

# VOLUME 3

## TECHNICAL SPECIFICATIONS

CONSTRUCTION OF A VISITORS CENTER FOR THE FORESTRY UNIT, BENDALS ANTIGUA AND BARBUDA

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## 100 - GENERAL AND PRELIMINARY

### 101 Construction of Visitors Centre

#### 1) General Description

The Works shall be deemed to include the provision of staff supervision during undertaking of these general activities of any kind necessary for the due and satisfactory construction of the Works to the intent and meaning of the Drawing and of these Specifications.

Where necessary, the various General Items shall be deemed to be inclusive of: all related materials, equipment and tools, fuel and water supplies, etcetera, for the staff and labour necessary for the proper organisation and supervision needed; for any protective works [including temporary fencing, lighting and watching] required for the safety of the public and the protection of the Works and adjoining lands.

It should also be noted that further drawings and data to be prepared by the Contractor and/or that may be issued by the Project Manager from time to time [whether specifically mentioned or not in the clauses of these Specifications] shall be deemed to be included in the Contract.

## 2) Location of Works, Access to Works, Working and Storage Areas

- a) The Works are located Bendals Antigua. The precise extent of the Works is shown on the Drawings.
- b) Working areas, storage areas and disposal areas for excess excavated material will be made available by the Employer.
- c) Before exercising any right negotiated by him in connection with way leaves or accommodation outside the Site, the Contractor shall notify the Project Manager in writing of the arrangements he has made.
- d) All necessary facilities will be given by the Employer for the access of the Contractor's employees to the Works and the Contractor shall be responsible for seeing that such employees obey all regulations made by the Employer concerning the conditions of access to and over his property.
- e) The Contractor shall take all reasonable steps to maintain the free movement of traffic on any permanent roads used by him to progress the Works. All permanent and site access roads are to be maintained free of any spillage from the Contractor's vehicles.
- f) The Contractor shall provide and maintain to the Project Manager's approval all temporary roads he may require, and shall permit the free use by the Employer, or any person employed by the Employer, subject to such use not causing undue damage or interference with the Contractor.

## 102 Description of Main Sections of the Works

### 1) The Works consist of:

- ✓ General Clearance of land around site;
- ✓ Construction of Visitors Centre as outlined on drawing;

### 2) Quantities of Major Activities

Provided in Bill of Quantities

## 103 Scope of Contract

As previously defined in 101 above

## 104 Units of Measurement

In general, the units of measurement to be used in connection with this Contract are metric units of mm, cm, m, Km, N (Newton), t (1000 kg) and degrees Celsius (°C). Decimal points are written as “.” herein.

## 105 Written Authority

Written Authority or “Order in Writing” shall mean any document or letter signed by the Project Manager and posted or delivered by hand or electronically to the Contractor containing instructions, guidance or directions to the Contractor for the execution of the Contract.

## 106 "Directed" and "Approved"

Whenever the words approved, directed, authorised, required, permitted, ordered, instructed, designated, considered necessary, prescribed or similar words (including nouns, verbs, adjectives

and adverbs) are used, it shall be understood that the direction of the Project Manager is implied unless another meaning is explicitly indicated.

### **107 Performance Guarantee, Insurance of the Works and Third Party Insurance**

The Contractor shall provide a Performance Security in accordance with Article 16 of the Conditions of Contract in the amount specified in the Particular Conditions of Contract and take out insurance cover against the risks specified under Article 16 of the General Conditions of Contract.

### **108 Order of Work**

1) The Contractor shall execute the Works in a logical and practical order and in compliance with the approved construction programme of operations that he prepares. He must complete the Works within the time limits laid down in the Contract and in a manner that is satisfactory to the Project Manager.

2) The Contractor is to ensure that the works programme has adequate provisions for the movement of vehicular and pedestrian traffic through alternative routes.

### **109 Completion Periods**

The Contract Works are to be completed within the periods from the Commencement of the Contract noted as 04 months.

### **110 Programme and Method Statements**

The Contractor shall submit to the Project Manager a fully detailed 'Programme' in accordance with the provision of Clause 25.1 of the General Conditions of Contract.

The Statement shall describe the methods, which the Contractor will employ in carrying out the Works, the Constructional Plant and Temporary Works, which he intends to supply or use. The programme shall show the estimated dates on which the various sections of the Works will commence together with the estimated rate of construction so that the whole of the Works may be completed within the Contract period. As may be required the Contractor shall develop a modified programme(s) subsequently in accordance with Clause 25.2 of the General Conditions of Contract.

The Contractor's Programme shall be supported by a list of plant and support facilities by which the Contractor will achieve the progress set out in it.

The Contractor's plant facilities and outputs quoted shall make due allowance for sufficient plant being on the site to ensure the maintenance of his programme and sufficient spare items of plant are to be available to allow for non-serviceability or ineffective working.

The Contractor is to progress the Works thoroughly in order to ensure that at all times it adheres strictly to the programme submitted.

The Contractor's programme should specify in detail when possession is required of land so that adequate arrangements for this can be made in good time.

For all major items of work such as culverts, culvert inlets and outlets, masonry work, concrete work, compacted earth and the like, the Contractor shall prepare trial sections or samples as appropriate, in advance of full scale work, for the approval of the Project Manager.

## **111 Traffic**

1) Prior to commencing any work in or which may affect the use of the roadway, the Contractor shall obtain the written approval of his proposed methods of working from the Project Manager, and the highway and the police authorities.

2) The Contractor is required to prepare for the approval of the Project Manager, a comprehensive 'Traffic Management Plan', which will identify the following aspects as a minimum at the start of the works:

- a. locations where the nature or extent of the required construction is such that no provision can be made for through traffic;
- b. existing public roadways that upon approval by the Employer, will be utilized as route detours / diversions for major thorough traffic flows;
- c. the length of time during which such detours must be in use;
- d. provisions to be made for the access to private properties affected by the required closure(s) including those for public transport;
- e. provisions to be made for passage by emergency vehicles during the required closure(s);
- f. the intended signage and other public advisory measures to be installed;
- g. provisions to be made for the maintenance of the detour road surfaces while in such use

3) Throughout the duration of the Contract, the Contractor shall co-operate with the roads/ highway and traffic authorities concerning works in, or access to, the highway. The Contractor shall notify the project Manager of any requirements of such authorities.

4) Where required and approved by the Project Manager, the Contractor shall provide and maintain all necessary temporary diversions, which shall be operational before interference with existing carriageways, footways or public right of way. This shall include the provision of any necessary support structures, drainage measures and ancillary works.

5) The Contractor shall pre-clear the ground and then shape and grade such diversions to obtain satisfactory alignments and running surfaces making full use of all material that is obtainable from the immediate vicinity or elsewhere. If sufficient materials are not obtainable in this manner, he shall import material from other sources. Where the subgrade is not sufficiently strong in its natural condition, it shall be compacted as specified in these Specifications prior to the addition of roadbed materials.

6) When the earthworks for diversions as described above have been completed, those portions of the diversions and of existing gravel roads used as diversions indicated by the Project Manager shall be provided with a wearing course of at least a suitable gravel material to be approved by the Project



Manager. The Contractor shall provide, spread, water, mix and compact such material to a density where it can carry traffic without undue wear and tear.

7) The Contractor shall maintain all temporary diversions in a safe trafficable condition.

8) Whenever required by the Project Manager, the diversions shall be suitably re-graded to provide a smooth riding surface free of corrugations and, if necessary, re-compacted. All potholes that develop shall be repaired promptly. The Project Manager may also require the Contractor to apply water to the surfaces to reduce dust nuisance etc.

9) The Contractor shall allow in his rates for providing and maintaining a suitable running surface at all times over a width of at least 2.5 m for the passage of single lane traffic [or 5 m if so ordered by the Project Manager during construction operations.

10) The length of all such diversions shall be of the shortest practical length having regard to topography and physical obstructions and shall be routed to the satisfaction of the Project Manager. Local diversions shall under no circumstances be longer than 500 m long and single lane traffic sections not less than 1 km apart except where, in the opinion of the Project Manager, greater lengths are unavoidable.

11) Reasonable access shall be maintained to properties adjacent to the Works.

12) The Contractor shall provide flagmen and signal equipment as may be necessary to control the traffic to the satisfaction of the Project Manager. Roadways closed to traffic shall be protected by effective barricades on which shall be placed acceptable warning and directional signs. All temporary detour routes shall be clearly indicated throughout their entire length. All barricades and obstructions shall be illuminated at night and all lights shall be lit from sunset to sunrise. When traffic is routed permanently onto the new road following the completion of construction, diversions that are no longer required shall be suitably removed and the land restored as instructed by the Project Manager.

13) Whenever the construction works are to be undertaken on an existing road surface and no suitable diversion routes are available, the Contractor shall work in 'half widths' allowing public traffic to use the half of the road not under construction at the time. The length of half width construction shall be kept to a minimum, with provision for traffic travelling in opposite directions to pass at frequent intervals.

14) If any section of the road will not be in a safe trafficable condition for 2-way operation at the end of each day's work, the Contractor shall supply adequate flag control, signage, barriers etc. and attendant staff at his own cost.

15) No separate payment will be made to the Contractor for working in half widths or for the associated traffic control.

## **112 Environmental Management**

1) The Contractor is required to prepare an 'Environmental Management Statement' [EMS] for approval by the Project Manager to provide a compilation of the general actions, organisational structures and procedures to be taken during the construction process. These are to be undertaken

to minimise and/or eliminate impacts to the natural and social environments due to the construction operations phase of the project, particularly in the following areas:

- a) Procedures to be followed during construction (e.g. fuel management, waste disposal, water management, dust control, traffic management, etc.)
- b) Construction stage monitoring, including inspection and reporting;
- c) Emergency response procedures (including spills management and contingency measures);
- d) Potential opportunities for the re-cycling of materials generated;
- e) Awareness training of construction personnel, etc.

2) The EMS submission must also indicate the timing of the implementation of each of the above actions as well as the person(s) nominated for ensuring the process is followed.

### **113 Abatement of Nuisance**

1) The Contractor shall adopt such measures, as the Project Manager may consider reasonable and necessary to minimise nuisance from dust, noise, or other cause. During periods of dry weather, roads in frequent use with heavy traffic shall be watered a minimum of 3 times a day at appropriate times to be agreed with the Project Manager. Other roads within the Site shall be watered at least once each day. The Contractor's attention is drawn to the damage to crops, which may be caused by dust. The Contractor is to take such measures as may be necessary to prevent such damage by dust arising from the execution of the Contract.

2) The Contractor shall observe all agreements entered into by the Employer with any person or persons relating to occupation of the properties by the Employer and to the execution of the Works thereon. The Contractor will be given on request copies of any agreement or part thereof relating to such matters.

3) The Contractor shall prohibit the committing of nuisance on the site of the Works or upon the land of the Employer or adjacent landowners and any employee found violating this provision shall be liable to immediate dismissal and shall not again be reemployed on the Works.

### **114 Termite Nests**

All termite nests encountered during the construction of the Works shall be completely excavated and destroyed making sure that the queen is killed.

### **114 Safety Policies, etc.**

1) When required the Contractor shall provide the Project Manager with a copy of the written safety policy and any revisions thereof, which he has prepared as an Employer and which relate to the execution of the Works. Prior to commencement of work on the Site the Contractor shall provide the Project Manager with a copy of the relevant notices submitted to the Government of Antigua and Barbuda to satisfy Health and Safety Requirements and shall inform the Project Manager of the name and location of his appointed safety supervisor(s).

2) The Contractor shall also provide the Project Manager with written details of any control measures he proposes to institute in compliance with the control of substances hazardous to health.

### **114 Construction Drawings**

The Drawings are listed in the table below:

1.	Floor & Roof Plan	A01
2.	Building Elevations	A02
3.	Building Sections	A03
4.	Construction Details	A04
5	Schedules	A05
6	Plumbing Plan	P01
7	Foundation	S01
8	Specifications	S01.1
9	Structural Layout	S02
10	Structure Layout	S03
11	Lighting Plan & Schedule	E01
12	Power Plan and Schedule	E02

### **115 Survey of Existing Properties, Roads, Lands, Crops, etc.**

1) Where required, the Contractor, in conjunction with the Project Manager and any relevant authority, owners or occupiers, shall carry out surveys of the condition of existing properties, roads, lands, crops, etc., which the Works may affect. The results shall be recorded in appropriate documents and submitted to the Project Manager for approval so that the approved copies constitute a record of the condition prior to commencement.

2) Levels shown on the drawings are given in feet above Ordnance Survey Datum. The Project Manager will indicate local control points for construction use.

3) All co-ordinates are grid co-ordinates. Actual ground distances may be computed by dividing grid distances by a scale factor in the range 0.999627 to 0.999645. The appropriate value for a given location is available from Lands and Surveys Department.

4) Before commencing work on any section of the Works, the Contractor shall survey [and level] the original ground surface and prepare and submit to the Project Manager, plans and sections for agreement.

### **116 Information from Exploratory Borings and Test Pits**

#### **1) Design Phase Data**

Where the Contract documents indicate the results of certain exploratory borings and tests previously carried out on the site of the Works for design purposes, the Contractor may draw from such information any details that may be necessary to confirm the characteristics of soil strata for

the purpose of constructing suitable foundations and retaining structures etc. The data provided may be used by the Contractor to assist with the determination of founding levels, appropriate construction techniques etc. as approved by the Project Manager, but its interpretation shall be the responsibility of the Contractor.

## **2) Construction Phase Data**

- a) In cases where additional or confirmatory testing is required by the Project Manager to be undertaken during the construction stages to verify ground conditions [e.g. assumed design values for structural foundation bearing pressures, rock table elevations etc.] the Contractor shall modify the programme of works accordingly.
- b) He shall also arrange to carry out the work in sufficient time as to allow the Project Manager to review the data and modify the design details as may be deemed necessary. The Contractor shall not be entitled to claim for delay or downtime in respect of these activities.
- c) The Contractor shall provide to the Project Manager in advance, a method statement describing the equipment and testing procedures to be adopted. Full details of all acquired information shall also be provided upon completion of each test in accordance with the requirements of the Project Manager.

## **117 Nature of the Ground and Conditions of Works**

1. The Contractor will satisfy himself by his own investigations and experience as to the strata and ground conditions actually occurring and must allow for such in his rates and prices. He must also satisfy himself as to the circumstances and conditions at the site of the permanent Works as well at any other areas including but not limited to quarry sites, borrow areas and temporary haul / access roads. Methods of working must take into account any variations, which may occur therein.
2. The Contractor shall satisfy himself on conditions pertaining in and near watercourses and consider the nature of materials to be excavated and placed including due allowance for the possibility of flooding, subsidence, rock falls, landslides etc. within the work site and at other areas outlined above.
3. Responsibility for the interpretation of such data obtained shall remain with the Contractor. The rates and prices in the Bill of Quantities shall be deemed to include all such conditions, which may arise, and no separate payments will be made for circumstances that the Contractor is responsible to discover.

## **118 Possession of Site**

In amplification of Clause 20 of the Conditions of Contract and subject to the requirements of the Contract with respect to the programme of work submitted by the Contractor, the Contractor will be given possession of the site in the sections and periods after Commencement of Contract as noted in the Letter of Commencement and the Particular Conditions of Contract.

## **118 Entry upon Existing and Acquired Right of Way**

- 1) The Contractor shall not take possession of the Site or enter any land or commence any operations until such time as he receives formal approval to commence work from the Project Manager. Should the Contractor enter land or commence any operations without first obtaining this direction, he shall be solely liable for all additional costs and/or legal charges, which might arise there from.

2) The Employer shall be responsible for the assessment and payment of compensation in respect of land to be permanently acquired and incorporated in the Works within or outside the present road Right of Way reserve, together with all buildings, crops, trees and any other properties so defined from the land.

### **119 Land for the Contractor's Own Purpose**

1) It is the Contractor's responsibility to obtain and provide suitable land for working areas including offices, workshops, equipment and materials storage facilities etc. This shall include any land to be temporarily acquired outside the road reserve for quarries and borrow pits, access roads thereto and for any areas needed for access to carry out the Works - whether specifically required by the Project Manager or the Contract or not. The Contractor shall obtain the approval of the Project Manager for the location of the proposed areas and provide a detailed layout before any work commences upon them.

2) The Contractor shall be responsible for the payment to landowners for any compensation in respect of loss of crops, access, damage to land and structures, etc. and for the subsequent reinstatement of any areas used to the approval of the respective owners.

### **120 Particular Matters to be brought to the Attention of the Contractor**

1) The Contractor shall be obliged to maintain and allow accesses to businesses and residences.

2) The Contractor's hours of working shall be limited to normal working hours (07.00 to 17.00). Night working and weekend working will not be permitted on this project, except in an emergency and with the written agreement from the Project Manager.

3) Noise levels at properties adjacent to the Works shall be limited to  $L_{eq} 70$  dB(A) and  $L_{max} 85$  dB(A) (maximum noise level in any hour).

4) The Contractor shall ensure that any nuisance caused by dust is kept to a minimum by appropriate measures including the use of water sprayed on the surface. If in the Project Manager's opinion, the Contractor is taking insufficient precautions to avoid such dust nuisance, the Project Manager may issue a written warning. In the event of subsequent dust nuisance, the Contractor will be liable to liquidated damages in accordance with Clause 4.1 of the Conditions of Contract and be responsible, at no cost to the Employer, for any cleaning of property that the Project Manager deems, was adversely affected by dust.

### **121 Removal of Excess Material**

1) The removal of materials in slips, slides or subsidence and over break of rocks extending beyond the lines and slopes or below the levels required by the Project Manager will not be paid for unless such occurrences were, in the opinion of the Project Manager, beyond the control of the Contractor and could not have been prevented by the exercise of due care and diligence.

2) Where payment is made for the removal of such material, it will be at the appropriate rate inserted in the Bill of Quantities having regard to the condition and situation of the material at the time of removal and regardless of its condition and situation prior to the slip.

## **122 Use of Explosives**

- 1) The Contractor is required to be familiar with and follow the procedures and regulations of the appropriate authorities if, and when using explosives.
- 2) He will be responsible for obtaining any necessary permissions and authorisation for the use of explosives and ensure that appropriately qualified and approved personnel and equipment are available on site and that operations involving the use of explosives conform to all safety and other requirements of the appropriate authorities.
- 3) The Contractor shall relieve the Employer and the Project Manager from all consequences whatsoever related to blasting operations.

## **123 Road Closures**

- 1) Where the extent and impact of the required construction operations are such that an existing roadway must be closed to the public, this may be accepted by the Project Manager provided that:
  - a) The date(s) of the closure and the duration of affected sections are in strict compliance with a 'Traffic Management Plan' previously prepared by the Contractor and approved by the Employer;
  - b) Sufficient notice (minimum of 14 days] is given to the Project Manager by the Contractor so that appropriate notification can be issued to the travelling public, transport and emergency services etc.;
  - c) Suitable signage is provided to indicate the closure and the diversion route;
  - d) Adequate provision for access to local properties is made.
- 2) Where the Contractor uses a public road for construction operations in connection with the Works, the Contractor will be required to undertake sufficient maintenance work as may be required to keep the roadway safe and fully operational.
- 3) In a case where such a road deteriorates to a condition that the Project Manager declares unsafe or otherwise unusable by public traffic, the Contractor shall ensure that an alternative route or routes are provided and suitably indicated by signage, at his own cost.

