

## **Technical Specifications**

**PROJECT:**

**SUPPLY, DELIVERY, INSTALLING, TESTING, COMMISSIONING,  
OPERATING, HANDING OVER AND MAINTAINING PV-DIESEL SYSTEM**

**FOR Al-Muwaijah Field PROJECT**

**IN Al-SHAER**

**YEMEN**

**Sub-project No.: IUS-AF-UWS-SHA-001**

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## 1. Specific Requirements

This chapter describes the requirements for the main components, the equipment and the design of the Plant. Applicants will have to specify and justify that their offer meets these criteria.

### ELECTRICAL Specific Requirements:

#### 1.1 PV Modules

- Solar PV panels suitable for the project purposes and local conditions;
- Solar PV panel should be of the mono-crystalline technology;
- The module rated power should be at least 625Wp at STC;
- Solar PV panel rating should be at least that specified in the technical drawings;
- The rated output power of any supplied module shall have positive tolerance;
- Solar PV panel conversion efficiency should be equal to or greater than 20 % under STC;
- The supplied module DC voltage should be not less than 1500 VDC;
- The module type must conform with CE and IEC 61215, IEC 61730, IEC 61701 or equivalent standards; The bidder shall provide the manufacturer certificates, proving that the PV modules are compliant with these requirements;
- PV panels should be procured from tier-1 manufacturers;
- The PV panels must have a minimum manufacturing warranty of 10 years and a performance warranty of a minimum of 25 years. The following minimum power warranties shall be guaranteed:
  - First 10 years at 90% of the nominal rated power output;
  - Subsequent 15 years at 80% of the nominal rated power output. Or linear power output characteristic can be accepted.

#### 1.2 Inverters

- On grid inverters, rated at 60KW, with at least one MPPTs;
- Insulation testing feature on DC side;
- The minimum 'European Efficiency' of the inverter shall be a minimum of 97.9%;
- Complete installation following recommendations by the manufacturer (minimum spacing, temperature of the room, etc.);

- Ground connection of the inverter to the equipotential bonding conductor and to the protective conductor of the AC side;
- PV specific surge arrester type 2 shall be provided on the DC side;
- AC Type 1+2 surge arrester shall be provided on the AC side;
- Setting, labelling and commissioning of inverters;
- Remote monitoring of the inverters;
- Inverters shall be suitable for the Plant climatic conditions and with proven track record for similar projects;
- Suitable consideration of inverter ventilation to avoid potential capacity de-rating;
- The quoted inverter capacity shall be suitable for local ambient temperature;
- Monitoring System – The inverters shall all be integrated in one Plant monitoring and control system.
- Product warranty shall be 5 years.

### 1.3 DC and AC cabling circuit cable routing

- All cables and connectors used for the installation of the solar array must be of solar grade robust and durable in harsh environmental conditions including High temperatures, UV radiation, rain, humidity and dirt as per IEC standards.
- Design, procure and supply all DC cables, connections, fixings and cable trays between the PV panels and the Inverters and all the AC connection and cables between the inverters and their respective MDBs.
- DC Cables: Outer sheath of cables shall be electron beam cross-linked XLPE type, or equivalent. Cable Jacket should also be electron beam cross-linked XLPE, flame retardant, UV resistant. 6mm<sup>2</sup>, 70mm<sup>2</sup> cables can be used.
- Cables terminations shall be made with suitable cable lugs & sockets etc., crimped properly and passed through brass compression type cable glands at the entry & exit point of enclosures, or equivalent.
- All cable/wires shall be provided with UV resistant printed ferrules for both DC and AC sides. The marking on tags shall be done with good quality letter and number ferrules of proper sizes so that the cables can be identified easily.
- Cable trays and racks shall also be provided of hot dip galvanized steel.

- AC Cable trays shall have a spare area of 50% of the whole section, a minimum distance equivalent to one diameter of the AC cables is to be left between cables on the cable trays.
- DC Cables can be bundled on cable trays
- Cables with different voltage level shall be separated by use of different ladders or trays. Particular attention should be given to separating Power lines from control cables.
- Cable trays shall be protected by use of a cover.
- For underground cables in trenches: Excavated in a depth of min. 70 cm. The bottom of the trench shall be smooth, compacted and free of stones, roots and pipes. The bottom of the trenches shall be covered with a 15-cm layer of riddled, stone-less sand. After laying of the electric conduits, they shall be covered with a further layer of the same sand, depth 15 cm. a second layer of conduits for control cables is then laid in place, covered with a third layer of 10cm sand. Remaining volume can be backfilled from excavated material. A warning tape and a bare copper cable should be installed as detailed in the trenches drawings. Asphalt should be corrected in all affected areas.
- Supply and Install a complete earthing system including earthing rods and all earth wiring and accessories for equipotential connection.

#### **1.4 Control and signal Cables**

- Multi core insulated cables suitable for outdoor use and laying underground, with copper conductor and copper shielding
- The cables shall be provided with a min. of 20% spare conductors, except for the inter-inverters control cables.
- Separate cable trays or conduits shall be used for LV and control / signal cables.
- Contractor is responsible for providing a layout of the control cables as required by the proposed topology, and responsible for installation of such network.

#### **1.5 Electrical Boxes**

- Class II boxes suitable for outdoor use (minimum IP67 protection if implemented outdoor, in compliance with the applicable standards which should be sunlight/ UV resistive as well as fire retardant)

- Includes a disconnecting device for upstream boxes by removable and lockable handles. This applies to both combiner boxes and main totalizer boxes.
- Includes suitable protections. e.g. DC fuses on both the positive polarity (+) and negative polarity (-) in the DC side,
- Protective device against surges suitable for photovoltaic systems according to the applicable standard.
- Included tracking labels and signal "Warning: energized cables " and "Do not operate in charge" both in Arabic and English language
- All electrical boxes must be labelled with permanent marking denoting the associated inverter and Combiner box numbers as per the as-built drawings.
- The boxes will have suitable cable entry points fitted with cable glands of appropriate sizes for both incoming and outgoing cables preserving the IP of the box.
- The electrical boxes must be grounded properly to ensure all safety related measures for safe operation.
- All the electrical boxes to be manufactured with sufficient space for easy handling and must have temperature suitability for local conditions and maximum current rating.

### 1.6 PV-Diesel System Controller

A tested commercial solar diesel hybrid control system should be provided to manage energy production from the solar inverters to preserve grid stability during Diesel Generators operation and guarantee a minimum loading factor on the generators.

The controller is expected to operate as follows:

- The controller shall be able to operate at least three different diesel generators which do not operate in synchronization.
- The controller will continuously monitor the running generator output via dedicated meters (independent from the GCU measurements). In case the loading on the diesel generator is reduced to less than a certain minimum loading factor (MLF), the controller will send instructions to all inverters to reduce their power output such that MLF is respected. This action should prevent reverse power on the generator side and will always maintain a stable grid. The inverters will be acting as a slave to the system controller. Response times should be within 1 second of instruction. The MLF value should reside between 30 to 40%, but the exact value of MLF should be customizable on site and will be communicated to the contractor at a later stage. It is expected that MODBUS communication will be used, but other configurations are acceptable if technically equivalent.

- The controller should also be able to actively control the reactive power output from the PV inverters to keep the DG running in its optimal power factor range. The control algorithm will be communicated in a later stage.
- The controller is to be put on hold when the Facility is powered by the public utility grid. In this case, full power from the solar inverters is injected. The controller will be able to detect public utility grid failures and act accordingly.
- All operating parameters from the controller should be fully logged in the dedicated logger. It should be placed in a protected enclosure. It should be protected from surges and power fluctuations.
- Product warranty shall be 5 years.

### 1.7 Monitoring & Data Acquisition

The contractor is responsible for the supply and installation of a data acquisition unit (data logger) for efficient plant operation and control and compatible with all measuring components. All measurements are to be logged locally, and available from a remote location through an internet connection, including the data from the weather station(s), the inverters, the power analysers and the solar-diesel controller.

- Supply, installation and connection of a solar technology sensors and temperature (ambient temperature + modules reference) within a weather monitoring station complete with sensors with valid calibration certificates including as a minimum:
  - 1 x Global Horizontal Irradiance pyranometers;
  - 1 x Plane of Array Irradiance pyranometers;
  - 1 x Shielded and ventilated ambient temperature sensors;
  - 1 x module temperature sensors;
  - 1 x wind speed sensors
- Supply, installation and connection of kWh meters. The power meter should measure 4 quadrant power parameters and have built-in storage and online monitoring capabilities.
- Provision of data acquisition software;
- The system should be capable to operate through both GSM and LAN, contractor should provide all accessories needed such as SIM / UIM card and modules;
- A data access for remote monitoring shall be provided to PMU, UNOPS and the facility operator.
- A small UPS system should be included to power all monitoring and controller equipment. The UPS should have a 1kWh battery storage capacity and a 1000W power rating. The UPS operating voltages should be chosen according to the offered components requirements.
- Bidder should grant access to a web portal page for at least 10 years, supporting documents from the vendor should be provided.

## 1.8 Dynamic Display Panel

50-inch TV screen and display interface for indoor use, exact location to be communicated later. The display shall follow below features:

- Should display at least: Instant Power (kW), Total produced Energy (MWh), cumulative CO2 emission saved (Ton);
- Graphic design considering the illustrations and texts to be approved by the facility;
- The Contractor will be responsible for the supply and installation of a communication device between the Plant remote monitoring system and the TV display (through LAN or other wired technology as convenient).

## 1.9 Other Components

### 1.9.1. Fire alarm system

Addressable Fire alarm system panel should be including all requirements from fire resistant cable, trunkings, pipes, termination and shall follow below features:

- one LOOP panel
- Each LOOP support to install at least 15 detector.
- 2 sounder circuits
- Include back up battery
- EN54 Approved from LPCB

#### 1.9.1.1. Flame Detector

Should be including all required fire resistant cable Technical Specifications:

- Operating voltage: 24 VDC nominal (18-32 VDC) - regulated
- Detects hydrocarbon and non-hydrocarbon fuel fires in all environmental conditions
- Alarm Current  $\leq 32$  mA
- Dual microprocessors for reliable performance
- Sensitivity according to EN 54-10
- Field of view: 90° full 100% core of vision,  $\pm 45^\circ$  from on axis.
- Sensitivity: Very high, high, medium and low - switch selectable.
- Humidity range: 5 to 98% relative humidity, non-condensing



- Test lamps for manual testing.
- EN54 Approved from LPCB

#### **1.9.1.2 smoke and heat Detector**

Should be including all required fire resistant cable Technical Specifications

- Operating voltage: 24 VDC nominal (18-32 VDC) - regulated
- Alarm Current  $\leq 32$  mA
- Dual microprocessors for reliable performance
- Humidity range: 5 to 98% relative humidity, non-condensing
- Test lamps for manual testing.
- EN54 Approved from LPCB

#### **1.9.1.3 Addressable bells(sounders)**

Should be including all required fire resistant cable Technical Specifications

Nominal voltage 9 - 28 Vdc

- Purpose-made weatherproof range.
- EN54 Approved from LPCB

#### **1.9.2 50kg Wheeled Monnex Powder Extinguisher**

- The wheeled 50kg Monnex powder extinguisher should be suitable for tackling Class B (flammable liquid) and Class C (flammable gas) fires and is also non-conductive.
- 50kg Monnex powder extinguishing agent
- 14-metre discharge range
- 300mm rubber wheels ease of movement
- 5 meter reinforced rubber hose
- Suitable for use near live electrical currents
- Provides 35 seconds of continuous discharge
- Two-year manufacturer's warranty
- CE Marked

#### **1.9.3 Fire extinguisher**

- Fire extinguisher1: 5 kg carbon dioxide (CO2);
- Fire extinguisher2: 6 kg powder;
- Warranty: at least two years.

### 1.10 Earthing System

For the equipotential bonding of the PV system the contractor shall equip the plant with an adequate earthing system with following below features:

- Earth rods of 2.4m length, 14.2mm diameter are to be installed in an earth pit, casted in concrete.
- Earthing diagram and earth cabling sections to be provided by the contractor. Main earth cables between earth rods and earthing bars should not be less than 70mm<sup>2</sup>.
- Each array structure of the PV modules should be grounded properly. Suitable accessories for bonding between copper and metallic structures to be used, to avoid potential difference induced corrosion.
- Piercing PV clamps should be used to bond PV panel frames on the same row
- All metal casing/shielding of the system and its components should be thoroughly grounded;
- Earth resistance should be tested in presence of the UNOPS representative by calibrated earth tester, the earth resistance should not be more than 5 Ohm.
- Earthing installation in accordance with the IEE Wiring regulations BS 7671.

### 1.11 Distribution enclosure with MCCB breakers:

- The distribution board should allow flexibility to connect switch disconnections, MCCB, SPD.
- Internal connection should be through bus bars 120X10mm on each phase, or at least a rating of 2000A.
- Three-phase 380V-420Vac.
- Ingress protection must be at least IP65.
- Enclosure material should be galvanized steel sheets.
- Fault level: at least 50 kA.
- Minimum Number of ways is 6.
- Bidders are advised to use high quality components

### **1.13 LED light:**

#### **1.13.1 LED Outdoor light (Solar Street Lighting Units)**

- Supply, installation LED Street Lighting Units with all requirements for installation on sites as instruction of inspector engineer.
- Input voltage: 12VDC and 220 VAC  $\pm 10$ .
- Warranty: 2 Years.

##### **1.13.1.1 Solar Panel**

- Capacity: should be Not less than 70 watts.
- Type: Mono.

##### **1.13.1.2 Battery**

- Battery Capacity: 50AH.
- Battery Type: Lithium Iron

##### **1.13.1.3. LED Lamp**

- LED Lamp Not less than 30Watt.
- Efficacy (lm/w): 90 – 100.
- Lumen (lm): 2000 – 3000
- CCT, Color: 400 – 4500 K, White Cool.
- Life L70: more than 30K hrs.
- CRI:  $\geq 80$
- Energy Effect. Label: A+
- Long lasting life.

##### **1.13.1.4. Control**

- Control Automatic (Photocell) and Manual (Remote/push bottom Switch )
- Protection Class IP 65

##### **1.13.1.5. Installation accessories**

- Beam Angle: 2000 +.
- Should be supplied with all accessories necessary for installation on the mounting structures or in the post of fencing or in the rooftop.

