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## **1. PRELIMINARIES**

### **1.1. Standard and Codes**

- 1.1.1. The Contractor shall, perform the Works in compliance with all regulations, standard specifications or statutes of the Government of Maldives unless otherwise conform to this specification.
- 1.1.2. The current British Standard Specifications and Codes of Practice shall apply to and form part of these specifications unless otherwise specified in respect of all materials and works to which they have application.

### **1.2. Drawings and Specifications**

- 1.2.1. Drawings and Specifications are intended to complement each other, so that if anything is shown on the Drawings, but not mentioned in the specifications or vice versa, it is to be furnished and built as though specifically set forth in all three. If any discrepancies, errors, ambiguities or omissions occur in the Drawings or Specifications, the same shall be referred to the Consultant before proceeding with the Works, and the Consultant decision on such discrepancies, errors, ambiguities or omissions shall be final.
- 1.2.2. In addition to the Drawings and Specifications attached hereto, the Consultant will during the progress of the Works furnish additional Drawings, Specifications, and instructions as may be necessary, in the opinion of the Consultant for the purpose of the proper and adequate execution and maintenance of the Works, and the Contractor shall make his work conform. Such drawings and instructions shall be deemed to be part of the Contract Documents.

### **1.3. Transportation to the Site**

- 1.3.1. The Contractor shall provide all necessary transport, handling and storage of all materials, components and the like to their points of installation on site including transport to and from storage. The Contractor shall provide all necessary transport of labour to and from the site.

### **1.4. Schedule and Execution Plan**

- 1.4.1. The Contractor shall prepare and submit to the Consultant for approval the construction schedule and an execution plan of temporary facilities, stockyards, etc., before the start of the Works.

### **1.5. Repairing and Correction**

- 1.5.1. Any breakage(s) or defect(s) of existing buildings, road utilities, or part(s) of them caused by the Works including transportation for the works shall be repaired or corrected by the Contractor with his responsibility.

### **1.6. Workmanship and Materials**

- 1.6.1. All workmanship shall be of the best standard. All goods and materials to be incorporated in the Works must be new, unused, of the most recent or current models and incorporate all recent improvements in design and materials unless provided otherwise in the contract.
- 1.6.2. The Contractor shall submit for the approval of the Consultant a list of names and addresses of the manufacturers and trade marks or names of all the various types of materials and goods he propose to use in the Works. The list shall include reference to the specifications clause or article to which the materials and goods apply.
- 1.6.3. Materials shall be obtained from approved sources and used in accordance with the manufacturer's printed instructions. In the absence of a specification, all materials shall comply with a relevant standard. The consultant shall order the removal of any materials, which he has not approved.



1.6.4. No orders for materials and goods shall be placed until approval has been obtained for the materials and goods from the consultant.

1.6.5. The Contractor shall note that it is his responsibility to include in his price for the cost of the materials and products as specified and no adjustment will be allowed should the consultant reject the alternatives.

**1.7. Obvious Work**

1.7.1. Where an item of work is obviously required for the type of work being undertaken then it shall be deemed to have been included even though the item is not specifically mentioned or shown in the Drawings or Specifications.

**1.8. Protection**

1.8.1. The Contractor shall have the Works and adjoining properties protected from inclement weather. Any loss or damage caused by weather, carelessness or lack of skill of workers, accident or otherwise shall be of such property that is affected. The Contractor shall provide all necessary dustsheets, barriers and guardrails and clear away at completion.

1.8.2. The work shall be suspended for such time as may be directed and/or approved by the Consultant if the specified quality of work is difficult to maintain during inclement weather.

**1.9. Scaffolding**

1.9.1. The Contractor shall provide, erect, maintain, dismantle and clear away at completion proper and adequate including that required for subcontractor and suppliers. Putlog holes shall be made good to match the adjacent surface as the scaffolding is dismantled.

1.9.2. The Contractor shall be responsible for all safety precautions in connection with the scaffolding including the provision of all bracing, scaffold boards, toe boards and the like and for entire sufficiency for the work.

**1.10. Construction Machinery, Plants and Equipment's**

1.10.1. All necessary construction machines shall be provided and maintained by the Contractor and shall be approved by the Consultant.

1.10.2. If cranes or any other type of plant which places any load on the structure are proposed, all details of such plant shall be submitted to the Consultant for approval before the work is actually commenced. If approved by the Consultant and Consultanturally acceptable, permission may be given for the structure to be strengthened, in order to carry out loads, and the Contractor shall be responsible for any resulting additional costs.

1.10.3. The Contractor shall be responsible for making good to the satisfaction of the Consultant any damage to the permanent structure that may be caused by his plant and equipment.

**1.11. Samples**

1.11.1. The Contractor shall furnish for the approval with reasonable promptness, all samples as directed by the consultant. The Consultant shall check and approve such materials with reasonable promptness only for conformance with the design concept of the Works and for compliance with the information given in the Contract Document. The Work shall be in accordance with the approved samples.

1.11.2. All samples shall be delivered to the Consultant's office with all charges in connection therewith paid by the Contractor and deemed to be included in the Contract Price.

1.11.3. Duplicate final approved samples, in addition to any required for the Contractor's use, shall be furnished to the Consultant, one for office use and one for the site.

1.11.4. Samples shall be furnished so as not to delay fabrication, allowing the consultant reasonable time for consideration of the sample submitted.



- 1.11.5. Each sample shall be properly labeled with the name and quality of the material, manufacturer's name, name of project, the contractor's name and date of submission, and the specification clause to which the sample refers.

**1.12. Ordering Materials**

- 1.12.1. The Bills of Quantities shall not be used as a basis for ordering materials and the Contractor is entirely responsible for assessing the quantities of materials to be ordered.
- 1.12.2. Upon receipt of the Consultant's order to commence the Works, the Contractor shall immediately place orders for all required materials and will be held responsible for any delays occurring due to late placing of such orders.
- 1.12.3. The Contractor shall pay all expenses, taxes and dues etc. incurred on the procurement of materials from abroad

**1.13. Water and Electricity for the Works**

- 1.13.1. The Contractor shall make all necessary arrangements and provide all water for the proper execution of the Works, together with all transport, temporary plumbing, storage and distribution, pay all charges and alter, adept and maintain temporary work as necessary and remove and make good at completion.
- 1.13.2. The Contractor shall make all necessary arrangements and provide all artificial lighting and power (maintain a generator if necessary) for the proper execution and security of the Works and its protection, with all meters, temporary wiring and fittings, pay all charges and alter adapt and maintain the temporary work as necessary and remove and make good at completion.

**1.14. Site offices for Contractor**

- 1.14.1. The Contractor shall provide maintain and clear away on completion of the Contract all necessary site offices, canteens, messing and welfare facilities, temporary buildings, toilets and the like for all site staff employed by the Contractor and required by subcontractors and suppliers.
- 1.14.2. The offices shall be open at all normal working hours to receive instructions, notices and other communications.

**1.15. Contractor's Site Area**

- 1.15.1. throughout the period of the Contract the Contractor shall maintain the area of his operation within the limits of the site in a clean, tidy and safe condition by arranging materials and the like in an orderly manner. All rubbish, debris, waste materials and the like shall be systematically cleared from the site as it accumulates.
- 1.15.2. The Contractor shall take steps necessary as directed by the Consultant to minimize or eliminate dust, noise or any other nuisance, which may occur. Plant emitting dust, smoke, excessive noise or other nuisance shall not be permitted.

**1.16. Progress Meeting**

- 1.16.1. During the course of the Works, progress meetings shall be held at weekly intervals for the purpose of coordinating the Contractor's works and to ensure that full compliance is maintained.
- 1.16.2. Minutes of such meeting should be recorded; copies will be distributed to all persons concerned and full effect shall be given to all instructions contained therein.

**1.17. Progress Photographs**



- 1.17.1. The Contractor shall supply once a month, at the time of submitting his interim Certificates, photographs showing the progress of the Works.

**1.18. Setting Out**

- 1.18.1. The Contractor shall be responsible for accurately setting out the Works to the specified positions, dimension, levels and Building Lines and also checking the site surveys for dimensional and level accuracy and reporting any discrepancies before building work commences.
- 1.18.2. The Contractor shall provide the Consultant with all facilities, equipment and labour to enable him to check the setting out and levels of the Works at all times. The checking of any setting out point, line or level by the Consultant shall not in any way relieve the Contractor of his responsibility.
- 1.18.3. All setting out points, benchmarks, site rails, pegs and other survey points shall be clearly marked and protected from damage or disturbance during the execution of the Works.

**1.19. Loading in Excess of Design Load**

- 1.19.1. No loading in excess of the design loading shall be placed on any portion of the structure without the written permission of the Consultant.

**1.20. Permanent Drainage, Electricity and Water connection**

- 1.20.1. The Contractor shall allow for arranging and obtaining the permanent drainage, water and electricity connections to the proposed development and he shall be responsible for making all payments in connection therein.

**1.21. Handing Over**

- 1.21.1. Prior to handing over the proposed development the Contractor shall gain the approvals and respective Completion Certificates from all the local government authorities and the like that the work has been completed in accordance with their requirements.
- 1.21.2. Any payment in connection therewith shall be paid by the Contractor.



## 2. CONCRETE WORKS

### 2.1. General

- 2.1.1. Materials used in the works shall be new, of the qualities and kinds specified herein and equal to approved samples. Delivery shall be made sufficiently in advance to enable further samples to be taken and tested if required. No materials shall be used until approved and materials not approved shall be immediately removed from the works.
- 2.1.2. Materials shall be transported, handled and stored on the site or elsewhere in such a manner to prevent damage, deterioration or contamination.

### 2.2. Cement

- 2.2.1. Cement shall be Ordinary Portland cement of an approved brand.
- 2.2.2. Cement shall conform to BS 12.
- 2.2.3. Cement shall be of recent manufacturer and used within 6 months of manufactured date.
- 2.2.4. The Contractor shall with each fresh consignment of cement delivered to the site furnish the Consultant with a copy of the Manufacturer's statement of compliance with the above Standard Specification together with the date of manufacture, certified by an independent agency in the country of origin and its date of delivery to Site.
- 2.2.5. Check tests will be required by the Consultant. These tests shall be carried out at the Contractor's expense.
- 2.2.6. Any cement failing to meet the required standards will be rejected and replaced at the Contractor's expense.
- 2.2.7. Any cement not conforming to BS 12 shall not be used unless otherwise approved by the Consultant.

### 2.3. Aggregate

- 2.3.1. Fine aggregate shall be river sand conforming to BS 882.
- 2.3.2. Coarse aggregate shall be crushed stone excluding limestone or derivatives of limestone conforming to BS 812.
- 2.3.3. Aggregate shall not contain injurious amount of rubbish, dirt, organic impurities and other foreign matters.
- 2.3.4. Strength of aggregate shall be more than that of hardened concrete paste.
- 2.3.5. Shape of coarse aggregate shall not be flat or slender.
- 2.3.6. Aggregate to be used in concrete shall possess the qualities indicated in the following tables.

#### Quality of Aggregates

Aggregate type	Open dry specific gravity	Percentage of water absorption (%)	Percentage of solid volume for the evaluation of particle shape (%)	Clay lump (%)	Loss in washing test (%)	Organic impurity (%)	Water soluble chloride (%)
Coarse aggregate	≤ 2.5	≤ 3.0	≥ 55	≤ 0.25	≤ 1.0	0	≤ 0.25
Fine aggregate	≥ 2.5	≤ 3.5		≤ 1.0	≤ 3.0	0	≤ 0.01



\*Colour of test solution not to be darker than standard solution.

### **Grading requirements for aggregates**

#### **Percentage passing each sieve by weight (%)**

Agg.	Max. size (mm)	Nominal sieve size (mm)											
Coarse	25	40	30	25	20	15	10	5	2.5	1.2	0.6	0.3	0.1
		100	100	90	60		20	0	0				5
Fine	20			100	90		20	0	0				
					100		55	10	50				
							100	90	80	50	25	10	2
								100	100	90	65	35	10

- 2.3.7. Manufactured sand and blast furnace slag to be use in concrete shall not be used unless otherwise specified or approved by the Consultant.
- 2.3.8. In case of using fine aggregate of 0.0 1 % or more water soluble chloride content, the necessary measures for corrosion inhibiting of reinforcement shall be instructed by the Consultant.
- 2.3.9. The maximum size of coarse aggregate shall be 25 mm.
- 2.3.10. Sources of aggregate shall be to the approval of the Consultant and samples of aggregate from the proposed source shall be submitted to the Consultant at least 28 days before its intended use.

#### **2.4. Water**

- 2.4.1. Water shall not contain injurious amount of impurities that may adversely affect concrete and reinforcement.
- 2.4.2. Ground water shall not be used for concrete works.
- 2.4.3. Water shall be obtained from a public supply where possible, and shall be taken from any other sources only if approved by the Consultant.
- 2.4.4. Only water of approved quality shall be used for washing out formwork, curing concrete and similar surfaces.

#### **2.5. Handling and Storage of Material**

- 2.5.1. Cement
  - 2.5.1.1. Cement shall be stored in a manner to prevent weathering.
  - 2.5.1.2. Bagged cement shall be piled no more than 10 bags so as to permit easy inspection.
  - 2.5.1.3. Cement caked even to the slightest extent shall not be used. Such cement and rejected cement shall be immediately separated from other bags of cement so that they shall not be mistaken for others.



#### 2.5.2. Aggregate

2.5.2.1. Aggregate shall be stored in a manner effectively separating coarse and fine aggregate according to type and shall be prevented from inclusion of dirt, rubbish and other undesirable foreign matters.

2.5.2.2. Coarse aggregate shall be unloaded and piled in a manner not to cause segregation of small and large particles. Aggregate to be stored in piles shall be in mounds of moderate height and at a location where good drainage is provided.

### 2.6. Mix Proportion and Strength

2.6.1. Mix ratio for reinforced concrete shall be in the proportion 1:2:3 (cement: fine aggregate: coarse aggregate) by dry volume. If the required design strength is not achieved with this mix proportion the contractor shall design an appropriate mix and obtain the consultants approval before its use.

2.6.2. Mix ratio for lean concrete shall be in the proportion 1:2:6 (cement: fine aggregate: coarse aggregate) by dry volume.

2.6.3. Water-cement ratio for concrete shall be 0.4% to 0.45%.

2.6.4. The specified design strength of reinforced concrete shall be 25 N/mm<sup>2</sup>.

2.6.5. The required slump of concrete shall be 100 mm.

2.6.6. Design mix proportion shall be to obtain required workability, consistency and durability.

2.6.7. Where specified in the drawings, an approved waterproofing agent shall be added to the concrete. Details of waterproofing agent including certificates of compliance to relevant standards and other specifications and details shall be submitted for consultants' approval before its use.

### 2.7. Production of Concrete

#### 2.7.1. Field-mixed Concrete Plant

2.7.1.1. The Contractor shall select the necessary facilities for storage, batching, mixing and transporting of each of the materials and submit them for approval of the Consultant prior to start work.

#### 2.7.2. Measuring

2.7.2.1. All materials shall be measure by volume for each batch and water may be measured volumetrically.

2.7.2.2. Cement shall be measured by number of bags unless automatic cement weight measure is in use.

#### 2.7.3. Mixing Control

2.7.3.1. Concrete mixture shall be constantly controlled to obtain required workability and mixed strength. Mixing time for each batch shall be not more than 3 minutes.

#### 2.7.4. Quality Control

2.7.4.1. The Contractor shall conduct tests for quality control toward insuring that concrete of the required quality is constantly produced.

2.7.4.2. The Contractor shall have all quality control tests report ready for submission as required by the Consultant.

#### 2.7.5. Quality Inspection of Concrete at the Point of Placement



2.7.5.1. The Contractor shall conduct tests on concrete at the point of placement. When test results meet the tolerances given below, the concrete shall be qualified to have passed the tests.

- a) The tolerance between actual slump and required slump of the concrete shall be  $\pm 2.0$  mm

2.7.5.2. For the estimation of compressive strength of concrete in compressive strength tests, when compressive strength of 95% of the test samples is not less than the specified design strength, it shall be qualified to have passed the test. In case of failure to the above requirements, the Contractor shall take necessary measures such as to perform appropriate test as instructed by the Consultant.

## **2.8. Transporting and Placing**

### **2.8.1. General**

2.8.1.1. The Contractor shall establish manner and schedule for transporting and placing of concrete and obtain approval of the Consultant.

2.8.1.2. Concrete shall be transported in a manner to minimize segregation, spill, age and other changes in quality thereof.

2.8.1.3. Concrete shall be placed and consolidated in a manner to insure uniformity and optimum density.

2.8.1.4. In case of rain or other conditions that may affect the quality of concrete during concreting, the Contractor shall take necessary measures as instructed by the Consultant.