## **124 Standards and Alternative Standards**

Materials, equipment and methods shall comply with the standards (current 30 days prior to the latest date for submission of tenders) indicated or the relevant British Standards and Codes of Practice. The Contractor may propose, for the Project Manager's approval, the adoption of alternative standards, in which case he shall provide comprehensive details and explanations, including translation of foreign language standards, with his proposal. The Contractor shall allow for the time necessary for review and approval of such alternative standards by the Project Manager.

## **125 Workmanship and Quality Control**

- 1) The onus rests on the Contractor to produce work, which conforms in quality and accuracy of detail to the requirements of the Specifications and Drawings. The Contractor must, at his own expense institute a quality control system and provide experienced technical staff and equipment to ensure adequate supervision and control of the Works at all times.
- 2) The costs of the supervision and process control including testing to be carried out by the Contractor in compliance with the above requirements shall be deemed included in the rates tendered for the related items of work.

3) The Contractor's attention is drawn to the provisions of the various sections of the Specifications regarding the minimum frequency of testing that will be required to be undertaken as part of the quality control process. The Contractor shall increase this frequency where necessary to ensure adequate control at his own discretion or as ordered by the Project Manager.

4) The Contractor shall submit to the Project Manager the results of all relevant tests, measurements and levels indicating compliance with the Specifications on completion of every part of the work for the Project Manager's examinations.

### **126 Faulty Work**

Any work, which fails to comply with these Specifications, 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.

### **127 Safety of Works and Adjacent Structures**

The Contractor shall at his own expense provide and erect to the approval of the Project Manager all supports required to protect efficiently all structures or works requiring support because of the Works and shall remove the same on completion.

### **128 Boundaries Cut Through**

Fences, walls, etc. crossed by the Works and forming boundaries of plots outside the area occupied by the Works shall not be cut through or destroyed for more than the distance necessary to permit the erection of new fencing etc. and the Contractor shall make the ends of the cut fences reasonably secure. Where fences or walls are damaged or destroyed, the whole shall be restored and reinstated with like materials to the satisfaction of the owners, occupiers and the Project Manager.

### **129 Damage to Access Roads**

The Contractor shall ensure that damage to any public or private roads, footpaths and tracks used by any vehicles or plant proceeding to or from the Site is kept to a minimum and he shall be responsible for the cost of all repairs necessary to restore such roads, tracks or footpaths to the satisfaction of the Project Manager and/or controlling authorities.

### **130 Protection of Completed Work**

The Contractor shall protect completed work from damage during subsequent operations, from the weather or any other cause, including the naturally aggressive nature of the environment in which the Works are to be constructed and make good any damage so arising.

### **131 Temporary Fences**

The Contractor shall erect and maintain at his own expense suitable and approved temporary fencing as may be necessary to meet his obligations under the Contract. Access shall be provided in the temporary fencing as necessary for the use of the occupiers of adjacent land(s).

### **132 Existing Services**

1) No warranty is given as to the accuracy or completeness of the information on existing services included in the Contract. The Contractor shall consult all relevant authorities and service owners before commencing any excavations and shall satisfy himself as to the exact position of existing

services, which affect or may be affected by the Works. If any service is found to exist but is not as indicated in the Contract then the Contractor shall at once give written notification to the Project Manager. The Contractor shall record the position of all located existing services on the horizontal alignment drawings a copy of which shall be made available by the Contractor to the Project Manager.

2) The Contractor shall execute the Works in such a manner that he does not damage or interfere with existing services on or near the Site. If damage or interference is so caused the Contractor shall make his own arrangements, to the approval of the Project Manager and the relevant authority, to execute the repairs at his own cost. If the service authority concerned elects to make good the damage, the Contractor shall give all facilities and shall pay all charges.

3) The Contractor shall make his own arrangements for any diversion or removal of services, which he may require for his own convenience or method of working, and shall obtain the prior approval of the Project Manager to such arrangements.

4) Permanent diversions of some public utility services may be required. This work may be carried out by others.

5) Where public utility services are to be diverted, the works shall be carried out in such a way that the service is maintained while the diversion is installed. The existing service shall not be broken into until the diversion is in place. Should temporary diversions of services be required, the Contractor shall be responsible for arranging such temporary diversions with the relevant Authority who will carry out the work of diverting the pipe or cable.

6) The planning and coordination of the work with and of the service authorities shall be the Contractor's responsibility and due allowance for such shall be made in the Contractor's programme.

### **133 Drains, Streams, Watercourses etc.**

1) Drains, pipes, canals, channels, watercourses or streams affected by the Contractor's operations are to be maintained by temporary channels or pumping if necessary and on completion restored to their original condition as soon as possible after the relevant operations have ceased. The Contractor shall notify the Project Manager in writing 14 days in advance of his intention to start any part of the Works affecting watercourses, canals, streams, drains, pipes, channels etc. The Contractor shall be responsible for maintaining the watercourses within the Site in effective working condition.

2) The Contractor shall execute the works in a manner that will avoid the pollution or siltation of rivers, streams or the sea. If in the opinion of the Project Manager, the Contractor is taking insufficient precautions to avoid such pollution or siltation the Project Manager may issue a written warning and in the event of subsequent damage, pollution or siltation the Contractor will be subject to liquidated damages in accordance with the Conditions of Contract.

3) The Contractor shall take steps to ensure that existing vegetation is disturbed as little as possible in the execution of the Works. Flagrant breaches of this clause will be treated as damage to property and dealt with by the provisions of the Contract.



### **134 Water**

It is the Contractor's responsibility to provide water both for construction purposes and for camp and office facilities. The Contractor's attention is drawn to the fact that no separate payment will be made for the provision of any water required in and for the Works.

### **135 Services for Site Use**

The Contractor shall arrange at his own cost the supply of electricity, fresh water, telephone, compressed air and other services as necessary to his Site establishment, including the Project Managers' Office, and shall provide, maintain and remove on completion all pipes, cables and fittings, which carry such services to his operations. The Contractor shall provide an adequate supply of safe drinking water on the Site. All electrical installations forming part of the Temporary Works shall comply with the relevant provisions of the current regulations for electrical installations applicable in Montserrat.

### **136 Sanitary Conveniences**

The Contractor shall provide and maintain sanitary conveniences for the use of persons employed on the Works in accordance with the appropriate regulations. All persons engaged upon the Works shall be required to use them. The Contractor shall provide and maintain temporary arrangements for the proper discharge of sewage, waste and drainage from or in connection with the Works.

### **137 Materials on and under Site**

Materials arising from clearance of the Site, soil stripping and excavations shall belong to the Employer and shall not be removed from the Site except as required by the Contract and with the approval of the Project Manager.

### **138 Keeping Works Free from Water**

Except where underwater construction is required the Contractor shall execute all work in the dry, and shall construct any temporary drains or other works that may be necessary for the purpose.

### **139 Testing**

1) The Contractor shall provide all staff, labour and equipment necessary for the performance of all tests required, or he may employ an independent testing laboratory approved by the Project Manager to carry out all or part of the testing.

2) If the Contractor provides his own testing facilities, the equipment, staff and method of operation shall be to the approval of the Project Manager, and up to 25% of all tests conducted by the Contractor shall simultaneously be carried out, on samples of the same material, by an approved independent testing laboratory. The cost of supplying samples shall be included in the Contractor's rates, but the cost of independent testing shall be under a provisional sum.

3) In either case, the Project Manager shall have access to the laboratories at all reasonable times.

4) The Contractor shall obtain the approval of the Project Manager for his proposed testing arrangements and shall submit all results without delay.

## **140 Assistance to the Project Manager**

The Contractor shall provide for the exclusive use of the Project Manager all instruments (which shall be new or in proven good condition) appliances, protective clothing, rubber boots, and labour required for checking the setting out of the Works, testing, inspection and for any other attendance on the Project Manager.

## **141 Photographs**

1) The Contractor shall provide the Project Manager with sets of colour photographs taken at the following stages:

- a) Commencement
- b) At monthly intervals during construction, or as otherwise instructed by the Project Manager
- c) Substantial completion

2) Photographs shall be taken from locations directed by the Project Manager. The digital copies shall be saved on a CD/Flash drive and two colour prints, approximately 150 x 90mm, of each photograph shall be supplied. Each print shall be neatly mounted on plain backing and titled. A set will consist of 10 photographs, and each set shall be handed to the Project Manager within 3 days of the photographs being taken.

3) The digital copies and all prints shall be the property of the Employer.

## **142 Site Office for the Project Manager**

1) The Contractor shall provide, furnish, equip, maintain and clean a site office as detailed for the exclusive use of the Project Manager. Where a septic tank has to be provided, the Contractor shall be responsible for obtaining the relevant approvals, its installation, regular emptying etc. and removal on completion. The office(s) shall be ready for use and occupation within 7 days of the Date of Commencement of the Works and fully serviced within 14 days of that date.

2) The Contractor shall be responsible for providing all sanitary services necessary for keeping rest rooms in a clean, neat and hygienic condition. When no community public sewage treatment is available, the Contractor shall provide the necessary collection and disposal systems. The Contractor shall also make provision for the removal of all solid waste and rubbish.

3) The Contractor shall provide a constant supply of clean potable water suitable for human consumption and 110/220-volt electrical supply to the facilities. Power sources shall be suitable for office and laboratory use with an anticipated large variance in load factor. 3-phase power shall be supplied. The source of power shall be either from a recognized power-supply authority or by an on-site generator supplied by the Contractor.

4) In the event of electricity being generated by the Contractor, the motor-alternator shall be suitable to maintain the voltage so that it will not deviate by more than  $\pm 5\%$  from the nominal voltage and to maintain the frequency so that it will not deviate from the nominal frequency by more than  $\pm 2$  Hz over the entire load range. Power shall be available to the facilities for at least 12 hours per day and 7 days per week.

5) Power shall be distributed by means of enclosed distribution boards with adequate weather and tamper protection, suitably rated circuit breakers, earth-leakage units or fuses, and by means of

adequately sized underground cables and earth conductors. Sizing of cables and rating of protective and control devices shall take into account the load and fault currents that can occur on the system. The Contractor shall maintain at all times the power supply, the distribution network and the wiring installation of all buildings and structures at the highest standard of safety and usability. The Contractor shall also provide a sufficient supply of liquid petroleum gas for the burners used in the laboratory.

6) The Contractor shall supply emergency fire fighting and 'first aid' medical equipment of a type acceptable to the Project Manager, at each facility. No separate payment shall be made in respect of such equipment and full compensation for the supply shall be deemed to be included in the tendered rates for the various items in the Bill of Quantities.

7) The Contractor shall provide all labour, equipment and materials, which may be necessary for keeping the offices and laboratory facilities in a neat and clean condition. Any necessary repairs shall be made immediately at the request of the Project Manager. The Contractor shall provide consumables (e.g. soap and towels) for the offices and miscellaneous materials for use in the testing procedures at the laboratory in addition to the regular cleaning services required.

8) The Contractor shall include in his rates in the Bill of Quantities, the cost of all such maintenance activities and no other payment shall be made. Should the Contractor fail to provide satisfactory services to the satisfaction of the Project Manager, the Project Manager shall have the right to provide such services and the cost of such services shall be deducted from the monies due or that become due to the Contractor.

#### **143 Transportation for the Project Manager**

The Contractor shall provide and maintain a vehicle as detailed to for the exclusive use of the Project Manager. The vehicle shall be available to the Project Manager and ready for use within 7 days of the Date for Commencement of the Works. The vehicle(s) and its maintenance shall remain the responsibility of the Contractor throughout the Contract and shall become the property of the Employer at the end of the Contract.

#### **144 Maintenance of Project Manager's Staff Vehicles**

1) The Contractor shall provide regular maintenance to the Project Manager's Staff vehicles in accordance with vehicle manufacturer's recommendations and shall furnish all repairs, supplies, fuel, lubricants and all other consumables as necessary.

2) The Contractor shall be responsible for replacement whether temporary or permanent, of any vehicle which becomes out of service through repair or accident.

#### **145 Notice Boards**

The Contractor shall provide and erect notice boards as detailed by the Project Manager. No other notice boards or signs of any description shall be erected unless directed or approved.

#### **146 Contractor's Accommodation**

1) The Employer will provide, free of charge, the areas of land indicated on the Drawings (or agreed with the Project Manager/Employer prior to the Commencement Date) where the Contractor shall

establish his office, plant yard and storage areas. The Contractor shall be responsible in all respects for any additional land that may be required by him.

2) The Contractor shall provide, erect, service and maintain all necessary buildings such as offices and plant yard/stores for himself, his staff and his employees. These buildings shall, from the time of their erection until the completion of the Contract be the property of the Employer and the Contractor shall not demolish or remove any buildings or part of any buildings without the written permission of the Project Manager.

3) The Contractor shall make all necessary arrangements for and pay all costs in connection with the supply of electricity, water, sewage and waste disposal (including the construction of septic tanks).

4) All buildings shall comply with the appropriate local regulations and the Contractor shall provide the appropriate Authority with sufficient details of the establishment so that approval of the appropriate Authority can be obtained prior to construction. The Contractor shall also construct and maintain adequate roads or paths to all buildings.

5) The Contractor shall provide and maintain adequate first-aid facilities and shall provide transport facilities for the removal of injured or sick personnel to hospital or home.

6) All hutments, buildings, fixtures and fittings provided under this Clause shall be removed and the site reinstated at the end of the Contract.

#### **147 Contractor's Transport**

The Contractor shall make his own arrangements for the transport, where necessary, of his staff and workers to and from the site of the Works.

#### **148 Royalties**

The Contractor shall be liable for payment of any Royalties and related costs due to obtaining materials from whatever source and the cost thereof shall be deemed to have been included in the unit rates for providing such materials.

#### **149 As Constructed/ Shop Drawings**

1) The Contractor will be required to prepare records or 'as-constructed' drawings of the completed work. The drawings shall be produced to a standard similar to that of the Contract Drawings or as otherwise approved by the Project Manager.

2) Should fabrication or workshop drawings or any other further drawing be required or necessary for the execution of the Works, the Contractor shall prepare and submit them for the approval of the Project Manager.

3) For any of the works or part thereof as requested, the Contractor shall supply four copies of the Construction and/or Working drawings for the approval of the Project Manager. All Working and Construction drawings shall be A1 or A3 as ordered and folded to A4 size. The Project Manager shall promptly return one copy with any necessary corrections for re-submittal or approval.

## **150 Straight Edges & Camber Boards**

- 1) Where directed by the Project Manager, the Contractor shall provide the Project Manager with camber boards to the profile of the normal camber and 3 metres long straight edges and measuring wedges calibrated for 5 mm, 10 mm, 15 mm and 20 mm.
- 2) The straight edges and measuring wedges, and camber boards shall be made of strong durable materials such that they are inflexible, will not warp and do not suffer from abrasion.
- 3) No separate payment will be made to the Contractor for the provision of camber boards, straight edges and measuring wedges.

## **151 Use of River Bed Materials**

- 1) The Contractor shall take into account that the extraction of materials from riverbeds for use as the sources of aggregate materials will not be allowed under this Contract. However, the Employer may permit the recovery of larger size rock material for use as riprap, armour protection, etc.
- 2) In such a case, the Contractor must make a written application for permission to extract the materials. The application must be submitted to the Project Manager at least 10 days in advance of the proposed start of the extraction operation. The submission shall take the form of a detailed method statement describing at least, the requested location of the extraction point(s), the access / haul routes required, the type and quantity of the materials to be removed and the nature and extent of the restoration procedure to be implemented at each site.

## **200 EARTHWORKS**

### **201 Definition of Earthworks Material**

- 1) The following definitions of earthworks materials shall apply to this and other Clauses of the Specification in which reference is made to the defined materials:
  - a) top soil' shall mean the top layer of soil that can support vegetation
  - b) suitable material' shall comprise all that material which arises from excavations within the Sites and which is approved by the Project Manager as acceptable for use in the Works
  - c) unsuitable material' shall mean other than suitable material and shall comprise:
    - i. material from swamps, marshes and bogs
    - ii. peat, logs, stumps and perishable materials
    - iii. material susceptible to spontaneous combustion, and
    - iv. clay of liquid limit exceeding 90 and/or plasticity index exceeding 65
    - v. soft' material shall mean all material other than that defined as hard material or rock hereunder
    - vi. hard material' shall mean all material that cannot be ripped with a Caterpillar D6 bulldozer with a single tooth ripper tyne or similar equipment
  - d) Original Surface means the surface of the ground before any work has been carried out.
  - e) Final Surface means the surface indicated on the Drawings to which excavation is to be carried out.

f) Commencing Surface (in relation to individual Items in the Bill of Quantities) means the surface of the ground or underlying construction layer before any work covered by an individual Item has been carried out.

g) Excavated Surface (in relation to individual Items in the Bill of Quantities) means the surface elevation to which the excavation has been carried out under a particular Item of work.

h) Subgrade is the final compacted and prepared surface upon which a road pavement is to be constructed. The term 'formation level' is to be taken to be synonymous with 'subgrade'.

i) Road bed is the natural in situ material on which the fill or, in the absence of fill any pavement layers are constructed.

j) Embankment (or fill) is that portion of earthworks utilizing generated native or approved imported material which lies above the road bed and is bounded by the side slopes shown on the Drawings and upon which the road base materials are to be placed. Material which is imported to replace unsuitable material excavated from the road bed shall also be classified as fill.

k) Pavement layers are the upper strata of the road comprising the sub-base if any, base and surfacing materials.

## **202 Classifications**

1) *Topsoil* is fertile, friable soil of a loamy character and usually covered by natural vegetation that is native to the region. Topsoil shall not be taken from swampy areas unless authorised by the Project Manager.

2) Common Excavation Material is any material that can be excavated without recourse to the methods described under rock and shall be classified as 'common' excavation material.

### **3) Rock**

a) Any material that, in the opinion of the Project Manager (who shall take into account the situation in which the excavation is taking place), requires for its removal blasting or the use of a compressor and hand tools.

b) Material that can be effectively ripped and removed using a single tine operated by a tracked type machine of specified flywheel power <425 horsepower, shall not be classified as rock. The cost of proving rock shall be included in the Contractor's rates and no extra payment will be made for this cost.

### **4) Isolated Boulders**

Isolated and competent boulders of < 1m<sup>3</sup> in size occurring within any mass of material and that can be removed by the Contractor's ordinary earthmoving plant and suitably disposed of to the Project Manager's satisfaction, shall be measured as 'common' material. Otherwise, such boulders shall be considered 'rock' material.

5) *Cut* is earthworks material generated by the various excavation processes.

### **6) Unsuitable Material:**

a) Refers to earthworks or excavated material, which in the opinion of the Project Manager, is not suitable as fill and is to be removed to an approved disposal site or spoiled outside the road reserve.

b) Such material shall include that deemed to be unsuitable in the opinion of the Project Manager, including any materials:

- i. found in swampy areas such as peat, buried logs, tree stumps, perishable material and any that may be susceptible to spontaneous combustion;
- ii. that are otherwise unsuitable for use in the location where they are required to be placed;
- iii. that have excessive moisture content and that cannot be effectively dried

7) *Surplus Material* is that which is judged by the Project Manager to be suitable for use as fill but that is surplus to the filling requirement and must be 'spoiled'. The Project Manager shall direct whether such material shall be disposed of as 'overfill' in embankment side slopes or shall be disposed of in authorised spoil areas outside the road reserve.