#### 1.14 Air Conditioning.

- Adjustable fan speed.
- Split unit inverter type.
- Cooling capacity: 18,000 TO 36,000 BTU<sub>h</sub>
- Voltage: 220-240.
- Frequency: 50 Hz.
- Single phase.
- Noise level shall not exceed 45 db.
- Star rating 3 star or above.
- Full inverter versions
- Suitable for wall mounting
- Warranty: at least two years.

#### 1.15 Electrical Pump Inverter (Controller):

##### **More requirements for pump controller ( inverter )**

- The inverter (Pump Controller) should have self-cooling system with high efficiency and protection degree not less than IP65 and carries a temperature 10 to +50 degrees Celsius and humidity up to 83%.
- Should have VFD Variable Frequency Drive to control speed of the pump
- The Inverter classified to run Induction motors
- Dry running protection
- Overload
- High current.
- Protect against reverse.
- Loss of one of the phases
- High voltages.
- Low voltages.
- Short circuit.
- Loss of insulation.
- Have a monitoring feature and display the readings of operation status and the most important:
- It has a large LCD screen to save the setting data.
- It has the ability to save chronic data by day and hour.

- Measure the energy consumed during the operation (kw) and measure the accumulative energy consumed during any period.
- Display voltage measurement.
- Display the AC output voltages for the motor.
- Display pump working hours.
- Display the inverter temperature.
- Display the motor frequency.
- Display for motor rotational speed.

The system should be provided with automatic control system between pump and MDB at station location

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## CIVIL Specific Requirements:

### 1. Mounting Structure.

#### 1.1. Mounting Structure for Al-Muwaijah Water Field Project in Al-SHAER- Hadhramout City:

The structure carries the PV modules, the gateways for workers, and DC electrical components of the Plant (cabling, junction boxes, protections, sensors, etc.).

The support structure for panels shall be made of permanent materials, be strong enough to withstand all climatic conditions (wind, heat, water) without deflection or vibrations and be securely braced and fixed to the roof or the wall of a building or the ground. Frames, support structure and other metal parts shall be made of non-corroding materials, or protected against corrosion by galvanization, painting, etc. as appropriate for the material used. It is good practice to keep dissimilar metals separate, unless they are well sealed against water by paint or sealing compound. Calculations and supporting documentation to demonstrate adequate design may be required.

Tabulation of structural Properties: -

Wind velocity withstanding capacity	>120 km / hour
Structure material	Cold-formed galvanized steel (min galvanized ratio 80%) with a minimum galvanisation thickness of (80-120) microns or. (ASTM A123 or ASTM A153 and ASTM A385)
Bolts, nuts, fasteners, panel mounting clamps	Stainless steel SS 304 / A325 or A490 high strength bolts (Hardness equal 8.8)
Mounting arrangement for RCC-flat roofs	Fixed by bolts to the roof itself or removable concrete ballast made of pre-fabricated PCC (1:2:4),
Mounting arrangement for metal sheet roofs	Mounting directly on the sheet metal, ensuring stability and wind withstanding capacity, or penetrating the sheet metal and fixing to the sub- structure, ensuring that the roof remains waterproof and ensuring stability and wind withstanding capacity.
Mounting arrangement for elevated structures	Structures MENTIONED ON ground level

Mounting arrangement for ground installations	With removable concrete ballast made of pre-fabricated PCC (1:2:4), M15; assuring enough ground clearance to prevent damage of the module through water, animals and other environmental factors. NO REMOVABLE CONCRETE
Installation	The structures shall be designed for simple mechanical on-site installation. There shall be no requirement of welding or complex machinery at the installation site. Stainless steel bolts is required.
Access for panel cleaning and maintenance	All solar panels must be accessible from the top for cleaning and from the bottom for access to the module- junction box.
Panel tilt angle	As per structure drawings

#### Method of Measurement:

- The quantities shall be calculated horizontally.
- The quantities shall be computed net using dimensions from the drawing, unless directed otherwise by the client.
- No other type, terms or regulation for computing the quantities will be used and accepted.
- Quantities may be rounded up or down where appropriate.
- Fractional quantities are not generally necessary. If considered, such quantities shall be rounded off to two places of decimals.

#### Dimensions and Access:

- The horizontal distance between two adjacent mounting structures shall not be less than 1.2 m as indicated in the layouts.
- The distance between PV panels shall be not less than 5 cm from two sides and shall not less than 100 cm from the other sides.
- The minimum height of mounting structures shall not be less than 110 cm as indicated in the shop drawings.
- The tilt angle must be South orientation with a fixed tilt angle 16 degrees.

#### Foundation of ground level mounting structures:

- For columns with a section of IPE100, their foundations are (0.4x0.4x0.7) m isolated footings reinforced concrete type C25 with reinforcement bars as shown in the shop drawings with installation of 4 anchor bolts  $\Phi 16$ mm 500mm long inside each footing and all necessary related work as detailed in the shop drawings. This work includes all



excavations work and all necessary related work according to the shop drawings and the instructions of the supervising Engineer.

- For mounting structures, the bases of 70 cm height 50 cm under ground level while 20 cm above ground level as per in the shop drawings.
- The reinforced concrete with proportion cement/ sand/ gravel 1: 1.5: 3 respectively.
- The concrete must be mechanically mixed by a machine.
- The reinforcement bars shall be with minimum yield stress 280MPa.

#### **MATERIAL SPECIFICATION:**

- The frames, post, cap plate, assembly of the structures, etc. shall conform to European standards as detailed in shop drawings of structural members. All elements sections shall be A36 steel with minimum yield stress 248MPa.
- The U-beam columns fixed by stainless steel self-drilling fasteners or by welding as detailed in the shop drawings.
- The flash plates on the purlins shall be galvanized steel 02mm thick and fixed by stainless steel self-drilling fasteners.

#### **Fabrication and erection:**

- Supplying, fabricating, delivering at site, hoisting and fixing in position, including all temporary staging and supporting, work at all levels and locations, necessary scaffolding work and making all steel elements complete as per in the shop drawings for mounting structures.
- All steel elements shall be fabricated in shop such that welding in field is not acceptable.
- Activities like Welding, Galvanization, punching of holes etc., are not acceptable at site.

#### **CONNECTIONS:**

- Welding of galvanized elements is not allowed.
- Welds to steel for mounting shall be full depth fillet welds unless otherwise stated in the shop drawings.
- The Bolts shall be approved make with nuts of various diameters and lengths, Class 8.8 Type for joining of various Structural components like Column, Rafters, Beams, Purlins etc., complete as shown in the drawing and as directed by the Consultant and Engineer IN Charge.
- The length of bolts shall be such that the threaded portion of each bolt projects through the nut by at least two threads and by not more than five threads.
- All fasteners (nuts, bolts and washers) shall be of Stainless Steel or galvanized steel.
- All fasteners shall be tightening with designed torque mechanically.

- Connection of columns and rafters shall be of Flange Haunch as indicated in the shop drawings.

#### **COATING FOR STRUCTURAL STEEL WORKS:**

- The first coat shall be from approved zinc chromite primer which applied by using mechanical spaying as well as final two coats of synthetic enamel paint over mounting elements except the galvanized elements as directed.
- Weld and steel elements surfaces shall be clean and flush before application of the protective coating.
- Steel shall not be welded after coating unless permitted by the Engineer and if permitted, the welded areas shall be free of scale and slag and shall be treated with an alternative galvanizing or zinc coating system approved by the Engineer.
- Steel frames should be filled with fine aggregate, mortar concrete, for fixation all according to specifications and instructions of supervisor engineer.

#### **Civil work includes:**

1. The development of ground base on which the PV panels will be mounted.
2. All of the excavation done for cables routing and installation.
3. 534.6 KW system installation space should not be more than 64000 square meter.
4. A separate control Room with Exhaust fan/AC for the installation of inverters.
5. The contract will be given on competitive basis among different contractors.

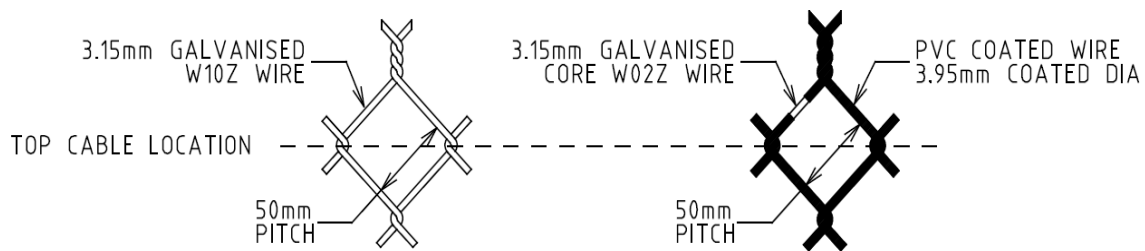
#### **1.2 Security Fence ( Chain Link Fabric )**

- GENERAL:
  - All fences shall be constructed as detailed in the shop drawings.
  - The fencing shall have at least proper entrance gate with key and lock arrangement.
  - The work covers supply, providing & fixing of Chain Link Fencing as per attached shop drawings.
  - Fencing shall be erected to a smooth alignment with no abrupt irregularities. The ground shall be trimmed or filled in such a manner that the bottom of the fence will approximately follow the level of the ground. The distance between the bottom of chain link mesh and hoardings and the ground shall not exceed 100 mm and any gap between the bottom of hoardings and the ground shall be sealed to the satisfaction of the Engineer.
  - The contractor will make good any surfaces and finishing damaged during course of construction.
- Security Fence (Chain Link Fabric). Materials:

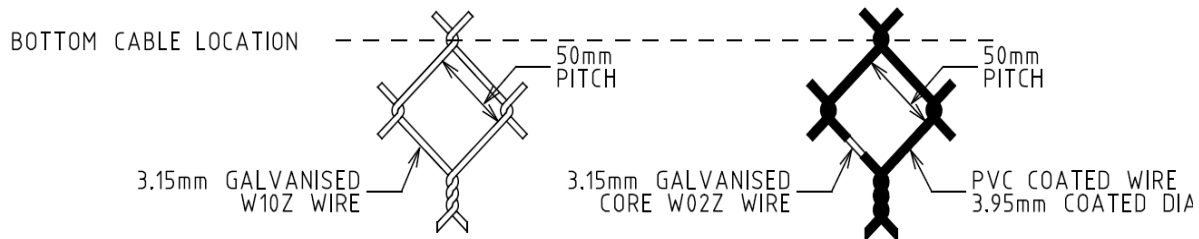
- The Mesh Wire and the Line Wire of the Fabric shall be manufactured from galvanized steel wire.
- Mesh Size:
  - The Mesh Size must be not less than 50 mm x 50 mm (wire dia 3.15mm, hole 50x50mm) as figures below.
- Workmanship & Finish:
  - Each roll shall be warranted to contain no weld joint or splice whatsoever.
  - The wire shall be circular and shall be free from scales, irregularities, imperfections, flaws, sand splits and other defects.
  - The Zinc Coating shall be smooth, even and bright.
  - The rust formation on the cut ends of the wire at the fabric selvages are inherent characteristics of this material and do not warrant rejection of the fabric.
- Weaving:
  - Woven Diamond Pattern provides strong, durable and flexible construction.
- Corrosion Resistant:
  - HDG (Hot Dip Galvanized) and if adding the PPC (Polyester Powder Coated), it will be preferred.
  - Fittings, including eye bolt strainers, cleats, winding brackets, stretcher bars, extension arms, hook bolts and base plates, shall be galvanized mild steel.
  - The length of bolts shall be such that the threaded portion of each bolt projects through the nut by at least one thread and by not more than four threads.
  - Bolts, nuts, washers and fittings for fixing to steel shall have the same protective treatment as the steel.
  - All fittings including nuts and bolts are to be spot-welded to stop removal and coating quality as the chain link fabric.
  - Staples shall be D-section galvanized wire.
- Panels:
  - Height is to be 2m or 2.5m. (min 2m, max 2.5m overall fabric height and proper fencing to stop unauthorized entrance).
  - **Length / Width:** is to be 3m for each panel and shall be checked in fully stretched condition. The Fabric shall be supplied in rolls of 15.0m to 20.0m. The supplied length shall be enough to surround the site from all directions.
  - **Wire Diameter:** Nominal diameter of Mesh Wire shall be  $\geq 3.15$  mm.
  - All wire and clips for fencing, including plastic coated wire, shall be galvanized steel.
  - Barbed wire shall galvanize and consist of two line wires and point wires.
  - Tension wire and chain link mesh for fencing shall be strained tightly between straining posts by using winding brackets.
  - Barbed wire for fencing shall be strained tightly between straining posts by using eye bolts.