### **2.8.2. Time Limit**

2.8.2.1. The time limit from start of mixing to completion of placing of a batch as a rule, shall be 30 minutes.

### **2.8.3. Preparation prior to Placing.**

2.8.3.1. The place where concrete is to be deposited shall be cleaned and sheathing shall be sprinkled with water. Subsequently, water accumulated in the form shall be removed.

### **2.8.4. Construction Joint**

2.8.4.1. Joint surfaces shall be cleaned, made free of laitance and other foreign matters, and an approved bonding agent applied prior to concreting. Joint surface shall be roughened if directed by the Consultant.

2.8.4.2. The locations of shapes of construction joints shall be consulted and approved by the Consultant.

### **2.8.5. Concrete Placing**

2.8.5.1. Concrete placing shall be proceeded to keep the surface of placed concrete as horizontal as possible.

2.8.5.2. Concrete shall be continuously poured to compact around reinforcing bars and comers of formwork. Concrete should not be dropped from a height of more than 2.8 meters without taking appropriate measures to prevent segregation.

2.8.5.3. The maximum time interval between placements of continuous concreting shall not exceed 0.5 hours. However, when special measures are taken this time limit may be changed according to instruction or approval of the Consultant.

### **2.8.6. Consolidation**



2.8.6.1. Vibrating of concrete and tapping of formwork shall be performed to wall, column and other places difficult for concrete to proceed. Proper number of workers for placing and compacting concrete shall be arranged.

2.8.6.2. Vibrator shall be operated for concrete called for water tightness, difficult portion for concrete to proceed and other cases directed by the Consultant. However, vibrator shall not be touched reinforcing bars and shall not be operated more than 30 seconds at same spot.

2.8.6.3. Concrete shall be placed 300 - 600 mm thickness at once in case vibrator is performing. In case flexible-insert-vibrator is called for, concrete shall not be placed thicker than the length of the insert or vibrator at one pouring.

#### 2.8.7. Placing Speed

2.8.7.1. Concrete shall be placed at the speed suited for the workability of the concrete and condition of the place of placement, which insures proper consolidation of concrete.

### 2.9. Concrete Curing

#### 2.9.1. Curing Method

2.9.1.1. After concrete has been placed, the concrete surface shall be kept moist by sprayed with water or by other appropriate methods, and shall be protected from direct sunlight and rapid drying. The top surface of slabs shall be kept flooded with water at all times after concreting for the duration of curing period. This curing period shall be for not less than 14 days.

2.9.1.2. As a rule, no foot traffic or loads shall be permitted on concrete for at least 24 hours after placement.

### 2.10. Test

#### 2.10.1. General

2.10.1.1. The contractor shall be required to conduct all tests according to BS method and procedure.

2.10.1.2. Test, as a rule, shall be conducted at the locations directed or at the testing institutions approved by the Consultant.

2.10.1.3. The Consultant shall conduct test, as a rule.

2.10.1.4. In case of failure in test, measure shall be taken as instructed by the Consultant.

2.10.1.5. The Contractor shall keep test records during the work and for 2 years completion of the contracted work.

#### 2.10.2. Material

##### 2.10.2.1. Cement Test

1) Setting test.

2) Soundness test.

3) Compressive strength test.

Note: Item (1) shall be conducted once in every manufacturer.

Item (2) & (3) shall be conducted once in every 2,000 bags.

##### 2.10.2.2. Aggregate test:

4) Grading and fineness modules.

### 2.11. Concrete Testing



2.11.1. Fresh concrete

- 2.11.1.1. Slump, air content, shall be conducted daily, and more often at request of the Consultant.

2.11.2. Compressive strength test of concrete

**Test for estimation on strength of concrete in structure:**

- 2.11.2.1. In order to assume estimated strength of concrete in structure, compressive strength test shall be conducted for prepared test pieces on the 7th day and 28th day and those test pieces shall be made for sampling at placing of concreting.
- 2.11.2.2. Strength test shall be conducted for each of the following conditions: each days pour, each class of concrete, each change of supplies or source and each 100 cubic meter of concrete or: fraction thereof. The number of test pieces to be used in a test shall be not less than 3 for each test of the 7th day and the 28th day unless otherwise instructed by the Consultant.
- 2.11.2.3. Test pieces shall be made in accordance with British Standards, and sampling shall be taken as near as possible at the point of placement.
- 2.11.2.4. Test pieces shall be stored without being disturbed and shall be covered during the first 24 hours, and carefully transported specimens to the testing laboratory. Test pieces shall be cured in water after de-moulding. The temperature of test pieces shall be kept as close as possible to the temperature of the concrete in structure until the time of testing.

**2.12. Defective Concrete and Finishes**

- 2.12.1. Honeycombed surfaces shall be made good or on the instruction of the Consultant be cut out by the Contractor and make good at his own expense.
- 2.12.2. Concealed concrete faces shall left as from the formwork except honeycombed surfaces shall be made good. Faces of concrete to be rendered shall be roughened by approved means to form a key. Faces of concrete that are to have finished other than those specified shall be prepared in an approved manner as instructed by the Consultant.
- 2.12.3. Concrete arches as shown on the drawings shall be precast with 10mm granite chippings as aggregate, ground smooth to expose aggregate and applied with a clear weather-proof coating (Formwork to be applied with a retarding agent and treated as required to expose aggregate prior to casting). Samples shall be submitted for consultants' approval before pre-casting the arches.



### 3. CONCRETE FORMWORK

#### 3.1. Structure and Material

##### 3.1.1. Structure

- 3.1.1.1. Formwork shall be performed to obtain accurate concrete in accordance with the designated drawings.
- 3.1.1.2. Formwork shall be firmed and secured to bear the force of concreting and tightened to avoid cement paste seeping.

##### 3.1.2. Materials

- 3.1.2.1. Sheathing for formwork shall be waterproof plywood of not less than 12 mm thick for underground concrete and steel or vinyl coated formwork for all other concrete. Joint of sheathing shall be butt joint and firmly assembled. In case of using wood board for sheathing, boards shall be 15 mm thick and applied planer. Joint shall be tongued and grooved unless otherwise approved by the Consultant.
- 3.1.2.2. Form liners shall be sound and suitable materials to accurately and safely cast the insitu and precast concrete structure as shown on the Drawings.
- 3.1.2.3. Timber form boards for sheathing where used for fair-faced concrete shall be of such new materials as not to cause any defects to the surface of the concrete. Special care shall be taken in fabrication, storage and protection of these boards.

##### 3.1.3. Other Material

- 3.1.3.1. Fastening hardware to be used shall be those with allowable tensile strength guaranteed by manufacturer through strength tests.
- 3.1.3.2. Form oil shall not have injurious effects on quality of concrete nor to bonding of surface finishing materials and shall be subject to approval of the Consultant.

#### 3.2. Performance

##### 3.2.1. Design of formwork

- 3.2.1.1. Formwork shall be designed to withstand construction loads during concreting, lateral pressure of fresh concrete, shock and vibrators due to concrete placing.
- 3.2.1.2. Formwork shall be free of injurious leakage of water, easy to remove, and shall not damage concrete at removal.
- 3.2.1.3. Supports shall be provided with the adequate horizontal and diagonal bracing and/or stays to prevent collapsing, heaving and twisting of formwork due to horizontal loads working during concrete placing.

##### 3.2.2. Tolerance

- 3.2.2.1. The dimensional tolerance in location and cross section of concrete member used for designing and construction of formwork shall conform to the following table.

**Standard Values of Dimensional tolerances**

Item	Tolerance (mm)
Tolerance in distance from datum line of each floor to respective members	+10
Tolerance in cross section of columns, beams and walls	- 5, + 10
Tolerance in thickness of floor and roof slabs	0, +10

##### 3.2.3. Fabrication and Erection

- 3.2.3.1. Erection of formwork, and transportation and storage of materials thereof shall be started only after previously placed concrete has reached an age which acceptance of these loads will not have any adverse effect on the concrete.



- 3.2.3.2. Sheathing shall be fabricated and installed accurately to match the locations, shapes and dimensions of members called for in the Drawings.
- 3.2.3.3. Sheathing shall be installed tightly so as not to permit cement paste or mortar to escape from joints.
- 3.2.3.4. Pipes, boxes and other embedded hardware shall be properly secured to sheathing or others so that they will not move during concrete placing.
- 3.2.3.5. Supports shall be erected plumb. Supports at any two vertically consecutive floors shall be erected as near as possible to identical locations on a common plane.
- 3.2.3.6. Shoring shall be erected paying special attention to safety.
- 3.2.3.7. If sheathing is reused, the surface in contact with the concrete shall be thoroughly cleaned off and sufficiently repaired before reuse. In case of using for fair-faced concrete, the same sheathings shall be used twice after approval of the Consultant.

#### 3.2.4. Inspection

- 3.2.4.1. Formwork shall be inspected by the Consultant prior to placing of concrete.

#### 3.2.5. Striking of forms

- 3.2.5.1. The minimum period for keeping the forms in position and for watering after laying the concrete shall be as stated below, except otherwise specified in drawings. Forms shall be removed in such a manner as to ensure the complete safety of the structure, so that there is no shock or vibration as would damage the reinforced concrete.
- 3.2.5.2. The responsibility for the safety of the concrete shall rest entirely with the Contractor and the Contractor shall be held liable for any damage done and shall have to make good the same at his own expenses.
- 3.2.5.3. The Contractor shall inform the Consultant when he intends to remove shuttering and shall obtain his consent, but the consent of the Consultant shall not relieve the Contractor of his responsibility.
- 3.2.5.4. The minimum time for formwork to remain in place shall be as per the following table.

Vertical sides of beams, slabs and columns	24 hours
Soffits of slab	10 days
Soffits of beams	21 days
Cantilevers	28 days

#### 3.2.6. Relocation of Support

- 3.2.6.1. Supports under concrete shall be not relocated.

#### 3.2.7. Removal of formwork

- 3.2.7.1. Formwork shall be removed gently, after its removal has been approved by the Consultant.
- 3.2.7.2. Inspection by the Consultant shall be obtained immediately after the removal of sheathing and defects shall be immediately remedied according to instruction of the Consultant.
- 3.2.7.3. After shoring has been removed, members shall be carefully observed for cracking and deflection, when found, they shall be reported immediately to the Consultant.



## 4. STEEL REINFORCEMENT

### 4.1. Material

- 4.1.1. Reinforcing steel shall be of the dimensions given in the Drawings.
- 4.1.2. Reinforcing bars shall comply with the requirement of B.S.4449 and welded wire fabric, square bar fabric and expanded metal shall comply with appropriate part of B.S.4483.
- 4.1.3. Dia. 6mm reinforcing steel shall be round mild steel bars, and 12mm, 16mm, 20mm and 25mm shall be deformed high strength bars.
- 4.1.4. Any other non-specified reinforcing steel shall be used only with the approval of the Consultant.
- 4.1.5. All reinforcing steel and binding wire shall be stored under cover and shall be at least 250mm above the ground.

### 4.2. Cleaning

- 4.2.1. Reinforcing bars shall be cleaned before use so that it is free from rust, oil, dirt or other coatings that reduce bond.

### 4.3. Bending and Laps

- 4.3.1. The reinforcement shall be bent cold in an approved bar bending machine.
- 4.3.2. Preferably bars of full length shall be used. Lapping of bars where necessary shall conform to BS1487 'Bending Dimensions of Bars of Concrete reinforcement.'

### 4.4. Reinforcement Cover

Concrete cover for reinforcement shall be as follows:

For any steel in underground concrete	50mm
Clear cover in slabs	25-30mm
Clear cover in beams soffit	30-35mm
Clear cover in sides of beams	30mm
Clear cover in columns	40mm

### 4.5. Placing

- 4.5.1. Reinforcement intended for contact when passing each other shall be securely tied together with binding wire.
- 4.5.2. Binders and stirrups shall tightly embrace the longitudinal reinforcement to which they shall be security bound or spot welded.
- 4.5.3. Binding wire shall be turned in from the formwork and shall not project beyond reinforcing bars.
- 4.5.4. All reinforcement shall be inspected by the Consultant and approved before concrete is placed in the forms.



## **5. METAL WORKS**

### **5.1. 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 bevelled or chiselled 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.

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.



## 5.2. Materials

Materials	Standard	Remarks
Hot Rolled-Mild Steel Sections Excluding Angles and Hollow Sections	BS 4 Part – 1	To be hot rolled from weldable steel for structural purposes conforming to BS 4360
Hot-Rolled Ms Hollow Sections	BS 4848: Part 2	To be hot rolled from weldable steel for structural purposes conforming to BS 4360
Hot-Rolled Ms Angles	BS 4848: Part 4	To be hot rolled from weldable steel for structural purposes conforming to BS 4360
M.S. Bars	BS 4360	
M.S. Bars	BS 1775	
M.S. Plates	BS 4360	
Galvanized Steel Sheet	BS 2989	
Steel Plate & Sheet	BS 1449: Part 1	
Stainless Steel Tubes	BS 3014	
Stainless Steel Plate, Sheet & Strip	BS 1449: Part 2	
Aluminium Alloy Extruded Section	BS 1161 or BS 1474	
Aluminium Alloy Drawn Tube	BS 1471	
Aluminium Alloy Plate, Sheet & Strip	BS 1470	
Cepper Alloy Sections	BS 2874	
Cepper Alloy Tubes	BS 2871: Part 2	
Cepper Alloy Sheet, Strip And Foil	BS 2870	
Cepper Alloy Plate	BS 2875	
Fastenings - Wood Screws (Iron)	BS EN 20898-1	
Fastenings - Wood Screws (Brass)	BS 1210	
Fastenings - Bolts, Screws & Nuts	BS EN 20898-1	
Fastenings - Rivets	BS 641 & VS 4620 or as specified	
Expanding Bolts & Nuts	As specified	
Plugs	As specified	
Adhesives	As specified	
Electrodes For Manual Arc Welding	BS 639	

**Note:**

*Evidence to show that the steel supplied conforms to the relevant British Standards shall be furnished to the Officer-in-Charge to his satisfaction. For steel conforming to the specification for Structural Steel of any other country, the relevant specifications shall be forwarded to the Engineer for prior approval.*



### **5.3. Fabrication & Erection - Shopwork**

#### **5.3.1. Preliminaries**

##### **5.3.1.1. 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 and shall generally conform to B.S 449: Part 2 – “specifications for the use of structural steel in Buildings.”

##### **5.3.1.2. Co-Ordination**

The work shall be carried out in co-ordination with the work on related building elements and services. The fabrication/installation drawings showing complete details of the work shall be furnished by the contractor well in advance for checking by the Officer-in-Charge; necessary modifications shall be made and sufficient number of corrected copies shall be furnished to the concerned parties.

##### **5.3.1.3. Samples**

Where directed, the contractor shall furnish samples of the components and obtain approval for the same before proceeding with the fabrication.

##### **5.3.1.4. Inspection**

The Officer-in-Charge shall have access at all reasonable times to all places where the work is being carried out, and shall be provided by the contractor with all the necessary facilities for inspection during construction.

#### **5.3.2. Shop Preparation**

##### **5.3.2.1. Straightness**

All material before and after fabrication, shall be straight unless required to be of curvilinear form, and shall be free from twists.

##### **5.3.2.2. Clearances**

Care shall be taken to ensure that the clearances specified are adhered to. The erection clearance for cleated ends of members connecting steel to steel shall be not greater than 2 mm. at each end. The erection clearance ends of beams without web cleats shall be not more than 3 mm at each end, but where for practical reasons this clearance has to be increased, the seating shall be suitable designed.

Where black bolts are used the holes may be made not more than 2 mm greater than the diameter of the bolts unless otherwise specified.

##### **5.3.2.3. Cutting**

Cutting may be by shearing, cropping, sawing or machine flame cutting. Hand flame cutting may be adopted subject to the approval of the Officer-in-Charge if thermal cutting is permitted for plates which will be subjected to dynamic or fatigue loading, the edges shall be machined. In the case of highly stressed welded joints, thermal cutting shall be controlled to prevent excess hardening. Sheared or cropped edges



shall be dressed to a neat workmanlike finish and be free from distortion where parts are to be in metal-to-metal contact.

#### **5.3.2.4. Holing**

Holes through more than one thickness of material for members such as compound stanchion and grider flanges shall where possible be drilled after the members are assembled and tightly clamped or bolted together. All matching holes for rivets and black bolts shall register with each other so that a gauge 2 mm less than the required diameter of hole will pass freely through the assembled members in a direction at right angles to such members.

Finished holes shall be not more than 2 mm larger in diameter than the diameter of the rivet or black bolt passing through them unless otherwise specified.

When holes are drilled in one operation through two or more separable parts, these parts when so specified by the Officer-in-Charge, shall be separated after drilling and the burrs removed.

Punching may be permitted before assemble when the thickness of material punched is less than 15 mm. The holes punched shall be 2 mm less in diameter than the required size and reamed after assemble to the full diameter.

Holes in connecting angles and plates other than splices, as also in roof members and light framing, may be punched full size through material not over 12 mm thick. This shall not be permitted for close tolerance or barrel bolts.

