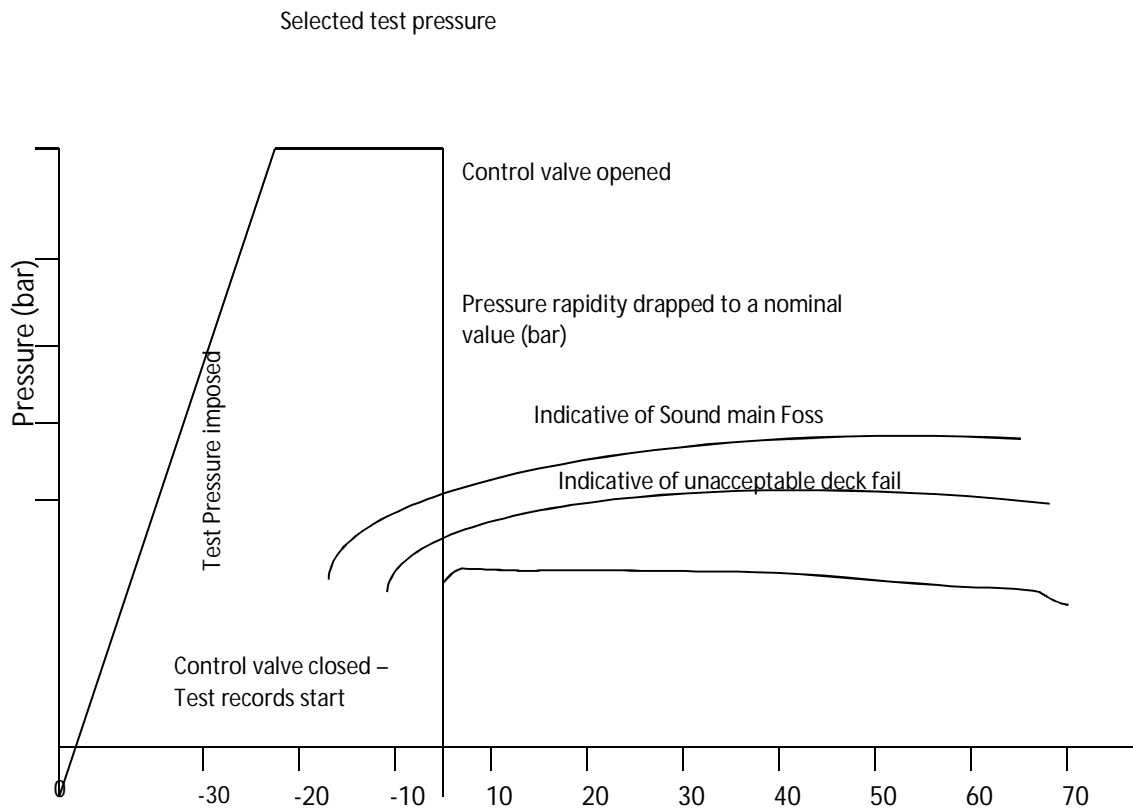
The selected test pressure which is applied must be maintained by additional pumping as required for a period of 30 minutes. During this time an inspection should be carried out to identify any obvious leaks.

The pressure should then be reduced rapidly by bleeding water from the system to a nominal pressure of 3 bars at the test gauge. The control valve should then be closed to isolate the installation.

The pressure gauge readings should then be recorded and plotted at the following intervals:-

- 0-10 mins @ 2 minutes (5 readings)
- 10-30 mins @ 5 minutes (4 readings)
- 30-90 mins @ 10 minutes (6 readings)

The resulting graph for a leak-tight system should have a characteristic profile similar to that shown in fig. 2.



Provisional Pressure Test TYPE 1  
Typical Pressure Graph

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In a leak free system the gauge pressure is expected to rise from its reduced setting due to polyethylene attempting to contract to its original diameter. The system should then retain this slightly higher pressure.

The degree to which the creep in the material affects the pressure graph and the time for response to reduced pressure will be influenced by:

- (a) Length of the test section
- (b) The diameter of the pipe
- (c) The presence of air
- (d) The efficiency of the bedding and compaction

Within about a 90 minute period a good indication will normally be available. If during that period there is a falling away of pressure, this indicates a leak within the system.

Any defects in the installation must be rectified and the test repeated.

**Test should be carried out at every 500m of pipe laid.**

#### **Article 16.5: Valves and chambers**

Valves shall generally be in accordance with the following standards and requirements:

##### **a. General**

Flanges on valves shall generally be drilled to B.S 4504:Table 16/11 unless higher pressures are specified in the Drawings of Schedules.

Valves shall be coated internally and externally to give the same standard of protection as for the pipework and fittings being used. Surface protection shall be all to the approval of the Project Manager.

##### **b. Gate and Sluice Valves.**

All gates and sluice valves for working pressure up to and including NP16 shall conform to:-

Approved fittings to enable their operation under a maximum differential pressure of 16 bars.

Stem sealing shall be by stuffing box and gland, of sufficient size to ensure the packing will have a long life or as shown on Drawings.

Valve caps shall be provided on pipelines except otherwise mentioned or instructed by the Project Manager.

Valves shall have been tested 'open-ended' unless specifically noted otherwise on the Drawings or in the Bill of Quantities. Certificates for this test for each valve shall be obtained from the manufacturer and submitted to the Project Manager.

##### **c. Air Valves**

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Single orifice air valves shall be “Messrs Glenfield and Kennedy Ltd”, “Apex type 1251” or **equally approved** complete with separate isolating cock or “type 1253” for appropriate diameter or as mentioned otherwise on Drawings or approved by the Project Manager.