- Chain link mesh shall be secured at each straining post by a stretcher bar 8mm.
- Chain link mesh shall be tied to the line wire by tying wire at 450 mm intervals.
- The tension in the wire on each side of straining posts shall be equal.
- Wire shall not be strained until at least 14 days after concrete has been placed in the foundation.
- Posts and Rails
  - Straining posts for fencing shall be provided at all ends and corners, at changes in direction, at abrupt changes in level, at gate posts and at intervals not exceeding 3m along straight lengths of fencing. Struts shall be fitted to straining posts in the direction of each wire secured to the post as detailed in the shop drawings.
  - Posts and struts for fencing shall be set in excavations for foundations and the excavations shall be filled with C25 concrete up to 50 mm below ground level.
  - The ground surface around posts shall be made good with the same material as in the adjoining area.
  - Corner posts are to be galvanized pipe  $\geq$  DN65.
  - Intermediate posts are to be galvanized pipe  $\geq$  DN50.
  - Single gate posts are to be galvanized pipe  $\geq$  DN50.
  - Double gate posts are to be galvanized pipe  $\geq$  DN65.
  - Top rail posts are to be galvanized pipe  $\geq$  DN50 or suitable MS Angle/MS Flat.
  - Bottom rails are to be galvanized pipe  $\geq$  DN50 or suitable MS Angle/MS Flat.
  - All posts must be completed with plastic or Galva bond metal cap.
  - Bracing rails, bracing stays and back stays if required are to be provided without joint and will be 32mm extra light nominal bore.
  - All rails will be securely connected to posts with galvanized bolted split clamp.
  - Steel shall not be welded after galvanizing unless permitted by the Engineer and if permitted, the welded areas shall be free of scale and slag and shall be treated with an alternative galvanizing or zinc coating system approved by the Engineer.
- Post footings
  - End/corner/gate posts are to be (W $\times$  L $\times$  H) 50cm x 50cm x 60cm Concrete base C20 for appropriate installation concrete footings.
  - Intermediate posts are to be (W $\times$  L $\times$  H) 30cm x 30cm x 60cm Concrete base for appropriate installation and strength concrete footings.
  - Above ground concrete finish is to be domed with steel trowel finish to eliminate water lying at base of posts and is to be completed at time of original concrete pour.
  - Knotted joins in cable wire are not permitted.
- Gates
  - Gates to be manufactured from medium-quality galvanized pipe( galvanized (zinc) coating on the steel pipes).
- Double leaf gate:

- Maximum width of gate to be 3m.
- Gates to open 180 degrees and lock back against fence line where ground contour allow.
- Base plates
  - Base plates can be installed where suitable concrete pavement or similar surfaces are available.
  - If required, there are to be 4 holes in a heavy duty base plate.
  - The base plates are to be fixed with heavy duty galvanized dyne bolts to the fence line by using suitable posts.
  - Posts are to be fully secured and the bolt nuts are welded or burred to prevent removal.
- Type of Selvage



BARBED SELVEDGE - TOP DETAIL



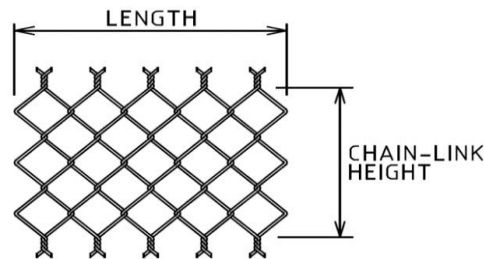
BARBED SELVEDGE - BOTTOM DETAIL

### 9.18 Control Room

- Site Settlement:
  - Survey and conduct all site levelling such as cut and backfill in any type of soil , and clear all planned areas for the work from materials , debris , trees , chairs and unwanted stuff in the site to authorized area prior to the commencing of the work .
- Foundation:
  - Strip foundations of Joam Stone under Base Stone

Laying, spreading and compacting well graded stone in layers not exceeding 30cm, including spreading in uniform thickness, hand picking, watering and compacting to the required density levelling, and finish the surface.
  - Base Stone Works

Build base black " BASILTE " stone above strip foundations up to design level with cement mortar 1 : 3 in first class and first . The middle filling shall be 60 % concrete and 40 % stone. Stone material, size, and texturing shall be in accordance with Engineer's instructions and approval. Cutting, shaping and building of stone shall be in straight angles, no twisting, distortion or uneven sizes shall be allowed. Finishing work as



**BARBED BARBED FABRIC (BB)**

workmanship recommendations.

- Cement Block Works

The bearing walls of the room shall construct from cement solid blocks ( 40x20x20 ) cm ( Automatic ) with all required works . Prices of block works shall include supply of automatic solid concrete blocks from v. good and approved factory in perfect dimension and build it in good manner, cement sand mortar ( 1 : 3 ) . Works shall include all materials, testing, scaffolds, placing of approval blocks, curing, racking out the joints, workmanship, all ducts, sleeves, opening areas, fibre board, protection concrete ( B - 200 ) around sleeve sand pipes (for electrical, sanitary & mechanical), tools and anywhere else, needed, all according to drawings, conditions and directed instructions

by the Engineer. The price includes installing concrete R.C LINTEL with reinforcement above the door and the window, .Fcu = 25 Mpa , the length shall extend 15cm on both sides .

- Concrete Works

Laying and cast reinforced concrete class (C30) for Plinth beams above Stone Strip foundations and roof solid slab including formwork, placing, vibrating, shuttering, curing. complete as directed. The price includes Supplying reinforcement of (Grade 40), size and length as detailed in the drawings, storing on site including cutting, bending and fixing in position and providing all tying wires, spacers. Item include Preliminary installations for Electrical, plumbing and floor drainage in concrete beams, and any concrete elements wherever required. The price includes surface levelling, making good the harmed surfaces and edges and all surface finishing as per shop drawings, the instructions of supervising Engineer and workmanship recommendations.

- Insulation Works

Supply and install roof water proofing membrane of bitumen rolls 5mm thick covered with quartz granules for main roof, parapet walls and primer coat GS at rate 25 kg / m2 installation of 15x15cm angle fillet 474 groove, groove sealant, groove cover, joints over lapping, backing sheets or pieces all around external and internal corners roof drains, and all necessary material to complete the works as shown in the drawings and as per manufacture instructions and codes of practice.

- Floor Tiling

cement tiles for the room floor tiles size 25x25x03 cm. The price should include 2.5cm mortar bed and 5cm thick sand bed, cutting & trimming around floor utilities opening. Item include all required finishing including Pointing, grouting, cleaning, and polishing ... etc. all according to Drawings and Instructions of the Engineer. The tiles be laid and fixed in patterns, style and forms as directed by the engineer. The type and color of the tiles shall be as chosen by the Engineer.

- Plastering Works

Plastering 20 mm thick for walls with four faces. The first is the rough nail rendering (mix 1 : 1 ) cement : sand , the second is 5mm thick mortar ( mix1 : 2 ) cement : sand , the third is the undercoat 13mm ( mix 1 : 3 ) cement : sand , the forth is make Finishing Coat , smooth surface with ( 1 : 1 ) cement : sand mortar . and all this is according to instructions of supervising Engineer. plastering 12 mm thick for ceiling with two faces.

- Painting Works

Prepare and apply one coat of wall primer, putty, one undercoat and 3 coats of semi - gloss enamel white paint on smooth finish cement and all necessary related work according to the instructions of the supervising Engineer.

The external surface of walls shall paint with 2 coats moisture resistant pants after applying one coat of wall primer.

- Windows Works

Aluminium sliding window ( 1.2 x 1 m ) with 6 mm dark glass , complete with two sliding leaves complete , glazing , silicone sealant , Ironmonger and hardware , all and anywhere else , needed , all according to and all necessary related work according to the instructions of the supervising Engineer.

- Window Steel Protection ( Anti burglar bars )

Supply and install Steel metal grille for window protection with all required works. 12mm di Steel bars decorative (standard shape), approx. spacing between bars about 12cm in the two directions, the window edges angle (L- section) 4cmx 4cmx3mm. Providing panting with primer paint and approved colour, and all to the full satisfaction of Engineer. The price included any work and all accessories to finish work as directed by the engineer.

- Door works

The door shall be metal made of steel tubes adjoining vertically without space (tube 50x50x1.25) mm with all required accessories, handles, locks, hinges and rubber.

- Perimeter Side Walk

The Perimeter side walk shall have a minimum thickness of 70 cm and construct from concrete Curbs 50 cm height with buried 20 cm. filled in layers with good compacting.

The top surface of side walk shall cover with cement tiles include sand bedding under tiles bedding with cement and sand mortar 3 : 1 ( 300kg cement / m<sup>3</sup> sand ) with 10 cm plain concrete.



**CIVIL, STRUCTURAL & ARCHITECTURAL  
SPECIAL TECHNICAL SPECIFICATIONS**

### **TECHNICAL SPECIFICATIONS: INTRODUCTION**

- 00.01** These specifications contained in Part inclusive are intended to provide overall guidance in the execution of Buildings and UNOPS Engineering Works  
The Technical Specifications shall apply except where otherwise provided for in other Tender Documents or where the UNOPS Engineer may specifically direct a variation.
- 00.02** The Technical Specifications shall, except where suppressed by any other specifications shall be a Contract Document, and shall be read in conjunction with the Instructions to Tenders, General Conditions, Bills of Quantities, Drawings, and other Contract Documents.
- 00.03** The Drawings on which this Contract is based are shown in the list of Drawings, and any notes or dimensions therein shall take precedence over the Technical Specifications.
- 00.04** In various places throughout these Specifications and by laws issued by: The American Society for Testing Materials; British Standards Institution. These shall be considered as a basis and complementary to these Specifications and the Contractor shall be bound by them.
- 00.05** Notwithstanding anything contained herein, the Contractor shall be responsible for compliance in all respect with such laws as may be in force at the time of the execution of the Works.
- 00.06** These Specifications refer to the type and quality of materials to be used, and to the methods of construction to be employed, in carrying out the Works under this Contract.
- 00.07** The Contract shall execute all preparatory work and setting-out, and shall provide all necessary labor, plant, transport, tools, materials, water, fuel and power, and anything else necessary to complete the Works as shown or as reasonably implied in the Contract Documents.
- 00.08** All materials shall be the best of their respective kinds. The Contractor shall submit to the UNOPS Engineer for his written approval samples of the materials which he proposes to incorporate in the Works, and all materials used thereafter shall be in full conformity with such approved samples. Should the UNOPS Engineer so require, the Contractor shall produce, at his own expense, Test Certificates in respect of consignments of bulk materials. Should the UNOPS Engineer so require, the Contractor shall furnish, free of charge, samples of materials for testing at an approved laboratory.
- 00.09** When reference is made to materials of specific manufacture, it shall also mean: "an approved equivalent:, Which is to be interpreted as being a product having the same characteristic of physical and chemical composition, quality, texture, action, etc.
- 00.10** The Contractor shall make due allowance for testing, both when directed by the UNOPS Engineer and again upon completion, for all drains, mains, services and installations, and for leaving them in an efficient working condition.
- 00.11** The Contractor shall modify or readjust drawings or studies, without compensation, where such modifications become necessary because of obstacles created or encountered during construction and such modifications shall be initiated either by Contractor or the UNOPS Engineer, but in either case will be approved by the UNOPS UNOPS Engineer.

**00.12** The Contractor shall submit to the UNOPS Engineer for his approval and whenever requested to do so by the UNOPS Engineer, two (2) sets of workshop drawings (one of which is to be given back to the Contract Drawings.

**00.13** "Approved" or "Approval" where used in these Specifications shall mean the written approval of the UNOPS UNOPS Engineer.

**00.14 Abbreviations:-**

In these Contract Documents, the following abbreviations shall have the meanings attached hereto:

**Abbreviation**

**Description**

**(Standards and Standards' Institution):**

A.A.S.H.T.O.	American Association of State Highway and Transportation Officials
A.C.I.	American Concrete Institute
A.S.H.R.A.E.	American Society of Heating, Refrigeration and Air Conditioning UNOPS Engineers.
A.S.T.M	American Society of testing and Materials
B.S.S.	British Standard Specifications
D.I.N.	Deutsche Industrie-Norm
N.E.M.A.	National Electrical Manufacture Assoc.

**(Metric Measurements):**

mm.	Millimeter
cm.	Centimeter
m.	Meter
m <sup>2</sup>	Cubic meter
LM.	Linear meter (meter run)
g.	Gram
Kg.	Kilogram
MT.	Metric Tone
L.	Liter

**(Imperial Measurements):**

In. or".	Inch
Ft. or'	Foot
Yd.	Yard
Oz.	Ounce
Lb.	Pound
Gal.	Imperial Gallon

**(Standard Units):**

Dia.	Diameter
ea.	each
HP.	Horsepower
Hz	hertz
LS.	Lump sum
N.	Newton
No.	Number
V.	Volt
W.	Watt

**00.15 GENERAL CONDITIONS OF CONTRACT & GENERAL SPECIFICATIONS**

The General Conditions of Contract, are to be read in conjunction with the Special Conditions and Specifications of the project. In case of any differences, the Special Technical Specifications supersede .

**SECTION 1.00**  
**PRELIMINARY WORKS**

ITEM	TITLE
<b>1.01</b>	<b>DESCRIPTION</b>
<b>1.02</b>	<b>EARTHWORK</b>

## **SECTION 1.00**

### **PRELIMINARY WORKS**

#### **1.01 DESCRIPTION**

This section shall cover most but not all preliminary works required for the completion of the project such as diversion of sewage line, connecting existing and new structures, connecting of all services to the Site such as electricity, telephone, water. etc., and also shall cover most of the Works required to prepare the Site such as the provision good and furnishing of offices for the resident staff of the Client representative, UNOPS Engineer and Contractor, clearing away all unrequired materials and existing temporary buildings and making the Site ready for commencing the works related to this Project.

#### **1.02 EARTHWORK**

##### **1) Excavation - General**

- a) All excavations in open cut shall be the minimum necessary or practicable for the construction of the Works.
- b) Any excavated material stored on Site for backfilling approved by the UNOPS Engineer or other purposes shall be compacted in such a manner that it will cause no damage and as little inconvenience as possible.
- c) The UNOPS Engineer reserves the right to direct the Contractor as to the length of trench or portions of bulk excavations which shall remain open at any one time.
- d) No pipes or concrete shall be laid nor any Permanent Work shall commence until the UNOPS Engineer has inspected and approved the excavations.
- e) Construction of sewers and associated working shafts shall be executed in a manner approved by the UNOPS Engineer.
- f) If in the opinion of the UNOPS Engineer, a formation is unsound as a result of the Contractor's failure to keep the excavation free from water or sewage, the UNOPS Engineer will order the removal and disposal of the unsound material and the filling of the resulting void. The Contractor shall execute the Work as directed and shall have no claim for any costs thus incurred.

## **2) Backfilling Excavation in Open Cut.**

- a) The backfilling of excavations shall be commenced as soon as practicable after the permanent works have been tested, inspected and approved by the UNOPS Engineer.
- b) Trenches other than in roads and paved/tiled areas shall be backfilled with selected excavated material in layers not exceeding 300mm. to obtain a minimum of 95% of the relevant maximum dry density of the material.
- c) In all other excavations other than in roads and paved/tiled areas after the UNOPS Engineers has approved the Permanent Work, the first 500 mm. over such Permanent work shall be backfilled by hand with lightly compacted selected excavated material. The Contractor shall backfill the remaining void with selected excavated material in layers not exceeding 300mm. in depth to obtain a minimum of the relevant maximum dry density of the material.
- d) All filling materials, which in the opinion of the UNOPS Engineer are of a non-cohesive nature, shall be well watered to the approval of the UNOPS Engineer, and in layers as specified to obtain the specified compacting.
- e) Any excavated material, which in the opinion of the UNOPS Engineer are unsuitable for backfilling, shall be removed from the Site by the Contractor, and any deficiency of backfill shall be made good with material as ordered by the UNOPS Engineer at the Contractor's expense.