Where a connection is subject to impact or vibration or to reversal of stress (unless such reversal is solely due to wind) or, where for some special reason such as continuity in rigid framing or precision in alignment of machinery, slipping of bolts is not permissible, then rivets, close tolerance bolts, high strength friction grip bolts or welding shall be used. Holes for close tolerance and barrel bolts shall be drilled to a diameter equal to the nominal diameter of the shank or barrel subject to a tolerance of +0.15 mm and – 0 mm. Parts to be connected with close tolerance bolts or barrel bolts shall preferably be firmly held together by tacking bolts or clamps, the holes drilled through all the thicknesses in one operation and subsequently reamed to size. All holes not drilled through all thicknesses in one operation shall be drilled to a smaller size and reamed out after assembly. Where this is not practicable the parts shall be drilled and reamed separately through hard bushed steel jigs.

Holes for rivets or bolts shall not be formed by a gas cutting process.

#### **5.3.2.5. Flattened Ends Of Tubes**

For welded, riveted or bolted connections, the ends of tubes may be flattened or otherwise formed provided the methods adopted are such as not to injure or deface the material. The change of section shall be gradual.

### **5.3.3. Shop Assemble**



The component parts shall be assembled in such a manner that they are neither twisted nor otherwise damaged, and shall be so prepared that the specified cambers if any are provided.

All tubular members shall be sealed so as to prevent the access of moisture to the inside of the members (see also Clause 9.5.2)

#### **5.3.4. Riveting**

Rivets shall be heated uniformly throughout their length, without burning or excessive scaling, and shall be of sufficient length to provide a head of standard dimensions. They shall when driven, completely fill the holes and if countersunk, the countersinking shall be fully filled by the rivet, and proudness of the countersunk head being dressed off flush if required.

Riveted members shall have all parts firmly drawn and held together before and during riveting, and special care shall be taken in this respect for all single-riveted connections. For multiple riveted connections, a service bolt shall be provided in every third or fourth hole.

Wherever practicable machine riveting shall be carried out by using machines of the steady pressure type.

All loose, burned or otherwise defective rivets shall be cut out and replaced before the structure is loaded, and special care shall be taken to inspect all single-riveted connections.

Special care shall be taken in heating and driving long rivets.

#### **5.3.5. Bolting**

Bolts shall be of sufficient length to have at least one complete thread projecting beyond the outer face of the nut when tightened up.

Washers shall be provided in all cases. Where necessary, washers shall be tapered or otherwise suitable shaped to give the heads and nuts of bolts a satisfactory bearing.

In all cases where the full bearing area of the bolt is to be developed, the bolt shall be provided with a washer of sufficient thickness under the nut to avoid any threaded portion of the bolt being within the thickness of the parts bolted together.

Where a tubular member is drilled to take bolts or studs, provision shall be made to prevent the access of moisture to the interior of the tube. For example, a transverse sleeve can be inserted where a bolt passes through a tube, or grommets can be used under the heads and nuts.

#### **5.3.6. Welding**

##### **General**

Steel shall normally be welded by the metal arc process conforming to B.S 5136. Other methods shall be subject to the approval of the Officer-in-Charge.

Welding of stainless steel, aluminium alloys, copper alloys, bronze etc. and brazing shall conform to the appropriate British Standard where specified, approval and testing of welders, and welding procedures shall be as per BS 4870, BS 4871 and BS 4872. 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:

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

#### **5.3.6.1. Equipment for Welding Of Steel**

##### **Equipment**

The contractor shall be responsible for ensuring that the capacity of welding plant, instruments, cables and accessories is adequate and suitable for the welding procedure to be used and for maintaining all welding plant and ancillary equipment in good working order. The contractor shall also take all necessary safety precautions in connection with the work. All electrical plant in connection with the work shall be adequately earthed. The welding return lead from the work shall be adequate in cross section and shall be correctly connected and earthed.

Adequate means of measuring the current shall be available with the welding plant or a portable ammeter shall be provided.

##### **Electrodes**

The electrodes used for manual metal arc welding shall comply with the requirements of BS 639 or other appropriate standard with the prior approval of the Officer-in-Charge. Electrodes shall be selected having regard to the application i.e. joint design, welding position and the properties required to meet service conditions.

All consumables shall be stored and handled with care and in accordance with the manufacturers' recommendations. Electrodes filler wires, rods and fluxes that show signs of damage or deterioration shall not be used.

Covered electrodes shall be stored in their original packets or cartons in a dry place adequately protected from the effects of the weather. When special protection or other treatment during storage or immediately prior to use is recommended by the manufacturer of the electrodes, they shall be treated accordingly.

#### **5.3.6.2. Butt Welds**

The details of the angle between fusion faces gap between parts etc. shall be as per BS 5135.

The details for a single V-butt weld (without backing) are given below.



The dimensions of the weld preparation may have to be modified for welding in positions other than flat, in which case they should be the subject of arrangement between the contracting parties.

In the as welded conditions the weld face shall be proud of the surface of the parent metal, the butt weld shall be built up so that the thickness of reinforcement at the centre of the weld shall be not less than 10% of the size of the butt weld nor more than 3 mm. See fig. 9/1. Where a flush surface is required, the butt weld shall be first built up as specified above and then dressed flush. When no dressing is to be carried out, the permissible weld profile shall either be as specified or as directed.

a) Full Penetration Butt Welds

Full penetration single V, U, J, bevel or square butt welds shall be completed by depositing a sealing run of weld metal on the back of the joint; else where these or other butt welds are to be welded from one side only, backing material may be used except where it is agreed between the Officer-in-Charge and the contractor that, by the adoption of an approved special method of welding, full penetration will be obtained without the use of backing material.

*Note: It should be noted that under fatigue conditions backing material may be undesirable.*

Backing material shall consist of another steel part of the structure, or of material approved by the Officer-in-Charge. Where backing material is employed, the joint shall be arranged in such a way as to ensure that complete fusion of the parts to be joined is readily obtained.

In all complete penetration butt welds which are to be welded from both sides, the particular welding procedures which allow this to be done without back gouging shall be adopted; but where complete penetration cannot be achieved, the back of the first run shall be gouged out by suitable means to clean sound metal before welding is started on the gouged out side.

b) Partial Penetration Butt Welds

Partial penetration butt welds shall not be allowed unless specially designed in which case; the weld shall have a throat thickness not less than that specified.

**5.3.6.3. Fillet Welds**

A fillet weld as deposited shall be not less than the specified dimensions clearly indicated as throat thickness and/or leg length as appropriate, taking into account the use of deep penetration processes or partial penetration. The effective length of a fillet weld designed to transmit loading shall be not less than 50 mm nor 6 times its leg length.

For concave fillet welds, the actual throat thickness shall be not less than 0.7 times the specified leg length. For convex fillet welds, the actual throat thickness shall be not more than 0.9 times the actual leg length.



Where the specified leg length of a fillet weld at the edge of a plate or section is such that the parent metal does not project beyond the weld, melting of the outer corner or corners which reduces the throat thickness, shall not be allowed.

#### **5.3.6.4. Preparation Of Joint Faces**

If preparation or cutting of the material is necessary, this shall be done by shearing, chipping, grinding, machining, thermal cutting, thermal gouging or machine gas cutting. Edges shall be left free of slag. When shearing is used, the effect work hardening shall be taken into account and precautions shall be taken to ensure that there is no cracking of the edges.

#### **Fusion Faces**

The preparation of fusion faces, angle of bevel, root radius and root face shall be to the required accuracy.

Fusion faces and adjacent surfaces shall be free from cracks, notches or other irregularities which might be the cause of defects or would interfere with the deposition of the weld.

Fusion faces and the surrounding surfaces for a distance of at least 12 mm shall be free from heavy scale, moisture, oil, paint or any other substance which might affect the quality of the weld or impede the progress of welding. This is particularly important when a controlled hydrogen welding process is used.

#### **5.3.6.5. Assembly for Welding**

Parts to be welded shall be assembled such that the joints to be welded are easily accessible and visible to the operator. Welding shall be done in the flat position whenever practicable.

Jigs and manipulators shall be used where practicable so that the welding can be carried out in the most suitable position.

##### **a) Alignment of Butt Joints**

The root edges or root faces of butt joints shall not be out of alignment by more than 25% of the thickness of the thinner material for material up to and including 12 mm thick, or by more than 3 mm for thicker material. For certain applications and welding processes closer tolerances may be necessary.

##### **b) Fit Up Of Parts Joined By Fillet Welds**

The edges and surfaces to be joined by fillet welds shall be in as close contact as possible since any gap increases the risk of cracking, but in no case shall the gap exceed 3 mm.

#### **5.3.6.6. Tack Welds**

Tack welds shall be not less than the throat thickness or leg length of the root run to be used in the joint and shall be subject to the same welding conditions as those specified for the root run. The length of the tack weld shall not be less than four times the thickness of the thicker part or 50 mm whichever is the smaller.

Where a tack weld is incorporated in a welded joint its shape shall be suitable for incorporation in the finished weld and it shall be cleaned and fused thoroughly with the



final weld. Cracked, broken or otherwise defective tack welds shall be removed before final welding.

#### **5.3.6.7. Identification**

When specified by the Officer-in-Charge adequate means of identification, either by an identification mark or other record, shall be provided to enable each weld to be traced to the welder (s) by whom it was made.

#### **5.3.6.8. Inspection & Testing**

The Officer-in-Charge shall have access to the contractor's work at all reasonable times, and the contractor shall provide him with all facilities necessary for inspection during manufacture and on completion.

Welds showing cavities or in which the weld metal tends to fall over the parent metal without proper fusion shall be cut out and re-welded to the satisfaction of the Officer-in-Charge. Care shall be taken to avoid under cutting of the base metal along the weld edges and where serious undercutting occurs the reduction shall be made good to the satisfaction of the Officer-in-Charge.

Where specified for important works, radiographic or ultrasonic testing procedures shall be carried out to the satisfaction of the Officer-in-Charge.

Finished welds and adjacent parts shall be protected with clean boiled linseed oil after all slag has been removed.

Welds shall not be painted or otherwise obscured until they have been accepted by the Officer-in-Charge.

#### **Quality of Welds**

Welds joints shall be free from defects that would impair the service performance of the construction.

#### **5.3.6.9. Correction Of Faulty Welds**

Where welds do not comply with the requirements of the Clauses above, the defective portions shall be cut over they shall then be re-welded and re-inspected in accordance with this standard. Where serious undercutting of the base metal along the weld edges is noticed, the education shall be made good to the satisfaction of the Officer-in-Charge.

#### **5.3.7. Machining Of Butts, Caps, & Bases**

Stanchion splices and butt joints of compression members dependent on contact for the transmission of compressive stresses shall be accurately prepared to butt so that the permitted stress in bearing is not exceeded nor eccentricity of loading created which would induce secondary bending in the members. Stanchion caps and bases shall be prepared in a similar manner to the above, and where this is obtained by machining, care shall be taken that any attached gussets, connecting angles or channels are fixed with such accuracy that they are not reduced in thickness by more than 2 mm.

#### **5.3.8. Slab Bases & Caps**



Slab bases and slab caps, except when cut from material with true surfaces, shall be accurately machined over the bearing surfaces and shall be in effective contact with the end of the stanchion. A bearing face which is to be grouted direct to a foundation need not be machined if such face is true and parallel to the upper face.

To facilitate grouting, holes shall be provided where necessary in stanchion bases for the escape of air.

**5.3.9. Marking**

Each piece of steel work shall be distinctly marked before delivery in accordance with a marking diagram, and shall bear such other marks as will facilitate erection.

**5.3.10. Painting**

All surfaces which are to be painted, oiled or otherwise treated shall be dry and thoroughly cleaned to remove all loose scale and loose rust; all other steel worked shall be given one coat of red oxide of iron paint at the earliest possible opportunity. During the process of erection and subsequently until the work is completed the contractor shall maintain these protective coats.

Shop contact surfaces need not be painted unless specified. If so specified, they shall be brought together while the paint is still wet.

Surfaces not in contact, but inaccessible after shop assembly, shall receive the full specified protective treatment before assembly. This does not apply to the interior of sealed hollow sections.

All faces to be riveted or bolted together shall be painted before assembly.

In the case of surfaces to be welded, the steel shall not be painted or metal coated within a suitable distance of any edges to be welded if the paint specified or the metal coating would be harmful to welders or impair the quality of the welds.

Welds and adjacent parent metal shall not be painted prior to de-slugging, inspection and approval.

Parts to be encased in concrete shall not be painted or oiled.



#### **5.4. Erection - Site Work**

##### **5.4.1. Plant & Equipment**

The suitability and capacity of all plant and equipment used for erection shall be to the satisfaction of the Officer-in-Charge.

##### **5.4.2. Storing & Handling**

All structural steel at the site shall be stored and handled so that members are not subjected to excessive stresses, damage deformation etc.

##### **5.4.3. Permission**

The erection of steel work shall be started only after obtaining the permission of the Officer-in-Charge.

##### **5.4.4. Setting Out**

The positioning and levelling of all steel work, the plumbing of stanchions and the placing of every part of the structure with accuracy shall be in accordance with the approved drawings and to the satisfaction of the Officer-in-Charge.

##### **5.4.5. Security during Erection**

The work may be erected in suitable units as may be directed by the Officer-in-Charge. Fabricated members shall be lifted at such points as will avoid the deformation or excessive stress in members.

The structures or part of it placed in position shall be secured against overturning or collapse by suitable means.

During erection the work shall be securely bolted or otherwise fastened and if necessary temporarily braced, so as to make adequate provision for all erection, stresses and conditions, including those due to erection equipment and its operation. Neither riveting, permanent bolting nor welding shall be done until proper alignment has been obtained.

##### **5.4.6. Modification to Fabrication**

Modification to fabricated steel work which would involve cutting, welding etc. must not be made without the prior approval of the Officer-in-Charge.

##### **5.4.7. Painting after Erection**

All surfaces to be painted shall be dry and thoroughly cleaned from all loose scale and rust.

The specified protective treatment shall be completed after erection. All rivet and bolt heads and site welds after de-slugging shall be cleaned. Damaged or deteriorated paint surfaces shall first be made good with the same type of paint as the shop coat. Where specified, surfaces which will be in contact after site assembly shall receive a coat of paint (in addition to any shop priming) and shall be brought together while the paint is still wet.

Where the steel has received a metal coating in the shop, this coating shall be completed on site so as to be continuous over any welds and site rivets or bolts. Protection may be completed by painting on site in lieu of metal coating subject to the approval of the Officer-in-Charge. Bolts which have been galvanized or similarly treated are exempted from this requirement.



Site painting should not be done when humidity is such as to cause condensation on the surface to be painted. Please also see clause 15.8

**5.4.8. Bedding Of Stanchion Bases & Bearing Of Beams & Girders On Stone, Brick or Concrete (Plain or Reinforced)**

Bedding shall be carried out with Portland cement grout or mortar or fine concrete.

For multi-storied buildings this operation shall not be carried out until a sufficient number of bottom lengths of stanchions have been properly line, leveled and plumbed and sufficient floor beams are in position.

Whatever method is employed, the operation shall not be carried out until the steel work has been finally levelled and plumbed, the stanchion bases being supported meanwhile by steel wedges and immediately before grouting the space under the steel shall be thoroughly cleaned.

The belt holes and space beneath column base plates shall be filled with grout or mortar of specified below:

- a) Space not deeper than 25 mm neat cement slurry to as thick a consistency as possible and pured under a suitable pressure head.
- b) Spaces between 25 mm and 50 mm deep; A mortar of cement and fine aggregate in the proportion of 1.1, just fluid enough to pour, poured under a suitable head and tamped as filling proceeds.
- c) Spaces over 50 mm deep: A damp dry mortar of cement fine aggregate 1:2 well tamped against properly fixed forms as filling proceeds.

**5.4.9. Encasing of Steelwork in Foundations & Filling between Grillage Beams**

Grillage beams and all steel in foundations shall be solidly encased in dense concrete of structural Gr. 20 (10 mm) with a minimum cover of 100 mm.

**5.4.10. Erection of Trusses**

Trusses shall be lifted only at nodes. The trusses above 10 m in span shall not be sligned at the apex, as this will develop compression stresses in the bottom tie member. They shall be lifted by slinging at two mid points of rafters, which shall be temporarily braced by a wooden member of a suitable section. After the trusses are placed in position, purlings and wind bracings shall be fixed as soon as possible.

The end of the truss which faces the prevailing winds shall be fixed with holding down bolts, and the other end kept free to move. In case of trusses of spans upto 10 m the free end of the truss shall be laid on lead sheet or steel plate as per design, and the holes for holding down bolts shall be made in the form of oblong slots, so as to permit the free movement of the truss end. For larger spans, the truss shall be provided with bearing as per design.