8) *Fill* is common material and shall be compacted to 95% of BS Heavy Compaction as defined in BS 1377.

9) *Selected Fill* is common or selected material and shall be compacted to 98% of its maximum compaction (BS 1377). Selected fill shall have a minimum depth of 200 mm.

**10) Borrow**

a) Borrow is any suitable earthworks materials that, with the prior approval of the Project Manager, can be obtained by over-excavation or from borrow sources outside the road reserve. All borrow shall be authorised by the Project Manager. His authorisation shall be granted only if the cut operation does not yield sufficient fill or the Contractor makes a request, accepted by the Project Manager, that he be permitted to use spoil material (paid for as material for re-use) located at a distance and to borrow material nearer at hand, for re-use without payment.

b) The Contractor shall obtain the prior permission of the Project Manager before developing any borrow area including the widening of cuttings

**c) From Cuttings:**

In certain circumstances, where widening of cuttings is necessary, borrow may be obtained from excavating within the road reserve, preferably on the inside of bends. Such widening shall be worked in single machine widths and extend to the full depth of the cutting or drain. When widening cuttings, the side drain shall generally be sited at the foot of the new cut face, the cut slope shall be to the same batter as the original face and the shoulder shall extend across the widening at the same cross fall as the original cross-section.

**d) From Borrow Areas:**

The Contractor may be authorised to obtain borrow material from a source outside the road reserve. In that case, the Contractor will be responsible for locating the source, undertaking all necessary negotiations with Local Government or other occupier, preparing and signing legal agreements, making payment and giving proper notice to enter upon the land, and obtaining all the necessary consents.

e) The Contractor shall include in his rates for all other costs, including prior investigation and sampling, fencing, stripping, removal of overburden, operating transportation, drainage and reinstatement at the conclusion of the borrowing operation, including the provision and maintenance of haul roads.

f) Borrow areas that in the opinion of the Project Manager would provide materials suitable for the road pavement, or for selected fill, shall not be used for other purposes unless expressly authorised by the Project Manager.

g) The Project Manager shall give prior approval to sites of borrow areas. When the use of the borrow area is terminated the Project Manager shall have the power to withhold payments in interim certificates for borrow pending reinstatement of such borrow area to his satisfaction.

11) *Rock Fill* is broken material derived from hard non-weathering homogeneous rock and which contains more than 25% by volume of particles larger than 150 mm in greatest dimension. All rock fill must receive the prior approval of the Project Manager before use.

#### *12) Spoil Areas*

a) By prior permission of the Project Manager, surplus material other than rock or rippable material may be disposed to spoil by the widening of embankments providing such widening and the Contractor's method of working will not, in the opinion of the Project Manager, affect adversely or endanger the embankments, or put embankment toes or toe drains outside the road reserve and providing that the shaping and trimming of the extended embankments is completed as specified. No additional payments will be made.

b) The Contractor shall on no account place spoil outside the road reserve without first obtaining the permission of the Project Manager and the owner of the land. He shall not dump or otherwise dispose of surplus material over precipices.

c) The Contractor shall be responsible for locating suitable spoil areas outside the road reserve, undertaking all negotiations with the Local Government Authorities or other occupier, preparing and signing legal agreements, making payment and giving proper notice to enter upon the land. The Project Manager shall give prior approval to sites of spoil areas. When the use of the area is terminated, the Project Manager shall have the power to withhold payments in interim certificates for spoil pending reinstatement of such spoil areas to his satisfaction.

d) The Contractor's rates shall be deemed to include any payments to be made to Local Government Authorities or private owners, as well as other costs, such as stripping the area, transportation, drainage provisions and reinstatement at the conclusion of works.

### **203 Site Survey**

1) Prior to the commencement of each type of excavation or filling the Contractor shall carry out a survey of the existing ground surface in conjunction with the Project Manager to establish the commencing surface for the purpose of measurement of quantities. Levels shall be taken at cross sections at not more than 15 metre intervals unless directed otherwise.

2) The Contractor shall plot the results on plans and sections and submit copies to the Project Manager for his approval and subsequent use in measurement.



## **204 General Earthworks Operations**

This Section deals (after site clearance and removal of topsoil) with the excavation of cuttings including side drainage ditches, the preparation of foundations and the construction of embankments.

### *1) Order of Works*

- a) The construction of cuttings and embankments shall proceed in a methodical and orderly manner - generally from one end of the work section to the other. Work is to proceed after due regard for overall balancing of earthwork quantities, so that cuttings are excavated continuously and each embankment is completed before the next is commenced.
- b) Contractor shall submit a general programme for earthworks to the Project Manager and having obtained the Project Manager's approval, shall as far as possible adhere to its provisions.
- c) All trimming of cuttings, embankments, ditches etc. to the specified slopes and shapes, shall be carried out concurrently with the earthworks that are being undertaken at any particular location.

### *2) Use of Materials*

#### *a) General*

The Contractor shall (unless the Project Manager instructs otherwise) undertake cuts and fills in the manner specified in this Section and according to the approved earthworks programme. However the Project Manager may direct where materials of different quality shall be used and/or order borrow from approved sources, [whether from widened cuttings or elsewhere] to be introduced or for materials to be spoiled. The Contractor shall borrow or spoil only after verbal approval, which is to be subsequently confirmed in writing by the Project Manager.

#### *b) Unsuitable Material*

Upon coming across unsuitable material, the Contractor shall, immediately bring this to the attention of the Project Manager. Any unsuitable material, which by the Contractor's operations or due to his method of working has been included in the Works (whether or not it has already been declared unsuitable by the Project Manager) shall be removed to spoil by the Contractor and replaced with suitable materials at the Contractor's expense.

#### *c) Removal and Re-use of Topsoil*

- i. The removal of topsoil, where directed, shall be to an average depth of 150mm, or as otherwise directed, prior to bulk excavation or filling operations, and shall be placed in thin layers on designated areas within the road reserve or stockpiled for re-use.
- ii. The Contractor shall notify the Project Manager at least 5 days before he intends to start topsoil stripping operations.
- iii. Slope areas to receive top soil shall be disked or scarified to a depth of 100 mm or as otherwise directed by the Project Manager prior to placing topsoil. After the Project Manager has approved the graded areas, topsoil shall be spread to a depth, which, after settlement, will provide the nominal depth shown on the plans or as instructed. Spreading shall not be done when the ground or the topsoil itself is excessively wet or in a general condition detrimental to the work.
- iv. The roadway surfaces shall be kept clean during hauling and spreading operations.
- v. After spreading has been completed, large clods, stones larger than 50 mm and any roots, stumps or debris shall be raked, removed, and disposed of at an approved location. Spread topsoil shall be lightly tamped as approved by the Project Manager in order to reduce erosion on the finished surface.

## **205 Excavation - General**

1) Excavation shall be carried out to the lines, levels and profiles shown on the Drawings or to such other lines, levels and profiles as the Project Manager may direct or approve in writing. The Contractor shall carry out the work in such a way to avoid disturbance to the surrounding ground. Particular care shall be taken to maintain stability when excavating in proximity to existing works.

2) The work shall be carried out in a careful manner to ensure that the exposed surfaces are as sound as the nature of the material permits and that no point shall protrude inside the lines shown on the Drawings except as otherwise specified or agreed by the Project Manager. In soft excavation, which is to remain open permanently, exposed faces shall be formed accurately to the required slopes and profiles. Excavations in rock, which remain open permanently shall be so trimmed that no point protrudes within the required profile.

3) Excavation in areas of subsidence shall be carried out to the depth directed by the Project Manager and leaving side slopes to a maximum of 45°. The exposed formation surface shall be compacted to 95% of BS Heavy Compaction as defined in BS 1377. A permeable separator geotextile shall be placed at the bottom of the excavated area as may be decided by the Project Manager before commencing backfill. The geotextile should meet the minimum requirements of Section 1400.

4) Excavated material from the Works selected for reuse shall be placed directly in its final position or may be stacked on Site provided suitable precautions are taken to prevent excessive change in moisture content. Otherwise it shall be removed to spoil tips as noted above.

5) The Contractor shall be responsible for keeping all excavations free from water from whatever cause arising and shall provide such pumping capacity and other measures as may be necessary for this purpose.

6) The Contractor shall properly support the sides of excavations and shall be responsible for their safety.

7) Where shown on the drawings, cut slopes are to be formed to a benched profile with each bench being cut as the overall excavation proceeds. The dimensions of benches shall be sufficient to permit the operation of placing and compaction equipment thereon to generally a minimum width of 2-3 m. Dimensions of heights and widths of benches together with any required cut-off ditches and toe walls are included in the Drawings.

8) The Contractor shall notify the Project Manager without delay of any permeable strata, fissures or unusual ground encountered during excavation.

## **206 Excavation Beyond True Lines and Levels**

If from any cause whatsoever excavations are carried out beyond their true line and level other than at the direction of the Project Manager, the Contractor shall at his own cost make good to the required line and level with approved material and/or deal with the matter in such a manner as the Project Manager may direct.

## **207 Approval of Excavation**

1) When excavations have been taken out accurately to the profiles or dimensions required for the work, the Contractor shall inform the Project Manager so that he may carry out an inspection. If, after his inspection the Project Manager requires additional excavation to be carried out, the Contractor shall do so to such new profiles or dimensions as the Project Manager may direct.

2) Before any fill or pavement forming part of the permanent works is placed, the Contractor shall conduct the specified tests. The Contractor shall obtain the agreement of the Project Manager that the underlying layer is satisfactory prior to placing any further layer.

3) The Contractor shall maintain open excavations in an approved condition, and shall rectify the effects of deterioration due to weather.

## **208 Excavation for Structural Foundations**

1) Prior to commencement of any excavation, the Contractor shall notify the Project Manager in advance to allow for checking of layouts and dimensions and for measurements, cross sections and control levels to be established.

2) Where suitable material is encountered during excavation against which the casting of concrete is permissible, that part of the trench or foundation pit shall be excavated neat to the dimensions of the base, unless directed otherwise by the Project Manager. Over excavation (over break) in such suitable stable material shall be backfilled with the same Class of concrete as that in the base - or with mass concrete fill as may be directed by the Project Manager.

3) Where in the opinion of the Project Manager, the casting of concrete against the excavated earth faces is not permissible or where formwork is to be provided, the extremities of the excavation shall be measured for payment purposes as shown on the relevant Drawings or otherwise to a maximum of 600 mm outside of and parallel to the net perimeter of the base or member.

4) When material suitable for founding is encountered above the designed founding level, excavation to final grade shall not be made until the Project Manager has inspected the excavation and before any working floor [blinding layer] is placed.

5) Where in the opinion of the Project Manager unsuitable material is encountered at founding level such material shall be removed and replaced with approved compacted granular fill. Boulders, logs or any other unsuitable material excavated shall be removed.

6) No concrete shall be placed before the excavation has been cleaned, inspected and approved by the Project Manager. A concrete working floor [blinding layer] of 75 mm thickness shall be placed underneath all bases except, where otherwise directed by the Project Manager.

7) Where required rock sockets shall be excavated for bridge pier foundations and to the dimensions shown on the drawings. They shall be formed in rock formations of adequate strength, quality and thickness and may be extended at the direction of the Project Manager until suitable for supporting the required loading.

## **209 Founding on Rock**

Where a structure is required to be founded on rock but is not required to penetrate into it, all soft overburden shall be removed and the surface of the rock cleared of any loose material by barring and wedging. Where the foundation is required to penetrate into the rock, excavation of the rock may be carried out using a suitable excavator with a rock bucket, or by the use of approved pneumatic tools so that the exposed surface is sound.

## **210 Trench Excavation**

- 1) Trench excavation shall be performed by the use of hand tools and approved mechanical equipment, in such manner as to minimise disturbance of the sides and bottom of the excavation.
- 2) Trenches for pipes shall be excavated to a sufficient depth and width to enable the pipe and the specified joint, bedding, haunching and surrounding to be accommodated.

## **211 Trenches**

- 1) The Contractor shall carry out excavation in a safe manner such that the sides of the trench are adequately supported and stable.
- 2) The Contractor shall leave a clear adequate space between the edge of the excavation and the inner toes of the spoil banks.
- 3) Trenches shall be excavated to the lines and levels shown on the drawings. Trenches shall not be excavated too far in advance of pipe laying and shall be sufficiently wide to allow proper and efficient jointing to be carried out in clean and dry conditions. Due allowance shall be made for bedding and surrounds where these are specified.
- 4) The bottoms of all trenches shall be trimmed to grade and level and thoroughly compacted by ramming before any bedding is placed or pipes laid.
- 5) The widths of trenches crossing roads or at other locations as directed shall be as narrow as practically possible. The maximum width measured between undisturbed soil in the trench sides shall not exceed the outside diameter of the pipe being laid plus 550mm for pipes up to and including 230mm in diameter and plus 750mm for pipes over 230mm in diameter.

## **212 Channels**

- 1) Channels shall be excavated by methods, which will not endanger the stability of the side slopes.
- 2) Existing channels, which are to be reshaped, cleared and trimmed, shall be cleared of all weeds and growth and the beds graded to the required levels. The area of waterway shown is the minimum required and the sides of channels shall be trimmed to the required slope so as to provide widths not less than those shown on the Drawings.
- 3) Side banks of channels shall be trimmed to a neat appearance and even surfaces.

## **213 Disposal of Spoil Material**

- 1) Possible spoil areas to be used for disposal of surplus excavated materials shall be as shown on the Drawings or as otherwise approved by the Project Manager.
- 2) The Contractor shall organise and carry out the placing of spoil in such a way that flow passages to existing streams and creeks are not diverted. Contamination of existing rivers shall be avoided and suitable drainage, grassing and turfing shall be provided to prevent erosion of spoil materials.
- 3) The Contractor shall submit to the Project Manager for approval all necessary data showing mucking areas, working methods and drainage and stabilising provisions before placing of spoil in any areas.

## **214 Quarries and Borrow Pits**

- 1) The Contractor shall select his own quarry site or sites but before opening up any quarry he shall supply the Project Manager with: an adequate number of borehole logs and details of test pits; and any other such information that the Project Manager may require to satisfy himself that the quarry site or sites selected by the Contractor may be expected to provide sufficient stone of the specified quality to complete the Works. In the event of the site or sites selected by the Contractor being shown by such information in the opinion of the Project Manager to be incapable of supplying the requirements of the Contract for reasons of either quality or quantity, the Project Manager will require the Contractor to investigate further sites in a similar manner until the Project Manager is satisfied that adequate supplies of the specified stone may be anticipated.
- 2) Notwithstanding satisfactory borehole logs, the Project Manager shall have the right to reject unsatisfactory stone exposed when the quarry is opened. The Contractor shall make provision for the cost of all the exploratory work described above in the rates inserted in the Bills of Quantities.
- 3) The quarries shall be run in a safe manner and on completion of the Works; they shall be left in a tidy state with all loose rock on the face barred down. No rock shall be left overhanging except with the approval of the Project Manager. All quarries shall be worked in such a manner that they do not constitute a danger to health or a nuisance to the neighbourhood, either during the operation of the quarries or after completion of the works.
- 4) The Contractor shall obtain the Project Manager's approval for the sites of borrow pits. The Contractor shall leave all borrow pits in a tidy and regular state, and he shall ensure that where possible they are self-draining at all times and do not constitute a danger to health.

## **215 Approval of Excavations**

The Contractor shall obtain approval of excavations prior to placing pavement layers, fill or concrete. The Contractor shall maintain open excavations in an approved condition, and shall rectify the effects of deterioration due to weather.

## **216 Preparation of Ground for Filling**

- 1) The Contractor will form benches in steeply sloping ground before placing fill over it.
- 2) In the areas designated "soft clay" or any other place so designated by the Project Manager, the top soil shall not be disturbed, only trees and bushes removed.
- 3) After site clearance, and before and/or after proof rolling, the Project Manager may order the excavation and removal of any material deemed unsuitable for supporting the fills or pavements to be placed thereon, and its replacement by suitable approved granular fill material compacted in 150 mm thick layers to 95% of BS Heavy Compaction as defined in BS 1377.
- 4) Paved or fill areas other than "soft clay" areas are to be proof rolled to the satisfaction of the Project Manager before placing any fill or pavement. A minimum of 5 passes shall be made by a pneumatic tyred roller with mass per wheel of 1500 kg to 2000 kg or other roller as agreed by the Project Manager. On completion of proof rolling in areas where the sub-base is the succeeding layer, the formation shall have a dry density of not less than 95 per cent of the maximum dry density obtainable with BS Heavy compaction.
- 5) The limits of embankment foundation areas shall be marked on the commencing surface. The Project Manager will inspect the layout or alternatively order the removal of unsuitable material to a

spoil area to a specified depth prior to the placement of fill. The commencing surface for fill areas shall be compacted to 95% BS Heavy maximum dry density as defined in BS 1377.

6) Where fill is to be constructed across swampy, waterlogged or soft clayey ground that will not support the weight of trucks or other hauling equipment, the Project Manager may direct that the lower parts of the fill be constructed by dumping successive loads in a uniformly distributed layer of thickness not greater than is necessary, to support the hauling equipment placing subsequent layers.

7) Light hauling equipment and light rollers shall be used whenever necessary so as not to overstress the underlying construction.

8) Where embankments are to be constructed over soft to cohesive lean clays, an additional removal of 500 mm may be required and the voids filled with selected granular materials.

9) The upper layers of embankments shall comply with the following requirements - for a depth of 300 mm below the subgrade, materials and construction shall comply with the requirements for selected material.

10) The Contractor shall be responsible for the location of suitable capping layer material and selected material fill to meet the above specified requirements. The use of any necessary borrow pits shall be subject to the approval of the Project Manager.

11) Any additional costs involved in excavation in small areas and depths - as a separate operation or location, shall be deemed to be covered by the rates for cut and fill, as entered in the Bill of Quantities.

12) Where material falling within the subgrade is classified as suitable for use but fails to meet the specified requirements for subgrade at formation level, the layers shall be scarified and mixed, water shall be added, or the material allowed to dry, to appropriate moisture content – before the layer is re-compacted. Any such additional work incurred shall be considered to be at the Contractor's expense.

13) During the process, the final surface of each subgrade layer shall be graded to level, parallel to the crossfall or camber and profile shown upon the Drawings unless otherwise directed by the Project Manager - and to the tolerances specified. The maximum compacted thickness which shall be processed and compacted at one time shall be 150 mm.

## **217 Earth Filling**

1) Material for filling shall be obtained from approved sources or selected from excavations containing no vegetable or perishable matter, graded to ensure a dense, stable and homogeneous fill when compacted.

2) Prior to commencement of filling, the Contractor shall submit in writing to the Project Manager for approval his proposals for carrying out the work such that the optimum use may be made of excavated material and the proposals shall include the compaction plant and methods for adjusting the moisture content of the material which he intends to use. No filling shall be carried out until the Project Manager approves the proposals and the material intended to be used.

3) Construction equipment must operate over the whole area to ensure uniform compaction. Fill shall be placed in layers not exceeding 250 mm thickness, each layer being scarified and thoroughly compacted to obtain a dry density as specified below. More than 450 mm below top of fill level the density shall be not less than 90 per cent BS Heavy maximum dry density as determined by BS 1377. The top 450 mm of fill shall be compacted to a density of at least 95 per cent BS Heavy maximum dry density and shall be capable of achieving a CBR of 8 per cent when so compacted. This CBR percentage should be realised on samples, which have been compacted at optimum moisture content and soaked for 96 hours. The insitu dry density of the compacted fill will be determined by the sand replacement method described in Test No. 15 BS 1377 at locations ordered by the Project Manager.