**SECTION 2.00**  
**EXCAVATION & EARTHWORK.**

**INDEX**

<b><u>ITEM</u></b>	<b><u>TITLE</u></b>	<b><u>PAGE No.</u></b>
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2.03	Clearing And Grubbing.	
2.04	Topographical Map.	
2.05	Classification of Excavation.	
2.06	Excavation for Site Leveling - General Excavation.	
2.07	Excavation for Structure - Common Excavations.	
2.08	Utilization of Excavated Materials.	
2.09	Backfilling and Filling.	
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2.12	Upholding Excavations.	
2.13	Water in Excavations.	
2.14	Restoration of road surfaces.	
2.15	Shoring Excavations.	
2.16	Measurement.	
2.17	Payment.	

**SECTION 2.00**  
**EXCAVATION & EARTHWORK.**

**2.01 INTRODUCTION.**

The UNOPS Engineer may make available, for the Contractor's guidance only and without guarantee, information regarding the nature of the ground to be excavated.



## **2.02 DESCRIPTION.**

This work shall consist of clearing and grubbing, excavation for foundations, filling and backfilling, upholding excavations for the remaining structures to be executed within the site

## **2.03 CLEARING AND GRUBBING.**

Prior to commencement of excavation operations in any area, the contractor shall perform all necessary clearing and grubbing in those areas where it is shown on the plans or as instructed by the UNOPS Engineer. The clearing and grubbing shall consist of clearing the said areas of all shrubs, roots and other vegetation and all other objectionable materials.

## **2.04 TOPOGRAPHICAL MAP.**

The Contractor shall notify the UNOPS Engineer well in advance of the commencement of the excavation. The contractor shall check, at his own expense, the given topographical map and "as built drawings", prepared by the Contractor, sign it and submit it for the UNOPS Engineer's counter signature. Cross-sectional elevations and profiles may be taken of the natural or pre-finished ground before commencing the work, if they are needed.

## **2.05 CLASSIFICATION OF EXCAVATION.**

### **a) Unclassified - General Excavation.**

Excavations for site Leveling shall be classified as "general excavation" and shall include excavation in all soils to any depth, in any type of material encountered whatsoever including rock.

### **b) Unclassified - Common Excavation.**

Excavation for foundations, trenches and the like shall be classified as "common excavation", which is defined in this Contract as common excavation, in any type and material encountered whatsoever, including rock.

## **2.06 EXCAVATION FOR SITE LEVELING - GENERAL EXCAVATION.**

The Contractor shall excavate over some areas around the existing main building within the site to the required dimensions and levels indicated on Drawings or as directed by the UNOPS Engineer.

All excavations for site leveling shall be considered as "Unclassified General Excavations" and no allowance hereunder shall be made for excavation in rock or other.

The excavations shall be carried down below the grade levels to allow for sub-base and/or base course as required for the construction of pavements floor systems. The work shall include leveling and preparation of the surface to the entire satisfaction of the UNOPS Engineer.

All surplus material shall be transported from Site to a dump approved by the Government or the appropriate local authority.

## **2.07 EXCAVATION FOR STRUCTURE.**

a) Trenches or foundation pits for foundations of different ancillary structures shall be excavated to the lines and grades shown on the plans. They shall be of sufficient size to permit the placing of structures or structure footings of the full width and length shown.

The elevations of bottom of footings shall be considered as approximate only, and the UNOPS Engineer may order such changes in the dimensions or elevations thereof as he deems necessary to secure a satisfactory sub foundation in accordance with the soil testing reports done by others.

Boulders, logs and other objectionable materials encountered in the excavation shall be removed.

All rock or other hard foundation materials including leftovers from skeleton construction shall be cleaned of all loose material and cut to a firm surface, and either leveled or stepped as directed by the UNOPS Engineer.

All seams or services shall be cleaned out and grouted, and all loose and disintegrated rock and strata shall be removed.

When the footing is to rest on material other than rock, excavation to the final grade shall not be made until just before the footing is to be placed.

Wherever the foundation material is soft or muddy or otherwise unsuitable in the opinion of the UNOPS Engineer, the Contractor shall remove the unsuitable material and backfill with Grade (18) concrete, for which work the Contractor shall then be entitled to receive payment as for other similar items.

b) For portions of underground concrete structures where shuttering work is required, the excavation shall be made far enough from the final lines of the structure to afford ample room for the setting and removing of forms and for waterproofing the external surfaces of concrete structures where and if so required.

The Contractor shall, in any case, judge the amount of materials to be removed beyond the foundation line in order to meet his needs. He shall in his Tender have anticipated this and all over-breakage that might result from slips or slides due to the nature of the soil, the result of blasting and moving or handling equipment over the foundation, and the Contractor shall have included in his Tender Prices a sufficient amount to cover all these contingencies.

c) After each excavation is completed, the Contractor shall notify the UNOPS Engineer to that effect, and no footing shall be placed until the UNOPS Engineer has approved the depth of excavation and the character of the sub-foundation material.

## **2.08 UTILIZATION OF EXCAVATED MATERIALS.**

All excavated materials, insofar as suitable and approved by the UNOPS Engineer, shall be utilized as back-fill for Site Leveling, forming of roads, yards and parking areas, behind external walls of basements and retaining walls, and around structures.

The surplus and unsuitable materials shall be transported and dumped and finally disposed of in such a manner as to be satisfactory to the UNOPS Engineer and without detriment to any property.

## **2.09 BACKFILLING AND FILLING.**

### **a) Material:-**

Material for backfilling and filling shall be compactible soil selected from excavated materials, insofar as such materials are approved by the UNOPS Engineer.

In the case where quantities of excavated materials are not sufficient for backfilling or filling or, if in the opinion of the UNOPS Engineer, the same are not suitable, then additional quantities shall be brought for these purposes from external sources approved by the UNOPS Engineer.

- b)** The Contractor shall backfill or fill for site leveling to form terraces, landscape and road works as shown on drawings. This work shall be done by filling to the required levels with allowance for any subsequent settling.

Backfill of selected material around foundations shall be done in layers not exceeding 20 Cm. thickness, to be watered and compacted with mechanical compactors to the required elevations, and shall maintain 95% of maximum dry density in conformity with relevant standards.

## **2.10 EXCAVATION BELOW REQUIRED LEVELS.**

The Contractor shall fill up with Grade (18) concrete, at his own expense, all excavations made below design levels of foundation indicated on the drawings, or as required to obtain a solid bottom to the actual levels needed.

## **2.11 DEFECTIVE BACKFILLING AND FILLING.**

The Contractor shall be responsible for any depression resulting from defective backfilling or filling, and he shall reconstruct or repair any damages to structures, pipelines or trenches resulting from defective backfilling or filling at his own expense.

## **2.12 UPHOLDING EXCAVATIONS.**

The Contractor shall take all the necessary precautions, by planking and strutting or otherwise, to ensure that the faces of excavations are upheld. In the event of the collapse of any faces of excavation, the contractor shall re-excavate and make good any damage at his own cost.

## **2.13 WATER IN EXCAVATIONS.**

All water accumulating in excavations through any cause whatsoever, including for underground water level, shall be removed by the contractor at his own expense, and pumping shall be done in such a way as not to disturb the condition of the excavation.

## **2.14 RESTORATION OF ROAD SURFACES.**

Where the excavation is in or near asphalted roads, it shall be carried out with as little damage to surrounding surfaces as possible.

On completion of backfilling with proper consolidation, the Contractor shall immediately carry out the reinstatement of the road, bringing the backfill up to the required level and leaving the necessary space for sub-base and base course and the asphalted layer. Compacting of backfilling shall be 95% dry density as per relevant standards. Both the base course and the asphalted layer shall be thoroughly compacted by tamping or rolling, and the top of the asphalt shall be rounded over the trench slightly higher than the street level to allow for any subsequent settlement.

## **2.15 SHORING EXCAVATIONS.**

The sides of excavations shall be supported as necessary to maintain a vertical face and/or to prevent caving-in of any nature, especially during subsequent operations.

The Contractor shall be responsible for the design, supply, fixing, safety and removal of all planking, strutting and shoring required to the side of the excavation.

## **2.16 MEASUREMENT.**

### **a) Clearing and Grubbing:-**

This item shall be considered as a subsidiary obligation of the Contractor, and its cost shall be deemed to be included in the Unit Prices of the other excavation work. No direct payment shall be made under this item.

### **b) Excavation:-**

i) General excavation for Site Leveling shall be measured by the cubic meter as "Unclassified general Excavations" and shall include for excavation all over the existing underground structure if any.

Measurement shall be for the actual number of cubic meters in the original position, based on measurements before and after excavation. The contractor's Unit price shall include for getting out excavated material, depositing soil within or off the Site, and returning for backfilling or as directed. It shall also include for upholding excavation faces or for cutting to stab slope, de-watering and clearing, backfilling inside and outside buildings including watering and compacting in places where needed whether under buildings or roads or landscaped areas, and backfilling for forming of roads, landscaping and yards.

The pay-line of excavations shall be the vertical line of the extreme outer edge of concrete footings.

The Contractor shall allow in his Unit price for any extra excavation he has to carry out to facilitate his work.

ii) Common excavation for foundation pits, trenches and the like shall be measured by the cubic meter.

In all cases of foundation excavations, the measurement shall be as follows:

- In respect of horizontal dimensions for the poured concrete, no extra width shall be considered for any reason.
- Vertical dimension shall be for the reduces levels obtained below General Site excavation levels.
- Where the foundations are located in fill areas, only that part to be excavated below the natural ground level before filling shall be measured as common excavation, whether general filling was carried out before or after common excavation was made.

**c) Backfill and Filling:-**

i) Backfill and filling for Site Leveling and in building which is composed of excavated materials shall not be subject to measurement for payment and its cost shall be included in excavation items.

ii) Filling made with materials brought from external resources shall be subject to measurement and payment and its cost shall be included in Imported fill item as well as use of excavation fill item.

**2.17 PAYMENT.**

The quantities determined as provided above shall be paid for at the Contractor's Unit Price of measurement shown in the Bill of Quantities, which price and payment shall be full compensation for all material labour, plants, equipment, tools and incidentals necessary to complete the works prescribed in this section.

**SECTION 3.00**

**CONCRETE WORKS**

**INDEX**

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<b>3.02</b>	<b>QUALITY CONTROL.</b>
<b>3.03</b>	<b>CEMENT.</b>
<b>3.04</b>	<b>CEMENT STORAGE.</b>
<b>3.05</b>	<b>TESTS OF CEMENT &amp; REJECTION AND REMOVAL OF UNSATISFACTORY CONSIGNMENTS.</b>
<b>3.06</b>	<b>FINE AGGREGATE.</b>
<b>3.07</b>	<b>COARSE AGGREGATE.</b>
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<b>3.09</b>	<b>ADDITIVES.</b>
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<b>3.25</b>	<b>SCREEDING.</b>
<b>3.26</b>	<b>CONCRETE FLOOR FINISHING.</b>
<b>3.27</b>	<b>LIGHT WEIGHT CONCRETE.</b>
<b>3.28</b>	<b>R. CONCRETE RAISED FLOORING ( FLOATING FLOOR )</b>
<b>3.29</b>	<b>CAUSES OF REJECTION.</b>
<b>3.30</b>	<b>MEASUREMENT.</b>
<b>3.30</b>	<b>PAYMENT.</b>

## **SECTION 3.00**

### **CONCRETE WORKS**

#### **3.01 DESCRIPTION.**

This work shall consist of concrete and ancillary concrete structures, to be constructed in conformity with the lines, grades and dimensions shown on the drawings or ordered by the UNOPS Engineer, and in accordance with this and other relevant sections of the Specifications.

The contractor shall submit to the UNOPS Engineer all workshop drawings for all details not mentioned in the contract drawings issued to the contractor, including connections to existing skeleton structures.

#### **3.02 QUALITY CONTROL.**

The material used, as well as the execution of the works, shall be of the standard called for in these Specifications, and it is deemed to be the sole responsibility of the Contractor to produce according to such a standard.

Unsatisfactory portions shall be liable to rejection and shall be, if so directed, cut out and re-executed at the expense of the Contractor, whatever the extent of the demolition and the cost of the re-execution may be.

#### **3.03 CEMENT.**

All cement used shall be ( unless otherwise specified ) local ordinary portland cement, and shall comply in every respect with B.S No.12 for portland cement and to ASTM C150Type

1.

Subject to the approval of the UNOPS Engineer, low-heat portland cement may be used in hot weather concreting to limit the rate of heat generation due to the hydration of cement. Low-heat portland cement shall comply with B.S 1370 or ASTM-C150, Type V.

Waterproof additives to concrete shall be used where required.

The Contractor shall keep accurate records of deliveries of cement and its use in the works. Copies of these records shall be supplied to the UNOPS Engineer in such forms as may be required.

#### **3.04 CEMENT STORAGE.**

The cement shall be delivered to the Site in such consignments as shall ensure satisfactory progress of the work, each bag or container to be sealed and branded to the satisfaction of the UNOPS Engineer. The cement shall be stored on site in a dry store or in approved bulk containers large enough to contain the required quantities. The store shall be provided by the Contractor and shall have sufficient sub-divisions of such sizes as the UNOPS Engineer

may approve. It shall be properly roofed and perfectly watertight, and shall have a dry wooden floor above ground level, with an air space at least 15 Cm. high.

Cement delivered in bulk and stored in silos shall be accepted only if a central mixing plant is used.

The cost of all work specified under this item shall be borne by the Contractor.

The cement shall be used in the order in which it has been delivered and placed in the stores.

### 3.05 CEMENT REJECTION.

The UNOPS Engineer have the power to reject cements if, at any time, he finds any deterioration in the quality.