## **5.5. Rolling Shutters**

### **General**

Rolling steel shutters shall be the product of an approved and recognized manufacturer regularly engaged in the production of the type of shutters required. Standard commercial products, which meet the general requirements of the specifications and vary only in non-essential details, shall be accepted subject to the approval of the Officer-in-Charge. These shall include necessary locking arrangements and handles etc. These shall be suitable for fixing in the specified location and position i.e. outside or inside on or below lintel or between jambs of the opening. The doors shall be either push and pull type or operated manually or mechanically with a suitable gear mechanism.

#### **5.5.1. Shutters**

These shall consist of mild steel laths 1 21 mm thick (18 G) and 80 mm wide or as specified. The laths shall be machine rolled from a continuous strip into an easy curve free from crimps or sharp bends and with an effective bridge depth of 16 mm. These shall be interlocked together throughout their entire length and jointed at the ends with end locks designed in such a way as to maintain alignment and protect the slats against abrasion in the guides. All joints shall be completely air and weather tight.

The shutter shall be supported by means of spring barrels which in turn are supported by cast iron or steel brackets. The shutter slats shall coil on the spring barrel. A galvanized steel sheet hood not lighter than 1.5 mm G reinforced as for the end closures for the hood.

The spring shall be preferably of coiled type and shall be manufactured from high tensile spring steel wire or strip of adequate strength to balance the shutters in all positions.

#### **5.5.2. Guide Channels**

The guide channel shall be a mild steel deep channel section of rolled, pressed or built up (fabricated) construction. The thickness of the sheet used shall not be less than 3 mm. The minimum depth for guide channels shall be as follows:

Clear width of Shutter	Depth of Guide Channel
Under 3.5 m	60 mm
3.5m and above	75 mm

The gap between the two legs of the guide channel shall be sufficient to allow the free movement of the shutter and at the same time close enough to prevent the rattling of the shutter due to wind.

Each guide channel shall be provided with a minimum of three fixing cleats or supports for attachment to walls or columns by means of bolts or screws. The spacing of cleats shall not exceed 750 mm. Alternatively the guide channels may be provided with suitable dowels, hooks, or pins for embedding in the walls.

#### **5.5.3. Fixing**

The installation shall be mounted plumb, square and true on the vertical surface of lintels and/or masonry. When completed, the door shall completely fill the opening for which it was designed and shall not obstruct the opening when in the open position. The shutters shall operate easily and smoothly under all conditions.



## **5.6. Tubular Roofs & Columns**

### **5.6.1. Structural Steel Tubes**

These shall conform to B.S. 1775 and shall be one of the following types:

- I. Hot finished welded (HFW) type.
- II. Hot finished seamless (HFS) type
- III. Electric resistance welded (ERW) type.

The steel shall contain:

- I. Not more than 0.06 per cent Sulphur
- II. Not more than 0.06 per cent Potassium

The steel shall have a yield strength of 209 N/mm<sup>2</sup> or as specified. The sizes of tubes and wall thickness shall be as specified.

### **Tolerances**

These shall be in conformity with BS 1775 for each type of Tube. The tubes shall not deviate from straightness by more than 1/600 of any length. Tubes shall be cleanly finished and reasonably free from scale. They shall be free from crack, surface flaws, lamination and other defects. The ends shall be cut clean and square with the axis of the tubes unless otherwise specified. Where Galvanized tubes are specified these shall be not dip galvanized and in conformity with the requirements of BS 1775.

### **Minimum Wall Thickness of Tubes**

Structural tubes shall have the minimum wall thickness indicated below depending upon the exposure.

Construction not exposed to weather	3.2 mm
Construction exposed to weather	4.0 mm
Structures not readily accessible for Maintenance	5.0 mm

### **5.6.2. Fabrication**

This shall conform to the requirements of clause 9.2.

### **Caps & Bases For Column**

The ends of all the tubes for columns, transmitting loads through the ends, shall be true and square to the axis of the tube and shall be provided with a cap or base accurately fitted to the end of the tube and screwed, welded or shrunk on. The cap or base plate shall be true and square to the axis of the column.

### **Sealing of Tubes**

When the end of a tube is not automatically sealed by virtue of its connection by welding to another member, the end shall be properly and completely sealed. Before sealing, the inside of the tube shall be dry and free from loose scale.

### **Flattened Ends**

In tubular construction the ends of tubes may be flattened or otherwise formed to provide for welded, riveted or bolted connections provided that the methods adopted for such flattening do not injure the material. The change of sections shall be gradual.

### **5.6.3. Hoisting & Fixing**

Shall conform to 8.3.



## **5.7. Steel Doors, Window, Ventilators & Composite Units**

### **General**

The type, overall sizes and location of steel door window and ventilators shall be either as shown on the drawings or as per details given by the Officer-in-Charge. For doors, the provision of the threshold or the tie-bar at the bottom of the door frame shall be as specified or as directed. (Usually external doors are provided with threshold and the internal doors with tie bars.)

The actual sizes of doors, windows and ventilators shall not vary by more than 1.5 mm from the dimensions given in the drawings. Where these are not built into the wall construction, the openings shall allow 12 mm clearance around to facilitate easy installation later on.

### **5.7.1. Materials**

Cold rolled steel sections made from steel sheet conforming to BS 1449: Part I.

### **5.7.2. Protection**

Rust proofing and protective finishes shall be as specified.

### **5.7.3. Workmanship**

The fabrication, erection, glazing and finishing shall conform to the following standards.

BS 1245	Metal door frames (steel)
BS 990: Part 2	Steel windows generally for domestic and similar buildings
BS 1767	Steel windows for industrial buildings
BSCP 152	Glazing and fixing of glass for buildings

## **5.8. Aluminium Framed Sliding Glass Doors**

These shall be made of extruded Aluminium alloy sections anodized to Grade AA 25 as per BS 1615 or as specified mechanically jointed and erected and finished conforming in all respects to BS 5286.

## **5.9. Aluminium Windows**

These shall be made of extruded aluminium alloy sections anodized to Grade AA 25 as per BS 1615 or as specified, mechanically jointed, erected and finished conforming in all respects to BS 4873.



## **6. MASONRY**

### **6.1. Materials**

- 6.1.1. Material used for masonry and plastering work shall conform to Section 3 - CONCRETE WORKS.
- 6.1.2. Masonry work shall be done with bricks or blocks of approved quality unless specified otherwise.
- 6.1.3. The blocks shall be free from excessive amounts of salt or other impurities and shall be inspected and approved by the Consultant.

### **6.2. General**

#### **6.2.1. Execution Drawing**

- 6.2.1.1. Work shall be complied with this specification unless otherwise stated on particular Specification or Drawings. Any work not specified shall be discussed and directed by the Consultant.

#### **6.2.2. Stake-Board**

- 6.2.2.1. Stake-board shall be provided at each 5m in length and shall be inspected by the Consultant for the accuracy, firmness and secureness. However, suitable ruler, plumb bob and leveler shall be provided for minor performance of cement block and bricks.

#### **6.2.3. Transportation and storing**

- 6.2.3.1. Care shall be taken for damage during transportation of materials and any defect of natural finished concrete blocks or bricks shall be rejected.

#### **6.2.4. Curing**

- 6.2.4.1. Any shock or load shall not be applied until concrete mortar or other fills hardened. Comer, projection and top of cement block or brick work shall be protected from rain, dryness, cold, damage and stain by covering.
- 6.2.4.2. Void between blocks or bricks shall not be intruded by rainwater.

### **6.3. Block work**

#### **6.3.1. Material**

- 6.3.1.1. Blocks shall be of standard quality low permeability blocks with no defects and sample shall be submitted for approval of the Consultant.
- 6.3.1.2. Blocks shall be aerated blocks 150 mm thick for external walls and 100 mm thick for internal walls or as specified in the drawings. The average compression strength should be not less than 2.8N/mm<sup>2</sup> and shall comply with physical requirements of ISO 6073:1981.

#### **6.3.2. Placing Blocks & Bricks**

- 6.3.2.1. Cement blocks shall be saturated with water and joint shall be cleaned.
- 6.3.2.2. Bonding mortar shall be used immediately after mix, and mixed mortar left for more than one hour shall be rejected.
- 6.3.2.3. Vertical and horizontal joint of blocks shall be filled completely and suitable with mortar on line shall not be moved or rearranged. Joint and surface of block of exposed finished block wall shall be cleaned immediately after joint is filled.
- 6.3.2.4. In case concrete block wan is attached to structural concrete, block wan shall be placed before concreting structure.



- 6.3.2.5. Mortar for joint shall be touched with steel trowel before hardened and exposed joint shall be finished with uniform width and planned without roughness or cavity.
- 6.3.2.6. Height for placing block per day shall be maximum 1.2 m unless otherwise specified.
- 6.3.2.7. Blocks shall be placed with cavity side under.

#### 6.3.3. Joints

- 6.3.3.1. The thickness of joints shall not exceed 10 mm and the joints shall be rated (13 mm dup.) when the mortar is still floor, so as to provide for proper bond for the plaster. Any mortar which falls on the floor from these joints or removed due to raking of joints shall not be reused.

#### 6.3.4. Lintel

- 6.3.4.1. Lintel shall be reinforced concrete as approved or directed by the Consultant.
- 6.3.4.2. Main reinforcing bar shall be anchored more than 40D (40 x diameter of the bar) at both end.
- 6.3.4.3. In case lintel is prefabricated, shop drawing shall be submitted for approval of the Consultant.

#### 6.3.5. Frame of Opening

- 6.3.5.1. In case frame is temporarily installed before placing of blocks, frame shall be firmly placed and joiner shall be bonded with mortar as placing each block at side and top of frame.
- 6.3.5.2. In case frame is installed after placing of blocks, joiner shall be bonded with additional mortar at space or every two blocks or more.
- 6.3.5.3. Back of frame shall be filled and compacted with mortar by providing shuttering board.
- 6.3.5.4. Wood plug and anchor bolt shall be covered with mortar or concrete.

#### 6.3.6. Piping

- 6.3.6.1. Principally, piping shall not be placed in block wall unless piping block is in use.
- 6.3.6.2. In case electric conduit pipe is placed in cavity of concrete blocks, care shall be taken not to obstruct reinforcing bar, and cavity shall be completely filled.
- 6.3.6.3. In case chipping and piping on face of blocks is unavoidable, performance shall confirm to instruction of the Consultant.
- 6.3.6.4. Joiner and supporter for exposed piping shall be buried at joint which back is filled or otherwise approved by the Consultant.



## 7. PLASTERING

### 7.1. General

- 7.1.1. All masonry walls shall have smooth finished cement plaster on both sides with a surface setting coat of neat cement applied within an hour of the completion of rendering.
- 7.1.2. Cement rendering to floor shall be same as above.

### 7.2. Materials and Storage

- 7.2.1. Plaster materials which are affected by moisture such as plaster and cement shall be stored properly.
- 7.2.2. Materials used for plastering shall conform to those of Section 3 - Concrete Works. Grading of sand, however, shall be as in table below:

Grading of sand	Mortar plastering	Plastering
5mm sifting thorough 100%	for first coat	for first coat and dubbing out
0.15mm sifting less than 10%	for finish coat	
2.5mm sifting through 100%	for finish coat	for second coat
0.15mm sifting less than 10%		

- 7.2.3. White cement or filler or similar shall confirm to the requirements of Portland cement, BS.12.
- 7.2.4. The use of mixtures shall be approved by the Consultant's representative. The amount of admixture shall be such that it affects mortar strength very little.

### 7.3. Mixing ratio

- 7.3.1. Mixing volume ratio of mortar shall be as in table below:

Base	Area of Application	First Coat Cement:Sand	Dabbing Out Cement:Sand	Finish Coat Cement:Sand
Masonry Blocks	Floor	-	-	1:4
	Interior Wall	1:4	1:4	1:4
	Exterior Wall	1:4	1:4	1:4

### 7.4. Thickness of Coating

- 7.4.1. Standard thickness of coating (mm)

Base	Area of Application	First Coat	Dabbing Out	Second Coat	Total
Masonry Blocks	Floor	-	-	-	As per dwg
	Interior Wall	15mm	-	-	15mm
	Exterior Wall	10mm	-	10mm	20mm

- 7.4.2. Thickness of coating shall be standard thickness of coating unless otherwise indicated on the Drawings.
- 7.4.3. All concrete / masonry interfaces shall be properly water proofed with a water proof plaster or as approved.

### 7.5. Finish

- 7.5.1. Type of finish and work schedule

Type	Work Schedule	Notes
Smooth Trowel finish	1. Shall be applied flat by metal trowel 2. Shall be finished by pressing with	Before applying second coat, corner and edge shall be screed well.
Wooden float finish	Shall be applied by wooden float	



## **7.6. General Preparation**

- 7.6.1. Remove efflorescence, laitance, dirt and other loose material by thoroughly dry brushing.
- 7.6.2. Remove an traces of paint, grease, dirt and other materials incompatible with coating by scrubbing with water containing detergent and washing off with plenty applying coatings unless specified otherwise.
- 7.6.3. Insitu Concrete Surfaces: Scrub with water containing detergents to ensure complete removal of mould oil, surface retarders and other materials in compatible with coating. Rinse with clean water and allow to dry unless specified otherwise.
- 7.6.4. Organic Growths: Treat with fungicide to manufacturer's recommendations and brush off.
- 7.6.5. Hacking for Key: roughen specified surfaces thoroughly and evenly by removing the entire surface to a depth of 3mm by scabbing, bush hammering or abrasive blasting. Clean surfaces by washing and brushing.
- 7.6.6. Smooth Concrete Surfaces: where no keying or mix or is specified, apply a bonding agent before plastering.

## **7.7. External Plastering**

- 7.7.1. Dissimilar Solid Backgrounds for Plastering: where plaster is to be continued without break across joints between dissimilar solid backgrounds which are rigidly bonded together, cover the joints with a 200mm wide mesh strip (back grounds in the same plane) or with the corner mesh ( internal angle) fixed at not more than 600mm centers along both edges, unless specified or otherwise.
- 7.7.2. Dissimilar Solid Backgrounds for Plaster: where plaster is to be continued without break and without change of plane across the face of a 300mm and rigidly bonded to the background.
  - 7.7.2.1. Cover the face of the column /beam/lintel with building paper extending 25mm on the adjacent background.
  - 7.7.2.2. Over lay with expanded metal lathing extending 50mm beyond the edges of the paper and securely fixed with masonry nails at not less than 100mm centers along both edges.
  - 7.7.2.3. Alternatively, an approved paper and mesh lathing may be used.
- 7.7.3. Dissimilar Solid Backgrounds for Rendering: where rendering is to be continued without break across joints between dissimilar solid backgrounds which are in the same plan and rigidly bounded together, cover joints with an 150mm wide strip of building paper overlaid with 300mm wide metal lathing fixed at not more than 600mm centers along both edges unless specified otherwise.
- 7.7.4. Service Chases: cover with steel mesh strip fixed at not more than 600mm centers along both edges.
- 7.7.5. Conduits bedded in under coat to be covered with 90mm wide jute scrim budded in finishing coat mix, pressed flat and trowelled in. Do not lap ends of scrim.

## **7.8. Internal Plastering**

- 7.8.1. Accuracy of plaster 20mm thick or more: maximum permissible gap between an 1800mm straight edge and any point on the surface to be 3mm.
- 7.8.2. Dubbing Out: if necessary to correct inaccuracies, dub out in thickness of not more than 10mm in same mix as first coat. Allow each coat to set before the first is applied Cross scratch surface of each dubbing out coat immediately after set.
- 7.8.3. Metal Mesh Lathing: Work undercoat well in to interstices to obtain maximum key.



- 7.8.4. Under Coats: generally to be not less than 10mm with thickness greater than 20mm applied as two equal coats. Rule to even surfaces and cross scratch - end coat to provide a key for the next hand applied coat.
- 7.8.5. Cement Based Under Coats: all to dry out thoroughly but not rapidly, to ensure that drying shrinkage is substantially complete before applying next coat.
- 7.8.6. Dissimilar Backgrounds: where scrim or lathing or beads are not specified, cut through plaster with a fine blade in a neat, straight line at junctions of:
  - 7.8.6.1. Plastered rigid sheet and plastered solid backgrounds.
  - 7.8.6.2. Dissimilar solid backgrounds.
- 7.8.7. Smooth Finish: trowel or float to product a tight matt, smooth surface with no hollows abrupt change of level or trowel marks. Do not use water brush and avoid excessive trowelling and over polishing.