4) The fill material prior to compaction shall be brought to moisture content within an agreed range of the optimum, in order to obtain the required density. If watering is required it shall be carried out in such a manner as to ensure the even distribution of water throughout the layer to be compacted and the compaction operations will follow whilst the moisture content remains within the specified range.

5) Filling in layers over 250 mm compacted thickness but not exceeding 500 mm compacted thickness may be approved by the Project Manager for mass filling where the nature of the work allows for unimpeded passage of compacting equipment, but not for backfilling of trenches or around isolated or confined foundations. Approval will be given only if the Contractor carried out full scale compaction trials using the proposed procedures or amendments thereto shown during the trials as being necessary, and can demonstrate to the satisfaction of the Project Manager that the degree of compaction specified in sub-clause (3) hereof can be achieved throughout the full depth of the layer.

6) Longitudinal and transverse joints in any two successive layers shall be staggered by a minimum distance of 1.5 times the thickness of the layer.

7) The Contractor shall take all necessary measures to prevent any damage or defects to the Works, which may be caused by settlements, slips or falls of embankments and shall make good such damage or defects as may occur, to the satisfaction of the Project Manager.

8) Any instability of any adjacent excavation resulting from the embankment not being formed to the lines, levels and profile shown in the Drawings or as ordered by the Project Manager will be the responsibility of the Contractor. Where double handling of excavated material is necessary, the Contractor will be responsible for the temporary disposition of the material such that it does not endanger the stability of the excavation.

## **218 Backfill - General**

1) Except around structures, excavations shall be backfilled with suitable excavated material and/or approved material compacted in layers of 300mm maximum thickness to achieve a density of at least 95% of the maximum dry density (heavy compaction) determined in accordance with BS 1377.

2) Materials shall be placed simultaneously on both sides of an abutment, wall, or pier where necessary to equalize forces. Backfilling shall be carried out with an approved material in horizontal layers not exceeding 150 mm in depth after compaction. Each layer shall be moistened or dried as

necessary, to reach the optimum moisture content before being compacted to 95% of the maximum dry density (heavy compaction) determined in accordance with BS 1377.

## **219 Backfill to Structures**

1) The Contractor shall not backfill around structures until the structural elements have attained adequate strength and the Project Manager grants approval to proceed. Unless otherwise directed, the backfill material shall be selected excavated material, thoroughly compacted in layers not exceeding 200mm deep to achieve a density of at least 95% of the maximum dry density (heavy compaction) as determined by BS 1377.

2) Unless otherwise permitted, no filling shall be placed against concrete bridge abutments, wing walls or retaining walls within fourteen days of casting. Strut walls will be constructed as necessary to prevent movement during placing and compaction.

3) Filling shall be placed and compacted over and around pipes, culverts, bridges and other structures so as to avoid unbalanced loading or movement.

4) Unless otherwise detailed, the abutments and wings of bridges shall be filled as follows:

- a) Where the gap between the structure and undisturbed ground is less than 900mm, backfill with sub-base material shall consist of clean, durable fill material.
- b) Where the gap between the structure and undisturbed ground exceeds 900mm but is less than 2m, backfill with select material, single-sized 10mm gravel.
- c) Where the gap between the structure and the undisturbed ground exceeds 2m, backfill the zone within 2m of the structure with select material as defined below, and backfill in the zone beyond 2m of the structure with general fill complying with General Fill requirements

5) Selected well -graded granular material can consist of natural gravel, natural sand, crushed gravel, crushed rock etc. This is mainly frictional material with less than 15 per cent passing the 63 micron sieve and with a minimum acceptable uniformity coefficient of 10.

## **220 Backfilling Materials to Structures**

1) Unless otherwise specified or directed the materials used for filling shall be obtained from cuttings.

2) The Contractor will be required to manage and sort the materials so obtained from cuttings to ensure that the best available material, that is the most granular and least plastic is available for use in road embankments and that any loam material obtained from cutting is used for general fill over the top layers which are to be grassed.

3) Material used in the top 150mm below subgrades shall be free of particles larger than 75mm; material used in the top 600mm below subgrades shall be free of particles larger than 150mm; and material used in the top 1 m below sub-grades shall be free of particles larger than 300mm. Elsewhere rock material shall be broken down to less than 600mm unless otherwise permitted.

4) Rock material shall be broken down and evenly distributed through the fill material, and sufficient fine material shall be placed around the larger material as it is deposited to fill the voids and produce a dense, compact embankment.



5) Stony patches with insufficient fine material to fill the voids shall be reworked with additional fine material being blended in to achieve a dense, compact upper layer. The Contractor shall bear the cost of any reworking.

6) After compaction, embankment material in the subgrade zone(s) below the pavement material (select material layer or sub-base layer, where there is no select material layer) shall conform to the requirements of Clause 425.

7) The Project Manager may direct that material unsuitable for road embankments be used elsewhere on site or run to spoil. If this should result in a deficiency of material available for filling, then additional material shall be obtained as specified in Clause 417.

### **221 Filling under Buildings Slabs**

The material to be used as general filling under raised foundations and building base slabs shall consist of suitable material obtained from adjacent excavations or approved borrow sources, and shall be placed in layers not exceeding 200 mm loose thickness. The material shall be compacted to the degree of compaction specified for earth filling.

### **222 Embankments**

1) Embankments shall be formed of fill as defined and specified herein and compacted as described in the relevant Section hereafter.

2) Embankments shall be constructed in accordance with the profiles and true to side slope width and levels, as shown in the Contract Drawings, or as otherwise instructed or authorised or approved by the Project Manager.

3) Where the Contractor has been authorised to dispose of surplus fill by widening embankments, they shall be constructed to an approved size and made integral with the construction of the embankment proper.

### **223 Placing Fill on Slopes**

1) Fills are normally to be formed of material generated by excavations for cuttings and side drainage ditches. Materials shall be as defined and specified, placed and compacted as described elsewhere in these Specifications.

2) The dimensions of benches shall be sufficient to permit the operation of placing and compaction equipment thereon with a minimum width of 2 m except in rock.

3) The slope shall be given an initial bench at the toe of the fill as set out from the specified levels and cross-sections and protective toe walls installed where specified.

### **224 Rock Fill**

1) Where shown on the Drawings, or ordered by the Project Manager, rock fill shall be placed to a finished level of not less than 300 mm below formation level.

2) *Placement of rock fill*

- a) Rock fill shall be as defined and specified. Each layer of rock fill shall be spread, levelled and compacted by means of suitable equipment. Hauling, spreading and compacting equipment shall be operated over the full width of the layer. Layers of rock-fill spread for compaction shall not exceed 600 mm in thickness in the loose condition.
- b) The maximum particle size shall be 1.0 m in the greatest dimension. All larger particles are to be removed and disposed to spoil. Where a deficiency in fine materials is obvious during the spreading of the layer, additional material must be selected and added, as directed by the Project Manager.
- c) Compaction shall preferably be by a heavy roller of 15 tonne dead weight or by a vibrating roller, giving equivalent results and each layer shall be rolled over the full width of the fill with sufficient number of passes to provide no observable movement under the compacting equipment.

### *3) Treatment of Rock Fill Surfaces*

- a) When the top level of the rock fill has been reached and compaction undertaken on the layer surfaces, the top shall be saturated then 'blinded' with, small size rock material and again compacted over the full width.
- b) This process is to be repeated until the surface no longer shows voids or crevices and in the opinion of the Project Manager is ready to receive any specified capping layer materials for compaction of the final 300 mm to formation level, in accordance with the specifications.

## **225 Compaction**

This Section describes the work of placing materials in fills including the processing and compacting of the material, in formation preparation and related works in accordance with the requirements of the Specifications.

### *1) General*

- a) Compaction shall be carried out in a series of continuous operations over the full width of the layer concerned. The length of any section of a layer being compacted shall, whenever possible, not be less than 300 m, unless otherwise authorised by the Project Manager.
- b) The thickness of any one layer, when measured after compaction, shall not exceed 150 mm, except where specifically indicated on the Drawings or otherwise directed.
- c) Any new layer of less than 75 mm in compacted thickness shall be bonded to the previous layer by scarifying the latter to a depth of not less than 75 mm.

### *2) Preparation*

The material to be compacted shall be thoroughly broken up over the width and depth of the layer by means of scarifiers or other suitable equipment and all large size aggregates, stone or lumps with a maximum dimension larger than 50% of the specified compacted thickness of the layer concerned, shall be broken down or removed.

### *3) Drying*

Should the material be too wet, due to rain or any other cause, it shall be harrowed and allowed to dry to a moisture content that is consistent with achieving the required degree of compaction.

### *4) Watering*

a) Any water required before the material is compacted, shall be added to the material in successive applications by means of water tankers fitted with proper sprinkler bars and capable of applying the water evenly and uniformly over the area concerned.

b) The water shall be thoroughly mixed with the material to be compacted by means of motor graders or other suitable equipment. Mixing shall continue until the required amount of water has been added and until a uniform mixture is obtained before compaction is commenced.

c) The moisture content of the material, when compacted, shall be such that the specified density is achieved.

d) The Contractor shall provide, at his own expense, the necessary staff and equipment for controlling moisture content and for ensuring adherence to specified compaction requirements.

## **226 Methods of Compaction**

a) Compaction shall be carried out by means of grid rollers, sheep's foot rollers, flat-wheel road rollers, vibratory rollers and/or pneumatic-tyred rollers.

b) The types of rollers to be used and the amount of rolling to be undertaken shall be such as to ensure that specified compaction densities are obtained.

c) During compaction, layers shall be maintained to the required shape and cross-section and all holes, ruts and depressions eliminated by frequent blading with motor graders.

## **227 Testing of Fill (To be carried out by the Contractor)**

1) Classification tests shall be carried out to ensure that true comparisons can be made between in situ densities, laboratory compaction densities and field trial densities i.e. variations in properties of materials being used in the tests are not affecting the results.

2) Density shall be measured by either of the methods described in BS 1377. Moisture content will generally be determined by the 'Speedy' method with spot checks by the oven method.

3) The CBR test shall be carried out in accordance with standard test procedure as set out in BS 1377 and all fill material will be tested with surcharge rings compatible with the pavement thickness.

4) Except when it is specified that CBR specimens shall be soaked for 96 hours, the CBR shall be measured at the moisture content estimated by the Project Manager to correspond with the moisture content pertaining under the most unfavourable conditions to which the soil may be subjected. The Project Manager will establish the value of the moisture content at the commencement of the Works.

5) In situ density and Clegg Hammer tests will be carried out routinely at 30 meter intervals on each finished layer. CBR tests will be carried out on materials sampled from the finished layer at intervals determined by the Project Manager.

## **228 Finish of Subgrade**

The subgrade i.e. that layer which immediately underlies the sub base, shall be finished to within +0 mm to 40 mm of the levels indicated by the Project Manager and shall be free draining.

## **229 Ancillary Earthwork Operations**

### **1) Finishing Slopes**

- a) The slopes of cuttings and fills shall be trimmed to neat lines with all loose rock and loose boulders removed. Except in solid rock the tops and bottoms of all slopes, including the slopes of drainage ditches shall be rounded, as ordered by the Project Manager.
- b) When so directed by the Project Manager, adjustment in slopes shall be made to avoid damage to standing trees and to harmonise with existing landscape features. The transition to such adjusted slopes shall be gradual.
- c) All earth slopes shall be finished to smooth and uniform surfaces without any noticeable break. Embankment slopes shall be cleaned of loose materials and trimmed back to design profiles or where overfill has been permitted, back to material, which is compacted as specified.
- d) The slopes of cuts and fills, which are designated for grassing, shall, after finishing, be prepared for top soil and grass seed application as specified.

### **2) Drainage of Earthworks**

- a) All cuttings, embankment and borrow areas shall be kept free of standing water and drainage during the construction period. The provision of any temporary drains etc., necessary for adequate drainage, shall be the Contractor's responsibility and be deemed to be included in his rates.
- b) Should water accumulate on any part of the earthworks during construction giving rise to soaking or erosion conditions in the earthworks, the Project Manager may order the Contractor to remove and replace, at the Contractor's expense, any material that has been so affected. All drains shall be maintained throughout the Contract in working order.
- c) Well in advance of commencing earthmoving operations over swampy or waterlogged areas, the Contractor shall cut drains and ditches and carry out any other works necessary to assist in draining the ground.
- d) The Contractor must allow in his rates for the satisfactory draining of the earthworks at all stages during the construction and arrange his methods and order of work accordingly. No work above the subgrade shall be executed until it has been inspected and approved by the Project Manager.
- e) The subgrade shall be cleaned of all foreign matter and any potholes, loose material, ruts, corrugations, depressions or other defects, which have appeared in the subgrade layer, due to improper drainage, traffic or any other cause, shall be corrected. If so directed by the Project Manager, the Contractor shall scarify, grade and re-compact the subgrade to line and level at his own expense.

### **3) Development and Reinstatement of Borrow Areas and Spoil Areas**

All such areas shall first be stripped all over the operating area to a depth of 150 mm and any topsoil stacked for reuse. At the conclusion of use, all individual heaps shall be graded flat, spoil heaps blended and depressions graded and/or drained so that there will be no standing water. The stockpiled top soil shall be spread over all bare areas and lightly rolled.

#### 4) Work on Existing Roads

a) Where an existing road is to a reasonable vertical and horizontal alignment and cross-section sufficient to permit the construction of the widening, sub-base and/or base course and shoulders upon it without major alteration, then the road may be re-centered and reshaped.

b) Re-centering means that the road is to be realigned both horizontally and vertically such that the maximum and most economical use is made of the existing earth-works, particularly of embankments. The vertical and horizontal alignments of the road are to be comparable with those produced during its original construction.

c) Re-shaping means performing minor earthworks and grading so that the final cross-section of the road complies with the standard cross-section of the type of road specified or indicated on the Drawings.

d) Where existing embankments are to be widened, the existing batter shall be benched to form a key to the additional width of fill. The benching shall be constructed to widths that will permit the use of self-propelled or hand operated compaction equipment.

e) Construction shall be carried out in stepped layers so that the added construction is integral with the embankment proper, and the additional fill shall be placed in layers not exceeding 150 mm after compaction.

#### f) Excavation in areas of widening

Trenching to a nominal minimum depth of 200mm shall be excavated alongside sections of roadway to be widened, to the extent specified in the Drawings. The exposed formation level shall be compacted to 98% (AASHTO T 180) as specified in this Division of the specifications.

#### 5) Tolerances

a) The finished surface of the formation (subgrade) shall be within  $\pm 25$  mm of the specified level. In the final trimmed slopes a tolerance of  $\pm 7.5\%$  will be permitted.

b) The tolerance permitted in the overall width of the bottom of cuttings shall be 75 mm in the distance between the centre line of the road and the toe of the cutting slope.

c) The centre line dimensions of embankments, measured as the distance from the centre line of the road to the shoulder break point, shall be never less than the design width and shall not be more than 250 mm greater than the specified dimension.

d) The Contractor will be paid for the net volume of the earthworks measured from agreed pre-construction cross-sections using the appropriate commencing surface.

e) Any additional material excavated or filled within or beyond these tolerances will be at the Contractor's expense.

### **230 Top soiling**

The Contractor shall obtain topsoil from temporary dumps or approved borrow pits and shall spread it on level or sloping surfaces, where ordered, to the depth shown on the Drawings.

### **231 Grassing**

- 1) The topsoil shall be raked lightly and uniformly to give a fine tilth up to 25mm deep.
- 2) The surface shall be grassed with a local grass with creeping habit, or which the source and variety shall be approved by the Project Manager. Grass sprigs shall be planted at 0.3 m x 0.3 m spacing. The grass shall be adequately watered until such time as the grass becomes established.
- 3) Should the growth fail to become established for any reason the Contractor shall re-cultivate and replant grass as necessary in accordance with the above specification, for as many times as necessary for the grass to become established. When established between 50 and 75mm high, the grass shall be topped by cutting to leave between 25 and 50mm minimum growth and watering shall be continued as necessary until the grass is firmly established to the Project Manager's satisfaction.

### **232 Grass Turfing**

- 1) Where a cut slope is required to be grass turf the grass sods shall be of local grade with creeping habit or which the source and variety shall be approved by the Project Manager. Grass turfing will only be used on cut slopes or areas where top soiling and grassing would be inappropriate.
- 2) Grass sods shall be individually pegged, with sods at 0.3m x 0.3m spacing. Pegs shall be of wood. The grass sods shall be adequately watered until such time as the grass becomes established.
- 3) Should the growth fail to become established for any reason the Contractor shall re-turf areas as necessary in accordance with the above specification, for as many times as necessary for the grass to become established.

## **300 – CONCRETE**

### **301 Concrete**

Concrete shall consist of cement, graded aggregate and water thoroughly mixed, placed and compacted as specified in the following clauses.

### **302 Chlorides in Concrete**

The total combined content of calcium chloride and sodium chloride in any batch of concrete is not to exceed 0.33% by weight of the amount of cement.

### **303 Cement**

- 1) The cement used throughout the Works shall be obtained from manufacturers approved in writing by the Project Manager and shall as appropriate comply with the following specifications:
  - a) Ordinary Portland cement: B.S. 12
  - b) Sulphate Resisting cement: B.S. 4027

### **304 Cement Testing**

- 1) All cements shall be certified by the manufacturers as complying with the requirements of the appropriate Specification. Before orders are placed the Contractor shall submit details of the proposed supplier(s) together with such information on the proposed methods of transport, storage and certification so that the Project Manager may satisfy himself that the quantity and quality required can be supplied and maintained throughout the construction period. Where necessary the Project Manager may require further representative samples of the proposed cement to be taken and forwarded to a nominated laboratory for analysis and testing before the source is approved.
- 2) Having obtained the Project Manager's approval of the source(s) of supply, transport, storage and certification of the cement, the Contractor shall not modify or change the agreed arrangements without first having obtained the Project Manager's permission.
- 3) In addition to routine test certificates which are to be supplied by the manufacturer to show the average results of sample tests made on batches of cement produced at the works, the Project Manager may also make any further tests which he shall consider necessary or advisable to satisfy himself that the cement on Site complies with the Specification and has not suffered deterioration in any manner during transit or storage.
- 4) The Contractor shall ensure that the arrangements for the storage of the cement on the Site as hereinafter specified are sufficient for the segregation and identification of each consignment until the results of the sampling and testing referred to in sub-clause (3) above are available.
- 5) No cement shall be used in the Works until the Project Manager has passed it as satisfactory.

### **305 Storage of Cement**

- 1) The cement shall be delivered to the site of the Works in bulk or in sound and properly sealed bags and while being loaded or unloaded and during transit to the concrete mixers whether conveyed in vehicles or by mechanical means, must be protected from the weather by effective coverings. Where directed by the Project Manager the Contractor shall supply and erect efficient screens at his own expense to prevent wastage of cement during strong winds.
- 2) If the cement is delivered in bulk, the Contractor shall provide at his own cost, approved silos of adequate size and numbers to store sufficient cement to ensure continuity of work and the cement shall be placed in these silos immediately it has been delivered on the Site. Approved precautions must be taken during unloading to ensure that the resulting dust does not constitute a nuisance.
- 3) If the cement is delivered in bags, the Contractor shall provide at his own cost perfectly weatherproof and well-ventilated sheds having a floor of wood or concrete raised at least 500 mm above the ground. The sheds shall be large enough to store sufficient cement to ensure continuity of work and each consignment must be stacked separately therein to permit easy access for inspection, testing and approval. On delivery at the Site, the cement is at once to be placed in these sheds and shall be used in the order in which it has been delivered.
- 4) Cement, which has been damaged in transit to the Site or has become stale or otherwise unsuitable, and hardened lumps or cakes of cement, which cannot be crumbled into fine powder in

the hand shall not be used in the Permanent Works except with the specific approval of the Project Manager.