Double orifice air valves shall be “Messrs Glenfield and Kennedy Ltd”. “Apex type 1272” or equally approved complete with separate isolating cock or “type 1253”, for appropriate diameter or as mentioned otherwise on Drawings or approved by the Project Manager.

Large orifice air valves shall be” Messrs Glenfield and Kennedy Ltd”. “Apex type 1262” for appropriate pipe diameter or as mentioned otherwise on Drawings or equally approved by the Project Manager.

**d. Chamber covers and frames.**

Chamber covers and frames shall be as manufactured by Messrs Brickhouse Broads Ltd or similar and be of the type and dimensions stated below:-

Heavy Duty and frame, lockable, for opening 600mmx600mm (Brickhouse Broads No. L 51165)

Light Duty cover and frame, lockable, for opening 600mmx 600mm (Brickhouse Broads type “Broadstel” No. 7349C)

Light Duty cover and frame, lockable, for opening 600mmx 1471mm (Brickhouse Broads “Broadstel” type 2349G)

Heavy Duty steel covers for clear opening 750mmx 600mm with central surface box 100mm x 100mm (Brickhouse Broads type 6241/4)

Or as mentioned or shown on Drawings or as approved by the Project Manager.

**e. Surface and Valve Boxes**

Fire hydrant covers shall be manufactured in accordance to BS 750 and shall be suitable for heavy duty. They shall be 600mm x 450mm clear opening, marked with letters F.H., and incorporate a lift out cover chained to the frame.

Air valve chamber covers shall be cast iron with 600mm x 450mm clear opening incorporating a lift out, ventilated cover lettered “A.V.” and be suitable for heavy duty.

Sluice valve chamber covers shall be cast iron with 100mm clear opening, 100mm deep incorporated a chained lift out or hinged over lettered “W” and be suitable for Heavy Duty.

All covers and boxes shall be of Brickhouse Broads manufacture or similar, and shall be manufactured in accordance with B.S. 497 Part 1.

**f. Step irons**

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Steps irons shall be galvanized malleable cast iron in accordance with B.S. 1247 and shall be of general purpose pattern with 120mm tail length or as instructed by the Project Manager.

**g. Mechanical joints**

Flexible couplings and flanged adaptors shall be of Viking Johnson manufacture or similar approved, in accordance with B.S. 534: Steel Pipes and Specials for Water and Sewage. They shall be protected internally and externally with an approved epoxy coating. Bolts and Nuts shall be in stainless steel or shall be galvanized.

In addition, buried couplings shall be protected by an approved anti- corrosion paste and tape wrappings – Denso or similar.

**h. Flow meters**

Flow meters shall be of the in-line helical type as manufactured by Kent Meters Ltd or similar approved complete with gaskets, nuts and bolts. Note that individual water metres will be installed by the Utility body upon an application being made by the prospective house owner.

**i. Fire Hydrants**

Fire Hydrant shall be of screw-down type to B.S 750 and shall be fitted and tested in accordance with this standard. They shall be of cast iron construction with gunmetal stopper.

Fire hydrants shall be clockwise closing by means of spindles fitted with cap tops of the same dimensions as fitted to the sluice valves. The outlet flange of the hydrant shall have a bore diameter of 65mm or as otherwise mentioned or approved by the Project Manager, and shall be fitted with an outlet to be screwed with round thread. Details of the screwed outlet are in accordance to B.S. 750: figure 4.

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## SECTION 17 PLUMBING WORKS

### Article 17.1 General

A general layout for the typical house unit is enclosed in the set of drawings. The Contractor shall submit the shop drawing and design notes on the installation of the potable water supply to points as shown in drawing and wastewater discharge networks up to final disposal in the absorption pit. The shop drawings and notes shall be submitted in 3 sets to the Project not later than 21 days from the order to commence.

The set of specifications shall be used as a guidance. Contractor wishing to provide alternative proposals shall ensure that all standards and codes of practices are submitted to the Project Manager together with such alternatives.

An as-built drawing shall be submitted in 3 sets (hard copies) and 1 soft copy (ACAD 2010 Version) not later than 15 days from practical Completion

Potable water supply within the housing unit shall be fully operational from the main water supply line (CWA line) as well as from the overhead water tank. All potable water distribution shall be a pressurised system.

Proper pipes and fittings shall be incorporated to provide cold/hot water to shower and kitchen sink. The installation shall be such that they are easily fixed when the solar panels are installed. Solar heating system would be installed by another contractor under a separate contract.

Wastewater piping shall be designed as non-pressure system. All wastewater shall be discharged into a septic tank. The Contractor shall provide for all pipe and fitting required for the safe disposal of wastewater. Wastewater from pipe from WC pan (European Type) shall be 110mm dia. and adjusted to the pan by a flexible coupling.

An air vent system shall be provided as indicated in the drawing. The vent shall be of 75mm dia. PVC pipe clamped to the house wall and projecting at least 500mm above the roof level.

Rainwater pipes shall drain roof water via a gargoyle as indicated in the drawings. The rain water pipe shall be connected to a soak-away. Rain water pipe shall be of 75mm dia. PVC non-pressure pipe.

### Article 17.2 PLASTICS PIPES AND FITTINGS:

#### 17.2.1 PLASTICS PIPING SYSTEMS FOR WATER SUPPLY - PIPES TO BS EN 1452:

- Material: Un-plasticised polyvinyl chloride (PVC-U).
- Standard: BS EN 1452-2.
- Dimensions: Length - manufacturer's standard range. BS EN 1452-2 tables 1, 2, 3, 4 and 5.
- Ends: Plain; elastomeric ring seal socket and spigot; or socket and spigot for solvent cement.
- Finish: Grey.