## **7.9. External Rendering**

- 7.9.1. Dubbing Out: if necessary to correct inaccuracies, dub out in thicknesses of not more than 10mm in same mix as first coat. Allow each coat to dry before the next is applied. Cross scratch surface of each dubbing out coat immediately after set.
- 7.9.2. Under Coats for hand applied finishes:
  - 7.9.2.1. Apply first undercoat or dubbing out coat by throwing from a trowel.
  - 7.9.2.2. Coats to be no less than 10mm thick, with thickness greater than 16mm applied as two equal coats. On weak backgrounds, first under coat to be not less than 10mm thick.
  - 7.9.2.3. Brush down each under coat to remove dust and loose particles and wet thoroughly before application of next coat.
  - 7.9.2.4. Cross scratch under coat without penetrating the coat, to provide key for following coat(s).
- 7.9.3. Drying: Keep each coat damp for the first three days by covering with polythene sheet and/or spraying with water. Thereafter prevent from drying out too rapidly. Work in shade whenever possible.
- 7.9.4. Allow each coat to dry out thoroughly to ensure that drying shrinkage is substantially complete before applying next coat.
- 7.9.5. Playing Floated Finish: Finish with wood or other suitably faced float to give an even texture.
- 7.9.6. Do not draw excessive laitance to surfaces.

## **7.10. Metal Mesh Lathing / Reinforcement For Plastered/Coatings.**

- 7.10.1. Lathing to be provided as reinforcement for plastering in columns, walls or as specified in drawings.
- 7.10.2. Products:
  - 7.10.2.1. Plain Expanded Metal Lathing: To B.S 1369 with a minimum weight of 1.9kg/mm<sup>2</sup>. (Manufacturer to get approval of the Consultant)
  - 7.10.2.2. Wire Ties: Unless other specified, annealed iron, galvanized to B.S 443.
  - 7.10.2.3. Clout Nails: galvanized steel or stainless steel nails to B.S 1202: Part 1, table 3.
  - 7.10.2.4. Staples: Galvanized steel wire staples to B.S 1494: Part 2.
- 7.10.3. Workmanship



- 7.10.3.1. Framing: fix securely and accurately to help ensure that coatings on lathing, when finished, are true to line and level, within specified tolerances and free from cracks, rippling, hollows, ridges and sudden changes of levels.
- 7.10.3.2. Runners/Bearers spanning between concrete beams/ribs: fix with 3mm wire ties twisted around 38 mm X 10 gauge screws driven well into fixing blocks or plugs in sides of beams/ribs.
- 7.10.3.3. Wire Ties: .twisted ends tightly together,-cut off surplus and-bend ends of wire away from face of coating.
  - a) Plain Expanded Metal Lathing:
  - b) Stretch lathing and fix securely in accordance with manufacturers recommendations to give a taut, firm base for plaster/ rendering.
  - c) Fix with the long way of the mesh at right angles to supports and with all strands sloping in the same direction.
  - d) Lap side edges not less than 25mm. Lap ends 50mm at supports and 75mm between supports. Laps must not occur within 100mm of angles or bends.



## **8. CARPENTRY AND JOINERY**

### **8.1. Materials**

- 8.1.1. Timber shall be in accordance with the requirements of BS 1186 'Quantity of Timber and Workmanship in Joinery', Part 1, 'Quality of Timber'.
- 8.1.2. Timber and timber products shall be subject to the inspection and approval of the Consultant.
- 8.1.3. Timber shall be seasoned to stable moisture content compatible with the finished use, straight and true and free from wind, warp and distortion and in lengths suitable for the members required.
- 8.1.4. All timber shall be in long lengths and laps, scars or splices shall be over a bearing surface. Where obtainable, finishing timber exposed to view shall be in single lengths.

### **8.2. Preservation of Timber**

- 8.2.1. All timber shall be treated for insect attack and is to be of the correct moisture content and free from surface moisture content and dirt.
- 8.2.2. All rafters, purlins, framing scribe pieces, wall plates, and trusses etc. shall be treated for insect attack with approved timber preservative. No extra payment shall be made for such coating and will be considered inclusive in the rate of the respective item in the BOQ.
- 8.2.3. Treatment shall be- carried out after all cutting and shaping is completed.

### **8.3. Hardware**

- 8.3.1. Hardware shall be standard quality and samples shall be submitted to the Consultant for approval.
- 8.3.2. All hinges shall be stainless steel or brass and shall be approved by the Consultant.
- 8.3.3. The dimensions and quality of hardware shall meet the requirements and shall not be rested, deformed or defective.

### **8.4. Dimensions and Finish**

- 8.4.1. All dimensions of timber given are finished dimensions.
- 8.4.2. All elements and others of structural nature, which are exposed, must be machine planed to a smooth finish.
- 8.4.3. All unexposed timber shall be machine planed to a rough finish.
- 8.4.4. All joinery work shall be dressed on all four sides and hand dressed where necessary and sanded to all exposed surfaces. All arises in any way accessible shall be sanded and smoothed off.

### **8.5. Workmanship**

- 8.5.1. All connection whether nailed, screwed glued, mortised or dove-tailed shall be accurately made and properly executed to provide sound, satisfactory connections for the class of work required.
- 8.5.2. Timbers containing defects or distortions shall not be used.
- 8.5.3. All joinery shall be manufactured by skilled tradesman with accurate tolerances and set out and with tools, jigs, machines and equipment appropriate for the work.
- 8.5.4. Assembly of the joinery units and joinery frames, etc. shall be by means of glued connections appropriate to the work - mortise and tendon, housing and doweling, etc. where practicable including the use of glued blocks wherever required. Nailing, screwing shall only be used with prior approval of the Consultant; corrugated fasteners shall not be used for effecting connections.



## **9. FINISHES**

### **9.1. General**

- 9.1.1. Glazed Ceramic Tile shall comply with British Standard specification No. 1281 and shall be approved sizes as shown on Drawings and the product of a reputable manufacturers approved by the Consultant.
- 9.1.2. Unglazed Ceramic Tile shall comply with the requirements of British Standard No.1286 and shall be of approved sizes as shown on the drawings and the product of a reputable manufacturer.
- 9.1.3. Glazed Terra-cotta Tile shall comply with the requirements of British Standard and shall be of approved sizes as shown on the drawings and the product of a reputable manufacturer.
- 9.1.4. Natural sandstone flooring shall comply with the requirements of British Standard (BS5385) and shall be of approved sizes shown on drawings and the product of a reputable manufacturer and shall be installed to manufacturer specifications.
- 9.1.5. Slate flooring shall comply with the requirements of British Standards and shall be approved sizes and the product of reputable manufactures and shall be installed to manufacturer specifications.

### **9.2. Manufacturers**

- 9.2.1. Tiles, slate and sandstone from manufacturers not specified shall only be used with prior written approval of the Consultant.

### **9.3. Ceramic and Vitreous Tile Materials**

- 9.3.1. Ceramic and Vitreous clay Wall Tiles:
  - 9.3.1.1. All tiles for wall installation shall have cushion edge, impervious porcelain and highly glazed surface. Colours shall be as selected by the Consultant and shall include trimmers, comer pieces, bullnose and all other special shapes indicated or required. All this shall be free from flaws, cracks and crazing.
- 9.3.2. Floor Ceramic and Vitreous Tiles
  - 9.3.2.1. Non-slip ceramic tile for shall be used on all floor locations. Floor tiles shall be specially prepared for floor use but shall have all the qualities of ceramic tiles listed above for wall use.

### **9.4. Mortar Materials**

- 9.4.1. Standard brand of light gray or white Portland Cement as specified in drawings, conforming to current British Standard specifications shall be used.
- 9.4.2. Sand: shall be clean, sharp, river sand, conforming to British Standard Specifications and graded fine to coarse within the following limits: 100% passing 8 sieve, 90% to 100% passing 16 sieve, 60% to 90% passing 30 sieve, 25% to 55% passing 50 sieve and 0% to 15% passing 100 sieve.

### **9.5. Cement Colour**

- 9.5.1. Dry cement colour, chemically inert, non-fading, alkali-fast, mineral pigment, as approved shall be used wherever refinished.

### **9.6. Waterproofing**

- 9.6.1. Floors of toilet areas, corridors, terrace area and planter boxes shall be treated with an appropriate water proofing coating, approved by the Consultant.



## **9.7. Installation Requirements**

- 9.7.1. Construct a mock-up in area indicated by Architect, not less than 5ft by 5ft (1.5mX 1,5m), to serve as a standard of appearance of workmanship for the installation. Approved mock-up may remain as part of the work or may be demolished and removed upon completion of slate and tile flooring work.
- 9.7.2. As far as possible, tile layout work should be in such a way that no tiles less than half size occurs.
- 9.7.3. Align joints in wall tile vertically and horizontally except where other patterns are shown or specified, Align joints in floor tiles at right angles to each other straight with walls to conform to the patterns selected.
- 9.7.4. Verify locations of accessories before installing tiles. Work shall be coordinated with plumbing and other trades before starting of tile work.
- 9.7.5. Installation of ceramic and vitreous tile shall be in accordance with manufacturer's instructions.

## **9.8. Floor Tile Installation**

- 9.8.1. All ceramic and vitreous clay tile floors shall be -in Portland cement setting beds. Concrete surfaces shall be cleaned and surface of concrete shall be wetted prior to placing of setting bed mortar. Tiles shall be immersed in water for minimum of 4 hours before laying.
- 9.8.2. Setting Bed Mortar Mix: shall consist of one (1) part Portland cement and two (2) parts dry sand, by volume, to which not more than 1/10 part of hydrated lime may be added.
- 9.8.3. When mixed with water, the mortar mix shall be of such consistency and workability as to produce maximum density. Determine consistency by stroking the mortar surface with a trowel. Whereof correct consistency, the trowled surface readily assumes a smoothed, slickened appearance.
- 9.8.4. Spread setting bed mortar and screed to provide smooth, dense beds with true planes pitched to drains. The thickness of bed shall be such that the floor tile will finish flush with adjacent finished flooring, but bedding shall have average thickness of 38mm.
- 9.8.5. After bed has set sufficiently to be worked over, trowel or brush a thin layer, 3mm in thickness, of neat Portland cement paste over the surface of the back of tile.
- 9.8.6. Do not prepare larger setting bed than can be covered with tile before the mortar sets.
- 9.8.7. Press tile firmly into the bed tapping with wood blocks to obtain firm bedding of total tile area and a smooth top surface.
- 9.8.8. All tile shall be properly aligned with straight joints in even widths. Joints width shall be determined by spacers on ceramic tiles. Tamping shall be completed within one (1) hour after placing tile. Adjust work out of the line within this period.
- 9.8.9. Tiles shall be fitted closely around pipes running through walls and floors. Pitch floors to drains.

## **9.9. EPDM Flooring Installation**

- 9.9.1. All EPDM rubber flooring shall be laid on concrete, asphalt or stone floor with plain surface.
- 9.9.2. Proper drain slope surface to drain out rain water from surface on either side shall be provided.
- 9.9.3. Edge wall skirting around the EPDM rubber flooring area above specified height EPDM rubber floor thickness shall be provided.
- 9.9.4. Proper inspection of surface should be made for any type cracks, dirt, dust, oil or grease, moisture on surface.
- 9.9.5. EPDM rubber flooring works shall be done only after play equipment are installed on site.
- 9.9.6. The EPDM tile should have a minimum thickness of 25mm.
- 9.9.7. EPDM rubber should be colourfast and the PU binding agent must be UV resistant.



#### **9.10. Turf Flooring Installation**

9.10.1. The turf should have the following specifications:

Pile Height: 55mm

Gauge: 5/8 inch

Dtex: 15000

Backing: Double PP+Latex Net

9.10.2. The joints of the laid turf shall be 20cm between the lines 30cm wide and glued with the help of Helmetin glue.

9.10.3. Adhesive used in Helmetin gland shall be polyurethane based double component.

9.10.4. 6–9 kg / m2 Black S.B.R Granule shall be laid on the sand.

#### **9.11. Wall Tile Installation**

9.11.1. Base Plaster 13mm thick applied to masonry wall shall be one-part Portland cement, three parts of river sand by volume. Where additional thickness build-up is required to conform to indicated lines, apply as separate coat at no cost to employer.

9.11.2. Setting bed of tiles shall be done with cement slurry. The thickness of slurry bed shall be 3mm thick minimum for setting tiles and walls.

9.11.3. Installation of tiles shall be in accordance with standards and applicable requirements previously specified for floor tile.

9.11.4. Tiles shall be installed in perfect vertical plumb and as per the pattern and joints as shown on drawings.

#### **9.12. Grouting**

9.12.1. Grouting shall not commence for at least 24 hours after placing of tiles.

9.12.2. Grout for floor and wall ceramic and vitreous tiles shall be waterproof, neat white Portland cement with dry cement colour added as directed by the Consultant. If white grout is selected, cement shall be white.

9.12.3. Grout mixed to a creamy consistency in accordance with manufacturer's directions shall be used for joint filling. Maximum width of joints shall be 3mm.

9.12.3.1. Force maximum grout into the joints with trowel. Before grout sets, strike or tool joints to base of cushion and fill all skips and gaps. Do not permit setting bed materials to show through grouted joints.

9.12.3.2. Cure grout joints by maintaining damp condition for three (3) days by sponging down, or other methods approved by the Consultant. Allow floors to set 48 hours before permitting ordinary foot traffic.

#### **9.13. Defects in Tiles and Tile Laying**

9.13.1. The surface of all tiled floors shall be perfectly in level and shall be executed by experienced workers in the field of tile laying.

9.13.2. A sample panel of laid tiles of each type shall be approved by the Consultant before commencement of tile laying.

9.13.3. Chipped or damaged tiles installed by the Contractor shall be rejected and shall have to be replaced by the Contractor at his own cost and risk.

#### **9.14. Guarantees**



- 9.14.1. Manufacturer shall be provide his standard guarantees for work under this section. However, such guarantees shall be in addition to not in lieu of all other liabilities which manufacturers and Contractor may have by other provisions of the Contract Documents.
- 9.14.2. Manufacturer shall be provide his standard guarantees for work under this section. However, such guarantees shall be in addition to not in lieu of all other liabilities which manufacturers and Contractor may have by other provisions of the Contract Documents.



## **10. PAINTING**

### **10.1. Material**

- 10.1.1. All paints shall be approved by the Consultant for colour, quality and type. All painting work shall be carried out in accordance with the paint manufacturer's specifications unless otherwise directed by the Consultant.
- 10.1.2. All paints and finishes used for the project shall be manufactured by or under license from one of the following manufacturers;
- 10.1.3. Imperial Chemical Industries (UK) - exterior walls, interior walls,
- 10.1.4. Sigma Paints (Saudi Arabia) - exterior walls, interior walls, wood
  - a) Nippon paint (Japan) - interior walls, wood, steel,
  - b) SKK - (Japan) - exterior walls, floor paint,Paints from manufacturers not listed above shall only be used with prior written approval of the Consultant.
- 10.1.5. Paint shall be ready mixed and all paints, varnishes, enamels, lacquer stains, paste fillers and similar materials shall be delivered to the site in the original containers with the seals unbroken and labels intact. Each container shall give the manufacturer's name, type of paint, colour of paint and instructions for reducing. Thinning shall be done only in accordance with the manufacturer's directions.
- 10.1.6. Use of product by the same manufacturer shall be a general rule in each stage of work in this Specification.
- 10.1.7. Colour, luster, colour scheme, finish shall be decided by the Consultant after checking sample paint test.
- 10.1.8. The painting shall be performed by experienced and competent painter.
- 10.1.9. Where walls are specified to be painted, all columns, arches, grooves, rough surfaces, reveals, soffits and returns, etc. shall be included and no extra shall be payable.

### **10.2. Definition of Terminology**

#### **Surface Sealing**

Surface to be painted shall be sealed to have uniform suction and prevent lye from oozing out.

#### **Spot Puttying**

All cracks and depressions shall be filled flush with putty.

#### **Puttying**

All surfaces to be painted shall be puttied uniformly flat surface.

#### **Spot painting**

Spot puttied area shall be touched up by paint.

#### **Touch-up**

Any damaged area after the prime coat has been applied shall be touched up.

#### **Drying hour**

The drying time of double coated paint shall be measured at the temperature of 20°C and humidity of 70%.

#### **Amount of paint**



The amount shall be standard amount of paint itself not including thinner. It shall increase or decrease depending on shape and surface condition in the process of painting.

### **10.3. Paint Finish Symbols**

- OP** Synthetic resin mix paint finish
- EP** Polyvinyl acetate resin emulsion paint finish
- AEP** Synthetic resin emulsion paint finish

### **10.4. Painting in General**

#### **10.4.1. Preparation of Paint**

- 10.4.1.1. Mixing: Paint content with pigment shall be thoroughly stirred to make a uniform consistency.
- 10.4.1.2. Thinning: Portable water shall be used for thinning of emulsion paint and water-soluble paint. Proper thinner, product of the same manufacturer as paint, as a rule, shall be used for other types of painting. Percentage of thinning and viscosity shall be conducted with direction of manufacturer or catalogue as they vary with the method of paint, temperature, type of material to be painted.
- 10.4.1.3. Allowable period of Use: Paint mixed with more than 2 types shall be used with direction of a manufacturer or catalogue allowable period of use, mixing ratio and mixing method vary. The paint which has passed allowable period of use shall not be used.