### 3.06 FINE AGGREGATE.

a) Fine aggregate shall be natural sand, and of a specific gravity of not less than 2.50. It shall be clean, sharp and free from dust and coagulated lumps. Fine aggregate from different approved sources of supply shall not be mixed or stored in the same pile nor used alternately in the same GRADE of construction without the permission of the UNOPS Engineer.

b) The fine aggregate shall not contain deleterious substances of the following percentage:

Material	AASHTO Test Method	% by Weight
- Clay Lumps	T - 112	1.00
- Material Passing Sieve No. 200	T - 11	3.00

Other deleterious substances shall not exceed five percent (5%).

c) When the fine aggregate is subjected to five alterations of the sodium sulphate soundness test AASHTO T-104, the weighted per centage of loss shall not exceed ten percent (10%) by weight.

d) Grading.

Sieve Size/No.	Percentage Passing by Weight
3/8 in.	100
3/16 in	90-100
No. 7	60-95
No.14	30-70
No.25	15-34
No.52	5-20
No.100	0-10
No.200	0-3

e) Fine aggregate failing to pass the minimum requirement for material passing the Nos. 52 and 100 sieves may be used provided an approved inorganic, fine, inert, material is added as correction for the deficient in grading.

f) The plasticity index of the tested specimen shall not exceed six percent ( 6% ).



- g) Fine aggregate shall comply with other specifications listed in item 3.07 thereafter.
- h) The Contractor shall be responsible for providing acceptable fine aggregates.

### 3.07 COARSE AGGREGATE

- a) The coarse aggregate for concrete shall consist of crushed hard limestone or clean gravel of a specific gravity of not less than 2.50 and free from earth, loam, clay, organic matters, and other impurities.

The coarse aggregate shall not contain deleterious substances in excess of the following percentages:

<u>Material</u>	<u>AASHTO Test Method</u>	<u>%</u>	<u>by</u>
<u>Weight</u>			
- Clay	T-112	0.25	
- Materials passing No. 200 Sieve.	T- 11	1.00	

Thin or elongated pieces (length 5 times greater than the maximum thickness) shall not exceed ten (10%) by weight.

- b) The designated size of coarse aggregate used in all GRADES of concrete shall by one inch to No.4 Sieve and shall be well-graded and retained on sieve No.4, when tested for grading, coarse aggregate conform to the following requirements:

<u>Square-mesh</u>	<u>Percentage by Weight Passing</u>
<u>Sieve Size /No.</u>	<u>AASHTO T-27</u>
1.00 in.	100
0.75 in.	95-100
3/8 in.	20-55
No.4	0-10
No.8	0-5

- c) The sum of percentages of all deleterious substances in any size, as delivered to the mixer, shall not exceed three percent (3%) by weight.
- d) Coarse aggregate may be rejected if it fails to meet the following test requirements:
  - 1- The loss Angeles Abrasion Test (AASHTO T-96) loss hereunder shall not exceed 35% by weight at 500 revolutions.
  - 2- The Sodium Sulphate Soundness Test ( AASHTO T-104 ) Weighted average loss after 5 cycles, with samples described under Alternate B, Shall not exceed 12%.
  - 3- Specific Gravity, on the saturated surface dry basis shall not be less than 2.50.

- e) The coarse aggregate shall be supplied to the site separated into nominal sizes as follows:

<u>Designation of Sizes</u>	<u>Nominal Size Range</u>
12.70 mm. aggregate	4.76 mm. 12.70 mm.
25.40 mm. aggregate	12.07 mm. 25.40 mm.

- f) Aggregates shall not contain any materials that are deleteriously reactive with the alkalis in the cement, or any alkalis which may be additionally present in the aggregates and mixing water, in amounts sufficient to cause excessive localized or general expansion of the concrete.

- g) The fine aggregates shall not contain more than 25% by weight of soluble calcium carbonate in either the fraction passing a 600 micron B.S. Sieve.

- h) The levels of equivalent acid soluble chloride as (CL) should generally not exceed the following:

1. Coarse aggregate	03 % by weight
2. Fine aggregate	06 % by weight

- i) The total chloride content as (CL) of any mix, including that present in the cement, coarse and fine aggregates, water and any additives used, shall not exceed 0.30 % by weight of cement in the mix, or 0.12% if sulphate-resisting Portland Cement is used.

- j) The levels of acid-soluble sulphates as (S03) should generally not exceed the following:

1. Coarse aggregate	0.4 % by weight
2. Fine aggregate	0.4 % by weight

- k) The total Sulphate content ( as S03 ) of any mix, including that present in the cement, coarse and fine aggregates, water and any additives used, shall not exceed 3.8 % by weight of cement in the mix.

### **3.08 WATER**

Water for mixing and curing concrete shall be clean potable water, free from organic and other impurities to an extent that the durability or strength of the concrete will not be harmed.

### **3.09 ADDITIVES:-**

Additives to concrete shall be used only when approved by the UNOPS Engineer. The approved additives shall be used as instructed by the manufacturer and with the approval of the UNOPS Engineer.

Plasticizing according to ASTM C-494 : Types A, B and D, BS 5075 : Part 1

### **3.10 TESTING OF AGGREGATE AND DETERMINING CONCRETE MIXES**

In sufficient time prior to commencing any concrete work, the Contractor shall arrange for samples of the fine and coarse aggregates he intends to use to be delivered to an approved laboratory, to be tested for their compliance with the Specifications. Trial mixes shall be made to fix the appropriate proportions of the various ingredients of sand and aggregate by weight ( and to establish the equivalent volumetric proportions ) and to determine the water/cement ratio for each GRADE of concrete that will give the desired strength. All these tests shall be paid for by the Contractor.

In the case of satisfactory results, subject to the UNOPS Engineer's approval, the relative proportions and the water/cement ratio thereof shall be used through the contract, and similar tests and conditions shall be applied before any substituted materials are used in the works.

If the source of the aggregate is changed at the contractor's request and with the approval of the UNOPS Engineer at any time during the course of the work, all sampling and testing described under this Item shall be repeated at the Contractor's expense.

### **3.11 PROPORTIONS AND BATCH WEIGHTS**

The UNOPS Engineer shall approve the weight in kilograms of fine and coarse aggregates ( in the saturated surface dry conditions ) per 50kg. of cement for the specified GRADE of concrete as recommended by the laboratory. As a general procedure, the Contractor shall batch the aggregate on Site by weight.

"Weight-batching" machines of types approved by the UNOPS Engineer shall be used for charging the hoppers of the mixers. They shall be maintained in a clean condition in proper working order, and shall be checked as directed by the UNOPS Engineer for accurate weighing.

The weighing devices shall be precise to within  $\pm 2\%$  of the scale setting. A standard set of weights shall kept on the Site and the Weighing mechanism shall be daily checked before commencement. Where batching is by weight, allowance shall be made for the weight of water in the aggregates at the time of batching. This shall be checked once per day during concreting or more frequently when ordered. The weighing equipment shall be arranged to permit the compensations for changes in the weights of moisture contained in the aggregates, and to permit the convenient removal of excess material from the weighing hopper.

The UNOPS Engineer may, if he deems it practicable, substitute approved volumetric measuring devices to be used in lieu of weighing devices for minor works only. In such event, weighing will not be required but the volumes of coarse and fine aggregates measured in each batch shall be approved by the UNOPS Engineer and the correct proportions shall be accurately measured in approved gauge boxes.

### **3.12 ADJUSTMENT IN PROPORTIONS**

#### **a) Adjustment for Variation in Workability:-**

If it is impossible to obtain concrete of the desired workability with the proportions originally designated by the UNOPS Engineer, he shall make such changes in aggregate

weights as are necessary, provided that in no case shall the cement content originally designated be changed except as provided in Sub-items b) and c) of this Item.

b) Adjustment for Excess Net Water Content:-

If, when using the designated cement content, it is impossible to produce concrete having the required consistency without exceeding the maximum allowable net water content recommended by the laboratory, the cement content shall be increased as directed by the UNOPS Engineer so that the maximum water content will not be exceeded.

c) Adjustment for New Materials:-

No change in the source or character of the materials shall be made without due notice to the UNOPS Engineer, and no new materials shall be used until the UNOPS Engineer has accepted such materials and has designated new proportions based on tests of trial mixes.

### **3.13 CONCRETE MIXING**

Concrete shall be mixed thoroughly in a batch mixer of an approved type and capacity. No hand mixing will be allowed unless authorized by the UNOPS Engineer and only for small quantities.

Batching, whether by weight or by the equivalent volumetric proportions, shall be for whole bags of cement as approved by the UNOPS Engineer. Mixing time shall not be less than one and one half minute after all component materials including water are in the drum of mixer with a one cubic metre or less capacity.

The mixing time shall be increased by 20 seconds for each additional cubic metre (or fraction thereof) of mixer capacity.

The charging of water into the mixer shall be gauged from a calibrated container or from such other approved device as shall be capable of delivering the required quantities to within one liter of the gauged amount. Charging of water shall begin before the cement and aggregates enter the drum.

(During mixing, the drum shall be operated at the speed specified by the manufacturer. Any concrete mixed for less than the specified time shall be dumped outside the work area and removed by the Contractor at his own expense.

No mixer with a nominal capacity of less than one bag shall be used. The concrete shall be mixed only in such quantities as are required for immediate use. Re-tempering of concrete will not be allowed.

Concrete which is not of the required consistency at the time of placement shall not be used. The entire contents of the mixer shall be discharged from the drum before materials for a succeeding batch are placed therein.

Upon cessation of mixing for any considerable length of time, the mixer shall be cleaned thoroughly. Upon resumption of mixing, the first batch of concrete materials placed in the mixer shall contain sufficient sand, cement and water to coat the inside surface of the drum without diminishing the required mortar contents of the mix.

The UNOPS Engineer may approve the use of ready mixed concrete in the works subject to the following:-

- a) The provisions of B.S. are adhered to in all respects.
- b) The source, location and details of batching installation are submitted to the UNOPS Engineer for his approval and access to the plant is allowed for inspection of general control purposes prior to commencement and during the progress of work.
- c) The undertaking by the ready mix suppliers to provide concrete in accordance with this Specification.
- d) Ready mixed concrete shall be fully mixed at the works prior to loading an agitator lorry and delivered to site continuously agitated; the delivery ticket must show the mix proportions and time of mixing. The concrete must be compacted in the form work within:
  - 1) mixing time in hot days.
  - 2) mixing time with retarders of the mixing time stated on the delivery ticket; no water may be added to the mix in transit or on Site.
- f) Ready mixed concrete may be delivered in an agitator truck mixed and the water added and mixed on Site, when authorized by the UNOPS Engineer. The amount of water to be added to the mix on Site shall be stated on the delivery ticket; no water is to be added in excess of that quantity.

Concrete shall be handled from place of mixing to place of final deposit as rapidly as approved methods which will prevent segregation and loss of ingredients. It shall be deposited as nearly as practicable in its final position to avoid re handling unset concrete inside the forms; chutes for transporting the concrete will only be allowed with the approval of the UNOPS Engineer.

### 3.14 CONCRETE GRADES

Concrete work shall be done in one of three GRADES and used in the places assigned to each GRADE in the structural drawings. Concrete mixes shall give the desired consistency and crushing strength as specifies in Table (1)...

**Table (1) : GRADE OF CONCRETE**

GRADE OF CUBE CRUSHING CONCRETE	MINIMUM CEMENT		6 IN-
	CONTENT kg/m <sup>3</sup>	SLUMP C M .	STRENGTH (kg/cm <sup>2</sup> ) 28 DAYS

GRADE (18)	260	5-10	180
GRADE (20)	275	5-10	200
GRADE (25)	275	5-10	250

NOTE :

- 1- WATER / CEMENT RATIO SHALL BE LESS THAN 0.45
- 2- THE MIX PROPORTIONS ARE TO BE DETERMINED BY AUTHORIZED LABORATORY TESTS.
- 3- ALL CEMENT IN CONCRETE BELOW FINISHED FLOOR LEVEL SHALL BE SULPHATE RESISTING CEMENT.

**TABLE 2:-CHARACTERISTICS OF CONCRETE GRADE ES**

Concrete GRADE es	Characteristics and Uses
GRADE (18)	Shall have a minimum cement content of 260 kg. per cubic metre of finished concrete and shall be used in special blinding concrete works under foundations.
GRADE (20)	Shall have a minimum cement content of 275 kg. per cubic metre of finished concrete and shall be used in reinforced concrete members such as slab on grade
GRADE (25)	Shall have a minimum cement content of 275 kg. per cubic metre of finished concrete and shall be used in reinforced concrete members in the site

### 3.15 TESTING CONCRETE

The Contractor shall, before commencing and subsequently at regular intervals and whenever called upon to do so by the UNOPS Engineer, prepare 15 cm. (6in.) works test cubes in such numbers and at such frequencies as may be ordered. The test cubes shall be made in metal moulds complying with the B.S. 1881, part 2, and ASTM C-143.

Enough number of metal moulds shall be supplied by the Contractor and kept on site for the duration of the Contract. Or as UNOPS Engineer Instructions

Care shall be taken to assure that the tests are representative of the concrete being made at the time. Six (6) cubes from each sample are required. Concrete for the works test cubes shall be taken immediately after it has been deposited in the form or, where this is impracticable, samples shall be taken as the concrete is being delivered at the point of desposit. All the concrete for each sample shall be taken from one place.

A sufficient number of samples, each large enough to make one test cube, shall be taken at different points so that the test cubes will be representative of the concrete placed in that portion of portion of the structure selected for the test.

The location from which each sample is taken shall be clearly noted for future reference. The procedure for making and testing the test cubes shall be in strict accordance with B.S. 1881, Part 1, and the consistency of each sample of concrete shall be measured by the Slump Test and recorded.

The preparation of the test cubes and the Slump Test shall be under the supervision of the UNOPS Engineer's representative and the Contractor's forman. The Slump Test shall be in accordance with ASTM C-143.

The contractor shall arrange for the sets of cubes to be tested in a sequence of two (2) at seven days and two (2) at twenty eight days, and the result shall be given directly to the UNOPS Engineer. The remaining two cubes shall be kept in case of dubious testing results. The Contractor shall supply adequate facilities for transporting the cubes without damage or deterioration to them from any cause .

Two test cubes shall be made for each age at which test are required.  
The cube strength shall be calculated from the maximum load sustained by the cube at failure.