#### 17.2.2 PLASTICS PIPING SYSTEMS FOR WATER SUPPLY - FITTINGS TO BS EN 1452:

- Material: Un-plasticised polyvinyl chloride (PVC-U).



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- Standard: BS EN 1452-3.
  - Size range: 12mm to 315mm
  - Dimensions: Length - manufacturer's standard range. BS EN 1452-2 tables 1, 2, 3, 4 and 5.
  - Ends: Plain; elastomeric ring seal socket and spigot; or socket and spigot for solvent cement.
  - Finish: Grey.

#### 17.2.3 UNPLASTICIZED PVC FITTINGS, SOLVENT WELDING TO BS 4514:

- Material: Un-plasticized PVC.
- Standard: BS 4514, table 2.
- Size range: 82mm, 110mm or 160mm.
- Dimensions: BS 4514 tables 3 and 5.
- Ends: Spigot/plain.
- Finish: Black, grey or white.

#### 17.2.4 PLASTICS PIPING SYSTEMS TO BS EN 1453:

Plastics piping system with structured wall pipes for soil and waste discharge (low and high temperature) within the building structure.

- Material: Un-plasticised polyvinyl chloride (PVC-U).
- Standard: BS EN 1453.
- Dimensions: Length - manufacturer's standard range. BS EN 1453 tables 1, 2 and 3.
- Ends: Plain; elastomeric ring seal socket and spigot; or socket and spigot for solvent cement.
- Finish: Grey, black, or white.

#### 17.2.5 COMPRESSION FITTINGS FOR POLYETHYLENE PIPES:

- Material: Copper/copper alloy (dezincifiable resistant).
- Standard: BS EN 1254-3 or BS 864-5.
- Size range: 20mm to 63mm.
- Dimensions: To suit pipes to BS EN 12201.
- Ends: Socket.
- Finish: Cast.

#### 17.2.6 POLYETHYLENE PIPES TO BS EN 1555:

- Material: Polyethylene.
- Standard: BS EN 1555-1, BS EN 1555-2 and BS EN 1555-5.
- Dimensions: BS EN 1555-2, table 1.
- Lengths: straight pipe 6m or 12m.
- Lengths: coiled pipe multiples of 50m.
- Marking: BS EN 1555-2, table 7.
- Ends: Plain.
- Finish: Black with yellow identification stripes.

#### 17.2.7 POLYETHYLENE FITTINGS, FUSION TO BGC/PS/PL2 PART 2:

- Material: Polyethylene.
- Standard: To BGC/PS/PL2 Part 2.
- Size range: Socket type up to 125mm. Butt type up to 500mm. Saddle type up to 180mm.
- Dimensions: To BGC/PS/PL2 Part 2.

- 
- Ends: Plain.

- Finish: Natural self colour.

#### 17.2.8 PVC-U PIPING SYSTEMS - PIPES:

- Plastics piping systems for soil and waste discharge (low and high temperature) within the building structure.
- Material: Un-plasticised polyvinyl chloride (PVC-U).
- Standard: PVC-U to BS EN 1329-1.
- Dimensions: Length - manufacturer's standard range. BS EN 1329-1 tables 1, 2, 3 and 4.
- Ends: Plain; elastomeric ring seal socket and spigot; or socket and spigot for solvent cement.
- Finish: Grey, black, or white.

#### 17.2.9 PVC-U PIPING SYSTEMS TO BS EN 1329-1 - FITTINGS:

- Plastics piping systems for soil and waste discharge (low and high temperature) within the building structure.
- Material: Un-plasticised polyvinyl chloride (PVC-U).
- Standard: PVC-U to BS EN 1329-1.
- Size range: 32mm to 315mm.
- Dimensions: BS EN 1329-1 tables 5-14.
- Ends: Plain; elastomeric ring seal socket and spigot; or socket and spigot for solvent cement.
- Finish: Grey, black, or white.

### **Article 17.3 WORKMANSHIP**

#### 17.3.1 APPEARANCE:

Arrange all exposed pipe runs to present neat appearance, parallel with other pipe or service runs and building structure, subject to gradients for draining or venting. Ensure all vertical pipes are plumb or follow building line.

#### 17.3.2 SPACING:

Space pipe runs in relation to one another, other services runs and building structure, allow for specified thickness of thermal insulation and ensure adequate space for access to pipe joints, etc.

#### 17.3.3 GRADIENTS:

Install pipework with gradients to allow drainage and/or air release, and to the slopes where indicated.

#### 17.3.4 AIR BOTTLES:

- Provide a means of venting the pipe system at all high points.
- Provide a vertical extension from the pipe approximately 100mm long, at the bore of the pipe, with a copper extension pipe with a manual vent cock located in an easily accessible position.

#### 17.3.5 AUTOMATIC AIR VENTS:

- Provide a means of venting the pipe system at all high points.

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- Provide an automatic air vent valve with a copper outlet pipe from the valve to a tundish in an adjacent drain line or to another suitable location.

#### 17.3.6 DRAIN REQUIREMENTS:

Grade pipework to allow system to be drained. Provide a means of draining the system at all low points.

#### 17.3.7 EXPANSION AND CONTRACTION:

Arrange supports and fixings to accommodate pipe movement caused by the thermal changes, generally allow the flexure at changes in direction. Allow for movement at branch connections.

#### 17.3.8 PIPE FITTINGS, BENDS/SWEPT TEES:

Use eccentric type reductions and enlargements on horizontal pipe runs to allow draining and venting, concentric on vertical pipes, with easy transition and an included angle not exceeding 30 degree. Do not use bushes, except at radiators and at fittings where required size is not of standard manufacture. Where required, use eccentric bushes to allow draining or venting; maximum aspect ratio not to exceed two pipe sizes; above this ratio use reducing fittings. Use square tees at venting and draining points. Square elbows are not acceptable. Use bends and swept tees where practical.