### **306 Fine Aggregates**

1) Fine aggregate for concrete shall be clean sand complying with B.S. 882 "Aggregates from natural sources for concrete". The sand shall be from approved sources and a sand, which in the opinion of the Project Manager is not clean, shall be washed before use.

2) Crushed sand up to a maximum of 50% may be added to natural sand in order to achieve the required grading. Crushed sand alone may only be used with approval of the Project Manager.

3) Sand for use in mortar and rendering shall conform in all respects with B.S. 1199 1200, "Building sands from natural sources".

4) The amount of deleterious substances in fine aggregates shall not exceed the limits prescribed in the following table

<b>Limits for Deleterious Substances in Fine Aggregates for Concrete Items</b>	<b>Mass per cent of total sample, max</b>
Clay lumps and friable particles	3.0
Material finer than 75µm (No. 200) sieve:	
Concrete subjected to abrasion	3.0
All other concrete	5.0
Coal and lignita:	
Where surface appearance of concrete is of importance:	0.5
All other concrete	1.0

1) Should the amount of clay, fine silt and fine dust exceed the limits specified, then the Contractor shall refrain from using the aggregate until he satisfies the Project Manager of its suitability for making concrete of the quality required.

2) Fine aggregates shall be free of injurious amount of organic impurities. Except as herein provided, aggregates subjected to the test for organic impurities and producing a colour darker than the standard shall be rejected.

3) The use of fine aggregates failing in the test is permitted, provided that this coloration is due principally to the presence of small quantities of coal, lignite or similar discrete particles. The use of fine aggregates failing in the test is permitted, provided that, when tested for the effect of organic impurities on strength of mortar, the relative strength at seven days, calculated in accordance with test method C87, is not less than 95%.

### **307 Coarse Aggregate**

1) Coarse aggregate for concrete and other purposes shall comply with B.S. 882 "Aggregates from natural sources for concrete". Subject to sub-clause (6) hereof it may be either natural gravel or stone broken to the desired size and shall be obtained from quarries, pits or other sources approved by the Project Manager.



2) Gravel or ballast shall be free from clay, earth, loam or other organic or similar material and shall be approved by the Project Manager. Any sand that may be amongst it shall, unless otherwise directed, be removed by screening if required and kept apart. Should the sand thus obtained be suitable in the opinion of the Project Manager for use in concrete, it may be used for the purpose if it complies with the conditions specified for sand in the preceding Clause. Gravel or ballast, which in the opinion of the Project Manager is not clean, shall be thoroughly washed before use.

3) Broken stone shall be of hard durable rock. Notwithstanding approval by the Project Manager of its source, the stone as delivered to the Works will be subject to rejection if for any reason the Project Manager considers it unsatisfactory. It must be perfectly clean and no soft, clayey, shaley, decomposed or weathered stone will be approved. The stone must be broken in a stone crusher of approved type to the sizes hereinafter specified and any dust or fine material below 5 mm in size made in the stone crusher is to be removed by screening if so required and if the Project Manager so orders the stone shall be thoroughly washed by an approved method.

4) When so required and before the Work commences, laboratory tests shall be made of the aggregates to be used on the Works to establish their suitability for concrete. In addition to these laboratory tests, the Project Manager may require check tests of actual deliveries to be made at the Site from time to time.

5) The grading of coarse aggregate by analysis shall be within the limits laid down in B.S. 882 1201, Table 1, Coarse Aggregates. Should an analysis of the grain size of the material show a deficiency in any particular size such as to affect the density of the concrete, the Project Manager may require the Contractor to add such quantity of aggregate of any particular size that he may deem advisable. In every case, the material shall when mixed with sand produce a well graded mixture from the largest to the smallest size specified to ensure that concrete of high density shall be produced.

6) The "flakiness index" for coarse aggregate as determined by the sieve method described in B.S. 812, "Methods for sampling and testing of mineral aggregates, sands and fillers," shall not exceed 40 for 40 mm aggregate nor 35 for 20 mm and 10 mm aggregate.

7) The "ten per cent fines" value of the coarse aggregate determined in accordance with BS 812 shall not be less than 8 tonnes, and not less than 5 tonnes on a soaked specimen. Alternatively, the aggregate crushing value determined in accordance with BS 812 shall not exceed 35 per cent, and shall not exceed 40 per cent on a soaked specimen.

8) The material shall be subjected to 5 alternations of AASHTO Sodium Sulphate Soundness test T104. The weighted loss shall be not more than 12 per cent mass. Where the presence of weathering rock is suspected, petrographic tests shall be carried out to determine the proportion of secondary minerals present.

### **308 Storage of Aggregates**

All sand and aggregate for concrete shall be stored on close fitting timber, steel or concrete stages of approved design with drainage slopes or in bins of substantial construction in such a manner as to prevent segregation of sizes and to avoid the inclusion of dirt and other foreign materials in the

concrete. All such bins shall be emptied and cleaned at intervals as instructed by the Project Manager. Each size of aggregate shall be stored separately unless otherwise approved by the Project Manager.

### **309 Water for Concrete**

1) Clean fresh water is to be used for the mixing of all concrete and mortar and is to be from a source approved by the Project Manager. If required by the Project Manager, samples shall be taken from the proposed source of supply and submitted to a nominated laboratory for testing in accordance with B.S. 3148 - "Tests for water for making concrete" and on the results of these tests the Project Manager will decide whether the source is acceptable.

### **310 Admixtures**

2) The use of non-corrosive additives or admixtures in concrete may be ordered or approved by the Project Manager according to circumstances. Such approval will be given only when the Contractor has demonstrated to the satisfaction of the Project Manager that the resulting concrete is no less strong, dense and durable than that obtainable without the use of additives.

3) Samples of any additive or admixture proposed by the Contractor shall be submitted for testing at least 60 days in advance of use, which shall require the written approval of the Project Manager.

4) When additives or admixtures are used in the Works very strict control is to be maintained to ensure that the correct quantity is used at all times.

### **311 Steel for Reinforced Concrete**

1) Steel reinforcement, other than steel for pre-stressing, used in reinforced concrete shall comply with the following British Standards as appropriate:

- a) B.S. 4449 Specification for Hot rolled steel bars for the reinforcement of concrete.
- b) B.S. 4461 Specification for Cold worked steel bars for the reinforcement of concrete.
- c) B.S. 4482 Hard drawn mild steel wire for the reinforcement of concrete
- d) B.S. 4483 Steel fabric for the reinforcement of concrete

2) Deformed bars of high tensile steel may be used if the Project Manager approves or it is shown on the Drawings.

3) The Contractor shall furnish the Project Manager with copies of the manufacturer's certificates of tests for the steel reinforcement to be supplied. The Project Manager may, however, order independent tests to be made and any steel, which does not comply in all respects with the appropriate foregoing specifications, will be rejected.

4) Bends, cranks or other labours on reinforcement bars shall be carefully formed in accordance with the Drawings, B.S. 4466 "Bending dimensions and scheduling of bars for the reinforcement of concrete" and B.S. 8110 "Structural use of reinforced concrete in buildings". The bars shall be bent cold in a manner, which will not injure the material. Bending hot at cherry red heat (i.e. not exceeding 850 °C) may be allowed except for bars, which depend for their strength on cold working. Bars bent hot shall not be cooled by quenching. Bends shall be made round a former having a diameter of at

least four times the diameter of the bar except for bends in cold twisted steel bars and deformed bars of high tensile steel for which a former of at least six times the diameter of the bar shall be used. Where splices or overlapping in reinforcement is required the bars should, unless otherwise shown on the Drawings, have an overlap of not less than thirty diameters where a U-hook is employed on each of the overlapping bars and forty-five diameters for bars without hooks.

5) Fabric reinforcement sheets are to overlap by two meshes.

6) The number, size, form and position of all steel reinforcing bars, ties, links, stirrups and other parts of the reinforcement shall be in exact accordance with the Drawings and they shall be kept in the correct position and with the required cover without displacement during the process of compacting the concrete in place in a manner approved by the Project Manager. The Contractor shall provide all necessary distance pieces and spacer bars at his own cost to maintain the reinforcement in the correct position. The type of distance pieces shall be subject to the approval of the Project Manager. Timber blocks for wedging the steel off the formwork will not be allowed. Any ties, links or stirrups connecting the bars shall be taut so that the bars are properly braced and the inside of hooks and bends shall be in actual contact with the bars around which they are intended to fit. Bars shall be bound together with best black annealed mild steel wire and the binding shall be twisted tight with pliers. The free ends of binding wire shall be bent inwards.

7) Before any steel reinforcement is embedded in the concrete any loose mill scale, loose rust and any oil, grease or other deleterious matter shall be removed. Partially set concrete which may adhere to the exposed bars during concreting operations shall likewise be removed.

8) The Contractor will be provided by the Project Manager with bending schedules detailing the reinforcement required for the Permanent Works. The provision of the schedules shall not relieve the Contractor from his responsibilities under the Contract for providing the materials called for on the Drawings. All further working drawings and lists of reinforcement necessary to carry out the Works shall be provided by the Contractor at his own cost.

### 312 Concrete Classes

1) The classes of concrete to be used in the Works shall be as shown on the Drawings, Bills of Quantities or as directed by the Project Manager. For each class of concrete the characteristic 28-day crushing strengths, when tested in accordance with the following clauses, shall be as set out in the table below, the 7-day strengths shall be used only as a guide.

Concrete type	Concrete class	Maximum aggregate size [mm]	Characteristic 28 day strength [N/mm <sup>2</sup> ]	Characteristic 7 day strength [N/mm <sup>2</sup> ]	Minimum cement content [kg/m <sup>3</sup> ]
Mass concrete	20/40	40	20	14	220
	20/20	20	20	14	250
	15/40	40	15	10	200
Blinding concrete	10/40	40	na	Na	150

Reinforced concrete	30/20	20	30	24	325
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The term characteristic strength means the value of the strength of concrete below which not more than 5 per cent of the test results fall.

2) The characteristic strengths specified above are for concrete cured at a mean temperature between 75 and 23 degree F. Should the curing temperature be in excess of the higher values of these ranges, the acceptable cube strength should be increased by an amount to be determined by the Project Manager.

3) The actual cement contents and aggregate/cement ratios will depend on the closeness of control, which the Contractor is prepared to exercise in production and upon the quality of materials used. Where necessary the Project Manager may impose an upper or lower aggregate/cement ratio, which shall not be exceeded for any class of concrete.

4) Before any concrete is placed in the Works the Contractor shall submit to the Project Manager for his approval full details of the mixes he proposes to use for each class of concrete together with their expected average strengths. These mixes shall be based on the results of trial mixes as specified hereafter.

### **313 Concrete Mix Designs**

1) Preliminary tests are to be carried out jointly by the Contractor and the Project Manager to determine the mixes, which will satisfy the Specification with the available materials. These mixes shall be designed with due regard for the workability necessary to allow the Contractor to place and compact the concrete with the equipment he proposes to use in any particular situation.

2) The mixes shall be designed to have mean strengths that are greater than the specified characteristic cube strengths by a margin of 1.64 times the standard deviation expected from the concreting plant. The standard deviation shall be calculated from at least 40 individual cube results each representing separate batches of similar concrete produced by the same plant and under the same supervision except that no standard deviation less than 3.5 N/sq.mm shall be used as a basis for designing a mix. In the absence of such previous information, a standard deviation of 7 N/sq.mm shall be used for initial mix design purposes. It is assumed that the same standard deviation applies to both the 7 day and 28 day strengths.

### **314 Trial Mixes**

1) Unless there are existing data showing that the proposed mix proportions will produce the grade of concrete required with adequate workability for full compaction by the method to be used in production, trial mixes shall be prepared under full scale conditions and tested in accordance with B.S. 1881 "Methods of testing concrete". Trial mixes shall also be made subsequently whenever a change is intended in materials or in the proportions of the materials to be used. Representative samples of the materials to be used shall be taken and three trial mixes using the proposed proportions shall be made on different days. The workability of each of these three mixes shall be determined and a batch of six cubes from each mix shall be made, three for tests at 7 days and three for tests at 28 days. The Project Manager will normally approve the proposed mix proportions provided the average strength of the three trial mixes is not less than the designed mean strength

minus the designed standard deviation and subject to the conditions noted below. Further trial mixes shall be made if the range of strength that is the maximum minus the minimum, of the three cube results in any batch exceeds 15% of the average of that batch, or if the range of the three batch averages exceeds 20% of the overall average of the batches.

### **315 Mixing Concrete by Machine**

1) The concrete is to be mixed in machines of the batch mixing or other approved type. The machines are to ensure that all the concreting materials including the water are thoroughly mixed together between the time of their deposition in the mixer and before any portion of the mixture is discharged. The machines must be capable of discharging their contents while running. No hand mixing will be permitted. Mixing shall continue until there is a thorough distribution of the materials, and the mass is of uniform colour and consistency.

#### **a) Central-mix plant.**

- i. Dispense liquid admixtures through a controlled flow-meter.
- ii. Use dispensers with sufficient capacity to measure, at one time, the full quantity of admixture required for each batch. If more than one admixture is used, dispense each with separate equipment.
- iii. Charge the coarse aggregate, one third of the water, and all air entraining admixture into the mixer first, then add remainder of the material.
- iv. Mix for at least 50 seconds. Begin mixing time after all cement and aggregate are in the drum. Add the remaining water during the first quarter of the mixing time. Add 4 seconds to the mixing time if timing starts the instant the skip reaches its maximum raised position. Transfer time in multiple-drum mixers is included in mixing time. Mixing time ends when the discharge chute opens.
- v. Remove the contents of an individual mixer before a succeeding batch is charged into the drum.

#### **b) Truck mixer:**

- i. Do not use mixers with any section of the blades worn 25mm or more below the original manufactured height.
- ii. Do not use mixers and agitators with accumulated hard concrete or mortar in the mixing drum.
- iii. Add admixtures to the mix water before or during mixing.
- iv. Charge the batch into the drum so a portion of the mixing water enters in advance of the cement.

2) The entire contents of the drum shall be discharged before materials for the next batch are fed in. Should there, for any reason, be a stoppage of greater than 30 minutes duration, the drum of the mixer shall be thoroughly washed out with clean fresh water before mixing is resumed.

### **316 Works Test**

1) Test cubes shall be made, cured, stored, transported and tested in compression in accordance with B.S. 1881 "Methods of testing concrete". The method of compacting cubes by vibration shall be subject to the approval of the Project Manager.

2) Sampling and testing:

a) A sample of concrete shall be taken at random on eight separate occasions during each of the first five days of using a mix. Thereafter a sample shall be taken from at least 4% of the batches made, and in any case at least one sample shall be taken each day of concrete of each grade made. The number of samples per day and the times, which they shall be taken, shall be varied at random or as directed by the Project Manager.

b) From each sample, two cubes shall be made for testing at 28 days and one for testing at 7 days for control purposes.

c) To ensure that the mix proportions are suitable for a particular grade of concrete 28-day test cube results shall satisfy the four conditions given below.

d) The works test 28-day cube results shall be examined both individually and in consecutive (but not overlapping) sets of four, for which the average and the range of each set shall be calculated. The mix proportions shall be modified to increase the strength if, in the first ten consecutive (but not overlapping) sets, any of the following conditions are not satisfied:

i. not more than two individual results of the 40 cube tests shall fall below the specified characteristic cube strength,

ii. no value of the range in any set shall exceed 3.2 times the designed standard deviation,

iii. no value of the average of any set shall be less than the specified characteristic strength plus the designed standard deviation, and

iv. not more than one set shall have an average which is less than the specified characteristic strength plus 1.3 times the standard deviation

e) After ten consecutive sets of results have been obtained, the overall average and the standard deviation of the 40 results shall be calculated and any appropriate modifications made to the mix proportions. Subsequently, if any of the foregoing conditions do not apply to the individual results or the sets of four, the overall average and the standard deviation of the previous consecutive 40 results, including the non-complying set shall be calculated. If the overall average strength minus 1.6 times the standard deviation is less than the specified characteristic works cube strength, then the mix proportions shall be modified.

### **317 Additional Cube Tests**

In addition to the works test cube described above the Project Manager may order additional cubes to be made for the following purposes: to determine the strength of concrete at the time of stripping moulds; and to determine the duration of curing or to check testing errors.

### **318 Test Failure**

1) Should any works test cube fail to attain the specified strength, an immediate examination shall be made to find the cause of the failure and a report sent to the Project Manager's Representative who will take suitable action which may be one of the following:

a. He may order the concrete corresponding to the cubes to be cut out and replaced in accordance with Clause 39 of the Conditions of Contract.

b. When the failure relates to concrete used in structural members, which lend themselves to being load tested such as beams, columns or slabs, the Project Manager, may order the affected member to be so tested in accordance with his instructions. If cracking or any other sign of failure appears, the concrete shall be cut out to the extent ordered by the Project Manager and replaced with sound material. Otherwise, the member may be accepted as satisfactory.

c. When the failure, in the opinion of the Project Manager's Representative, is slight and occurs in a continuing concreting operation for a large mass of concrete, the next works test result may be awaited and, if the failure then persists, the Project Manager's Representative may order that concreting shall cease forthwith and not be resumed until further preliminary tests indicate that the mix has been corrected. Otherwise the concreting may be allowed to continue with the same mix.

d. When the failure is serious and relates to a concrete mass, which lends itself to it, the Project Manager's Representative may order one or more test cylinders to be drilled out and tested in accordance with B.S. 1881. According to the result of these tests, the Project Manager may order the suspected concrete to be cut out and replaced in accordance with Clause 39 of the Conditions of Contract.

2) The cost of these tests including the provisions and placing of jacks, kentledge, deflectometers, etc., and the cutting out and replacing of concrete of inferior quality shall be borne by the Contractor if the test results show the concrete not to be in accordance with the Specification.

### **319 Workability**

1) The concrete shall be of such consistency that it can be readily transported, placed and compacted in the Works without segregation of the materials. The resulting concrete shall be uniform and free from honeycombing.

2) Where necessary and before the mixes are approved the Contractor shall supply a section of formwork complete with reinforcement fixed in position and generally representative of the sections comprising the Works. This formwork shall be filled with concrete produced for the trial mixes and compacted in the same manner and with the same equipment to be used on the Works. The appearance of the concrete after striking the formwork shall be to the satisfaction of the Project Manager who may otherwise require the mix to be modified and further batches of concrete made and tested as before.

3) A simple and convenient system of varying the water released into each batch must be installed with graduated gauges fixed to the supply tanks, which can be set by the Project Manager. The method of releasing the water into the mixer shall be such that the full measured quantity is

discharged in one operation and the flow is stopped by an automatic valve or siphon arrangement only when the full quantity of water has been released. No arrangement, which permits the discharge of partial quantities of water at the discretion of the mixer driver, shall be allowed.