The appropriate strength requirement may be considered to be satisfactory if none of the strengths of the two test cubes is below the specified cube works test strength, or if the average strength of the two cubes is not less than specified cube strength, and the difference between the greatest and the least strength is not more than twenty percent (20%) or that average according to B.S 1881, Part 3 and ASTM C\_39 equivalence.

Statistical check on quality may be used in accordance with 116 of the British Standards.

In case any such cube does not meet the above requirement and fall below the prescribed minimum works test strenght listed in Table No. 1 heretofore, the Contractor shall cease concreting until the UNOPS Engineer permits resumption, work shall, subject to the discretion of the UNOPS Engineer, be removed and replaced by the Contractor at his own expense.

The Contractor shall be required to cut out concrete if deemed necessary by the UNOPS Engineer, and to repeat the concrete approval sequence.

The contractor shall be held solely responsible for ensuring that the crushing strength for the respective GRADE es of concrete is not less than the works test strength shown in Table 1 heretofore.

The consistency of the concrete shall be tested by the Slump test, and the Contractor shall be required to carry out Slump tests daily or as ordered by the UNOPS Engineer, in accordance with ASTM C-143 and B.S. 1881, part 2. The contractor shall supply, at his own expense, any apparatus which the UNOPS Engineer may require for testing the consistency of the concrete. The workability of the concrete shall give a Slump test value as ordered by the UNOPS Engineer within the ranges show on Table No.1 heretofore.

The cost of all prescribed tests and any other tests ordered by the UNOPS Engineer throughout the duration of the Contract shall be at the contractor's expense.

### **3.16 FORMWORK**

Formwork shall be constructed of steel or of new, clean, true and unblemished timber, laminated boards for fair-face or of glass-reinforced plastic and approved by the UNOPS

Engineer. All forms shall be free from bulge and warp, and shall be cleaned thoroughly if used a second time.

The Contractor shall be held solely responsible for the design, provision, suitability and safety of form work and moulds for concrete works wherever these are required in the Drawings, for fair-face concrete .

The forms shall be so designed as to prevent deflection or distortion, and shall be capable of removal by easing without shock to the concrete.

No hammering to the concrete shall be permitted. Any damage to the concrete caused by fully design, construction or removal of formwork shall be made good at the Contractor's expense.

The forms shall be mortar-tight, and treated with an approved shuttering oil, or saturated with water immediately before placing concrete, as may be required.

Columns and wall forms shall be daylighted at suitable intervals, the openings being sufficient to permit cleaning and inspection. The Contractor shall also provide permanent openings in forms, where indicated on Drawings or instructed by the UNOPS Engineer, to take care of the other trades covered by this Contract, without extra charge.

Metal ties for holding the forms and extending through the concrete structures shall be cut to a distance of not less than 0.6 cm. from the face of the concrete, and all holes shall be properly patched to the satisfaction of the UNOPS Engineer before plastering.

A rigid path of an approved type shall be fixed on top of the forms for passage of labourers so as not to disturb the reinforcement during concreting.

Form's shorings and bracings shall be inspected by the UNOPS Engineer immediately prior to the placing of concrete.

Dimensions shall be checked carefully and bulging or warping shall be remedied, and all dirt, sawdust, shavings or other debris on the form shall be removed. Special attention shall be paid to ties and bracing, and where forms appear to be in sufficiently braced either before or during placing of concrete then the UNOPS Engineer shall order the stopped until the defects have been corrected to his satisfaction.

Forms shall be constructed in such a manner that the finished concrete shall be of the form and dimensions shown on the Drawings and true to line and grade. Clean out ports shall be provided at construction joints.

Formwork for slabs and beams shall be laid with an upward camber to ensure that the ceiling and soffits of beams are level. Camber shall be in the range of 1:300 of the span unless otherwise indicated specifically on the Drawings.

The maximum permissible deflection of formwork under any load shall be 2mm.

### **3.17 REMOVAL OF FORMWORK**

The formwork shall be left in position for such length of time as to ensure that the concrete structure will not be affected by its removal.



The responsibility of ensuring with the Contractor, who shall make good at his own expense any and all damage caused by premature removal of formwork. The Contractor shall observe the following minimum intervals of time between placing of concrete and removal of formwork:

- Three days for vertical sides of beams, columns and walls.
- Twenty one days for roof slabs, staircase and suspended foundation beams and soffits of beams and cantilever slabs.

The above periods apply only when no drop of air temperature to below 1°C. In event of such temperature drop, the periods shall be increased as may judged necessary by the UNOPS Engineer.

### **3.18 STEEL REINFORCEMENT**

Steel reinforcement shall be high-tensile, high-bond deformed bars complying with the requirement of ASTM A615 and with a guaranteed yield of not less than 42 kg./mm<sup>2</sup>. and mild plain steel bars for steel reinforcement & stirrups with a guaranteed yield stress of 28 kg/mm<sup>2</sup>. and as shown on Drawings.

The Contractor shall test all or any size of reinforcing bars for strength and yield strength at the laboratory, and all costs related to seek testing shall be borne by the Contractor. Any steel which fails to satisfy specification shall be rejected and shall be immediately removed from the Site by the Contractor, at his own expense.

The wire shall be annealed black wire at least 1 mm. In diameter.

The contractor shall cut, bend, place, fix and tie all reinforcement as show on Contract Drawings of workshop drawings and the bar bending schedule prepared by the Contractor and on drawings approved by the UNOPS Engineer. All reinforcement shall be securely supported and tied in position. The supports shall be made of concrete , and shall not be exposed nor in any way affect the appearance and condition of concrete.

Concrete protection or reinforcing bars, laps, splices and spacing shall be in accordance with the relevant code and specifications, and to the structural Drawings. No concrete shall be placed until reinforcement has been inspected in position and approved by the UNOPS Engineer.

Secondary reinforced concrete members for which no reinforcement details are given in the Drawings shall have a minimum ratio of reinforcement area to concrete area of one-half percent (0.5%).

### **3.19 PLACING CONCRETE**

a) Placing:-

The method and equipment used for transporting concrete and the time that elapses during transportation shall be such as shall not cause appreciable segregation of coarse aggregate, nor slump loss in excess of 25mm. in the concrete as delivered to the work.

The contractor shall keep the UNOPS Engineer advised as to when placing of concrete will be performed. The UNOPS Engineer will inspect the work and check the accuracy of formwork and reinforcement, and if satisfied will give the Contractor a written permission to place the concrete.

Placing of concrete shall be performed only in the presence of the UNOPS Engineer or his Representative.

Special care shall be taken to ensure that formwork and the reinforcement is not displaced from its correct position by the movement of works, vibration, or any other cause.

Before placing any new concrete to previously poured surface, this shall be roughened, cleaned with cement mortar grout as specified hereinafter under Item (Construction Joints).

Concrete shall be conveyed from the mixer to its final position in a suitable manner, provided there is no segregation, loss of ingredients or contamination. It shall be placed in its final position before initial setting takes place and within twenty minutes of the addition of the water to the mixer. However, when such agitating shall be used to convey concrete such as in ready mixed concrete, the elapsed time between the addition of the water and placing may be increased to forty five minutes.

The order of placing concrete shall be such as to prevent water from collecting at the ends, corners and along the faces of forms. It shall not be placed in large quantities at a given point and allowed to run or be worked over a long distance in the form. Whenever possible concrete shall be placed and compacted in even layers with each batch adjoining the previous one.

The thickness of the layers shall be between 150 and 300 mm. for reinforced concrete and up to 450 mm. for plain (non-reinforced) concrete, the thickness depending on the width of the forms, the amount of reinforcement and the need to place each layer before the previous one stiffens. ( unless otherwise specified on drawings or on B.O.Q.)

Concrete shall not be allowed to drop freely for more than two meters. To convey the concrete as near as possible to be used for small section and bottom dump buckets or other suitable vessels for large sections.

Concrete shall be carefully compacted when placed to ensure a dense and uniform mass free from air holes and cavities. Concrete shall be compacted by vibration.

Vibration shall be performed by mechanical or electro-mechanical vibrators shall be of the plunger (poker) type for insertion in the concrete, except that plate type vibration ( external ) shall be used if so required by the UNOPS Engineer.

The plunger type vibrators shall have a diameter compatible with the spacing of reinforcement, a sufficiently high frequency, and shall be properly handle by experienced personnel.

They shall be immersed at regular intervals close enough together to vibrate all of the concrete, but not too close to effect previously vibrated and partially set concrete. Each immersion shall

continue until shortly after air bubbles cease to appear on the surface of the concrete, but shall not last more than thirty seconds.

All vibrations, compaction and finishing operations shall be completed within fifteen minutes from the time of placing the concrete in its final position. Until it has hardened sufficiently to carry weight without distortion, workers shall not be allowed to walk over freshly placed concrete.

Concreting of any part of section of the work shall be carried out in one continuous operation, and no interruption of the concreting work shall be allowed without the approval of the UNOPS Engineer. Where beams and slabs together form an integral part of the structure, they shall be poured in one operation, unless provision is made to form a construction joint.

A record shall be kept by the Contractor on Site of the time and date of the placing the concrete in each portion of the works and number and identification of the Works test cubes corresponding to these portions.

Such records shall be handed over to the UNOPS Engineer weekly during the progress of the Works.

b) Work in Hot or Cold weather:-

Concrete shall not be mixed or placed at a shade air temperature above 40 C on a rising thermometer, not at a shade air temperature below 5 C. on a falling thermometer.

When the shade air temperature is 37,C. and rising, special precaution shall be taken during concreting operation, such as shading of the aggregate and plant, cooling of the mixing water or other methods approved by the UNOPS Engineer, so that the temperature of the concrete when placed shall not be in excess of 39 C.

Fresh concrete placed at these temperatures shall be shaded from the direct rays of the sun to the satisfaction of the UNOPS Engineer for a period of at least twenty-four hours.

Concrete shall not be mixed and placed when the shade air temperature is 43 C. or above unless suitable precautions are taken to the approval of the UNOPS Engineer.

c) Deviations:-

Permissible deviations on in-situ concrete are as follows:

i) Foundations:

Mass concrete with or without reinforcement:

- |                       |          |
|-----------------------|----------|
| 1. Position on plan   | ± 38 mm. |
| 2. Dimensions on plan | ± 50 mm. |
| 3. Formation level    | ± 12 mm. |

Reinforced concrete, including rafts, ground beams, column bases, and strip foundations:

- |                       |   |
|-----------------------|---|
| 1. Position on plan   | ± 38 mm.  |
| 2. Dimensions on plan | ± 9 mm. per 100 mm.<br>but not exceeding ± 38 mm. total |

- |    |                 |                      |
|----|-----------------|----------------------|
| 3. | Formation level | $\pm 25 \text{ mm.}$ |
| 4. | Surface level   | $\pm 12 \text{ mm.}$ |

ii) Elements or Components Above Foundations :

- |    |   |                      |
|----|---|----------------------|
| 1. | Position on plan                                | $\pm 9 \text{ mm.}$  |
| 2. | Verticality                                     |                      |
|    | - Height over 0.6 m. up to and including 1.5 m. | $+ 6 \text{ mm.}$    |
|    | - Height over 1.5 m. up to and including 3 m.   | $+ 12 \text{ mm.}$   |
|    | - Height over 3 m. up to and including 30 m.    | $\pm 19 \text{ mm.}$ |
|    | - Height over 30 m. pro rata for each 30 m.     | $\pm 19 \text{ mm.}$ |

3. Cross-section and linear dimensions PD from dimensions of beams, slabs, columns and walls:

- |  |   |                      |
|--|---|----------------------|
|  | - Height 0 to 0.3 m.                            | $\pm 6 \text{ mm.}$  |
|  | - height over 0.3 m. up to and including 0.6 m. | $\pm 9 \text{ mm.}$  |
|  | - height over 0.6 m. up to and including 1.5 m. | $\pm 12 \text{ mm.}$ |
|  | - Height over 1.5 m. up to and including m.     | $\pm 19 \text{ mm.}$ |
|  | - Height over 15 m. up to and including 30 m.   | $\pm 38 \text{ mm.}$ |
|  | - Height over 30 m. pro rata for each 30 m.     | $\pm 19 \text{ mm.}$ |

4. Bow and camber other than designed camber, PD of any point of surface from a straight line along the extremities of that surface :

- |  |  |                      |
|--|--|----------------------|
|  | - For extremities up to and including 3 m. apart | $\pm 9 \text{ mm.}$  |
|  | - Over 3 m. up to and including 7.5 m. apart     | $\pm 12 \text{ mm.}$ |
|  | - Over 7.5 m. up to and including 15 m. apart.   | $\pm 19 \text{ mm.}$ |
|  | For each additional 7.5m. over 15 m.             | $\pm 9 \text{ mm.}$  |

5. Twist the distance of any one corner from the plane containing the other three corners:

- |  |  |                     |
|--|--|---------------------|
|  | - for a diagonal 0 up and including 3 m.             | $\pm 6 \text{ mm.}$ |
|  | - for a diagonal over 3m. up to and including 7.5 m. | $\pm 9 \text{ mm.}$ |

- For a diagonal over 7.5 m.  
up to and including 15 m.  $\pm 16$  mm.
- For each further 7.5 m.  
of diagonal over 15 m.  $\pm 6$  mm.

6. Squareness of corners - the longer of two adjacent sides shall be taken as the base line and the PD of the shorter side from a perpendicular to the base line is to be related to the length of the shorter side:

- Shorter side o up to and  
including 0.6 m.  $\pm 6$  mm.
- Over 0.6 m. up to and  
including 1.2 m.  $\pm 9$  mm.
- Over 1.2 m. up to and  
including 2.5 m.  $\pm 12$  mm.
- Over 2.5 m. pro rata  $\pm 12$  mm.