#### **10.4.2. Conditions of Painting**

- 10.4.2.1. Work shall not be executed in the following situations:
  - 10.4.2.1.1. When humidity is above 85%
  - 10.4.2.1.2. When raining or it is forecast
  - 10.4.2.1.3. When dusts are present
  - 10.4.2.1.4. When temperature of surface is high under hot weather and bubbles are likely to develop on the painted surface.
- 10.4.2.2. Conditions of Surface to be painted: Work shall not be executed or proper means shall be taken in the following situations:
  - 10.4.2.2.1. When surface is damp and wet
  - 10.4.2.2.2. When condensation is likely to develop on the surface.
  - 10.4.2.2.3. All nail holes on veneer, board, etc., shall be covered with proper rust-proof paint before the subsequent painting is applied in accordance with this specification.

#### **10.4.3. Performance**

- 10.4.3.1. Paint shall be evenly and uniformly applied on the surface. Areas of difficult application such as pointed part, internal angle, welded part, etc. shall be thoroughly painted and double coated as necessary to deep uniform coating thickness.
- 10.4.3.2. Painting shall be properly done by carefully selecting the painting method by the shape of surface and types of paint.

#### **10.4.4. Protection**

- 10.4.4.1. Dangerous material such as paint, thinner, etc., excluding emulsion paint and water-soluble paint shall be kept in accordance with regulations concerned.



### 10.5. Procedure of Painting

#### 10.5.1. Exterior - Surface of Mortar, Plaster and Concrete

Synthetic resin emulsion paint. - (gloss)

Coating Process	No. of Coats	Type of Paint	Drying Hour	Amount (Kg/m <sup>2</sup> )
1.Surface Preparation		Dry, clean and free from impurities		
2. Surface Sealing	1	Sealer for emulsion paint	Longer than 4 hours	
4. Grinding		Grind with proper grinding tool		
5. Spot Painting		Synthetic resin emulsion paint		
6.Second Coating	1	Synthetic resin emulsion paint	Longer than 4 hours	0.10-0.13
7. Finish Coating	2	Synthetic resin emulsion paint	Longer than 4 hours	0.10-0.13

Notes:

- Degree of dryness on the surface to be painted shall be kept under 6% in water content and below PH 9.5
- Puttying and sanding process shall be allowed to omit depending on the conditions of the surface.
- Drying time of putty shall be long enough for sanding to proceed.
- Amount of sealer for surface sealing shall be adjusted with direction of the Consultant as it varies with the surface conditions.

#### 10.5.2. Interior - Mortar, plaster, concrete, etc.

Polyvinyl acetate resin emulsion paint finish (matt)

Coating Process	No. of Coats	Type of Paint	Drying Hour	Amount (Kg/m <sup>2</sup> )
1.Surface Preparation		Dry, clean and free from impurities		
2. Surface Sealing	1	Sealer for emulsion paint	Longer than 4 hours	
3. Puttying	1	Putty for emulsion paint		
4. Grinding		Grind with proper grinding tool		
5. Spot Painting		Polyvinyl acetate resin emulsion paint		
6.Second Coating	1	Polyvinyl acetate resin emulsion paint	Longer than 4 hours	0.10-0.13
7. Finish Coating	2	Polyvinyl acetate resin emulsion paint	Longer than 4 hours	0.10-0.13

Notes:

- Degree of dryness on the surface to be painted shall be kept under 6% in water content and below PH 9.5



- b) Puttying and sanding process shall be allowed to omit depending on the conditions of the surface.
- c) Drying time of putty shall be long enough for sanding to proceed.
- d) Amount of sealer for surface sealing shall be adjusted with direction of the Consultant as it varies with the surface conditions.

#### 10.5.3. Exterior - Iron Products in General

##### OP - Synthetic resin mix paint

Coating Process	No. of Coats	Type of Paint	Drying Hour	Amount (Kg/m <sup>2</sup> )
1.Surface Preparation		Completely remove rust, moisture, oil and other impurities by sander, cleaner and surface.		
2. First Coating 24 Hours	1	Rust proof oil paint	Longer than 24 hours	0.13-0.15
3. Touch-Up		Touch-up rustproof oil paint		
4. First Coating	1	Rustproof oil paint	Longer than 24 hours	0.13-0.15
5. Second Coating	1	Synthetic resin mix paint	Longer than 15 hours	0.13-0.15
6. Finish Coating	1	Synthetic resin mix paint	Longer than 15 hours	0.13-0.15

Note:

- a) Paint for touch-up painting shall be the same as used for first coat in process No.2

#### 10.5.4. Exterior – Wood

##### OP - Synthetic resin mix paint finish

Coating Process	No. of Coats	Type of Paint	Drying Hour	Amount (Kg/m <sup>2</sup> )
1.Surface Preparation		Clean and sand to plane surface		
2. Knot treatment	1-2	Lacquer varnish	Longer than 24 hours	
3. First Coating	1	First coat paint of oil mix paint	Longer than 24 hours	0.13-0.15
4. Second Coating	1	Oil mix paint	Longer than 15 hours	0.11-0.13
5. Finish Coating	1	Oil mix paint	Longer than 15 hours	0.11-0.13

Note:

- a) Puttying and sanding shall be done after process No.2 when there are cracks, etc. on the surface putty shall be Oil-putty, but drying time shall vary depending on conditions.

#### 10.5.5. Floor - Concrete and Mortar

##### EXP - Epoxy resin paint finish



Coating Process	No. of Coats	Type of Paint	Drying Hour	Amount (Kg/m <sup>2</sup> )
1.Surface Treatment		Dry, clean and free from impurities		
2. First Coating	1	First coating paint for epoxy	Longer than 24 hours	
3. Finish Coating	2	Epoxy resin paint	Longer than 15 hours	

Note:

- a) Degree of dryness on the surface to be painted shall be kept under 6% in water content and below PH 9.5.
- b) Amount of paint and number of paint shall be as directed by the Consultant as they vary with the conditions of surface and required thickness of coating.
- c) Painted surface shall be kept out of use for more than 7 days after application of final coat.



## **11. PLUMBING**

### **11.1. General**

- 11.1.1. The materials used and workmanship shall be of highest quality and grade unless otherwise specified shall conform to the latest specifications of British Standards and Codes of Practice for "Water Supply "Sanitary, Pipe Work "Building Drainage" Surface Water and Sub- Soil Drainage" and applicable to details and work indicated on the Drawing and Bill of Quantities. In case of any discrepancy / ambiguity the decision of the Consultants shall be final, and the contractor will act and perform accordingly.
- 11.1.2. The work shall be executed strictly in accordance with the rules and regulations set by the relevant local authority of the Maldives.
- 11.1.3. The Contractor shall be responsible for obtaining the necessary approvals and test certificates from the concerned departments of Maldives.
- 11.1.4. Plumbing work shall be carried out by licensed plumbers and shall produce the copy of the license along with the tenders, or approved by the Consultant.
- 11.1.5. Any damage done by the Contractor to any existing work during the course of execution of his work shall be made good by him at his own cost. Failing which it shall be get done by the Consultants at Contractor's risk and cost.
- 11.1.6. The Contractor shall be responsible to connect the drainage and water supply to the mains and to obtain the necessary approvals and certificates from the relevant authorities of the Maldives.
- 11.1.7. All connections to mains and meter installation shall be arranged by the Contractor and payment of fees thereof, if any, shall also be made by him.
- 11.1.8. The Contractor shall be responsible for the watch and ward of all fittings until the Works is fully completed and handed over to the owner.
- 11.1.9. The levels, measurements and other information concerning the existing site as shown on the drawings or as described as are supposed to be correct. The Contractor shall, however, verify them by himself and no extra claim whatsoever shall be entertained on account of the errors or omissions in such matters or on account of the descriptions turning out to be different from what was expected.
- 11.1.10. The Consultant shall instruct the Contractor to purchase and use such materials of particular make or from particular source as it may in his opinion be necessary for proper and reasonable compliance with the specification and execution of the Works.
- 11.1.11. After all plumbing fixtures and equipment have been set ready for use, and before the Contractor leaves the job, he shall thoroughly clean all fixtures installed by him, removing all plaster, stickers, rust stains and other foreign matter of discolouration on fixtures, leaving every part in acceptable condition and ready for use to the satisfaction of the Consultants.

### **11.2. Drawings and Information Required**

- 11.2.1. The Contractor shall submit shop drawing for the entire installation including installation details for all items required or asked for approval of the Consultant.
- 11.2.2. Approved by the Consultant of shop drawing for any material, apparatus, devices and layout, shall not relieve the Contractor from the responsibility of furnishing same of proper dimension, size, quantity and all performance characteristic to efficiently perform the requirements and intent of the Contract Documents. Such approval shall not relieve the Contractor from responsibility for errors of any sort in the shop drawing.
- 11.2.3. If the shop drawings deviate from the contract Documents the Contractor shall advise the Consultants of the deviations in writing accompanying the shop drawings including the reasons for the deviations. At the start of the Project the Contractor shall periodically and thereafter submit to the Consultants list of all shop drawings which will be submitted in the course of the



project. The list shall show the disposition of each item including date of submission approval etc. The list shall be kept up to date through the entire course of construction.

**11.3. Record Drawing**

- 11.3.1. During Construction the Contractor shall keep an accurate record of all deviations between the work as shown on the Contract Drawings and that which is actually installed.
- 11.3.2. The Contractor shall secure from the Consultants after approval of his Shop Drawing a complete set of drawing and note changes thereon in ink.
- 11.3.3. The Contractor shall make a complete record of all changes and revisions in the original design which exist in the completed work.
- 11.3.4. The cost of furnishing above prints and preparing these for record" shall be deemed to be include in the tendered cost and its effects spread over other items of work, and as such item shall not be a subject to payment". When all revisions showing the work as finally installed the corrected Original Transparencies shall be submitted to the Consultants before final payment for the completed work will be made.

**11.4. Operating and Maintenance Instructions**

- 11.4.1. Three sets of operating and maintenance instruction covering completely the operation and maintenance of all plumbing equipment, controls, heaters, pumps and the like shall be furnished to the Owner, by the Contractor.

**11.5. Tests**

- 11.5.1. The entire system of drains, waste and vent piping inside and outside the building shall be tested by the Contractor under a water test, which shall include the entire system from the lowest point to the highest pipes above the roof.
- 11.5.2. The water test shall be made in accordance with all local requirements. Every portion of the system shall be tested to a hydrostatic pressure equivalent to latest 15 feet head of water. After filling, the Contractor shall shut off water supply and shall allow it to stand 2 hours under test during which time there shall be no loss or leakage.
- 11.5.3. The Contractor shall furnish and pay for device, material supplies, labour and power require for all tests. All tests shall be made in the presence and to the satisfaction of Consultant.
- 11.5.4. Defects disclosed by the test shall be repaired or if required by the Consultant defective work shall be replaced with new work without any extra charge to the Owner. Test shall be operated as directed until the work is proved satisfactory.
- 11.5.5. Fixture shall be tested for soundness, stability of support and satisfactory operation.
- 11.5.6. The Contractor shall notify the Consultant at least one week in advance of making the required test, so that arrangements may be made for their presence to witness the test.
- 11.5.7. Equipment shall be tested in service and the Contractor shall demonstrate that the equipment performs the work intended for it and that it complies with the requirement of these specifications for such equipment, to the satisfaction of Consultants.
- 11.5.8. The rates shall include for all costs associated with tests.

**11.6. Work in Common Piping**

- 11.6.1. Material
  - 11.6.1.1. Piping and fitting material shall be uP.V.C, Hard Impact P.V.C. or High Temperature P.V.C. and approved by the Consultant.
  - 11.6.1.2. Piping material shall comply with requirements of water supply and sewerage and other relevant authorities.
  - 11.6.1.3. Materials for the piping and service requirements shall basically conform to the service pressures encountered.



#### 11.6.2. Providing Drawings and Manuals

11.6.2.1. The Contractor shall submit one set of originals and further two copies of layout drawings to the Consultant after completion of the Works. These drawings must give the following information:

- a) Run of all piping and diameter on all floors and the vertical stacks.
- b) Location and sizes of all control valves, access panels and other equipment.
- c) Location of all manholes and their sizes.

11.6.2.2. No completion certificate will be issued until the drawings are submitted.

11.6.2.3. The Contractor shall submit to the Consultant for approval, samples, shop drawings, manufacturer's drawings, equipment characteristics and capacity data etc. of all equipment, accessories devices etc. that he proposes to use in the installation.

#### 11.6.3. Samples

11.6.3.1. The Contractor shall provide samples of all sanitary fittings, pipes and specials man-hole cover and frames, gratings and water supply pipes and fittings etc. and shall be deposited with the Consultant (which will be returned to the Contractor at the completion of the Works) and shall obtain approval from the Consultant before using in the Works. Any material rejected by the Consultant shall be removed from the site within 24 hours of rejection.

#### 11.6.4. Drawings

11.6.4.1. The works shall be done in conformity with the plans and within the requirements of the general architectural, electrical and structural plans. This work shall be properly coordinated with the work of the other trades. Hangers and sleeves shall be furnished in time for their installation as other work proceeds.

11.6.4.2. The plumbing drawings are diagrammatic, but shall be followed as closely as actual construction. All deviations from drawings required to conform to the building construction shall be made by the Contractor at his own expense.

11.6.4.3. The architectural drawings shall take precedence over the plumbing drawings as to all dimensions.

11.6.4.4. Large size details shall take precedence over small size drawings. The special dimensions in the specifications or schedule of quantities or instructions of the Consultant shall supersede the drawings. The Contractor shall verify all dimensions at site.

11.6.4.5. The recommend position of the fittings, fixtures, control valves, tanks etc. as shown on the drawings will be adhered to as far as practicable.

11.6.4.6. Should there be any discrepancy due to incomplete description ambiguity or omission in the drawings and other documents, whether original or supplementary, forming the contract, either found on completion or during the currency of the installations work, the Contractor shall immediately, on discovering the same, draw the attention of the Consultants and the Consultants decision in final and binding on the Contractor.

#### 11.6.5. Existing pipes



- 11.6.5.1. The site shall be examined for field drains and those, when found, shall be either entirely removed or diverted, trenches filled with dry earth in 200mm to 300mm layers and consolidated as directed by the Consultant.

#### 11.6.6. Excavation

- 11.6.6.1. All excavations shall be timbered to the satisfaction of the Consultant and the type of timber shall be suitable to the kind of earth encountered. Fixing of timber and removal after completion of work shall be done as directed by the Consultant.
- 11.6.6.2. Should any water accumulated in the trenches, headings or other excavation, the Contractor shall do such work as may be necessary to drain away the accumulated water and shall install pumps as may be required to keep the excavation and trenches dry. The Contractor shall ensure that the flow water in trenches or excavation does not injure or remove cement or aggregate of any concrete that has not set. No subsoil water shall be discharged into open drains or sewer at the site.
- 11.6.6.3. In refilling trenches-after-excavation this should be done in layers of 150mm after consolidating each layer. Special care shall be to see that the earth is packed uniformly and no injury to the pipe.
- 11.6.6.4. Rates for excavation should include for backfilling in consolidated layers where necessary and as directed by the Consultant.

#### 11.6.7. Piping

- 11.6.7.1. The Contractor shall, as soon as possible after the award of the contract, prepare and submit to the Consultant for approval, working drawings showing exact locations and pipe runs for all pipe work, the layout and setting up of equipment and the connection of piping to the equipment. Such drawings shall include details and methods of supports, anchors and sleeves etc.
- 11.6.7.2. Pipe runs shown in the drawings are approximate and intended to indicate the general run and locations only. The exact locations of all pipework shall be determined on Site.
- 11.6.7.3. All pipes, fittings etc. shall be kept closed against moisture and foreign matters when stored at site and during installation.
- 11.6.7.4. All pipes shall be fixed clear of one another and be so arranged as to provide easy access for maintenance and repair.
- 11.6.7.5. All plumbing work shall be carried out by suitably qualified plumbers in accordance with the British Code of Practice and Regulations and requirements of related Authorities.
- 11.6.7.6. Materials for the piping and service requirements shall basically conform to the service pressures encountered.
- 11.6.7.7. Each part of the installation of the plumbing work shall be completed in all details as shown in the drawings or as specified and provided with all necessary control valves, etc. that will be necessary for their satisfactory operation.
- 11.6.7.8. All piping shall be run plumb, and straight and parallel to walls, except drain line which shall pitch 6mm per 300mm in the direction of flow.
- 11.6.7.9. Pockets, unnecessary traps, turns and off-sets shall be avoided. When traps or pockets are unavoidable they shall be valved drains.
- 11.6.7.10. Piping installed on the concrete slab shall be firmly fixed or anchored to the floor with packing to prevent damage to pipes. Pipes shall not be bent with bender where cross with other pipe or change to upward.