4) The Contractor shall be required to have an accurate knowledge of the moisture content of all sand and coarse aggregate as they reach the mixer and he shall make such adjustments to the mix as are necessitated by change in the moisture content of all aggregates.

### **320 Consistency**

1) The Contractor shall carry out slump, compaction factor or other workability tests as required during concreting of permanent works in order to relate the degree of workability of the mix with the numerical value obtained during the trial mixes.

### **321 Concrete Return and Records**

1) The Contractor shall send weekly to the Project Manager a return showing the quantities of cement and the number of mixings of each class of concrete used in each section of the Works.

2) Records shall be kept by the Contractor of the positions in the Works of all batches of concrete, of their class and of all test cubes or other specimens taken from them. Copies of these records shall be supplied to the Project Manager.

### **322 Batching**

1) The aggregates and cement shall be proportioned by means of efficient weigh batching machines except when the Project Manager has approved the use of volume batching. The machines shall be carefully maintained and cleaned and they shall be provided with simple and convenient means of checking the accuracy of the weighing mechanism, and they shall be checked when required by the Project Manager.

2) For volume, batching suitable gauge boxes shall be used. Cement shall be taken as weighing 1440 kg/cu.m or such other amount as may be determined by the Project Manager as a result of tests.

### **323 Mixing Concrete by Hand**

Where it is not possible to employ machine mixing and approval has been obtained from the Project Manager, concrete shall be mixed by hand as near as practicable to the site where it is to be deposited. Clean mixing bankers or platforms of sufficient area for the proper execution of the work shall be provided. These platforms if constructed of timber shall consist of planks closely jointed so as to avoid the loss of any grout or liquid from the wet concrete. The whole of the aggregate and cement shall be turned over on the banker in a dry state at least twice. The water shall then be added gradually through a rose head, after which the materials shall again be entirely turned over in a wet state at least three times.

### **324 Transport of Concrete**

The concrete shall be discharged from the mixers and transported to the Works by means which shall be approved by the Project Manager and which shall prevent contamination, (by dust, rain or other causes) segregation or loss of ingredients. The means of transportation shall ensure that the concrete is of the required workability at the point and time of placing.



## **525 Placing of Concrete**

- 1) The concrete shall be placed in the positions and sequences indicated on the Drawings, in the Specification or as directed by the Project Manager. Except where otherwise directed, concrete shall not be placed unless the Project Manager or his Representative is present and has previously examined and approved the positioning, fixing and condition of reinforcement and any other items to be embedded and the cleanliness, alignment and suitability of the containing surfaces or formwork.
- 2) The concrete shall be deposited as nearly as possible in its final position without re-handling or segregation and in such a manner as to avoid displacement of the reinforcement, other embedded items or formwork. Wherever possible bottom opening skips shall be used. Where chutes are used to convey the concrete, their slopes shall not be such as to cause segregation and suitable spouts or baffles shall be provided where necessary. Concrete shall not be dropped through a greater height than 1200 mm except with the approval of the Project Manager who may order the use of bankers and the turning over of the deposited concrete by hand before being placed.
- 3) Where pneumatic placers are used the velocity of discharge shall be regulated by suitable baffles or hoppers where necessary to prevent segregation or damage and distortion of the reinforcement, embedded items and formwork, caused by impact.
- 4) All concreting shall be carried out in sections previously ordered or approved by the Project Manager and shall proceed continuously in each section until completed and no interval shall be allowed to elapse while the work is in hand.
- 5) The concreting shall be carried out in such a way that the exposed faces of concrete shall be sound and solid, free from honeycombing and excrescences. No plastering of imperfect concrete faces will be allowed. Any concrete that is defective in any way will, if so ordered by the Project Manager, be cut out and replaced to such depth or be made good in such manner as the Project Manager may direct.
- 6) Where concrete is required to be placed against undisturbed ground, the entire space between the finished concrete surface and the ground, including any over break, is to be completely filled with concrete of the specified class. The concrete shall be well rammed and compacted to ensure that all cavities are filled and the concrete is everywhere in contact with the ground. Where permitted by the Project Manager, any extensive patches of over break may first be filled with concrete Class 10/40 as directed to within 100 mm of the payment line.
- 7) The Contractor will be required to furnish the Project Manager with satisfactory evidence that all preparations, precautions and provisions have been made to ensure that the concrete is placed and compacted in accordance with this Specification before the Project Manager gives his permission for concreting to proceed.
- 8) For members involving “vertical” placing of the concrete (e.g. walls) each lift shall be deposited in layers extending for the full width between shuttering and of such depth that each layer can be easily and effectively incorporated with the layer below by the means of consolidation being employed. The layers shall be placed horizontally, sloping beds not being permitted unless particularly so specified.

9) For members involving “horizontal” placing of the concrete (e.g. floor and roof slabs) the concrete shall be placed along the line of the starting point in such quantities as will allow the member to be cast to its full depth along the full width between side shuttering and then gradually brought towards the finishing point along its entire front, parallel to the starting line. The tampers for giving the required surface and compaction will follow as closely behind as practicable.

10) All members shall be concreted at such a rate as will eliminate any possibility of fresh batches of concrete being deposited immediately adjacent to batches which have commenced to set, and all members shall be poured in one continuous operation until completed; no interval being allowed to lapse while the work is in hand.

11) Care shall be taken to ensure that the process of placing concrete does not cause any harmful vibration to adjacent work that has hardened insufficiently.

12) Should any unforeseen occurrence result in a stoppage of concreting for such a time as might allow the concrete already in place to begin to set before the next batches can be consolidated in place the Contractor shall immediately insert, at this own cost, a proper end-shutter to form a proper tongue and groove construction joint, as specified normal to the work at that point which will ensure that the section already cast is formed completely in accordance with this Specification. Any additional reinforcement required as a result of the joint shall be provided by the Contractor at his own expense.

13) Large, exposed (horizontal) concrete surfaces may require protection from the direct rays of the sun or other adverse weather effects. The Contractor shall take all reasonable precautions to protect the concrete surfaces in accordance with these specifications, or as approved by the Project Manager. Failure to protect such surfaces may result in rejection of the work by the Project Manager.

14) Consolidation of the concrete shall be effected by either hand or mechanical means and all consolidating tools must be approved by the Project Manager before being used in the Works.

15) The concrete shall be worked well up against whatever surface it adjoins and consolidated to such a degree that it reaches its maximum density as a homogenous mass, free from air and water holds, and penetrates to all corners of the moulds and shuttering and completely surrounds the reinforcement.

16) Care shall be taken to ensure that neither hand tampers or mechanical vibrators come into contact with the formwork, reinforcement, or any embedded fittings and to prevent the operation of consolidation from transmitting any harmful vibrations or shocks to concrete which has not yet hardened sufficiently.

17) Compliance with the conditions of this Clause may require working longer hours than usual and the Contractor must allow for this in his program for concreting and in the rates for the work inserted by him in the Bill of Quantities.

### **326 No Partially Set Material to be used**

All concrete must be placed and compacted in its final position within 30 minutes of discharge from the mixer unless otherwise approved. No partially set material shall be used in this work.

### **327 Compaction of Concrete**

The concrete shall be fully compacted throughout the full extent of the layer and shall be brought up in level layers of such depth that each layer is incorporated readily and properly with the layer below with the use of internal vibrators or by spading, slicing or ramming. It shall be thoroughly worked against formwork and around any reinforcement or embedded items without displacing them.

### **328 Vibration of Concrete**

1) Except where otherwise permitted by the Project Manager, concrete shall, during placing, be compacted by hand held vibrators of a type to be approved by the Project Manager. The vibrators shall be suitable for continuous operation. The vibrators shall be disposed in such a manner that the whole of the mass under treatment shall be adequately compacted at a speed commensurate with the supply of concrete from the mixers. Vibration is to continue until the concrete being placed is fully compacted and all air bubbles have been expelled. Care must be taken that segregation of mortar and aggregate by excessive vibration is avoided.

2) Vibration is not to be applied directly, or through the reinforcement, to sections or masses of concrete, which have hardened or after the initial set has taken place. Vibration must not be used to make the concrete flow in the formwork to cause segregation.

### **329 Concreting in Adverse Weather**

No concreting will be allowed to take place in the open during storms or heavy rains. Where strong winds are likely to be experienced, additional precautions to ensure protection from driving rain and dust shall also be taken. The Project Manager may withhold approval of commencement of concreting until he is satisfied that full and adequate arrangements have been made.

### **330 Concreting at Night or in the Dark**

Where approval has been given to carry out concreting operations at night or in places where daylight is excluded, the Contractor is to provide adequate lighting at all points where mixing, transportation and placing of concrete are in progress.

### **331 Concreting in High Ambient Temperature**

1) Where the ambient shade temperature exceeds 32 °C, the Contractor shall take special measures in the mixing, placing and curing of concrete. The temperature of the concrete when deposited shall not exceed 30 °C. The Contractor shall carry out all necessary special measures to ensure that the maximum concrete temperature after placing shall not exceed 50 °C or 30 °C above the concrete temperature at the time of placing whichever is the lower.

2) During placing, suitable means shall be provided to prevent premature stiffening of the concrete placed in contact with hot surfaces.

### **332 Curing and Protection**

1) Concrete shall be protected during the first stage of hardening from the harmful effects of sunshine, drying winds, cold, rain or running water. The Contractor shall pay particular attention to the need to protect concrete immediately after the finishing operation and prior to its final set and shall submit his proposals to achieve this protection for the Project Managers approval. Protection of concrete which has achieved its final set shall consist of one or more of the following:

- a) A layer of sacking, canvas, hessian, straw mats or similar absorbent material or a layer of sand, kept constantly moist by spraying with water as necessary for 7 days or such periods as may be directed by the Project Manager;
- b) After thoroughly wetting, a layer of approved waterproof paper or plastic membrane kept in contact with the concrete for 7 days or such period as may be directed by the Project Manager;
- c) Except in the cases of surfaces to which concrete has subsequently to be bonded, an approved liquid curing membrane at a rate specified by the manufacturer. On horizontal surfaces, the curing membrane shall be applied immediately after placing the concrete and on vertical surfaces immediately after removing the formwork.

2) The use of saline water for curing purposes will not be permitted.

### **333 Concrete Placed Under Water**

1) Concrete shall be placed under water only where particularly so specified and approved by the Project Manager. The quantity of cement in any concrete placed under water shall be increased by at least 25% above the cement content of the appropriate approved mix. Concrete shall be placed in still water only and every precaution shall be taken to prevent the cement and fine materials from being washed out of the concrete. Concrete shall be placed either with a 'tremie' or a bottom-opening box of a type approved by the Project Manager.

2) Bottom opening boxes shall not be opened until they are resting on the work and the lower ends of 'tremie' pipes shall always be kept below the surface of the wet concrete already deposited.

3) No concrete shall be allowed to fall through water at any time. Concrete shall be placed evenly over the whole area closed by the shuttering and must not be raked over, only the minimum of screeding being allowed once the concrete has been placed.

### **334 Construction Joints**

1) Concreting shall be carried out continuously up to construction joints, the position and arrangement of which shall be as indicated on the Drawings or as previously approved by the Project Manager. The Contractor is to allow for working beyond the ordinary working hours where necessary in order that each section of concrete may be completed without any lapse while the work is in hand. All construction joints are to be formed square to the work. Keyways are to be formed in all horizontal and vertical construction joints except where ordered to be omitted by the Project Manager.

2) Surfaces against which further concrete is to be placed shall be prepared as early as possible after casting. This preparation shall be carried out preferably when the concrete has set but not

hardened by jetting with a fine spray of water or brushing with a stiff brush, just sufficient to remove the outer mortar skin and to expose the larger aggregate without its being disturbed. Where this treatment is impracticable and work is resumed on a surface, which has set, the whole surface shall be thoroughly roughened or scabbled with suitable tools so that no smooth skin of concrete that may be left from the previous work is visible. These roughened surfaces shall be thoroughly cleaned by compressed air and water jets or other approved means, brushed, and watered immediately before depositing concrete. If so ordered, the roughened surface shall be covered with cement mortar prior to placing the new concrete.

### **335 Movement Joints**

#### **1) General**

Movement joints shall be formed as shown on the Drawings to permit relative movement between adjacent parts of a concrete structure, special provision being made where necessary for maintaining the water tightness of the joint. Movement joints shall include contraction joints, expansion joints, sliding joints and other special joints as may be detailed on the Drawings. The Contractor shall ensure that there is no obstruction to free movement, which the joints are intended to provide. The concrete surfaces shall be plane and smooth.

#### **2) Jointing Materials**

Joints shall be provided with water stops, joint fillers, sealing compound, bond-breaking compound and other jointing materials as specified or detailed on the Drawings. All such materials shall be as approved by the Project Manager and their installation shall be strictly in accordance with the manufacturer's instructions. If required by the Project Manager, the Contractor shall demonstrate that the jointing materials can be applied satisfactorily.

#### **3) Contraction Joints**

Contraction joints shall be treated to prevent bond between joint surfaces by the application of two coats of an approved bond-breaking paint to the joint surface first constructed and allowing the paint to dry before placing new concrete against it.

#### **4) Expansion Joints**

a) A separating strip of preformed durable resilient joint filler shall form expansion joints, which shall be continuous through the joint. No broken pieces of joint filler shall be used.

b) Where dowel bars are to be incorporated in expansion joints as shown on the Drawings, they shall be round mild steel bars of the diameter and length indicated. The capped end of the dowel bar shall be sawn square and bar cropping, will not be permitted. The capped section of the bar shall be painted with two coats of an approved bond-breaking paint. The cap shall be of such a diameter as to provide a sliding fit on the bar and of length indicated on the Drawings. The cap shall be partially filled with an approved compressible filler.

#### **5) Sealing Compound**

Grooves shown on Drawings at the edges of joints for the placing of sealing compound shall be accurately formed. The sealing compound shall be stored, mixed and applied strictly in accordance with the manufacturer's instructions. Bituminous joint sealants shall be Plastic (for horizontal joints) and Plastijoint (for vertical joints) as supplied by Expandite Ltd., of Chase Road, London NW10 6PS,

England, or similar approved. Polysulphide sealants shall be two part polysulphide sealants complying with BS 4254 "Two - part Polysulphide based Sealants for the Building Industry".

6) Water stops - General

a) The Contractor shall supply and fix all water stops including all accessories and jointing materials. The Contractor shall make all splices, joints and bonds, as required and fabricate any special intersections in accordance with the Drawings as directed by the Project Manager. All water stops shall be stored in such a manner as to avoid deterioration.

b) All joints, splices, bonds and intersections shall be made in strict accordance with the manufacturer's printed instructions using materials recommended by the manufacturer. Joints in water stops shall be kept to a minimum.

c) The Contractor shall take suitable precautions to support and protect water stops during the progress of the work, and to ensure their accurate positioning in the completed work. Concrete shall be fully compacted around the water stops to ensure that no voids or porous areas remain and in such a manner as not to damage or displace the water stop. Where reinforcement is present, adequate clearances shall be kept between reinforcement and the water stops to permit proper compaction of the concrete. No holes are to be made through any water stops.

7) PVC Water stops

a) The shape of PVC water stops shall be as specified on the Drawings or as approved by the Project Manager. The water stop shall be manufactured by a method that results in a product of uniform cross-section. The water stop shall be free from surface imperfections, grooves, blisters or pores and any other blemishes.

b) The material of PVC water stops shall be plasticised polyvinyl chloride without the addition of copolymer resins and shall not contain any reworked material. The material shall not contain any plasticiser, stabiliser or pigment in excess of that necessary to meet this Specification. Only plasticisers of known resistance to hydrolysis and microbiological attack shall be used. The water stop shall be pigmented to protect it from the effects of ultra-violet light. The material, from which the water stop is manufactured, shall be resistant to chemical attack in the environment in which it will be installed.

(a) The physical properties of the PVC water stop shall comply with the following:

Property	Requirements	Test Method
Min. tensile strength	13.5 N/sq.mm	ASTM-D-412
Min. elongation at break 275% Hardness (BSS)	45+5	ASTM-D-412 BS 2782
Max water absorption (total immersion in distilled water 50°C for 48 hours)	0.5%	ASTM-D-1203

(b) Joints and PVC water stops shall be carried out using an approved fusion welding process.

8) Rubber water stops

a) The shape of rubber water stops shall be as specified on the Drawings or as approved by the Project Manager. They shall be manufactured by a process that results in a product of uniform cross-section. The water stop shall be free from surface imperfections, grooves, blisters or pores and any other blemishes.

b) The material of rubber water stop shall be natural or synthetic rubbers or a combination of these and shall not contain any reworked material. The material shall be suitable for hot vulcanizing and shall be pigmented to protect it from the effects of ultra-violet light. The material from which the water stop is manufactured shall be resistant to chemical attack in the environment in which it will be installed, particularly with respect to oxygen and ozone attack.

c) The physical properties of the rubber water stop shall comply with the following:

Property	Requirements	Test Method
Min. tensile strength (parent material)	20.0 N/sq.mm	ASTM-D-412
Min. tensile Strength (splice)	16.0 N/sq.mm	ASTM-D-412
Min. elongation at break	400%	ASTM-D-412
Hardness (Shore)	60 +/-5	ASTM-D-412
Max. water absorption	5% (7 days at 70 °C in water)	ASTM-D-471
Max. loss of strength on heat ageing	20%	Heat ageing for 70 hours at 100 °C in a dry oven
Max. loss of elongation at break on heat ageing	40%	Heat ageing for 70 hours at 100 °C in a dry oven
Max. increase in hardness on heat ageing (Shore)	10 points	

d) Rubber water stops shall be joined by an approved hot vulcanized butt jointing process except where the Project Manager specifically permits site joints of the sleeve type.

### 336 Preparation of Surfaces to Receive Concrete

1) Before concrete for reinforced concrete work is deposited on a foundation of soft ground, a screed of blinding concrete Class 10/40 of 75 mm minimum thickness shall be placed over the ground below the underside level of the reinforced concrete to form a hard even surface on which to construct the latter.

2) Immediately before depositing concrete on or against a surface of masonry, brickwork, old concrete or the like, the following preparation shall be done. All loose material shall be removed and the surface washed down; all seepages of water emerging at the surfaces shall be stopped as far as possible, or suitably channelled or piped away from the work. On upward facing horizontal or near horizontal surfaces a layer of 2:1 sand-cement mortar is to be spread over the surface of the section to be concreted if so directed by the Project Manager.

### 337 Formwork for Non-Exposed Concrete Surfaces

Unless otherwise stated on the drawings, rough formwork may be used for all surfaces, which are not permanently exposed. Rough formwork may be constructed of plain butt-joined sawn timber but the Contractor shall ensure that all joints between boards shall be grout-tight. The finished surface shall be within the tolerances specified and full cover to reinforcement steel shall be maintained.

### 338 Preparation of Formwork for Concreting

1) Before concrete is placed, the formwork shall be thoroughly cleaned and freed from sawdust, shavings, dust or other debris. Temporary openings shall be provided to assist in removal of the rubbish.

2) After cleaning, the formwork shall be coated with an approved release agent, which shall not be allowed to run on to reinforcement, other embedded steelwork or concrete at any construction joint.

3) All formwork shall be inspected and approved by the Project Manager before concrete is placed in it, though this shall not relieve the Contractor from the requirements as to soundness, finish and tolerances of the concrete specified elsewhere.