#### 17.3.9 PIPE FITTINGS, ELBOWS/SQUARE TEES:

Use eccentric type reductions and enlargements on horizontal pipe runs to allow draining and venting, concentric on vertical pipes, with easy transition and an included angle not exceeding 30 degree. Do not use bushes, except at radiators and at fittings where required size is not of standard manufacture. Where required, use eccentric bushes to allow draining or venting; maximum aspect ratio not to exceed two pipe sizes; above this ratio use reducing fittings. Use square tees at venting and draining points. Square elbows are not acceptable. Use elbows and square tees.

#### 17.3.10 PIPES THROUGH WALLS AND FLOORS:

- Enclose pipes passing through building elements, (walls, floors, partitions, etc.) concentrically within purpose made sleeves and fire resistant materials to maintain fire compartmentation and integrity of the building. Fit masking plates where visible pipes pass through building elements, including false ceilings of occupied rooms.
- Material: Fire Stopping Compound
- Thickness: 75mm
- Standard: BS 476-22
- Installation: To manufacturer's standard

#### 17.3.11 PIPE SLEEVES:

Where pipe insulation is not carried through pipe sleeve, cut sleeves from material same as pipe one or two sizes larger than pipe to allow clearance. Do not use sleeves as pipe supports. Install sleeves flush with building finish. In areas where floors are washed down install with a 100mm protrusion above floor finish.

#### 17.3.12 PIPE SLEEVES WITH INSULATION CARRIED THROUGH:

Where pipe insulation is carried through pipe sleeve, cut sleeves from material same as pipe one or two sizes larger than pipe and insulation to allow clearance. Do not use

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sleeves as pipe supports. Install sleeves flush with building finish. In areas where floors are washed down install with a 100mm protrusion above floor finish.

#### **Article 17.4 PVC PIPES**

- Comprises UPVC and MUPVC pipe and fittings, manufactured by the injection moulding process.
- For main soil, ventilation pipes and fittings, internal rainwater pipe and fittings, be UPVC plastic to BS 4514.
- For external rainwater pipe and fittings, is UPVC plastic to BS 4576.
- For branch waste and ventilation pipework and fitting up to and including 50mm diameter, be MUPVC plastic.
- For chemical waste pipes and fittings up to and including 100mm diameter, is propylene to BS 4991.
- For all branch pipes, be provided with a radius swept in the direction of flow.
- Shall not be fabricated by means of 'the cut and shut', hot air or solvent welded method.
- Shall: - have UPVC plastic pipes and fittings, jointed by the solvent weld method
- Have spigot ends, squarely cut, ensuring continuity of the internal pipe bore.
- Have excess jointing material removed and not allowed to accumulate on the internal surface of the pipe.
- Accommodate thermal movement; by having joints formed using the joint ring system, with the spigot end of the pipe fitting in the direction of flow. All items forming the joint to be cleaned before assembly.
- Be jointed using the correct solvent or lubricant and be installed to the Manufacturer's information.

#### **Article 17.5 FLOOR OUTLETS**

- Standard: BS EN 1253-1
- Material:
- Stainless steel

#### **Article 17.6 TRAPS**

- Provide traps to all sanitary appliances and as indicated in schematics. They shall be normally of the following types:
- Integral with appliance for WC's and Urinals.
- Bottle for wash basins and sinks.
- Resealing.
- Tubular for stacks and Form: P & S.
- Copper alloy: Chromium plated.

#### **Article 17.7 PLASTICS WC PAN CONNECTOR**

- All WC pan connectors shall comply with the following specifications as appropriate.
- BS 5627 for pans to BS EN 33, BS EN 37, BS EN 997.
- Figure 1 'S' or turned 'P' traps.
- Figure 2 'P' traps new installations.
- Figure 3 'P' traps replacements.

#### **Article 17.8 GRATINGS**

Material: - Plastics.

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### **Article 17.9 TESTING**

Shall require all soil and waste pipes to be subjected to an air pressure test in the following manner:

- The section of the installation to be tested to be sealed off by the insertion of expanding rubber, or inflatable stopper testing plugs, (one of which to incorporate a tee fitting complete with an air cock), on each of the free ends of the fittings.
- One of the air cocks to be connected by means of a flexible tube to a manometer (u gauge) and the other connected to a tube for applying the required air pressure to the system.
- Require air pressure to be applied to the whole section of pipework and fittings under test, this to be equal to 38mm water gauge and to remain constant for a minimum of 3 minutes.

Provide for the installation to be tested at the following stages:-

- Prior to concealment by suspended ceilings, duct covers, partition cladding etc.
- On completion of the whole installation.
- On completion of all work, including that of other trades.

Require all soil and waste pipes to be tested to the satisfaction of the Project Manager as determined by the Building Inspector.

### **Article 17.10 DRAINAGE BELOW GROUND**

#### 17.10.1 PLASTIC PIPES - GRAVITY

- Pipes, bends and junctions shall all be Kitemarked certified.
- PVC-U to BS 4660 for pipes of size DN 110 and DN 160; and to BS EN 1401-1 for pipes of size DN 200 or above.

#### 17.10.2 PLASTIC PIPES - PRESSURE

- Pipes: MPDE to BS 6437 or to WIS 4-32-09, with bends and fittings to WIS 4-32-04.
- Jointing-Popped fittings with electro fusion joints.