- 11.6.7.11. Where pipes are to be laid directly in the ground, bed shall be sufficiently compacted; necessary protection for piping shall be taken.
- 11.6.7.12. Backfill shall be done after the approval of the Consultant in such a manner not to damage the pipe line and shall be restored to the original stage.
- 11.6.7.13. Where pipes penetrate through waterproof part or fire partition or fire wall, pipe sleeves shall be provided and clearance between pipe sleeve and pipe shall be filled with caulking material approved by the Consultant.
- 11.6.7.14. Pipes, fittings, valves and accessories shall be thoroughly cleaned, both internally and externally before installation and shall be cleaned before putting into service.
- 11.6.7.15. Plumbing work shall be completed in accordance with the details shown on the Drawings or as specified and provided with all necessary control valves, etc. that will be necessary for their satisfactory operation.
- 11.6.7.16. All pipes shall be cut square and true to the pipe axis by means of suitable tools without reducing pipe diameter and cut ends shall be finished smooth. Before making connections, chips, dirt and other foreign matter shall be removed from inside interior of each pipe. Fixing of hangars and embedding of pipe sleeves shall be carried out without delay along with the progress of the work where required.
- 11.6.7.17. Pipe connections for the water supply system shall be by uP.V.C high pressure. Jointing shall be generally by means of solvent cement according to manufacturer's instructions.
- 11.6.7.18. Vertical pipe shall be braced at more than 2 point in every story.

## **11.7. Water Supply Work**

### **11.7.1. Materials**

- 11.7.1.1. Pipes, joints and fittings for water supply work shall be high pressure uP.V.C.
- 11.7.1.2. Materials and workmanship shall comply with the local water supply authority requirements.

### **11.7.2. Water Pump**

- 11.7.2.1. The specifications herein stated are basic guides only. Other items not so indicated but which are obviously necessary for the proper operation of the system as intended shall be supplied and installed, in accordance with accepted Consulting standard.
- 11.7.2.2. Manuals of operation and maintenance and list of spare parts shall be supplied together with the equipment.
- 11.7.2.3. The contractor shall submit at least four copies of pump performance curves showing among others, the pump rating and efficiency, properly marked out.
- 11.7.2.4. A metal name plate indication in indelible letters for the correct specification of the pump and motor shall be properly attached to the assembly at a location such that the information written thereon can be conveniently read by all concerned.
- 11.7.2.5. Well water pump: Flow rate = 60L/min, Head = 70m, Type: End suction Hydro pneumatic pump, 220/440V, 3-Phase, 50 Hz.

## **11.8. Spacing of supports**

- 11.8.1. Support spacing for uP.V.C pipes shall be as follows

Nominal Dia.	up to 40	more than 50
Space (m)	1.2	1.5



## **11.9. Drainage Work**

### **11.9.1. General**

- 11.9.1.1. High Pressure uP.V.C pipe and fittings shall be used for all drainage work including vent pipes.
- 11.9.1.2. Joints shall be made by the cold-jointing method, and the pipe interior shall have not offset at the joint interfering with the flow. Joint adhesive shall be good quality and shall not be affected by heat and shock.
- 11.9.1.3. Where horizontal drain branch joints the main, such branch shall be connected to the main in a substantially horizontal position and at an acute angle of not more than 45 degree to the main in all cases.

### **11.9.2. Vent stack pipes**

- 11.9.2.1. Vent pipe shall be vertically branched out upward from a horizontal drain branch pipe or other appropriate point. Horizontal branching of the vent pipe shall be done on approval of the Consultant.
- 11.9.2.2. Where vent pipes on each floor are to be connected to the vent stack, all connections shall be made at least 150mm above the respective overflow edges of fixture on that floor.
- 11.9.2.3. The provision of the preceding item shall also apply to the connection of vent stack vent pipe.
- 11.9.2.4. Vent stack shall be connected to the waste stack or soil stack at the lowest part to stack pipe.
- 11.9.2.5. Where vent pipe is to be connected to the horizontal drain pipe, such angle shall be more than 45 degree to upward.
- 11.9.2.6. Vent stack shall be extended 600 mm from the top of the roof or lead to the wall and top of pipe shall be covered with vent cap.

## **11.10. Laying of Pipes**

- 11.10.1. The pipes shall be laid to proper lines and levels as shown in the plans and directed by the Consultant, as the main is laid, the front pipes in the trench shall always be closed with a plug either of iron or wood and security fastened. The plug shall not be removed except when pipe laying is resumed or for purposes of testing.

## **11.11. Sewers**

- 11.11.1. After the cement has had time to set, the pipes shall be tested in length between manholes in following manner.
- 11.11.2. In the lowest manhole/intercepting trap as the case may be, a plug shall be inserted in the pipe. The disc in the pipe at the upper manhole shall be fitted with a filling pipe with a right angle bend and an air cock.
- 11.11.3. The pipe line shall then be filled with water by means of the pipe connection on the upper disc. The air cock on the upper disc shall be kept open while the pipe line is being filled to permit the escape of air.
- 11.11.4. When the pipes are filled with water and air excluded, the air cock shall be shut and the water shall be poured into conical filler, attached to the filling pipe until the water remains in the filter.
- 11.11.5. The filling pipe shall then be raised and fastened so that the height of surface of the water in the filler above the invert of the pipe is 1828 mm which will be usual test pressure for S.W pipes.



11.11.6. If the water level does not fall more than 16mm (12mm) in a length of 91.4 meter the test may be considered satisfactory.

11.11.7. The Contractor shall make good all defective work at his own expense.

#### **11.12. U.P.V.C Pipes**

11.12.1. Manufacturer's instruction should be followed in pipes to be used for water mains. Where specified; pipes shall have integral rubber ring joints and where solvent cement joints are specified, a sufficient number of expansion/contraction joints shall be incorporated in the length of mains to allow for variation of temperature to the recommendation of the pipe manufacturers.

11.12.2. These pipes shall be effectively protected from the direct rays of sun immediately after they are laid and until permission is given for the trenches to be refilled by the Consultant. Subject to such permission being obtained, trenches shall be refilled without delay. Final connection at a fixed point shall be deemed unto the majority of the length of the pipe line has been covered by backfill in order to reduce the effect of expansion and contraction caused by temperature variations.

#### **11.13. Bends and other Specials**

11.13.1. In fixing bends care shall be taken to see that the axis of the bend is truly vertical or horizontal as the case may be and the spigot of the bend is well in the socket of the pipe with which a joint has to be formed. The Contractor shall be called on to replace any faulty work at his own expense.

#### **11.14. Support for U.P.V.C Pipes**

11.14.1. When U.P.V.C pipe lines incorporate metal valves or other heavy fittings, it is essential to support the valves directly rather than allowing their weight to be carried by the uP.V.C pipe and support shall be placed on either side of the fittings mentioned above. Moulded plastic fitting also should be supported.

11.14.2. Maximum allowable horizontal support distance for uP.V.C are given below.

<b>Nominal Bore</b>	12mm (1/2")	18mm (3/8")	25mm (1")	32mm (1 1/4")	38mm (1 1/2")	50mm (2")
<b>Support Distance</b>	533mm (1 '9")	616mm (2 '0")	686mm (2'3")	764mm (2'6")	840mm (2 '9")	915mm (3 '0")
<b>Nominal Bore</b>	75mm (3")	100mm (4")				
<b>Support Distance</b>	1220mm (4'0")	1290mm (4'6")				

11.14.3. For vertical installation supports, distances shall be doubled.

#### **11.15. Sewer pipes**

11.15.1. All 'P', 'S', 'I' junctions bends etc. required shall be furnished and set without extra charge and shall confirm to the pipe specifications as to quality.

#### **11.16. Air Valves**

11.16.1. These valves to be fitted as per drawings and Bill of Quantities shall be tested and accompanied by a certifying their efficiency.

11.16.2. The floating ball in the valve shall be suitable metal or vulcanite or rubber specially manufactured for tropical conditions.



**11.17. Scour Washout Valve**

- 11.17.1. These shall be provided at portions shown in place and shall contain in one unit a flanged scour valve with short connection pieces, cast iron bend and T pieces for connection to main pipe.
- 11.17.2. The rate shall also provide for short length of straight pipe to a convenient as per details complete with covers and surface boxes.

**11.18. Foot valves and Strainers**

- 11.18.1. Foot valve and strainers should be reputable manufacture approved by the Consultant and shall be fitted with flushing lever attachment where specified.

**11.19. Pressure Reducers**

- 11.19.1. Pressure reducing valves shall be of the equilibrium type of approved manufacture and capable of reducing the pressure to the valve required as per plan and Bill of Quantities.

**11.20. Equilibrium Ball Valves**

- 11.20.1. These should be of reputable manufacture approved by the Consultant and be of the angle pattern with gun metal valve seats guide bush, copper float with wrought iron lever and links with bronze pins.

**11.21. Fittings**

- 11.21.1. All sanitary pipes, gullies, water closets/bidets, squatting basins, sinks bath tubs etc. to be of approved design and to be obtained from approved Manufacture and to be of the best stoneware, glazed inside and outside, with burnt hard and sound, free from flaws, blisters, cracks and other imperfections and best quality commonly called 'Firsts'.
- 11.21.2. Rates should include for all bends, junctions, traps, cleaning, painting, fixing clear of wall etc. complete as specified as per Bill of Quantities.
- 11.21.3. All pipes, fittings, flushing cisterns, valves, stop cocks, taps, tanks, surface boxes etc. to be of the best of their kinds and in addition to complying with previous clauses to be from approved Manufacturers and all taps, cocks, valves etc. to be screwed down pipe. Taps to be of brass/nickel coated and valves to be of gun metal. All tanks to be made fly-proof and to the complete satisfaction of the Consultant.
- 11.21.4. Rates should include for all cutting and waste, bends, taps junctures, cleaning eyes, tees.

**11.22. Fixtures and Accessories**

- 11.22.1. All sanitary wares shall be manufactured by one of the following manufacturers.
- 11.22.2. American Standard
  - 1) American Briggs
  - 2) Armitage Shanks
  - 3) Cotto
  - 4) Star sanitary wareSanitary ware from manufacturers not listed above shall only be used with prior written approval of the Consultant.

**11.23. As built Drawings**

- 11.23.1. The Plumbing Contractor shall mark down with red pencil on two sets of plumbing plans all the revisions, omissions and/or additions to the various plumbing installation drawings as the construction progress. One set of the plans as marked shall be submitted to the Consultant after completion of the work.



**11.24. Miscellaneous**

- 11.24.1. Throughout the construction period, open ends of all installed pipelines shall be kept closed by temporary plugs. Drainage lines shall not be used to conduct dirty construction wash-washer, especially, those with cement, to avoid possible clogging.
- 11.24.2. A temporary potable water supply shall be available to construction workers at each building floor as construction work progresses.
- 11.24.3. A temporary human Excrete Disposal System shall be provided by the Contractor to serve the workers during the construction period.

**11.25. Height of Fixture Installation**

- 11.25.1. Height of fixture shall be as follows unless otherwise specified on the Drawings

Fixture		Height (mm)
Wash Basin	Floor finish to front top edge - Male	700
	Floor finish to top of mirror - Male	1675
	Floor finish to top of mirror - Female	1660
Lavatory	Floor finish to front top edge	760
Shelf	Floor finish to top of shelf - Male	1005
	Floor finish to top of shelf - Female	990
Cistern	Floor finish to bottom of cistern	
	Floor mounted Japanese type Western type	500 550
Drinking Fountain	Floor to front top edge	765
Flush Valve, WC	Floor to center of valve	600
Paper Holder	Floor to center of holder - Japanese type	400
	Floor to center of holder - Western type	750
Faucets		
Sink	Sink floor to top of faucet	300
Lavatory	Lav. top to top of faucet	150
Bath Room	Floor finish to top faucet	300



## **12. ELECTRICAL INSTALLATIONS**

### **12.1. General**

- 12.1.1. The work shall be carried out strictly in accordance with the standard specifications and shall also conform to the requirements of Electricity Rules in force in Male', Republic of Maldives.
- 12.1.2. All materials to be used in the Works shall be of standard make and shall bear the certification marks of local authorities. All materials shall be approved by the Consultant before use in the Works.
- 12.1.3. Earthing shall invariably be done in the presence of the Consultant or his representative.
- 12.1.4. All the conduits shall be continuously earthed. Check nuts shall be provided at the point where the conduits enter the I.C. box and junction box.
- 12.1.5. The Contractor shall arrange for the inspection of all Medium Pressure Installation by the Electrical inspector of the local electric supply authority from where the electricity connections has to be obtained, and see that they are passed by him.
- 12.1.6. The Contractor shall be responsible for all necessary permits, approvals, fees, deposits etc., required to complete the Electrical works in accordance with the Contract.
- 12.1.7. Scope of work
  - 12.1.7.1. The work consist of furnishing all tools, plants, labour, materials and equipment and performing the internal electrical Works comprising of:
    - a) Light and power wiring
    - b) Fans and fixtures
    - c) Wires and cables
    - d) Lightning and Earthing System
    - e) Telephone system
- 12.1.8. Prequalification
  - 12.1.8.1. The Electrification Work shall be carried out only by a licensed contractor authorized to undertake such work under the Maldives Electricity Bureau.
- 12.1.9. Qualification
  - 12.1.9.1. A licensed Electrical Contractors should have the following qualifications:
    - a) Must have in his employment a competent Electrical Engineer registered with Maldives Electricity Bureau.
    - b) Must have in its employment an Electrical Consultant having certificate of competency who will exclusively supervise this work.
    - c) Must have necessary tools, plant and instruments.
    - d) Must have adequate experience of similar works.
    - e) If a contractor does not posses the above qualifications he shall be allowed to sublet the Work to a competent Sub-Contractor provided an application for his prequalification is made to the engineer for his approval. Decision of the Engineer in this case shall be binding on the Contractor.
- 12.1.10. Rules and Regulations
  - 12.1.10.1. The installation in general shall be carried out in conformity with the Electricity Rules, 1937 (UK), and the latest edition of the Regulations for the Electrical Equipment of Buildings issued by the Institution of Electrical Engineers, London (I.E.). However, in case of conflict between these specifications and the I.E. Regulations, these Specifications shall be followed.



#### 12.1.11. Standards

- 12.1.11.1. The latest relevant British Specifications, and I.E. recommendations shall be applicable and be followed for the equipment specified herein.

#### 12.1.12. Climatic Conditions

- 12.1.12.1. All equipment supplied shall withstand, without developing any defect, the following climatic conditions:
  - Maximum Ambient Temperature = 113° F or 45° C
  - Minimum Ambient Temperature = 28° F or - 2.2° C
  - Maximum Humidity = 98%

#### 12.1.13. Specifications

- 12.1.13.1. The Contractor shall furnish all material and equipment at site, confirming fully to the specifications given herein and to the accepted standards, the Institution of Electrical Engineers, London, and the Maldives Electricity Bureau.
- 12.1.13.2. It is not the intent of these Specifications to include all details of design and construction of various material and equipment to be supplied under this contract.
- 12.1.13.3. The Contractor shall supply and install all material and equipment specified herein and also all installation and small material such as nuts, bolts, washers, shims angles, leveling material, insulation, tape, solder, etc. and such required for complete installation as intended by the Specifications.
- 12.1.13.4. The contractor shall provide for all the required technical and non - technical personnel, skilled and non - skilled labour, construction equipment, transportation etc., as required for the completion of Work in strict accordance the Technical Specifications laid herein-after.
- 12.1.13.5. All material and equipment supplied by the Contractor shall be new and in all respects conforming to the high standard of engineering design and workmanship.
- 12.1.13.6. All material and equipment which have to be supplied and installed by the Contractor shall be passed/approved by the Consultant; even if the same is exactly in accordance with the Bill of Quantities and Drawings.

#### 12.1.14. Submittal

- 12.1.14.1. The Contractor, after the award of work, shall submit for approval of the Consultant all drawings and cuts of equipment, appliances, fixtures and accessories. Cuts, catalogues and drawings shall be clearly marked to indicate, the items furnished.

#### 12.1.15. Shop Drawings

- 12.1.15.1. The design drawings do not show conduit routes and depict only the position of various fixtures and outlets. All the planning for the conduit routes shall be carried out, well in advance of the actual execution of work, by the Contractor to the satisfaction of the Consultant. For this purpose the Contractor shall prepare shop drawings and obtain prior approval of the Consultant. These prints of each shop drawings shall be submitted for obtaining approval.
- 12.1.15.2. No piece of work shall be allowed to be executed at site without the availability of these approved shop drawings. These shop drawings shall clearly depict the load balancing chart of each Distribution Board.
- 12.1.15.3. Time required for the preparation and approval of shop drawings shall be considered to have been included in the total time allowed for the completion of the work.



#### 12.1.16. Guarantee

- 12.1.16.1. The Contractor shall furnish written guarantee in triplicate of the manufacturer for successful performance of each equipment. Such guarantee shall be for replacement which may be found defective in material or workmanship.
- 12.1.16.2. The guarantee shall cover a minimum period of 12 months effective from the date of completion certificate.