### 339 Removal of Formwork

1) Formwork shall be removed in such a manner as will not damage the concrete. No formwork shall be removed until the concrete has gained sufficient strength to support itself. Centres and props may be removed when the member being supported has gained sufficient strength to carry itself and the load to be supported on it with a reasonable factor of safety. The following table is a guide to the minimum periods, which must elapse, between the completion of the concreting operations and the removal of formwork. No formwork shall be removed without the permission of the Project Manager and such permission shall not relieve the Contractor of his responsibilities for the safety of the structure.

2) Minimum stripping and striking times shall be as follows unless otherwise approved by the Project Manager.

	Ordinary Portland Cement Concrete	Rapid Hardening Portland Cement Concrete
	NORMAL WEATHER HOURS	NORMAL WEATHER HOURS
Vertical surfaces	10	8
Vertical wall surfaces under 300 mm thick	30	20
Beam sides and columns	30	20
	DAYS	DAYS
Slabs (props left under)	4	2
Removal of props to slabs	9	4
Beam soffits (props left under)	7	4



### **340 Cover to Reinforcement**

- 1) The concrete cover to reinforcement shall be in accordance with the relevant British Standard Code of Practice or as shown on the Drawings.
- 2) The Contractor shall provide any necessary cement pads for ensuring the cover is attained and in no case shall timber packing be used.

### **341 Concrete Surface Finish**

- 1) The concrete surface finish on upward facing horizontal or sloping faces shall be, except for blinding concrete or otherwise stated on the drawings, a "fair" surface. A "fair" surface shall be obtained by screeding and trowelling with a wood float.
- 2) Screeding shall be carried out, following compaction of the concrete, by the slicing and tamping action of a screed board running on the top edges of the formwork or screeding guides to give a dense concrete skin true to line and level.
- 3) Wood float trowelling shall be carried out after the concrete has stiffened and the film moisture has disappeared. Working should be kept to a minimum compatible with a good finish and the surface shall be true to the required profile to fine tolerance. Whenever necessary the Contractor shall provide and erect overhead covers to prevent the finished surface from being marred by raindrops or dripping water.
- 4) The surface of blinding concrete shall be that obtained by screeding as described above.
- 5) Where a "fine" surface is indicated upon the drawings this shall be obtained in a similar manner to "fair" surface save that a steel float shall be used in lieu of the wood float.

### **342 Precast Concrete**

- 1) Concrete members specified to be fabricated as precast concrete units shall be fabricated with concrete of the specified class placed into a grout-tight mould. If so required the mould shall be laid on a vibrating table and vibration applied while the concrete is placed.
- 2) Permanently exposed surfaces shall have a finish obtained by casting the unit in properly designed moulds of closely jointed wrought boards or steel or other suitable material. The surface shall be improved by carefully removing all fins and other projections, thoroughly washing down and filling the most noticeable surface blemishes with a cement and fine aggregate paste matching the colour of the concrete.
- 3) Surfaces which will subsequently receive grout or concrete to complete a structural connection or other composite structural component of which the precast unit forms a part, shall be prepared as early as possible after casting. This preparation shall be carried out preferably when the concrete has set but not hardened by jetting with a fine spray of water or brushing with a stiff brush, just sufficient to remove the outer mortar skin and to expose the larger aggregate without its being disturbed. Where this treatment is impracticable, sand blasting or a needle gun should be used to remove the surface skin and laitance. Hacking is to be avoided.

4) With the approval of the Project Manager, the Contractor may be permitted to precast members, which were specified to be constructed in situ. In such cases, the Contractor shall carry out the work as described above but payment shall be made in the manner appropriate to the method of construction originally specified. Generally, members, which are structurally dependent on a rigid fixing with the adjoining structures, will not be permitted to be constructed by pre casting.

5) Precast units shall be jointed with cement mortar as specified in Clause 547 hereof or other cement-sand proportions as shown on the Drawings, or as may be directed by the Project Manager, but mixed as dry as possible so that it is only "earth moist". The mortar shall be packed in layers between the units with steel tools until the whole of the joint is solidly filled and the exposed surfaces of the joint shall be raked out to a depth of 5 mm. and flush pointed with similar mortar but of pointing consistency.

### **343 Supply of Precast Concrete Units**

- 1) The Contractor will be permitted to obtain precast concrete units from outside suppliers provided that they comply with the Specification and that the Contractor obtains the Project Manager's approval for each supplier.

### **344 Handling and Stacking of Precast Units**

1) The Contractor is to give the Project Manager full details of his proposed methods of handling and stacking precast concrete beams and units. The Project Manager will examine these details and will approve either the methods or order modifications designed to ensure that no excessive stresses are set up in the beams or units. The finally approved methods are to be adhered to at all times and the Contractor shall be deemed to have included in his rates for all measures required to handle and stack beams and units safely and without undue stressing.

### **345 Tolerances**

- 1) Concrete work shall be executed to the tolerances specified below:

a) Maximum departure from horizontal position:	25mm
b) Maximum departure from vertical position:	25mm
c) Maximum surface tolerance – gradual:	12mm in 2m
d) Maximum surface tolerance - abrupt:	6mm
e) Maximum departure in dimension:	-3mm +6mm

## **400.00 WATER & SEWER INSTALLATION**

This section sets out the requirements for plumbing and drainage in buildings and the disposal of waste to a septic tank or main sewer where this exists in accordance with the OECS Building Codes.

### **401.00 Workmanship Standards**

All plumbing shall be installed in a workmanlike manner, the contractor is required to apply the national rules including the following:

- After laying, soil and ventilating pipes shall be capable of withstanding smoke or air tests under pressure, have no bends, except where unavoidable, in which case bends shall be as obtuse as possible so as not to reduce the internal diameter of the pipe.
- Soil/waste pipes shall not discharge effluent so as to cause dampness to any foundation or wall of a building.
- All soil or waste pipe being fitted with double hubs, double tees or double y's shall have an access door.
- Waste pipe discharging into a water closet bowl cannot be attached to a bend.

### **Dead Ends**

The following conditions shall be met for dead ends

- Wherever a dead end exists or is proposed for a soil or waste system it shall be laid so as to prevent any accumulation of waste.
- All unconnected openings in a drainage system with the exception of a vent pipe shall be properly capped so as to be both air and water tight.

### **Changes in Direction**

All horizontal changes in direction of soil or waste pipes shall be provided with an accessible inspection chamber or clean out.

22-1/2 degree bends and sanitary tees should be used for changes in direction of flow in the horizontal plane.

Bends, tees, y's and crosses may be used to effect changes in direction in vent and water distribution pipes.

### **Supports and Hangers**

All vertical piping shall be supported, anchored and adequately fixed with spacing not exceeding 5'-0".

All horizontal piping shall be supported, anchored and adequately fixed to prevent sagging at each hub. For cast iron and copper piping, this shall be at 6 foot intervals, and for PVC and pitch fibre piping through-out its length.

Pipe hangers shall be fixed to stone, brick work, block work or concrete by means of expansion type plugs.

Hangers shall be of the same material as the pipe, or if of different material be insulated at areas of contact with the pipe to prevent electrolysis.

Drains laid in unstable ground shall be adequately supported so as prevent fracture of the pipe or loosening of the joints in the event of ground movement.

### **Joints and Connections**

All joints and connections shall be of the same material as the main pipe and shall be air and water tight. They shall be constructed so as to allow the free flow of waste, and before commissioning, be swabbed and cleaned inside to avoid obstructions of the bore.

In joining soil pipes the spigot or plain end of the pipe shall be laid in the direction of the flow or downstream.

Joints to soil pipes shall be as follows:

- For lead - wiped or burned.
- For cast iron - socket made with hemp or yarn and metallic lead properly caulked.
- For pitch fibre - tapered couplings.
- For PVC - with a suitable rubber joint fitting or welded with solvent cement.
- For vitrified clay/salt glazed ware - socket made with tarred hemp or gasket and the remaining space filled with cement/sand mixture.

No coating or paint shall be applied before testing.

Where waste pipes are connected to soil pipes, all pipes are to be constructed in the same way as specified for soil pipes.

### **Water Seals**

All traps shall have a minimum water seal of 3" for soil and 2" for waste and be not less than 3" diameter for soil fixtures and 1-1/4" for wastewater.

### **Clean-outs**

Every clean-out shall be equal in wall thickness to that of the pipe; they shall be readily accessible and have adequate space for cleaning. Also, clean-outs shall open opposite to the direction of flow or at right angles to it.

## **500.00 ELECTRICAL AND TELECOMMUNICATION**

The following electrical and telecommunication specification are selected from the NEC 2005 to ensure that adequate professional standards are applied to the contracted works. The Contractor is required to apply these specifications where national standards are either not available or where they are lower/lesser requirements.

### **501 ELECTRICAL**

#### **502 Grounding**

##### **Connection to Grounded System**

Premises wiring shall not be electrically connected to a supply system unless the latter contains, for any grounded conductor of the interior system, a corresponding conductor that is grounded. For the purpose of this section, electrically connected shall mean connect so as to be capable of carrying current, as distinguished from connection through electromagnetic induction.

#### **503 Means of Identifying Grounded**

**(A) Sizes 6 AWG or Smaller**

An insulated grounded conductor of 6 AWG or smaller shall be identified by a continuous white or gray outer finish or by three continuous white stripes on other than green insulation along its entire length. Wires that have their outer covering finished to show a white or gray color but have colored tracer threads in the braid identifying the source of manufacture shall be considered as meeting the provisions of this section. Insulated grounded conductors shall also be permitted to be identified as follows:

- (1) The grounded conductor of a mineral-insulated, metal- conductor sheathed cable shall be identified at the time of installation by distinctive marking at its terminations.
- (2) A single-conductor, sunlight-resistant, outdoor-rated cable used as a grounded conductor in photovoltaic power systems as permitted by 690.31 shall be identified at the time of installation by distinctive white marking at all terminations.
- (3) Fixture wire shall comply with the requirements for grounded conductor identification as specified in 402.8.
- (4) For aerial cable, the identification shall be as above, or by means of a ridge located on the exterior of the cable so as to identify it.

**(B) Sizes Larger Than 6 AWG**

An insulated grounded conductor larger than 6 AWG shall be identified by one of the following means:

- (1) By a continuous white or gray outer finish.
- (2) By three continuous white stripes along its entire length on other than green insulation.
- (3) At the time of installation, by a distinctive white or gray marking at its terminations. This marking shall encircle the conductor or insulation.

**(C) Flexible Cords**

An insulated conductor that is intended for use as a grounded conductor, where contained within a flexible cord, shall be identified by a white or gray outer finish or by methods permitted by 400.22.

**(D) Grounded Conductors of Different Systems**

Where grounded conductors of different systems are installed in the same raceway, cable, box, auxiliary gutter, or other type of enclosure, each grounded conductor shall be identified by system. Identification that distinguishes each system grounded conductor shall be permitted by one of the following means:

- (1) One system grounded conductor shall have an outer covering conforming to 200.6(A) or 200.6(B).
- (2) The grounded conductor(s) of other systems shall have a different outer covering conforming to 200.6(A) or 200.6 (B) or by an outer covering of white or gray with a readily distinguishable colored stripe other than green running along the insulation.
- (3) Other and different means of identification as allowed by 200.6(A) or 200.6(B) that will distinguish each system grounded conductor

## 504 Wiring

### All Wiring Installations

This article covers wiring methods for all wiring installations unless modified by other articles.

**(A) Integral Parts of Equipment** The provisions of this article are not intended to apply to the conductors that form an integral part of equipment, such as motors, controllers, motor control centers, or factory assembled control equipment or listed utilization equipment.

**(C) Metric Designators and Trade Sizes** Metric designators and trade sizes for conduit, tubing, and associated fittings and accessories shall be as designated in Table size counterpart. Therefore, Annex C wire fill tables are 300.1(C).

	Table 600a Metric Designator and Trade Sizes												
Metric Designator	12	16	21	27	35	41	53	63	78	91	103	129	155
Trade Size	3/8	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	3 1/2	4	5	6
<i>Note: The metric designators and trade sizes are for identification purposes only and are not actual dimensions</i>													

### Underground Installations

#### Minimum Cover Requirements

Direct-buried cable or conduit or other raceways shall be installed to meet the minimum cover requirements of Table 2. Conductors under driveways must be at least 18 in. below grade. However, if the conductors are protected by an overcurrent device rated at not more than 20 amperes provided with ground-fault circuit-interrupter (GFCI) reduced to 12in

#### Conductors of the Same Circuit

All conductors of the same circuit and, where used, the grounded conductor and all equipment grounding conductors and bonding conductors shall be contained within the same raceway, auxiliary gutter, cable tray, cable bus assembly, trench, cable, or cord, unless otherwise permitted in accordance with 300.3(B)(1)

**Table 600b: Minimum Cover Requirements, 0 to 600 Volts, Nominal, Burial in Millimeters (inches)**

Location of Wiring Method or Circuit	Type of Wiring Method or Circuit									
	Column 1 Direct Burial Cables or Conductors		Column 2 Rigid Metal Conduit or Intermediate Metal Conduit		Column 3 Nonmetallic Raceways Listed for Direct Burial Without Concrete Encasement or Other Approved Raceways		Column 4 Residential Branch Circuits Rated 120 Volts or Less with GFCI Protection and Maximum Overcurrent Protection of 20 Amperes		Column 5 Circuits for Control of Irrigation and Landscape Lighting Limited to Not More Than 30 Volts and Installed with Type UF or in Other Identified Cable or Raceway	
	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.
All locations not specified below	600	24	150	6	450	18	300	12	150	6
In trench below 50-mm (2-in.) thick concrete or equivalent	450	18	150	6	300	12	150	6	150	6
Under a building	0 (in raceway only)	0	0	0	0	0	0 (in raceway only)	0	0 (in raceway only)	0
Under minimum of 102-mm (4-in.) thick concrete exterior slab with no vehicular traffic and the slab extending not less than 152 mm (6 in.) beyond the underground installation	450	18	100	4	100	4	150 (direct burial)  100 (in raceway)	6  4	150	6
Under streets, highways, roads, alleys, driveways, and parking lots	600	24	600	24	600	24	600	24	600	24
One- and two-family dwelling driveways and outdoor parking areas, and used only for dwelling-related purposes	450	18	450	18	450	18	300	12	450	18
In or under airport runways, including adjacent areas where trespassing prohibited	450	18	450	18	450	18	450	18	450	18

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## 505 Communications

This article covers telephone, telegraph (except radio), outside wiring for fire alarm and burglar alarm, and similar central station systems; and telephone systems not connected to a central station system but using similar types of equipment, methods of installation, and maintenance.

## 506 Definitions

**Cable.** A factory assembly of two or more conductors having an overall covering.

**Cable Sheath.** A covering over the conductor assembly that may include one or more metallic members, strength members, or jackets.

**Communications Circuit Integrity (CI) Cable.** Cable used in communications systems to ensure continued operation of critical circuits during a specified time under fire conditions.

**Communications Equipment.** The electronic equipment that performs the telecommunications operations for the transmission of audio, video, and data, and including power equipment (e.g., dc converters, inverters and batteries) and the wire or cable emerges from an external wall, from a technical support equipment (e.g., computers).

**Exposed.** A circuit that is in such a position that, in case of failure of supports and insulation, contact with another circuit may result.

**Point of Entrance.** Within a building, the point at which equipment and the wire or cable emerges from an external wall, concrete floor slab, or from a rigid metal conduit or an intermediate metal conduit grounded to an electrode

**Premises.** The land and buildings of a user located on the user side of the utility-user network point of demarcation.

**Wire.** A factory assembly of one or more insulated conductors without an overall covering.

### **507 Mechanical Execution of Work**

Communications circuits and equipment shall be installed in a neat and workmanlike manner. Cables installed exposed on the surface of ceilings and sidewalls shall be supported by the building structure in such a manner that the cable will not be damaged by normal building use. Such cables shall be secured by straps, staples, hangers, or similar fittings designed and installed so as not to damage the cable.

### **508 Wires and Cables Outside and Entering Buildings Overhead Communications Wires and Cables**

Overhead communications wires and cables entering buildings shall comply with the following:

#### **(A) On Poles and In-Span**

Where communications wires and cables and electric light or power conductors are supported by the same pole or run parallel to each other in span, the conditions described in clause 1-4 shall be met.

(1) Relative Location Where practicable, the communications wires and cables shall be located below the electric light or power conductors.

(2) Attachment to Cross arms Communications wires cables shall not be attached to a cross-arm that carries electric

(3) Climbing Space The climbing space through communications wires and cables shall comply with the requirements of 225.14(D).

(4) Clearance Supply service drops of 0–750 volts running above and parallel to communications service drops shall have a minimum separation of 300 mm (12 in.) at any point in the span, including the point of and at their attachment to the building, provided the non-grounded conductors are insulated and that a clearance of not less than 1.0 m (40 in.) is maintained between the two services at the pole.



## **(B) Above Roofs**

Communications wires and cables shall have a vertical clearance of not less than 2.5 m (8 ft) from all points of roofs above which they pass.

- Exception No. 1: Auxiliary buildings, such as garages and the like.
- Exception No. 2: A reduction in clearance above only the overhanging portion of the roof to not less than 450 mm (18 in.) shall be permitted if (a) not more than 1.2 m (4ft) of communications service-drop conductors pass above the roof overhang and (b) they are terminated at a through- or above-the-roof raceway or approved support.
- Exception No. 3: Where the roof has a slope of not less than 100 mm in 300 mm (4 in. in 12 in.), a reduction in clearance to not less than 900 mm (3 ft) shall be permitted.

## **Underground Circuits Entering Buildings**

### **Underground communications wires and cables entering**

(A) With Electric Light or Power Conductors Underground communications wires and cables in a raceway, hand hole enclosure, or manhole containing electric light, power, Class 1, or non-power-limited fire alarm circuit conductors shall be in a section separated from such conductors by means of brick, concrete, or tile partitions or by means of a suitable barrier.

(B) Underground Block Distribution Where the entire circuit is run underground and the circuit within the span, the conditions described in 800.44(A)(1) through street block is placed so as to be free from the likelihood of accidental contact with electric light or power circuits of over 300 volts to ground, the insulation requirements of 800.50(A) and 800.50(C) shall not apply, insulating supports shall not be required for the conductors, and bushings shall not be required where the conductors enter the building

## **508 Circuits Requiring Primary Protectors**

Circuits that require primary protectors shall comply with (A) (B) and (C) below.

### **(A) Insulation, Wires, and Cables**

Communications wires and cables without a metallic shield, running from the last outdoor support to the primary protector, shall be listed.

### **(B) On Buildings**

Communications wires and cables in accordance with 800.50(A) shall be separated at least 100 mm(4 in.) from electric light or power conductors not in a raceway or cable or be permanently separated from conductors of the other system by a continuous and firmly fixed nonconductor in addition to the insulation on the wires, such as porcelain tubes or flexible tubing. Communications wires and cables in accordance with 800.50(A) exposed to accidental contact with electric light and power conductors operating at over 300 volts to ground and attached to buildings shall be separated from woodwork by being supported on glass, porcelain, or other insulating material.

*Exception: Separation from woodwork shall not be required where fuses are omitted as provided for in 800.90(A)(1), or where conductors are used to extend circuits to a building from a cable having a grounded metal sheath*

Telephone utility companies ordinarily provide primary protectors where telephone lines are exposed to lightning. Installers of private networks that include inter-building cable should also install primary protectors where cables are exposed to lightning. Generally, cable is considered to be exposed to lightning unless one or more of these conditions exist.