#### 17.10.3 WORKMANSHIP

- Pipes and fittings of common type to be procured from same manufacturer. Joint pipes and fittings with adaptors as recommended by particular manufacturer.
- Lay pipes to line and even gradient and on even bed for full length of the pipe with any sockets facing towards direction of flow.
- Use recommended lubricants for joints. Leave recommended gaps at end of spigots to allow for movement.
- Protect pipelines from ingress of debris. Seal all exposed ends of pipes during construction.
- Minimize time between laying and testing. Backfill after successful testing.

### **Article 17.11 EXCAVATION, CONCRETE, BACKFILLING, BEDDING/JOINTING**

#### 17.11.1 LOWER PART OF TRENCH

- Base to 300mm above crown of pipe: trench to have vertical sides: make as small as practicable, but not less than external diameter of pipe plus 300mm.
- For cover exceeding transition depth for pipe size ensure trench width up to 300mm above crown of pipe is not more than:

- 
- Nominal pipe bore (mm), 100 150 225 300
  - Transition depth (m), 6.0 5.4 4.0 2.9
  - Maximum trench width (mm), 600 700 800 900
  - For bedding class S, ensure trench width is not more than the following, irrespective of depth or cover.
  - Nominal pipe bore (mm), 100 150 225 300
  - Maximum trench width (mm), 600 700 800 900

#### 17.11.2 TYPE OF SUBSOIL

Where Subsoil at the level of the crown of the pipe differs from that identified in the relevant preceding clause, obtain instructions prior to commencement.

#### 17.11.3 FORMATION OF BEDS

- Ensure there is no delay between excavation and laying of beds or pipe.
- Remove harmful materials including mud, rock projections, boulders and hard spots: replace with consolidated bedding material.
- Tamp bedding material into local soft spots.
- Give adequate advance notice to allow inspection of each section of the work.

#### 17.11.4 COMBINED TRENCHES

- For situations where one pipe is at a lower level than another adjacent pipe in a common trench.
- Provided soil is stable and unlikely to break away at any step, a sub trench may be used.
- Where soil is not stable the whole trench must have a depth equal to the requirements for the lower pipe: increase thickness of bedding to upper pipe as required.
- Backfill lower pipe with compacted granular material to half height of upper pipe.

#### 17.11.5 TRENCH SUPPORTS

To permit compacted filling of entire trench, remove trench supports and other obstacles as necessary to permit compacted filling of all spaces.

#### 17.11.6 TRENCHES LESS THAN ONE METRE FROM FOUNDATIONS

For situations where base of trench is below base of foundations, use Class Z concrete surround. Ensure top of concrete is above base of foundation.

#### 17.11.7 TRENCHES IN EXCESS OF ONE METRE FROM FOUNDATIONS

- Critical level is defined as Dmm lower than level of foundation base: Dmm is equal to the horizontal distance of the near side of the trench from the foundation, less 150mm.
- For situations where base of trench is lower than critical level, use Class Z concrete surround. Ensure top of concrete is above critical level.

#### 17.11.8 CROSS-OVERS

Where two non-plastic pipes cross within 300mm of each other from any point on the pipes, surround each with Class Z concrete, for at least 1m centred on the crossing point. Extend concrete surround as necessary to within 150mm of next nearest flexible joint on each pipe.

#### 17.11.9 BACKFILLING TO PIPELINES GENERALLY

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Backfill from top of specified surround or protective cushion with material excavated from the trench, compacted in layers not exceeding 300mm. Until at least 600mm of cover, heavy compactors must not be used.

#### 17.11.10 INSITU CONCRETE TO BS 8500 AND BS EN 206-1

Designated mix GEN 1 or Standard mix SA 2 or an equivalent or better mix subject to approval.

#### 17.11.11 FOAMED CONCRETE BACKFILL

- Repair damaged pipes: seal off cavities in or adjacent to the excavation which are not to be filled. Obtain instructions where doubt prevails.
- Undertake backfilling in accordance with British Cement Association publication 46.044, 'Foamed Concrete – Specification for use in the reinstatement of openings in highways'.
- Minimum density 1050 kg/m<sup>2</sup>.
- Maximum 28 day compressive strength 10 N/mm<sup>2</sup>.
- Sulphate exposure - Class

#### 17.11.12 BACKFILLING UNDER ROADS AND PAVINGS

Backfill from top of specified surround or protective cushion up to formation level with Granular Sub base Material, Type 1 to DT Specification for Highway Works, Clause 803, laid and compacted in 150mm layers.

#### 17.11.13 BACKFILLING OVER CONCRETE

- Ensure a delay of at least 24 hours between placing of concrete and backfilling.
- Ensure a delay of at least 72 hours between placing concrete and the use of heavy compactors and allowing traffic loads.

#### 17.11.14 TEMPORARY BRIDGES

To prevent construction traffic damaging pipes after backfilling, provide temporary bridges over trenches as necessary.

#### 17.11.15 WARNING MARKER TAPES

- Whilst backfilling pipes lay warning marker tapes at 300 to 400mm below the level of the finished surface.
- Lay in continuous line over pipe.
- Install an additional marker 600mm above the top of the pipe where depth is greater.

#### 17.11.16 FITTINGS, TERMINALS, ACCESSORIES

Ensure each complete assembly of fittings, traps, etc., including appropriate couplings, is procured from a common manufacturer. Check compatibility components with each other and with the pipe system

### **Article 17.12 QUALITY CONTROL:**

- Check that all materials comply with the indicated standard before acceptance to store.
- Transport, handle and store materials following manufacturer's recommendations to avoid damage or contamination.
- Obtain all components for each type of pipework from the same manufacturer.
- Ensure cut ends of pipes are clean, square and free of burrs.

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- Prepare trenches to receive pipes to allow for jointing, testing and removal of slings.
  - Prevent entry of foreign matter to pipework and flush knout prior to testing or putting to use. Test to ensure adequate capacity and absence of clogging.
  - Test for water tightness.