7. Level:

- Length 0 up to and  
including 7.5 m.  $\pm 9$  mm.
- Length 15 m. up to and  
including 30 m.  $\pm 12$  mm.
- For each further 15 m.  $\pm 9$  mm.

iii) Fair-Face Surface Tolerances:

Fair-face surface tolerances shall be :

1. Abrupt irregularities  $3$  mm.
2. Gradual irregularities  
expressed as maximum per-  
missible deviation for 1 m.  
straight edge.  $3$  mm.

iv) Plain Finish Surface and Tolerances:

Plain finish surface and tolerances shall be:

1. Abrupt irregularities  $5$  mm.
2. Gradual irregularities  
expressed as maximum per-  
missible deviation for  
1 m. straight edge.  $5$  mm.

d) Curing:-

Freshly placed concrete shall be protected from rain, dust storms, chemical attack and the harmful effects of heat, wind, flowing water, vibrations and shocks. This protection shall continue until the concrete is sufficiently set such that it is no longer damaged by these factors. The UNOPS Engineer shall determine when this protection shall not be less than twenty four hours after the time of placing.

On removal of the formwork from the sides of columns, beams and walls, the concrete should be closely wrapped with wet hessian and enclosed with polythene sheeting. The hessian should be kept wet by frequent additions of mixing quality water and it should be retained in position for not less than 7 days. On removal of the hessian and sheeting, the concrete should be sprayed with a suitable curing compound as soon as it is just surface dry.

Immediately after finishing the top exposed surfaces of concrete, it should be covered with polythene sheeting. As soon as the concrete has stiffened sufficiently, the sheeting should be removed and the surface covered with wet hessian. Then the sheeting should be replaced to reduce evaporation from the hessian. The hessian should be kept wet by frequent additions of mixing quality water, and it should be retained in position for not less than 7 days. On removal of the hessian and sheeting, the concrete should be sprayed with a suitable curing compound as soon as it is just surface dry.

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

### **3.20 SURFACE FINISH**

a) Concrete walls, Ordinary finish:-

Concrete walls, under-ground level, may have ordinary finish, which is defined as the finish left after removal of forms, filling of holes left by formties, and repairing of all minor defects. The surface shall be true, even, free from stone pockets, depressions and projections.

The general requirements are :

- i) To produce an even finish
- ii) To arrange panels in a regular pattern
- iii) Blowholes equal to or less than 10mm. in diameter shall be permitted, but otherwise surfaces shall be free from voids, honeycombing and other large defects.
- iv) Variation in colour resulting from the use of an impervious form lining shall be permitted, but the surface shall be free from discoloration due to contamination of grout leakage.
- v) The finish shall be left as struck. Making good of small defects shall be generally permitted but only after inspection by the UNOPS Engineer.
- vi) All blowholes shall be filled with a matching mortar to an approved sample unless otherwise instructed by the UNOPS Engineer.

vii) All faces shall be protected from damage, specially arrises, and from rust marks and other surface disfigurements.

viii) From the holes shall be filled with mortar matching an approved sample.

b) Fair-face Finish :

In the case where a fair-face finish is specified or required, the forms shall be lined in a similar and matching way to the existing fair-face finishes of the main building, and all parts facing the forms shall be worked up against it, and be free of holes honey-combing or other defects.

The general requirements are :

i) To produce smooth, even finish , matching the existing building and walls.

ii) To make panels as large as practicable and arrange them to the approval of the UNOPS Engineer.

iii) Blowholes not exceeding 5 mm. diameter shall be permitted, otherwise surface shall be free form voids, honey-combing and other defects.

iv) Variation in colour resulting from the use of an impervious from lining shall be permitted, but the surface shall be free from discoloration due to contamination or grout leakage.

v) Concrete cover spacers shall not be used without prior approval of the UNOPS Engineer.

vi) The finish shall be left as struck, and making good shall not be permitted unless specifically ordered otherwise by the UNOPS Engineer.

vii) All from tie holes shall be filled with a mortar matching an approved sample.

viii) Wire from ties shall not be use. Approval of the UNOPS Engineer shall be obtained for the position of the holes.

ix) The surface shall be treated as required to receive paint.

c) Boarded finish:-

Boarded finish shall be carried out using rough swan softwood boards with nails well punched in, and shall be to the pattern shown on the Drawing.

The Contractor shall erect a sample panel, which on the UNOPS Engineer's approval shall be used as a standard for the work.

d) Concrete Ground Slabs:

Concrete ground slabs shall be of the specified GRADE , reinforced as shown on Drawing and laid on hard-core or base coarse as specified resting on well-compacted soil.

Protection for the applied damp-proof course (if any) shall be provided during the application of steel reinforcement of the slabs as specified in the relevant section of the damp-proof coarse.

e) Granolithic Concrete topping:-

- 1) The granolithic concrete topping shall be cast in alternate bays set out to pattern, . ( as specified on drawings or on B.O.Q.)  
structural grid with 2mm. thick aluminium angles or similar, extending to full thickness of the topping and bedded in 1:2 cement and sand MORTAR, securely fixed to the concrete base with the top surface straight, intersecting at right angles, and to the falls shown on the Drawings.

The cast bays shall be allowed to harden to the satisfaction of the UNOPS Engineer before adjacent bays are laid.

The surface of the topping shall be compacted and levelled using an aluminium tube and vibrating tamper. When the topping has hardened sufficiently, it shall be mechanically trowelled to a smooth but nonslippery surface finish.

Cement spreading over topping to hasten final trowelling time or to give a smooth finish will not be allowed.

- 2) The topping shall be treated with concrete hardner and dust-proofing compound applied in strict accordance with the manufacturer's instructions and the thickness as specified in the B.O.Q..
- 3) The topping shall be cured for a minimum period of seven days, during which it shall be kept constantly wet by wetting the surface with water and covering it with damp sacking, P.V.C. or similar plastic film, to the satisfaction of the UNOPS Engineer.

### **3.21 CONSTRUCTION JOINTS.**

The concreting shall be carried out so as to obtain the greatest possible continuity and with only necessary stoppages. Construction joints shall be located where shown on the plans, or shall be arranged as approved by the UNOPS Engineer.

Construction joints shall be made with vertical bulk-heads and perpendicular to the principal lines of stress, and in general shall be located at points of minimum shear.

The construction joints shall be rebated and the concrete poured consolidated against temporary stopboards.

The rebates shall be formed in horizontal joints by means of tapered battens and in vertical faces by fixing the tapered batten to temporary stopboard, and shall be to dimensions approved by the UNOPS Engineer.

Water stop bars will be fixed where shown on the Drawings or where required by the UNOPS Engineer.



The concrete surface at construction joints shall be cleaned, watered and roughened by wire brushing, and coated with thick cement mortar grout 1:2 mix ( one part cement to two parts sand ) immediately before the new concrete is placed over or against it. The new concrete shall be well-rammed up to the joint while the grout is wet.

Where vertical construction joints are necessary, reinforcing bars shall extend across the joint in such a manner as to make the structure monolithic.

### **3.22 EXPANSION JOINTS.**

Expansion joints at various locations and between the different parts of the walls shall be made in accordance with the Drawings and dealt with as delineated thereon and as specified hereinafter. Expansion joints in concrete walls shall have filler boards 2.0 Cm. thick or bitumenised sheeting or an approved equivalent. The external edges of the joints shall have 2cm. thick sealing compound filling applied in accordance with the manufacturer's instructions, as specified and shall be according to ASTM C920-79, BS 4254-83, BS 5212-90, WRC for use in Potable Water.

The Contractor shall, notwithstanding any approval from the UNOPS Engineer, be solely responsible for the proper watertightness of the expansion joints. Any damage resulting from lack of watertightness of the building shall be repaired by the Contractor at his own expense.

### **3.23 DRAINAGE HOLES AND WEEP HOLES.**

Drainage holes and weep holes shall be constructed in the manner and at the locations indicated on the Drawings or required by the UNOPS Engineer.

The ends shall be cut straight and flush faces with the faces of the concrete walls. The weep holes shall be formed by P.V.C pipes as specified in B.O.Q.

### **3.24 PRECAST CONCRETE FOR SILLS, TILES.**

- a) For quality of materials and workmanship in precast concrete work, the contractor shall refer to all previous and subsequent items contained herein.
- b) The rates for all precast work shall include for providing all materials, labour and plant needed to obtain the full section as specified or shown on the drawings, all moulds, surfaces finishes as described, reinforcement as detailed together with additional reinforcement as necessary for handling, providing and casting in ( and removing if necessary ) lifting devices, hoisting into position, setting level with mortar, bedding and jointing and pointing as described, cleaning off and leaving work perfect at completion.
- c) The Contractor shall manufacture and store the precast concrete units in adequately sized factories and stores to allow for adequate quality control, reserve storage area may be on or off Site, depending upon the area available to the Contractor on Site.

Where the Contractor's factory and main storage are off the Site, the Contractor shall include in his rates for all costs incurred in the provision of such off-site areas including the payment of rent, rates and the like and haulage to Site of finished units and for providing an adequate on

Site store separated from the general stores areas which shall allow delivery to Site of units in adequate quantities to allow steady progress of the works.

Where the Contractor's factory and storage are on Site, they shall be separated from the general stores area.

d) The moulds are to be soundly and accurately constructed and provided in such quantities as to ensure adequate supply of the units.

The moulds shall be constructed strongly enough to prevent deformation of the units while the concrete is still green. Moulds shall thoroughly cleaned and treated with mould oil between uses.

### **3.25 SCREEDING.**

Screeding concrete shall be composed of cement and aggregates cast to falls as indicated on the Drawings.

Cured for twenty eight days. The surfaces of the screeding shall be even, free from depressions and other defects, and all debris and substances detrimental to the work shall be removed.

### **3.26 CONCRETE FLOOR FINISHING**

Concrete Floor finishing, such as in Car Park Building, shall be of cement mortar mix with min. cement content of 400 kg/m<sup>3</sup> and the compressive strength 250 kg/cm<sup>2</sup> after 28 days with a mix ratio of 1:2:4 cement:0-3 mm grain sand:5-7mm grain size gravel , water ratio .4 . Use of super plasticizer as approved by the UNOPS Engineer. . ( unless otherwise specified on drawings or on B.O.Q.)

Before laying , the existing concrete ( sub-floor ) surface shall be cleaned down to a hard base with a rotating wire brush . All concrete laitance is to be removed and thicker patches of crumbling concrete shall be chiseled and all debris etc. shall be swept.

The concrete sub-floor shall be washed thoroughly and adequate forms shall be prepared to UNOPS Engineer;s instructions.

The cleaned sub-floor shall be primed with bonding agent 1:4 b.a. : water ratio by brush ( S. B. R. ) Lay 1 Y8@ 10EW cold rolled continuous wire mesh.

Cast screed between the forms , alternately and observe expansion and construction joints joints , tamper in the customary manner by use of obliquely positioned aluminium tube.

Spread the granolithic or quartz material over the surface as described in item 3.20.e above before the screed dry, type (master top 100) as manufactured by FEB or approved equivalent, then trowel the screed mechanically ( helicopter trowellers ).

Cure the screed , avoid spotting , and cover with polyethylene film for 7 days.

### **3.27 LIGHT WEIGHT CONCRETE ( FOAM CONCRETE )**

Light weight cellular concrete screed to roofs with dry density of 450 kg/m<sup>3</sup> and 1.4 Mpa compressive strength in accordance with ASTM C869, average thickness as indicated on drawings and B.Q. with 20mm cement/sand ( 1:4 ) topping with a minimum thickness of 40 mm at the drains and a min. slope of 7.5 % . . ( unless othwerwise specified on drawings or on B.O.Q.)

### **3.28 R. CONCRETE RAISED FLOORING ( FLOATING FLOOR )**

#### **3.28.1 DESCRIPTION**

- a) Scope of Work  
isolate floating floors from building structure by means of jack-up neoprene isolators and perimeter isolation board in each of the mechanical equipment rooms as shown on the drawings.

#### **3.28.2 DESIGN**

**a) Intent**

1. The floating floor system shall consist of a (100 mm) thick concrete slab isolated from and supported (50 mm) above the waterproofed structural slab by resilient neoprene isolators within cast iron housings designed to jack up the floor after pouring on the sub-floor.
2. The floating floor slab shall be isolated from adjoining walls, columns and curbs by means of perimeter isolation board.
3. Any floor drains, piping, conduit and duct penetrations must not short circuit the isolation system
4. Any equipment within these rooms shall be mounted on house-keeping pads or directly on the floating floor as shown on the drawings.
5. In seismic zones the floating floor shall be restrained horizontally by curbs or walls designed to withstand the horizontal seismic forces. Solid bridge bearing beoprene pads shall be interspersed between perimeter isolation fiberglass to withstand the seismic forces with a maximum deflection of 0.2" (5 mm).
6. In seismic zones 2, 3 and 4 or equivalent Av, the floor shall be protected by embedded double acting resilient floor snubbers set in opposition to the overturning moments at the equipment subbers in all locations where the center of gravity of major equipment is high.

**b) Performance Requirements**

The floating floor system shall have a minimum rating of STC-79 and INR+17 as verified by an independent laboratory in prior tests.

**c) Floor System Construction Procedure**

1. The setting of all isolation materials and raising of the floor shall be performed by or under the supervision of the isolation manufacturer.
2. Set and waterproof any drains and lower pipe seals in keeping with water proofing specifications.
3. Cement perimeter isolation board around all walls, columns, curbs, etc.
4. Cover entire floor area with 6 mil (0.15 mm) plastic sheeting and carry sheeting up perimeter isolation board.

5. Place bell-shaped casting on a maximum of 54" (1370mm) centers in the general areas in strict accordance with the approved drawings prepared by the isolation manufacturer. Spacing can be increased to straddle machinery locations. Additional reinforcement must be detailed on isolation manufacturer's drawings when required.
6. Place reinforcement bars and pour floor monolithically.
7. Raise floor 2"(50mm) by means of the jack-screws. (If construction sequence dictates raising the floor before placing machinery, heavy planking must be used to protect floor while machinery is being rolled into position).
8. Caulk perimeter isolation board in all locations and grout jackscrew holes.
9. In seismic zones adjust the double acting snubbers after machinery is in place to provide a maximum up and down clearance of 0.125" (3mm).

#### **d) Submittals**

1. Detailed product drawings and load and deflection curves of all isolators and in seismic zones double acting floor snubbers.
2. Certification of the elastomeric compound to the listed AASHTO specifications.
3. Dynamic frequency test data verifying 10 cycle frequency.
4. Acoustical test data from an independent laboratory showing a minimum STC of 79 and a minimum INR of 17 using a 4" (100mm) concrete floating floor, a 6"(152mm) structural floor and a 2"(50mm) air gap.
5. A drawing or drawings showing:
  - a- Dead, live and concentrated loads.
  - b- Isolator sizes, deflections, frequencies and locations and seismic zones, locations of seismic snubbers

If sound barrier walls are used, add the following to b:  
wall sway brace and isolated angle iron brace sizes, locations and frequencies.