- Conduit, where a continuous metallic cable shield or a continuous metallic conduit Inter-building cable runs of 42 m (140 ft) or less, directly buried or in underground containing the cable is bonded to each building grounding electrode system
- Areas having an average of five or fewer thunder storm days per year and earth resistivity of less than 100 ohm-meters.

A primary protector is required at each end of an inter-building communications circuit where lightning exposure exists.

## **600 PAINTING AND DECORATIONS**

The specified paint or finish shall be applied to all interior and wall exterior surfaces according to the following:

### **601 Delivery, Storage and Handling**

The products should be delivered to Project site in an undamaged condition in manufacturer's original sealed containers, complete with labels and instructions for handling, storing, unpacking, protecting, and installing. Packaging shall bear the manufacture's label with the following information:

1. Product name and type (description).
2. Batch date.
3. Color number.
4. VOC content.
5. Environmental handling requirements.
6. Surface preparation requirements.
7. Application instructions.

Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45°F (7 °C).

Maintain containers in clean condition, free of foreign materials and residue.

Remove rags and waste from storage areas daily.

If necessary, install measures for fire protection, heating, ventilation, and other conditions for storage areas on-site.

### **602 Examination**

Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 °F (10 and 35 °C).

Do not apply paints in rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 °F (3 °C) above the dew point; or to damp or wet surfaces.

Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers. Where acceptability of substrate conditions is in question, apply samples and perform in-situ testing to verify compatibility, adhesion, and film integrity of new paint application.

**Substrate Conditions:**

Maximum Moisture Content of Substrates when measured with an electronic moisture meter as follows:

- Concrete: 12 percent.
- Fiber-Cement Board: 12 percent.
- Masonry (Clay and CMU): 12 percent.
- Wood: 15 percent.
- Portland Cement Plaster: 12 percent.
- Gypsum Board: 12 percent.
- Portland Cement Plaster Substrates: Verify that plaster is fully cured.

**603 Preparation of Surfaces**

Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.

Prior to attempting to remove mildew, it is recommended to test any cleaner on a small, inconspicuous area prior to use. Bleach and bleaching type cleaners may damage or discolor existing paint films. Bleach alternative cleaning solutions may be advised. Remove mildew before painting by washing with a solution of 1 part liquid household bleach and 3 parts of warm water. Apply the solution and scrub the mildewed area. Allow the solution to remain on the surface for 10 minutes. Rinse thoroughly with clean water and allow the surface to dry 48 hours before painting. Wear protective glasses or goggles, waterproof gloves, and protective clothing. Quickly wash off any of the mixture that comes in contact with your skin. Do not add detergents or ammonia to the bleach/water solution.

**Concrete Substrates:**

Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.

**Masonry Substrates:**

Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces or mortar joints exceeds that permitted in manufacturer's written instructions.

Steel Substrates: Remove rust, loose mill scale, and shop primer if any.

**Shop-Primed Steel Substrates:**

Clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.

#### Galvanized-Metal Substrates:

Remove grease and oil residue from galvanized sheet metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.

Aluminum Substrates: Remove loose surface oxidation.

#### Wood Substrates:

Scrape and clean knots. Before applying primer, apply a coat of knot sealer. Sand surfaces that will be exposed to view, and dust off. Prime edges, ends, faces, undersides, and backsides of wood. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.

#### Plastic Trim Fabrication Substrates:

Remove dust, dirt, and other foreign material that might impair bond of paints to substrates.

### **604 Paint Application**

The Contactor can shall apply the techniques suited for paint and substrate indicated in the following manner

- Paint surfaces behind movable items same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed items with prime coat only.
- Paint both sides and edges of exterior doors and entire exposed surface of exterior doorframes.
- Paint entire exposed surface of window frames and sashes.
- Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
- Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.
- Tint undercoats the same color as topcoat, but tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Provide sufficient difference in shade of undercoats to distinguish each separate coat. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.
- Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.
- For the painting of Fire Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work, paint the following work where exposed to view:
  - Equipment, including panel boards and switchgear.
  - Uninsulated metal piping.
  - Uninsulated plastic piping.
  - Pipe hangers and supports.
  - Metal conduit.
  - Plastic conduit.
  - Tanks that do not have factory-applied final finishes
-

### Interior Application

VOC Content: For field applications that are inside the weatherproofing system, paints and coatings shall provide materials that comply with VOC limits of the relevant national authority. For interior paints and coatings applied at the project site, the following VOC limits exclusive of colorants added to a tint base, when calculated according to 40 CFR 59, Subpart D (EPA Method 24). Categories in the subparagraphs below are taken from LEED rating systems and the standards referenced by them;

<b>TABLE 7a: VOC CONTENT REQUIREMENT</b> ( <i>Limits The Grams Of VOC Content per Liter</i> )	
<b>PAINT CATEGORY</b>	<b>LEED V4</b>
Flat Paints and Coatings:	50 g/L.
Nonflat Paints and Coatings:	100 g/L.
Floor Paints	100 g/L
Primers, Sealers, and Under coaters:	100 g/L.
Anticorrosive and Antirust Paints Applied to Ferrous Metals:	250 g/L.
Varnish:	275g/L
Opaque stains:	250 g/L.
Semi transparent	250 g/L.

### 605 Waterproof Protective Cementitious Coating (Acrocrete)

The application of an acrylic, waterproofing, cementitious coating, to the exterior of vertical walls shall be guided by the following:

#### Storage

Pail components must be kept at a minimum of 4°C (40°F) during shipping and storage. A minimum temperature of 4°C (40°F) is required during application of fall components and until completely dried

Protect dry (bagged) products from moisture

#### Application

Prior to installation of the base coat, entire wall must be completely rasped to remove high and low spots and to remove dust from the surface

All substrates must be clean, dry and sound without planar irregularities greater than 1/4" in 10'. Repair any dings, dents and damaged form areas with the appropriate expanded insulation prior to the application of the wall finish. Do not fill damaged areas with base coat of cementitious products.

The cementitious coating cannot run below grade; terminate at a minimum of eight inches above grade.

No additives are permitted to any of the surfacing components.  
Install the surfacing after the concrete has been cured for a minimum of seven (7) days.  
Adhere to the application instructions for each component.

## **700 GLAZING**

### **701 Windows**

Windows specified are in accordance with Oran Security windows or better.

Style: Louver

Blades: glass, 6ins in size

Sizes: as specified in the construction drawing Sheet A05

Accessories: Insect screen\_\_ yes, Burglar bars \_\_ optional

### **702 Doors**

No glazing for interior or exterior doors

## **800 WOOD WORKS**

Where possible, only treated timber should be used. The timber should be sound, straight and well-seasoned with a moisture content between 15% and 20%.

### **801 Material Storage**

Areas should be allocated on the cleared site for the storage of materials. Stored timber shall be raised not less than four inches off the ground.

### **802 Roofs**

The timber in roofs shall be well seasoned, sound and straight. Pressure treated timber to resist termite attack should be used. If pressure treated timber is not available and the Contractor wish to substitute untreated timber is used, The Project Manager must consent. If untreated timber is allowed a proprietary wood preservative applied in accordance with the manufacturer's instructions must be applied.

### **Fixing**

The installation of roof shall adhere to the following guide:

- a) All roofs should be so framed and tied into the framework of the supporting walls so as to form an integral part of the whole building.
- b) All rafters should be fixed with metal plates or straps to the wall plates. Bird mouthing is occasionally used but metal straps and bolts provide a firmer connection.
- c) The ends of all trusses are to be directly supported by studs or columns not less than 4" x 4".
- d) All roof fixings must be improved by the use of the appropriate hurricane clips or straps.

### **803 Walls**

At all corners and intersections, uprights should be not less than 4" x 4" or 2 members of 2" x 4" each bolted together. The posts should be fixed to the sills or floor beams by dowel or metal cleats. Intermediate uprights should be not less than 4" x 2" and spaced at not more than two feet.

The corners of all rooms and intersections should be braced with timber members not less than 2" x 4" and shall be jointed to the upright in such a manner as to leave the upright whole.

The upper sills and wall plates at the outer corners and intersections can be tied with straps at least 9" x 9" x 3" x ¼" secured with 4# 3/8" diameter coach screws not less than 2 ½" long.

Alternatively, bracing may be effected by 2" x 4" diagonal timber struts in all corners. It is important to have a tight connection between the wall plates and posts.

The clear height of a wall should not be greater than 10 feet or as approved by the Board on the basis of structural calculations showing that the wall framing as designed is adequately supported and can withstand the horizontal imposed loads including wind and earthquakes.

Where nominal lumber is quoted in the construction drawings, the Contractor will install lumber at actual size. Table 900a below provides a chart of standard lumber size by type.

**Table 900a : Standard Sizes of Yard Lumber**

Type of Lumber	Nominal size (in inches)		Actual size (in inches)	
	Thickness	Width	Thickness	Width
<b>Timbers</b>	2	4	1 1/2	3 1/2
	2	6	1 1/2	5 1/2
	2	8	1 1/2	7 1/4
	2	10	1 1/2	9 1/4
	2	12	1 1/2	11 1/4
	4	6	3 1/2	5 1/2
	4	8	3 1/2	7 1/4
	4	10	3 1/2	9 1/4
	6	6	5 1/2	5 1/2
	6	8	5 1/2	7 1/4
	6	10	5 1/2	9 1/4
	8	8	7 1/4	7 1/4
	8	10	7 1/4	9 1/4
<b>Common boards</b>	1	4	3/4	3 1/2
	1	6	3/4	5 1/2
	1	8	3/4	7 1/4

	1	10	3/4	9 1/4
	1	12	3/4	11 1/4

### **Cladding**

The cladding of all external walls must be of approved weatherproof material. All cladding must be nailed securely to each framing member.

Where plaster is used as the cladding, it should consist of not less than two coats applied to metal laths, which shall be securely fastened to the weather proof backing.

The metal laths may consist of expanded metal sheets, "hy-rib" or other standard materials. Such material must be used in accordance with the manufacturer's instructions.

The first or scratch coat of plaster shall be not less than ½" thick and shall be kept moist by wetting for not less than 24 hours before applying the second coat, which shall also be a minimum of ½" thick.

### **Interior walls**

Non-load bearing interior timber partitions may be constructed using minimum standards. Drywall finish shall adhere to the following:

Level 4: Install 1/2ins or 5/8in cement board to stud wall, typically 1/4in off the floor. Joints are 1/8in and taped with an alkaline cement board mesh tape. Each taped joint is treated with a layer of thin set mortar extending 1in - 1-1/2in on each side. Remove all imperfections and apply a waterproof membrane to the entire surface. Apply surface finish.

### **Molding and Trims**

The Contractor shall install moldings and trims including: skirting boards, chair rails, crown moldings as well as door and window frames on all interior spaces. Door frames shall include jambs, casings, head and stops. Window frames shall include casings, jambs, stool (seat) and heads. The size of molding shall be 2-1/2inch – 3-1/2inch for door frames, window frames, chair rails, and skirting; crown molding shall be 5-1/2 inch.

### **Cupboards and closets**

The Contractor will install cupboards and closets in accordance with the drawings and according to the requirement of the Project Manager. These shall include Base cabinets, storage closets, and wall cabinets. All closets and cupboards shall be finished by sanding, caulking and staining/varnishing.

Base cabinets shall have a solid surface finish, free of scratches and blemishes. These shall be attached to the base according to the material used.

## **900 FLOORS**

### **901: Construction of floors and roof slabs**

The construction works shall include one ground bearing slab and suspended slabs. Slabs shall be a minimum of 5 inches thick, they shall be supported on beams or compacted soil and constructed in accordance with the approved drawings.



## 902 Testing

The Contractor shall make allowances for the testing of all structural concrete; which shall be of 1:2:4 mix and shall have a 3000psi minimum compressive strength per 150mm cube at 28 days. The Contractor shall ensure the collection of samples for testing each batch of concrete throughout the work process.

## 903 Reinforcement

Slabs shall be reinforced with 3/8"Ø HTS bars min. at 8 inches o/c. All concrete shall be thoroughly consolidated by suitable means during placement, and shall be thoroughly worked around reinforcement and embedded fixtures and into corners of forms. All reinforcement shall be cold bent and shall be installed free of mud, dirt or any injurious material.

## 904 Damp Proof Course

A damp proof course of 500-gauge polythene (visqueen) may be laid over the compacted floor foundation where moisture is present in the ground. This material must be used with caution, as it is easily broken. This course will halt rising moisture and retain moisture in the wet concrete during the setting period so that proper curing is effected.

- b) Laps in the damp proof membrane should not be less than 6".
- c) Damp proofing of walls must be carried out so as to avoid breaks in the damp proofing membrane

## 905 Design of formwork

Forms shall result in final structures that conform to shapes, lines and dimensions of the members as required by the design drawings and specifications.

Forms shall be substantial and sufficiently tight to prevent leakage of mortar.

Forms shall be properly braced or tied together to maintain position and shape.

Forms shall be removed in such manner as not to impair safety and serviceability of the structure.

All concrete to be exposed by form removal shall have sufficient strength not to be damaged when the forms are being removed.

Minimum stripping and striking times shall be as follows unless otherwise approved by the Project Manager.

<b>Table 1000a: Formwork Removal</b>	<b>Ordinary Portland Cement Concrete</b>	<b>Rapid Hardening Portland Cement Concrete</b>
	<b><u>NORMAL WEATHER HOURS</u></b>	<b><u>NORMAL WEATHER HOURS</u></b>
Vertical surfaces	10	8
Vertical wall surfaces under 12 inches thick	30	20

<b>Table 1000a: Formwork Removal</b>	<b>Ordinary Portland Cement Concrete</b>	<b>Rapid Hardening Portland Cement Concrete</b>
	<b><u>NORMAL WEATHER HOURS</u></b>	<b><u>NORMAL WEATHER HOURS</u></b>
Beam sides and columns	30	20
	<b><u>DAYS</u></b>	<b><u>DAYS</u></b>
Slabs (props left under)	4	2
Removal of props to slabs	9	4
Beam soffits (props left under)	7	4

## 906 Conduits

The Contractor shall accommodate the laying of pipes, sleeves, boxes and conduits in the concrete slab according to the markings of the Plumber and Electrician; there shall be no chases in the concrete slab.

Concrete cover for pipes and conduits shall be 1-1/2 inches for ground bearing and roof slabs and 1.0 inch for interior slabs.

## 907 Slab Finish

Construction joints in floors shall be located within the middle third of spans of slabs, beams, and girders. Joints in girders shall be off set a minimum distance of two times the width of intersecting beams

The slab should be floated immediately to produce a durable surface. Alternatively; the Contractor shall install a screeded finish to the exposed roof slab with a slope of 1:60. Screeding shall be carried out following compaction of the concrete, by tamping action of a screed board, running on the top edges of the formwork or screeding guides, to give a dense concrete layer true to line and level. Screed of proportions 1 cement to 4 sand (by volume) would be suitable.

## 907 Fill

All required fill shall be approved granular material and shall be placed in layers compacted to at least 95% of maximum dry density as defined by ASTM D1557 modified proctor test. Should ground water be encountered above the proposed underside of foundations, the natural soil should be blinded with concrete to prevent softening. The contractor is responsible for disposal of all accumulated water from excavations and de-watering operations in such a manner as not to cause damage to the works of the adjacent properties.

All organic or other unsuitable materials shall be removed from subgrade and backfill areas & replaced with an approved clean fill material compacted to at least 95% of maximum dry density as defined by ASTM D1557. Backfill material should be placed in layers, which, before compaction, shall not exceed 8" thick. Each layer shall be spread uniformly and evenly and shall be thoroughly mixed during the spread to ensure uniformity of material in each layer.

## 1000 MISC. METAL WORKS

## **1001 Definitions**

**Bead:** A single run of weld metal deposited on a surface.

**Butt Weld:** A weld in which the weld metal lies substantially within the extension of the planes of the surfaces of the parts joined or within the extension of the planes of the smaller of the two parts of differing size. the edges of the metal pieces shall be beveled or chiseled to the required shape at the throat.

**Crater:** A depression left in weld metal where the arc was broken or the flame was removed.

**End Crater:** A crater at the end of a weld or at the end of a joint.

**Fillet Weld:** A weld of approximately triangular cross-section joining two surfaces approximately at right angles to each other in lap joint, tee joint or corner joint. It is of two types (1) Continuous, (2) Intermittent.

**Fusion Welding:** Any welding process in which the weld is made between metals in a state of fusion without application of pressure. (a) In fusion welding – The depth to which the parent metal has been fused.

**Weld Metal:** All metal melted and or made plastic in making a weld and retained in the weld

## **1002 Quality of Work**

Metal work shall be fabricated carefully and accurately to ensure compliance with design and performance requirements, using types and grades of metal as specified for the purpose. The finished work must be free from distortion and cracks. Proprietary products shall be used to the recommendations of the manufacturers. Steel work shall be fabricated and erected by competent, experienced persons.

## **1003 Welding**

Steel shall normally be welded by metal. Welding of stainless steel, aluminum alloys, copper alloys, bronze etc. and brazing shall conform to the appropriate National Standard where specified.

Surfaces to be welded shall be dry. When rain is falling or during periods of high wind, necessary precautions shall be taken to protect outdoor welding areas.

Welding shall be so carried out as to ensure that:

(1) Welds will be of good clean metal deposited by a procedure which will ensure uniformity and continuity of work.

(2) The surfaces of the weld will have an even contour and regular finish and will indicate proper fusion with the parent metal.

All slag shall be removed after making each run by light hammering followed by wire brushing. Weld metal shall not be allowed to spatter on surfaces which will be visible in the completed work.

But welds which will be visible in the completed work shall be dressed off smooth and flush with adjacent surfaces.

## **1100 - HEALTH AND SAFETY**

### **1101 General**

- 1) The Contractor shall appoint a Safety Officer.
- 2) The Contractor shall be responsible for health and safety on the Site. He shall co-ordinate his own activities and those of his sub-contractors and suppliers to achieve safe and healthy working environments.
- 3) Not later than two weeks before work is due to start on the Site, the Contractor shall provide the Project Manager with a copy of the written safety policy which he has prepared under International Standards and which relates to the execution of the Works at the Site.
- 4) Prior to commencement of work on Site, the Contractor shall provide the Project Manager with a copy of the Notice of Building Operation or Works of Engineering Construction submitted to the Health and Safety Officer.

### **1102 Safety Plan**

- 1) The Contractor shall prepare a Health and Safety Plan covering all aspects of the Works and ensure that safety procedures are enforced.
- 2) The Health and Safety Plan shall be coordinated with other Contractors working on the Site, and other relevant authorities.
- 3) The Health and Safety Plan shall be submitted to the Project Manager within 4 weeks of the award of Contract, and shall be regularly reviewed and updated.

### **1103 Site Safety**

For the duration of activities at or adjacent to the Site the Contractor shall arrange and chair a monthly Site Safety meeting, to which the Project Manager or his nominated representative shall be invited.

### **1104 Substances Hazardous to Health**

Notwithstanding his general duties under health and safety legislation and regulations, the Contractor shall advise the Project Manager in writing of any substances which he: proposes to bring onto the Site or incorporate into or use about the Works; or which he discovers existing on the Site, which fall within the Control of the Substances Hazardous to Health Regulations; or otherwise require special precautions to be taken.