#### 17.12.1 PIPE LAYING:

Bring pipes to the correct alignment and orientation, concentric with the pipes already laid.

#### 17.12.2 INSTALLATION:

Install commission and set to work, irrigation system in accordance with manufacturer's recommendations.

#### 17.12.3 EXCAVATION:

- Excavate in a clean and organised manner. Schedule with other site activities to provide controlled access and minimal tracking of soil over the site.
- Set out and use sight boards to ensure uniform falls.
- Separate top soil and set aside for later use.
- Excavate trench width to a minimum of 300mm above the top of the pipe barrel within indicated limits.
- Keep available materials for adequate shoring when excavation depth over 1.2m is intended in accordance with The Construction (General Provision) Regulations.
- Where rock is encountered in trench bottoms designed as Class D bedding further excavate to the depth necessary to receive Class F. Backfill over-excavation, whether intentional at soft spots or accidental with rubble.
- Spoil, which is either in excess of or does not fulfil the requirements for selected fill.
- Place in spoil heaps.
- Take off site as directed.

#### 17.12.4 BEDDING, PROTECTION AND BACKFILL

- Make cavities in the bedding to facilitate sling removal. Elsewhere smooth the trench bottom. Prepare one full pipe length in advance of pipe laying.
- Locate interfaces between backfilled materials to the weaker material side of theoretical. Concrete is the strongest and selected fill the weakest. Lay all fill less than 300mm above the top of the pipe barrel in 150mm layers and hand compact. Above this level layers may be 225mm. Over 1m above top of pipe mechanical compaction may be used.
- Standard
- Ensure every layer reaches the percentage of maximum dry density indicated.



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## 1. SECTION 17 MISCELLANEOUS MATERIALS

### Article 17.1 General

Variations to the materials shown on the Drawings may be approved subject to the Contractor submitting full details of his proposals in writing.

### Article 17.2 Water stops

Galvanised 2mm thick metal sheets will be permitted as a water stop. PVC water stops shall be jointed with purpose-made junction pieces and in accordance with the manufacturer's written instructions.

A hydrophilic, expandable elastomeric profile water-stop system may be used to seal all contraction joints.

The hydrophilic water-stop profile to be used shall be either Hydrotite CJ0725-3K or Sika Swell-P 2507H.

The water-stop system must be a fully continuous barrier throughout the structure and across all joints.

### Article 17.3 Damp-proof Membranes

Damp-proof membranes shall be 500-micron polyethylene sheeting laid and jointed in accordance with the manufacturer's specifications.

### Article 17.4 Rejected Materials

All material which has been damaged or is contaminated or has deteriorated or do not comply with the requirement of this specification shall be rejected and shall be removed from the site immediately at the contractors expense.

### Article 17.5 Workmanship and construction

#### 17.5.1 Construction and Preparation of Formwork

##### 17.5.1.1 General

Before construction of the formwork begins the Contractor shall submit details of the systems of formwork he proposes to use for all main structural members.

No metal part of any device for maintaining formwork in the correct location shall remain permanently within the specified concrete cover to the reinforcement.

In watertight construction, methods of fixing formwork which result in holes through the concrete section when the formwork is removed shall not be used, all wall ties shall have water baffles and wall kickers shall be cast monolithically with the base slab.

For any water-retaining structures, the design of formwork ties must be such that they do not cause leakage or corrosion in service. The Contractor shall obtain prior

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written approval from the Project Manager for the formwork tie system to be used.

The use of concrete retarders or similar preparations on the formwork surfaces shall be subject to the prior approval of the Project Manager.

#### 17.5.1.2 Cambers

Unless otherwise directed all formwork to suspended beams and slabs shall be constructed so that the following upward cambers exist immediately before striking:

- a) Spanning between supports: 0.1% of span at centre
- b) Cantilevers: 0.4% of span at free end.

#### 17.5.1.3 Stiffness of Panels

Formwork panels shall be stiff enough to prevent damage to the concrete surface caused by excessive movements of the panel during vibration of the concrete.

#### 17.5.1.4 Repair of Formwork

Damaged formwork shall not be reused if in opinion of the Project Manager the making good would impair the surface appearance of the concrete.

#### 17.5.1.5 Mortices, Holes Chases in Concrete

Fixing blocks and ends of brackets and bars and bolts etc., shall be cast in the concrete at the time of placing and together with all mortices and holes and apertures and chases and grooves etc., shall be accurately set out in the formwork before the concrete is placed. No part of the concrete works shall be cut away for any such item or for any other reason without the Project Manager's approval.

The Contractor shall obtain from all sub-contractors complete information of their requirements regarding conduits and pipes and fixing blocks or boxes and chases and holes and any other items to be cast in.

The Project Manager drawings will not show cast in items such as light boxes, pipes, sleeves, rain water pipes, fullbores and conduits unless such items affect the structure itself in which case it is at the Project Manager's discretion to show such items. These items must be read from the Architectural/M&E drawings and any items fixed in place prior to casting.

No pipes larger than Ø 25mm are to run through beams at anytime unless shown on the structural drawings or approved by the Project Manager. If RWP's are to run down columns, the full bores are to be located as close to the column as possible with only a vertical drop allowed directly over and down the column allowed. Where conduits are to be cast in slabs they shall be placed above the bottom reinforcement and below the top reinforcement and not within 40mm of the top and bottom surface of the slab.

The Project Manager will only show services/voids/cast in items/penetrations on concrete

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drawings which it deems structurally relevant to show on drawings. All other items are to be obtained from the relevant architectural and MEP service or other consultant's drawings.