  - c- Any drain and penetration locations.
  - d- Size, type, elevation and spacing of concrete reinforcement.
  - e- Caulking details.
  - f- Floor or floor and wall construction procedure.

### **3.28.3 QUALITY ASSURANCE**

- a) Floating floor system components shall be designed and fabricated by a manufacturer with at least five years experience in fifty similar installations.
- b) The floating floor isolation materials shall be installed and the floor raised by or under the supervision of the isolator manufacturer.

### **3.28.4 SITE CONDITIONS**

If site conditions are unsatisfactory or raise questions about the installations of the floating floor, the work will not proceed until the condition has been corrected in a manner acceptable to the isolation manufacturer. The sub-floor must have the same pitch as the top of the floating floor or special provisions made for isolator housings of different height.

### **3.28.5 SEQUENCING AND SCHEDULING**

Coordinate work with other trades and coordinate scheduling with the construction supervisor to minimize delays.

### **3.28.6 ISOLATORS**

- a) Bell shaped casting with integral lugs to locate reinforcing, shrouding 2" (50mm) thick Du Pont Neoprene isolators molded to the following AASHTO bridge bearing specifications. All housings shall have ¾" (20mm) minimum diameter jackscrews. Deflections shall not exceed 0.3" (7.5mm) nor the frequency 10Hz. Isolators shall be Mason Industries type FSN.
- b) Wall sway Braces: Double acting neoprene sway braces with a fail safe feature in three planes. Braces shall be furnished with a bracket for bolting to the structural wall and a hooked end for insertion in the masonry joint. Braces shall have a frequency not in excess of 10Hz based on the weight of the wall area per brace and a vertical stiffness not in excess of 50% of the horizontal. Sway Braces shall be Mason Industries Type DNSB.
- c) Angle Brackets: 1 1/2" (40mm) x 2" (50mm) angle iron sections with provision for bolting to the structure and a minimum thickness of 3/8" (9mm) sponge cemented to the vertical leg.

### **3.28.7 BONDS BREAKER MATERIAL**

provide one (1) layer of 6 mil (0.15mm) polyethylene sheeting.

### **3.28.8 PERIMETER ISOLATION BOARD**

Minimum (20mm) thick (160 kg/m<sup>3</sup>) fiberglass isolation board.. ( as specified on drawings or on B.O.Q.)

### **3.28.9 PERIMETER CAULKING COMPOUND**

Non-hardening, drying or bleeding. Troweling or pouring grade.

### **3.28.10 FLOATING FLOOR DRAINS**

Cast iron design. The upper funnel section cast into the floating floor. Lower bucket, built into the structure, shall retain water surrounding the upper section as a between floors sound seal. Weep holes are required to drain the structural floor. Floor drains shall have water proofing membrane clamps

### **3.28.11 INSTALLATION**

Install the floating floor systems according to the installation and adjustment procedures and drawings submitted by the isolator manufacturer and approved by the architect.

## **3.29 CAUSES OF REJECTION.**

Any discrepancies in the dimensions of the executed concrete structures, the presence of any faults or defects, the presence of areas of honey-comb, and under strength concrete as proved by testing may be considered as sufficient cause for rejection of a structure. Upon written notice from the UNOPS Engineer that a given structure has been rejected, the Contractor shall remove and rebuild the structure, wholly or in part, as instructed and within the time specified, at his own expense.

**3.30 MEASUREMENT.** . ( unless othwerwise specified on drawings or on B.O.Q.)

a) Reinforced, Plain Concrete Footings, slabs and Walls:-

For the above works, the quantity of concrete to be paid for shall be the number of cubic meters of concrete complete in place and accepted unless otherwise stated. In calculating the quantity of concrete for payment, the dimensions used shall be those shown on Drawings or ordered by the UNOPS Engineer.

Measurement shall be net, with all openings exceeding 0.10 square metre and all volumes exceeding 0.05 cubic metre deducted. No deductions in quantity of concrete shall be made for the volume of reinforcing steel, drainages holes, weep-holes, electrical cables and sleeves.

The Unit Price shall include for all formworks, construction joints and the specified finishing of concrete.

Steel reinforcement shall be measured by the ton and paid separately.

b) Construction Joints:-

Performance of this work under the Contract is not directly payable, but shall be considered as a subsidiary obligation of the Contractor and covered under the Contract Price for concrete works.

c) Expansion Joints in walls:-

The expansive filler sheets or approved equivalent shall be measured and paid for by the square metre.

The mastic filler shall be measured and paid for by the linear metre.

d) Drain holes and weep-holes shall be measured and paid for by the linear metre of the pipe installed in place. Measurement shall be made under the appropriate provisions of the Specifications.

e) Fair-face Concrete:-

Fair-face concrete formwork shall be part of the relevant concrete item in B.Q..

The Contractor shall not be paid extra over for this item at the contract unit price.

f) Boarded Finish.

Boarded finish shall not be measured seperately. The Contractor shall not be paid extra over for this item at the contract unit price

g) Concrete floor finishing:-

Concrete floor finishing as per item 3.26 above shall be measured in square meter where thickness is stated within B.Q. Item . Price shall include sub-floor surface treatment, steel

reinforcement, bonding agent, screed, joints and aluminium fillers, granolithic topping and hardner, additives, tapering,trowelling, curing, and cover.

h) Roof screed:-

Roof screeds as per items 3.25 and 3.27 shall be measured in m2 regardless to thickness difference due to slope.

i) R. Concrete Raised Floor ( Floating Floor ):-

R. Concrete Raised Floor as per Item 3.28 shall be measured in m2 horizontal surface area where all works stipulated including waterproofing membrane and all supporting isolators, jacking up, concrete, steel reinforcement, isolation boards, drains, etc. are not measured seperately

j) Other Works:-

All other works contained in the contract which do not have explicit specifications herein shall be carried out as specified in the Bill of Quantities and shall be paid for per unit of measure ment or on a lump sum basis as provided for therein.

**3.30 PAYMENT.**

of The quantities determined as provided above shall be paid for at the Contractor's Unit Price measurement shown in the Bill of Quantities, which price and payment shall be full compensation for all material labour, plants, equipment, tools and incidentals necessary to complete the works prescribed in this section.

## **SECTION 4.00**

### **WATERPROOFING**

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<b>4.03</b>	<b>APPLICATION OF TORCH APPLIED WATERPROOFING MEMBRANE</b>
<b>4.04</b>	<b>WATER BASED BITUMINUS EMULSION WATERPROOFING</b>
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## **SECTION 4.00**

### **WATER-PROOFING**

<b>4.01</b>	<b>DESCRIPTION</b>
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This section shall consist of the supply of all materials for water-proofing of concrete roofs and surfaces.

#### 4.02 TORCH APPLIED WATERPROOFING MEMBRANE

- a) Torch applied membrane shall be of non woven polyester mat impregnated and coated with modified bitumen to the thickness indicated in the BOQ's. The bitumen is modified by the addition of thermo-plastic elastomers to allow the bitumen to remain elastic at low temperature, and without softening at high temperature to ASTM C869, ASTM 1227D type 4..

The torch applied membranes shall have the following characteristics:

weight 200	Carrier:	Non woven spun bonded polyester fiber mat, min.
		g/m <sup>2</sup> moisture and rot proof.
atactic	Bitumen:	Modified bitumen blended with thermo-plastic elastomer
		polypropylene and other polymers (APP)
	Softening Point:	Min. 120°
	Cold Liability:	No cracking at -5°C.
	Tensile Strength:	Longitudinal 800 N/500 mm Transversal 700 N/500 mm
	Elongation:	Longitudinal 50 % Transversal 50 %
	Surfacing:	White mineral granules, with 75 mm uncovered self edge or plain for covered areas .
application.	Backing:	Thin plastic film to prevent sticking, melts easily on
	Thickness:	Net bitumen thickness shall be 3 mm or 4 mm as
indicated in		BOQ's
	Weight:	Weight, including granules 3 mm : 3.3 Kg/m <sup>2</sup> 4 mm : 4.4 Kg/m <sup>2</sup>
ASTM-	Primer:	Highly penetration thin bituminous solution comply with
		D41, rubbed by brush at the rate 0.3 - 0.5 liter/m <sup>2</sup>
according to		porosity
		Elastomeric bituminous paste suitable for application by trowel or spatula.
	Overlap:	75 mm with adjacent side sheet 100 mm with adjacent side sheet

#### 4.03 APPLICATION OF TORCH APPLIED MEMBRANES

**a) Surface Preparation:-**

1. The substrate shall be primed to receive the membrane system in compliance with manufacturer's instructions.
2. The substrate shall be cleaned of dust, debris and any other substances detrimental to the work.

Any sharp ridges and depressions shall be leveled. The substrate shall be smooth and moisture free before application.

3. Voids shall be filled, including non-moving joints and rough areas of the substrata, with a coating of elastomeric mastic in the manner recommended by the manufacturer. Covers shall be formed at corner and penetrations in the substrata.
4. Expansion joints details in the substrata shall be as recommended by the manufacturer.
5. Metal surfaces shall be prepared, primed and sealed as recommended by the manufacturer.
6. Adjoining surfaces not to receive the membrane shall be masked off, and roof drains shall be closed off to prevent spillage and migration of liquid materials outside the membrane area or into the drainage system.
7. Membrane sheets shall be as specified overlapped in proper direction to falls.

**b) Application:-**

1. Installation of the membrane, including integral flashings and priming, shall be carried out in compliance with the manufacturer's instructions.
2. Installation of the membrane shall commence only in the presence of the manufacturer's technical representative.

All workmen applying roofing materials shall wear rubber soled shoes.

3. Cant strips, flashing sheets, tucks for edging of rolls and necessary items shall be installed where shown or as recommended by the manufacturer, at wall deck junctures, change planes and protrusions, etc.
4. Flashing shall be formed and extended vertically and horizontally on substrate base as indicated or required.
5. Ends of the membrane should go into a groove in the wall and covered with elastomeric mastic.
6. Flanges of sleeves, pipes, etc., shall be lapped with roof membrane, and completely sealed by mastic.

Careful inspection by all seams is an absolute necessary.

7. The installer shall water test the applied area with a 5cm. depth water flooding for a minimum of forty eight hours to determine integrity of application. If a leak is detected, the repair shall be made.
8. The waterproof membrane shall be clear of all debris.

#### **4.04 WATER BASED BITUMINOUS EMULSION WATERPROOFING**

- a) Water based bituminous emulsion waterproofing shall be vibrated homogenous asbestos free to ASTM D412 and ASTM D2240 and ASTM D624 and have the following characteristics:

Weight:	1030 ± 50 g/liter
Residue by Evaporation:	50 % ± 5 %
Ash:	15 % ± 10 % by weight of dry residue.
Water Content:	Max. 55 %
Flash Point:	Non-Toxic
Firm Set:	Max. 24 hours to elastic film.
Toxicity:	Non-toxic
Color:	Dark Brown when wet Black when dry
Heat Test:	No blistering or sagging at 100 ± 3°c
Flexibility:	No cracking or flaking at 0 ± 1°c
Standard:	ASTM-D 1227 type 11 class 1
Priming:	2 coats diluted with water 1:1
Coating:	2 coats not deluted.

- b) Surface should be round, clean and firm, soft brush shall be used for 2 priming coats and 2 final coats. The emulsion may be applied to damp surface but not wet. Each coat shall be allowed to dry before the next coat. Each coat shall be at right angle to the previous.
- c) The emulsion shall not be applied if temperature is less than 4°c or more than 35°c ,and shall not be applied during adverse weather conditions such as when rain or frost is expected.
- d) Testing shall be in accordance with ASTM -D 2939.
- e) All works shall be in accordance with the manufacturer's recommendations and as approved by the UNOPS Engineer .

#### **4.09 Vapour Barrier**

- a) Vapour Barrier shall be of polyethylene film applied with primer sealer to ASTM E96 Method E for vapour impleability by use of asphalt type, compatible with sheet barrier and substrate, thick mastic adhesive type 1 to ASTM D491.
- b) The subsurface should be cleaned and made smooth prior to fixing and the end product shall be protected up to application of foam concrete or other over.

#### **9.06 THE CONTRACTOR'S RESPONSIBILITY**

Notwithstanding any approval from the UNOPS Engineer regarding the use of any waterproofing materials or in the method of executions of the work, the Contractor shall be solely responsible for the proper waterproofing to tanks, basements and roofs. The Contractor shall hand over the building in a perfect waterproof condition at the end of the Maintenance Period and any damage resulting from lack of water-tightness of the building shall be repaired by the Contractor at his own expense.

#### **4.07 MEASUREMENT**

- a) Waterproofing of roofs and horizontal surfaces shall be measured by the square meter of the horizontal projection of the roof area between the inside of the parapets. The price shall include the provisions for fillets at the sides of walls and parapets; water-proof membranes, primer, elastomeric mastic to fix and seal the edges of the membrane on 30 cm light grooved walls, flanges of vent pipes, air-handling units supports, drains, etc. The price shall also include the overlap of water-proof sheets and expansion joints as specified.
- b) Water based bituminous emulsion water proofing, laid vertically and/or horizontally shall be measured and paid for by the square meter. The price shall include priming and all required coats as specified..
- c) Waterproofing of vertical wall surfaces shall be measured by square meter of the vertical projection. The price shall include waterproof membrane, primer, elastomeric mastic to fix and seal the flanges of installations, overlap and expansion joint as specified.
- d) Vapour Barrier shall be measured by square meter . The price shall include waterproof membrane, primer, elastomeric mastic to fix and seal the flanges of installations, overlap and expansion joint as specified.

#### **4.07 PAYMENT**

The quantities determined as provided above shall be paid for at the Contract Price per unit of measurement for the pay items listed in the Bill of Quantities, which price and payment shall be full compensation for furnishing all materials and labour, scaffolding, equipment, tools and incidentals necessary to complete the works described in this Section.