#### 12.1.17. As-Built Drawings

- 12.1.17.1. The Contractor shall, during the progress of work keep a careful record of all changes and revisions where the actual installation differs from that shown on shop drawings. These changes and revisions shall be accurately carried out on the shop drawings and submitted to the Consultant for approval. After approval these drawings shall become the property of the Owner. These updated and approved shop drawings depicting clearly all changes and revisions made on site shall be called As-Built Drawings.
- 12.1.17.2. Reproducible tracings of all these As-Built Drawings shall be handed over to the Consultant. Final payment will be withheld until the receipt of the approved As-Built Drawings.

#### 12.1.18. Test Reports

- 12.1.18.1. The Contractor shall be responsible for the submitting the test reports/certificates and get the installation inspected passed by the Maldives Electricity Bureau.

### 12.2. Conduit and Conduit Accessories

#### 12.2.1. Conduit Pipe

- 12.2.1.1. The conduit for the wiring of lights, socket outlets and other systems shall be made of PVC confirming to BSS 3505/1968 Class-D.

The conduit shall have following wall thickness and standard weights:

Pipe Size	Wt/100Rft.	Wall thickness
20mm dia	3.4 Kg	0.04 to 0.05
25mm dia	4.5 Kg	0.045 to 0.055

- 12.2.2. Steel conduit shall conform to BSS 31/1atest. The conduit shall be enameled with good quality non- cracking and non-flaking black paint.

#### 12.2.3. Conduit Accessories

- 12.2.3.1. The use of factory made round PVC junction boxes shall be used and should have nipples to receive PVC pipe with force fit, shall be used for ceiling outlets. The wall type junction box shall also be PVC.
- 12.2.3.2. Each junction box shall be provided with one piece cover which shall be fitted on the box with screws.
- 12.2.3.3. Conduit accessories such as switch boxes, socket outlet boxes, pull boxes and inspection boxes shall be made of PVC having dust tight covers. All boxes shall have required number of conduit entry holes. All the rectangular or square shaped boxes shall have nipples to receive PVC conduit force fit.
- 12.2.3.4. Manufactured smooth bends shall be used where conduit changes direction. Bending of Conduit by heating or otherwise shall be allowed only at special situations with the permission of the Consultant. Use of sharp 90 degree bends and tees is prohibited.
- 12.2.3.5. Bends shall have enlarged ends to receive the conduit without any reduction in the internal diameter of the PVC pipe.



- 12.2.3.6. All accessories e.g. boxes, coupling, bends, solid plugs, bushes, reducers, checknuts etc. shall be equal in quality to the specified conduit.
- 12.2.3.7. The drawings do not show conduit routes and all the planning for arranging conduit routes shall be carried out by the Contractor to the satisfaction of the Consultant.
- 12.2.3.8. The entire conduit system shall be essentially completed before the wiring pulling is taken in hand. Each conduit run shall be tested for continuity and obstructions. All obstructions shall be cleared in an approved manner. Water and moisture that has entered any section of the conduit installation must be dried with suitable swabs to the satisfaction of the Consultant.
- 12.2.3.9. Adequate expansion joints shall be provided in all conduit runs passing across the expansion joints in the concrete slab of the buildings.
- 12.2.3.10. All the free ends of conduit shall be solidly plugged till such time as final and proper terminations are made.

### **12.3. Wires, Cables and Cords**

#### **12.3.1. Wires & Cords**

- 12.3.1.1. The wires & cords for the conduit wiring shall be single core, made of stranded copper conductors, PVC insulated, tested to B.S. 6004, 1975. The voltage grade shall be 300/500 volts or 450/750 V unless otherwise specified on Drawings and Bills of Quantities.
- 12.3.1.2. All the wire and cables shall be of the approved standard of Maldives Electricity Bureau.
  - a) For light or fan point wiring with 2.5 mm square or as specified in the BOQ.
  - b) For light circuit wiring with 2.5 mm square or as specified in the BOQ.
  - c) For power plug 15A wiring with 4mm square or as specified in the BOQ.

#### **12.3.2. Installation Instructions**

- 12.3.2.1. All wiring shall be continuous between terminations and use of connectors or joints is not to be allowed. Spur and tee connections are strictly prohibited.
- 12.3.2.2. Manufacturers recommended lubricant shall be allowed to facilitate pulling of wires. Use of any kind of oil and soap is prohibited.

### **12.4. Wiring Accessories**

#### **12.4.1. Switches**

- 12.4.1.1. Indoor switches controlling lights and fans shall be single pole, 5A, one or two way, suitable for 250V, 50 Hz. The body of the switches shall be made of moulded plastic, one, two, three or four gang with integral built in moulded plastic face plate.
- 12.4.1.2. Weatherproof switches shall conform to B.S. standard.

#### **12.4.2. Switch Socket Outlet Units**

- 12.4.2.1. Switch & socket units shall be single, pole, 3 pin rated 5A, 15A or 20A, 250V, 50 Hz. These shall be moulded plastic type with white integral built-in face plate. Each socket shall have its control switch by the side of it on a common face plate. Thus the complete unit specified in BOQ shall be as switch and a socket outlet unit.

#### **12.4.3. Fans**



- 12.4.3.1. All fans shall be capacitor type Deluxe models or equivalent and suitable for operation on 200/220 volts, 50 Hz, AC Supply. All ceilings fans shall have five speed dimmers. The air displacement shall be 10,000 c.f.m for 48" (1219 mm) Sweep and 12,000 c.f.m. for 56" (1423 mm) Sweep at maximum speed. The fan motor shall be capacitor type and bearings shall be groove type to give noiseless and quiet operation. The noise level relative to a frequency of range 1000 Hz should be within the limits of +3 dB.

#### 12.4.4. Dimmer

- 12.4.4.1. The dimmer shall be recessed type as required and shall be approved by the Consultant.

#### 12.4.5. Fan Hook

- 12.4.5.1. The fan hook shall be made of 12 dia mild 5/5 steel rod bent to shape of approved design. It should be in the form of a loop about 3-1/4" (87.5 mm) long and about 2" (50 mm) wide. The rod shall be bent to have at least 8" (200 mm) extension on both sides for tying to the reinforcement steel of the slab. All ceiling fan shall be of one make only.
- 12.4.5.2. The fan hook shall be installed in the RCC slab of the ceiling at the time of pouring concrete.

### 12.5. Light Fixtures

#### 12.5.1. General

- 12.5.1.1. The description of light fixtures is given in the Bills of Quantities, and stated on the Drawings, and an relevant material are described in this Section.
- 12.5.1.2. The determination of quality is based on certified photometric data covering the coefficient of utilization, light distribution curves, construction material, shape, finish, operation, etc.
- 12.5.1.3. The Contractor shall submit samples of each and every lighting fixture specified for approval of the Consultant.
- 12.5.1.4. The type of fixtures with manufacturer catalogue reference are given in Bill of Quantities.
- 12.5.1.5. The lighting fixtures shall be manufactured by M/s. Philips, M/s.RZB Lighting, M/s Thorn or equivalent as approved by Consultant.

#### 12.5.2. Incandescent Light Fixture

- 12.5.2.1. The glass globes/ shades/ diffusers of the incandescent light fixtures shall be first class quality glass free from any air bubbles or voids. The glass shall generally be of opal white colour unless otherwise specified. The shape of the glass may be spherical, hemispherical, flattened bottom or tablet shaped as required.
- 12.5.2.2. Surface mounted fixture shall have stove enamelled sheet steel body. It may also be satin brass or aluminium anodised finish as required. The fixing holes shall match the outlet box. Wall bracket light fixtures shall have back plates with matching holes of the outlet box and decorative finish as required.
- 12.5.2.3. All the lighting fixtures shall be suitable for local climatic conditions.

#### 12.5.3. Fluorescent Light Fixture

- 12.5.3.1. All the light fixtures shall have lamps and electronic ballasts of the wattage specified. The fluorescent lamp shall be either 2 ft - 18 watts or 4 - 35 watts and the colour shall



generally be day light, cool day light in the order of preference or as mentioned specifically.

- 12.5.3.2. The fluorescent lamps shall be Philips to BSS 1853 but having a minimum useful life of 5000 hours. The new generation of 26mm dia 18 watts and 36 watts energy efficient lamps shall be preferred.
- 12.5.3.3. The ballast shall be totally enclosed electronic type suitable for operation on 220 V, 50 Hz, single phase supply, a wiring diagram, wattage, voltage and current ratings shall be printed on the body of the ballasts. The power loss shall not more than 10 watts for 36 watts ballast. The ballast shall be noiseless in operation without any whistling sound.
- 12.5.3.4. The manufacture shall be called upon to guarantee a trouble free life of 3 years, effective from the date of completion certificate.
- 12.5.3.5. The starters shall have radio-interference suppressers.
- 12.5.3.6. The internal wiring of the light fixtures shall be carried out at manufacturer's factory with heat resistance wires of size not less than 1.5 mm square.
- 12.5.3.7. The louvers of light fixtures shall be made of anodized aluminium and/or moulded plastic. The diffusers shall be made of acrylic perspex.
- 12.5.3.8. All the lighting fixtures shall be suitable for local climatic conditions.

#### 12.5.4. Installation Instructions

- 12.5.4.1. The light fitting shall be installed according recommendations or as approved by the Consultant.
- 12.5.4.2. Flexible connecting wires from outlet box to the fixture shall be provided by the contractor; connector made of porcelain or thermoplastic material shall be provided and installed in the outlet boxes for connecting flexible wires to the point wires.
- 12.5.4.3. Outlet boxes or any openings in the ceilings and walls shall be covered with appropriately fabricated accessories to provide an architectural entity to conceal them.

#### 12.5.5. Distribution Feeder Panel

- 12.5.5.1. Single line diagram of the LT. switch board shall be approved by the consultant and Maldives Electricity Bureau before placing order for the switch board.

#### 12.5.6. Earthing

- 12.5.6.1. The switch shall be effectively earth by means of a cooper strip of 25mm x 3mm (1" x 1/8") cross-section bolted to connections near the bottom of the switchboard.

#### 12.5.7. Accessories

- 12.5.7.1. Designations labels, lifting lugs, foundation bolts, interconnecting nuts blots, and washers, thimbles, lugs, levelling shims cable glands and/or cable end box for all the sizes of incoming and outgoing cable shall be supplied with the switchboard.

### 12.6. Testing

- 12.6.1.1. The following tests shall be conducted on each completed switchboard.
- 12.6.1.2. Type Tests
  - a) Temperature rise test
  - b) Mechanical endurance test
  - c) Making/Breaking Capacity test



- 12.6.1.3. Routing Test  
a) High Voltage test

12.6.2. The Switchboard shall be tested to British/Electricity Council Standard 41-5. Preference shall however, be given to Switchboards fabricated from all components manufactured by only one manufacturer.

### **12.7. Installation Instruction**

- 12.7.1. All labour, equipments, tools and plants required to complete the installation shall be provided by the contractor. The Switchboard shall be fixed firmly on the floor in perfect line, plumb and level position.
- 12.7.2. All incoming and outgoing cable connections shall be made from the bottom including Earth connections.

### **12.8. Distribution Board**

- 12.8.1. The distribution boards shall be either, free standing, cubical type or wall mounting type suitable for fully recessed mounting. Each distribution board (d.b.) shall be tropical in design, fully dust and vermin proof and liquid repellent.

## **13. ROOFING**

### **13.1. Scope**

- 13.1.1. This Section deals with steel profiled sheeting used as external weatherproof cladding of roofs.

### **13.2. Roof Cladding**

- 13.2.1. Sheet type: Trimdeck h-ten roofing sheets manufactured by John Lysaght, No.18 Sector, Jurong, Singapore 2262 or equivalent.
- 13.2.2. Structural support: 102 x 51mm Lysaght galvanized steel "C" purlins or equivalent on G.I pipe trusses as per drawings.
- 13.2.3. Fastening: No. 12-14x45mm hexagonal head self-drilling and tapping screw seal.
- 13.2.4. End laps: 200mm and should be sealed with a recommend sealant for pitches below 7 degrees.
- 13.2.5. Side laps: as per manufacturer's recommendations.

### **13.3. Products**

- 13.3.1. The profiled sheeting shall be in galvanized sheet steel with a factory per finished protective PVC film with colour to approval.

### **13.4. Workmanship**

- 13.4.1. Accessories: Flashing, trims, filler pieces, spacers, tapes, sealant, etc. where not specified to be the types recommended by the sheet manufacturer.
- 13.4.2. Fastening: Select types and location of fastenings to meet the following requirements.
- 13.4.2.1. Wind suction loaded: Calculate in accordance with CP 3: Chapter5: Part2, making due allowance for any internal pressure.
- Basic wind speed: 45 m/sec. Topography factory S 1 : 1.0
  - Ground roughness, building size and height Factory (S2) : as determined from CP3:Chapter5 : Part 2, Table 3.
  - Statistical factor ( S3) : 1.0



- 13.4.2.2. Imposed loads other than wind and maintenance load, 1.5 kN/m<sup>2</sup> concentrated on a 300mm<sup>2</sup> which ever produces the greater stress. Maintenance point load: 0.9 kN concentrated on any 125mm<sup>2</sup>.
- 13.4.2.3. Dead load: allow for self-weight of sheeting.
- 13.4.2.4. Roof pitch: as indicated on drawings.
- 13.4.2.5. Distance between not less than 900mm or as indicated on the drawings.

### **13.5. Fixing**

- 13.5.1. Quality of Work: Handle and store to preserve surface using clean dry gloves. Do not slide sheets over rough surface or each other. Packs of all sheets must be kept dry in transit and stored clear of the ground under cover to prevent water and / or condensation being trapped between adjacent surfaces. If packs become wet, sheets should be separated, wiped with a clean cloth without delay and placed so that air circulation completes the drying process.
- 13.5.2. Structure: Check that structure is in a suitable state to receive sheets before commencing fixing. Contractor must confirm acceptance to consultant.
- 13.5.3. Structure: Do not fix profiled sheeting until final coats of paints have been applied to outer surfaces of supporting structure.
- 13.5.4. Isolating Tape: Apply to those surfaces of supports which would otherwise be in contact with sheeting or accessories after fixing.
- 13.5.5. Cutting and drilling:
  - 13.5.5.1. Cuts sheets accurately with clean, true lines and no distortion with a power saw with abrasive cutting disc.
  - 13.5.5.2. Cut openings in sheet for out lets, vent pipes, flues etc. to the minimum size necessary. Reinforce edges of openings with structural members.
  - 13.5.5.3. Drill all holes. Position at regular intervals in straight lines. Holes for primary fastenings to be 1.5mm larger than the diameter of fastening unless self-drilling type is used.
  - 13.5.5.4. Remove burrs, drilling swarf, lubricant, dust and any other foreign matter before finally fixing sheets into position.
- 13.5.6. Direction of Laying: Lay sheets with exposed joints of side lap away from prevailing wind.
- 13.5.7. End Laps: to be fully supported.
- 13.5.8. Sealant:
  - 13.5.8.1. Install to manufactures recommendation.
  - 13.5.8.2. Position in straight, unbroken lines parallel to edges of sheets. Placed into corrugations. Do not allow to sag into position.
  - 13.5.8.3. Ensure continuity and effectiveness of seal, especially at comers of sheets.
  - 13.5.8.4. Do not over compress.

### **13.6. Fittings and Features**

- 13.6.1. Profile Fillers: use where specified and wherever necessary to close off corrugation cavities from the outside and inside of the building. Position on the line of, or above, fastening and ensuring a tight fit and leaving no gaps. Where sealed laps are specified bed profile fillers in sealant on top and bottom surface, but do not obstruct channels for ventilation or condensation drainage.
- 13.6.2. Flashing Trims: All fittings for flashing / trim shall be as per manufacturers recommendation and lapped at joints as follows:
  - 13.6.2.1. Vertical and sloping flashing / trims: end lap to be the same as for adjacent sheeting.
  - 13.6.2.2. Horizontal flashing / trims: end laps to be 150mm and sealed.



13.6.3. Gutter: Ensure that gutters are fully supported at each joint and at intermediate position not more than 900mm apart. Fix with spigot ends up the slope and make all the joints fully watertight. Position sheeting to leave a clear width across the gutter of not less than 230mm.

13.6.4. Quilt insulation:

- Thickness: minimum 75 mm with foil laminate
- Manufacturer and Reference: to approval



#### 14. KEY PERSONNEL FOR THE PROJECT

##### CONSTRUCTION OF PRE-SCHOOL IN HULHUMALÉ PHASE II

Position	Qualification
Project Manager	Bachelor's degree in civil engineering/architect/relevant field with 5 years of Project Management experience.
Architect	Degree in Architecture with 5 years of experience
Civil engineer	Degree in Civil engineering with 5 years of experience
Site engineer	Diploma in civil engineering with 5 years experience.
Quantity surveyor	Degree in Quantity surveyor or Civil Engineering, Construction Management, Project Management (Construction Field), Architect, Building Construction, any other Construction related field with 5 years of Quantity Surveying experience.
Project Administrator	with 5 years of experience