The Contractor shall ensure that all Sub-Contractors are informed of his programme for the structural works at the commencement of the Contract. He shall also ensure that the Sub-Contractor's requirements relating to concrete members are approved by the Project Manager before work is commenced.

At the commencement of the Contract the Contractor shall supply all the Sub-Contractors with hard copies of the Specification.

#### 17.3.1.6 Final Preparations

The internal faces of the formwork may be coated with an approved preparation to prevent adhesion of the concrete to the forms provided that the use of this preparation will not stain the surface of the finished concrete. None of this preparation shall be allowed to touch the reinforcement.

Immediately before the concrete is placed in any section of the formwork the interior of that section shall be completely cleaned of all extraneous materials including water.

Each section of the formwork to structural members shall be inspected by the Project Manager immediately before concrete is placed in that section.

### **Article 17.6 Falsework**

#### 17.6.1 Formwork Props

If formwork props are to be left in place when soffit forms are removed they shall not be disturbed during the removal process without approval.

Formwork props shall be positioned between permanent supports so that all members are supported at no more than 3m centres in both directions.

#### 17.6.2 Removal of Falsework

The responsibility for the safe removal of any part of the falsework shall rest with the Contractor.

### **Article 17.7 Construction Joints**

#### 17.7.1 General

If construction joints are not shown on the drawings the Contractor shall obtain approval for their positions before work starts.

In watertight construction water bars shall be used in all construction joints and movement joints in accordance with the manufacturer's written instructions and the Contractor shall obtain approval for the methods to be used to maintain them in

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their correct locations while the concrete is being placed and during or after the removal of the formwork.

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### 17.7.2 Preparation of Construction Joints

The contractor shall obtain approval for his proposals for forming and preparing construction joints prior to the work commencing on site.

### 17.7.3 Position of Construction Joints

The position of construction joints proposed by the Contractor shall be such as to avoid distress or damage to the works particularly from thermal movement or shrinkage effects.

The position and spacing of joints which will be acceptable will vary from place to place but the following table gives an indication of acceptable limits.

Construction	Max. Area/ m <sup>2</sup>	Max. Dimension/m
Water tight walls	25	5
Water tight slabs	100	10
Slabs with major restraint at both ends	100	13
Slabs with major restraint at one end only	250	20
Slabs with little restraint in any direction	500	30
Walls	40	10

Where the Contractor's proposals, result in alterations to the reinforcement, the Contractor shall be responsible for providing full revised details for approval prior to the work commencing on site.

### 17.7.4 Movement Joints

Concrete shall not be placed on both sides of movement joint at the same time unless otherwise approved.

## Article 17.8 Reinforcement

### 17.8.1 Cutting and Bending

Reinforcement shall not be bent except as shown in the bending schedules without approval.

Each bundle of bars shall be clearly tagged with their schedule and mark numbers.

### 17.8.2 Fixing

Conventional Reinforced Concrete:

Reinforcement shall be fixed in accordance with Clause 7.3 of BS 8110: 1997, but no reinforcement shall be welded.

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Unless otherwise specified the nominal concrete cover shall be in accordance with Table 3.3 & 3.4 of BS 8110: 1997.

Where spacers are required to maintain the concrete cover to the reinforcement these may be of either concrete or plastic unless otherwise specified. Plastic spacers shall not be permitted.

The Contractor shall supply and fix all chairs required to maintain the reinforcement in the correct position.

## **Article 17.9 Street lighting**

### **17.9.1 General**

The work to be carried out under the Contract shall include the manufacture, works tests, supply, delivery to site, erection, cabling and connections, including earthing, testing and commissioning of Lighting Columns, Luminaires, Control Equipment and all accessories to form a complete Road Lighting installation.

### **17.9.2 Extent of Works**

The Contractor shall supply, fix and commission all lanterns, brackets and lamps that would be fixed on the wooden poles installed by the CEB. The CEB shall provide and install all cabling works to supply power to the street lighting and carry out the final connection to the mains.

### **17.9.3 Testing**

All testing and commissioning shall be carried out in the presence of the Project Manager, the CEB and the representative of the District Council.

### **17.9.4 Design parameters**

The Contractor is required to check the design based on characteristics of the luminaires to be supplied. A uniform illumination must be achieved. A computer calculated point by point light levels must be submitted. The design is to provide lighting characteristics as per table below:-

<b>Maintained Average Illuminance L cd/m<sup>2</sup></b>	<b>Overall Uniformity Ratio U<sub>o</sub></b>	<b>Longitudinal Uniformity Ratio U<sub>L</sub></b>
2.0	.>0.4	0.7

The installation shall be carried out in accordance with the Institution of Electrical Engineers Regulations for the Electrical Equipment of Buildings and relevant British or I.E.C. Codes of Practice and shall also comply where applicable with such rules and regulations of the Mauritius Central Electricity Board that are in force at the time of tendering.

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The incoming supply will be provided by the Mauritian Central Electricity Board at 400/230 volt, 4-wire 50Hz with the neutral solidly earthed. The Contractor shall be included in the tendered rates and prices. No separate payment will be made to the contractor to that effect.

#### 17.9.5 Guarantee / Defects Liability.

The Contractor should be aware that the main contract does not cater for staged taking over of the works in sections. However sections will be complete and in use prior to the contract completion date and these sections will include lighting schemes that will be expected to be commissioned and functioning. Allowance should therefore be made for running costs and maintenance costs of these sections put into use during the contract period and costs spread over the bill items.

Liaison with the main contractor and assessment of his programme of works will indicate the magnitude of this running and maintenance cost liability. Furthermore the full responsibility of security of those works remains with the contractor, theft, vandal and accident damage, up to the time taking over of the main contract.

The Contractor shall guarantee all work (including lamp and ballasts) for a period of twelve months after the issue of the taking over certificate by the Engineer. In the event of a defect arising within this period, which in the opinion of the Engineer is due to faulty workmanship or materials, the contractor shall, at his own expense, make good such defects where instructed to do so, to the satisfaction of the Engineer.

The repairs shall be carried out within 48 hours of the demand expressed by the Black River District Council, the Road Development Authority or Engineer. The Contractor will provide the required spare parts to replace the faulty parts, at his own expense.

#### 17.9.6 – Road Lighting Columns and brackets

The road lighting columns shall be placed by the CEB. The poles would be of wooden materials. The Contractor would carry proper liaison with the CEB while installing the luminaires. The brackets shall have a high quality hot dipped galvanized finish with the zinc coating being at least 550g/m<sup>2</sup>, and giving protection both inside and outside it.

The galvanizing process shall comply to the relevant British Standard, namely BS 729/71 or French standard MFA 91.122 October 1959 or equivalent Mauritius Standard, if any.

An original certificate from the manufacturer shall be submitted for approval by the Project Manager or Concerned Authorities.

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#### 17.9.7 - Luminaires

The luminaires shall be to IP 65 or better and be of Class II.

The luminaire shall be to BS 4533-Part 102.3:1990 or IEC 598 -2 -3 No. 2 (1987) or equivalent.

The luminaires shall be of the totally enclosed type of sound and robust construction weatherproof and dustproof manufactured from cast aluminium and tempered glass.

The luminaires shall be of neat appearance presenting minimum windage area, designed of side entry mounting. The spigot mounting shall incorporate a substantial locking device to prevent rotation or displacement under the wind velocity of 83.33 m/s (300 km/hr).

The luminaires shall comprise of an optic compartment to SABS 1277-Amendment No. 1987 protection or equivalent and an auxiliary gear compartment to at least IP 44 or better. The lanterns are to have a Mechanical Index Factor of minimum 6 joules.

The luminaires to be used on 9m high wooden columns shall be of the 'cut off' type and suitable for 230 volt 60 watt LED lamps and associated auxiliary control gear. The gear compartment of certain luminaires shall be suitable to accommodate an appropriate ballast to work with an energy saving device.

#### 17.9.8 Lamps and accessories

Lamps shall comply with BS 6193:1990 and shall have a normal rating of 250 watts or as specified on the approved drawings and of the tubular or elliptical shape to give the most efficient luminaire / lumen output and control.

The Lamp auxiliary control gear shall be housed in a separate compartment of the lantern. The control gear shall be suitable for operation at 230 volts and the ambient temperatures prevailing in Mauritius.

Ballast chokes shall comply with the BS 5394:1988 (Radio Interference Suppression) and the ballast chokes shall not give rise to interference with radio or television reception.

The ballast chokes shall totally be enclosed and moisture proof against condensation and provided with safety leaks and either sealed-in heat resisting cable tails or a terminal block suitably shrouded to prevent live parts being exposed during operation. They shall be suitable for working with the lamp specified. The capacitance shall be sufficient to produce a power factor of 0.84 lagging or better. Capacitors shall comply with BS EN 61048 and BS EN 61049.

Separate ignitors shall be provided Lamps and control gears which become faulty during the defects liability period shall be replaced by the successful tenderer/ bidder within 48 hours at no extra cost.



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### 17.9.9 Earthing

The whole of the installation covered by these Specification shall be efficiently bonded back to the Feeder Pillars through the metal sheathing of cable wires all in accordance with the I.E.E. Regulations British Code of Practice and the Mauritian Code of Practice if applicable. All prices shall be inclusive of the cost of this bonding.

The tenderer shall note that the armouring of underground cables shall not be used as the sole means of bonding.

Accordingly, an earth conductor (colour green of appropriate size and according to IEE regulations) shall be provided with each underground cable for bonding/earthing purposes in addition to the armouring.

All earthing installations, size of earth wires and bonding shall be in accordance with IEE 364-5-54 (1982).

The earthing continuity of each metal sheathed cable shall be maintained by efficient bonding between the cable sheath, the gland and the metal case of switchgear or other metal – clad accessory or appliance at which the cable terminates.

All wires and cables shall be protected against mechanical stresses and corrosion.

All joints between wires and earthing metal – work shall be mechanically sound before soldering.

The earth stud or terminal of all columns shall be bonded to the armouring of the incoming cable and earth conductor in an approved method. A copper clad steel type earth electrode shall be provided **at each column**.

The armouring of the circuit cabling and earth conductor shall be used to each section of the installation back of the feeder pillar earth bar.

The frame and earth of feeder pillar and columns shall be connected to its adjacent electrode to ensure that the earth loop impedance is in accordance with I.E.E. Regulations.

The minimum size of the earthing rods shall be 2 m long and of 20 mm diameter and the rate shall include for extra 2m lengths if required. Connection from each feeder pillar frame and earth bar shall be by means of single core stranded copper cable green PVC covered IEE Regulations.

The Contractor shall be responsible for taking necessary earth readings and providing a satisfactory earth to meet the IEE wiring Regulations or Mauritian Code of Practice requirements but same value shall however not be more than 5 ohms.

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All final circuits shall be protected by the use of ELCB (300mA) of the type "Bloc differential" will not be accepted as an equivalent.

A light sensitive switch Photocell shall be connected, to the electrical supply cable feeding the streetlights. These switches shall be of appropriate ratings and shall be contractor operated and shall securely fixed on the poles as necessary. The photocell shall be capable of being adjusted over a range of 5 to 25 lux. The photocell shall be mounted with a weather proof enclosure to IP 65 which shall be securely fixed on the poles as necessary at a height of about 5.0m, they shall comply to BS 5972.

