Section-4 Technical Specification

Gujarat International Finance Tec-City (GIFTCL)

EPS - Building no. 49A, Block 49, Zone 04,
Gyan Marg, GIFT City Gandhinagar,
Taluka & District Gandhinagar – 382050

OUTLINE SPECIFICATIONS

HARD LANDSCAPE & STREET FURNITURE

SPECIFICATION DOCUMENT FOR LANDSCAPE

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1 PRELIMINARIES

1.1 Project Details

1.1.1 General Description

The project is located within GIFT City, a world-class smart urban development integrating commercial, residential, institutional, and public realm spaces. The landscape scope includes streetscapes, plazas, open spaces, pedestrian corridors, green networks, and associated site amenities. The proposed landscape development aims to create a connected, sustainable, and user-oriented public realm that enhances walkability, comfort, accessibility, and environmental quality. The design incorporates tree-lined streets, shaded pedestrian spaces, activity areas, and urban open spaces, contributing to the overall vision of GIFT City as a vibrant and globally recognized urban destination.

1.2 Purpose of Specification

The hardscape specification defines the requirements and gives guidance for implementation and maintenance of the hard landscape works.

1.3 Scope of Specification

The specification describes the general requirements for hard landscape elements in the landscape works. The works under this section include but are not limited to the following:

1.3.1 Earthworks

Ground works general, protection of existing trees, site clearance, excavation, placing, ground shaping, grading and compacting earth fill, installation of geotextile and earth reinforcement. Earthworks exclude slope protection, compaction and reinforcement;

1.3.2 Civil works (Masonry works –brick & stone; concrete work)

The general requirements for brick and stone masonry to Engineer’s concrete structure for external wall surfaces, also all allied works including all materials, labour, curing, scaffolding, tools etc.

1.3.3 Kerbs and edges

Section6.1 includes application of work for kerbs, edges etc, as well as all allied works.

1.3.4 Paving

Section6.3 includes application of work for surface finishes to walkways, paths etc as well as all allied works.

1.3.5 Wall finish

The general requirements for stone masonry and wall cladding to Engineer's concrete structure for external wall surfaces, also all allied works including all materials, labour, curing, scaffolding, tools etc.

1.3.6 Landscape features & site furniture

All landscape features as per landscape package.

1.4 List of relevant drawings and document

This specification to be read in conjunction with:

- Landscape Drawing Package submitted by Employers Representative;
- Bills of Quantities as prepared by appointed Quantity Surveyor;
- Relevant Indian Standards as listed in Annexure*;*
- Note: If work item is not included in Indian Standards, appointed contractor should refer to relevant international standard (BS or equivalent). This should be approved by Client's representative prior to commencing any works on site;
- Other documents – any documents not included above but relevant to the tender process. These should be provided/made available to Contractor by the Client/Client's representative if applicable.

1.5 Terminologies

In the Specification and other Documents forming part of the Contract, the following expressions and words shall, unless the context otherwise requires, have the meaning hereby respectively assigned to them:

"Approved" or "approval"	means approved by or approval of the Client's Representative
"Submitted" or "submit"	means submitted to or submit to the Client's Representative in writing prior to commencing works
"Accepted" or acceptance"	means accepted by or acceptance of the Client's Representative
"As shown on Drawings"	means all works required to conform with the intent shown on the landscape drawings whether or not specifically described in these documents/drawings but are necessary for the full and satisfactory completion of the Contract Works
"As required"	means as required to satisfactory standard match the description in the Specification and other Documents forming part of the Contract
"As directed"	means as directed by the Client's Representative

2 Site Management

2.1 General

Prior to site handover to the Landscape Contractor, Landscape Contractor should prepare and get written approvals of Site Management Plan.

After the handover of the site to the Landscape Contractor, site preparation measures must be taken up before the commencement of work.

2.2 Site Management Plan

a) Plan to be prepared by Contractor and approved by the Client/Client's representative prior to handover of the site.
b) Plan should be followed during Construction
c) Plan should comply with all relevant statutory regulations as well as Health and safety requirements (as per "*Section 2.3. Health and Safety*", of this Specification)
d) Plan should include and detail the following items;
   - Detailed information on site preparation measures to be taken up before commencement of works as well as during the works and maintenance period;
   - Clear site arrangement layout for temporary structures, storage, water, electricity supply, vehicular circulation and parking areas etc.
   - Method statements on how site management will be carried out;
   - Details of management structure and responsibilities, with clearly stated points of contact;
   - Communication procedure within site team;
   - Procedures for informing other contractors and employees of site management issues;
   - Procedures for communications between the project team, other contractors and site operatives;
   - Procedures for keeping the records of site queries, obtained approvals, tests, any documentation that affects the site works etc.
   - Storage of the materials and equipment on site;
   - Any additional information required by statutory regulations.

2.3 Health and Safety Plan

a) Health and Safety Plan to be submitted by Contractor to the Client/Client's representative for written approval;
b) Following items should be included as part of the plan:
   - Method statements on how risks from hazards identified in pre-construction information and other hazards identified by the Contractor will be addressed,
   - Details of management structure and responsibilities, with clearly stated point of contact in case of emergency,
   - Arrangements for issuing health and safety directions,
   - Selection procedures for ensuring competency of other contractors,
   - Procedures for informing other contractors and employees of health and safety hazards,

- Procedures for communications between the project team, other contractors and site operatives,
- Arrangements for coordination and cooperation between contractors,
- Procedures for carrying out risk assessments and for managing and controlling the risks,
- Emergency procedures including those for fire prevention and escape,
- Arrangements for ensuring that all accidents, illness and dangerous occurrences are recorded,
- Arrangements for welfare facilities,
- Procedures for ensuring that all persons on site have all the required safety gear and have received relevant health and safety information and training,
- Arrangements for ensuring that all visitors to site receive the required safety gear and training prior to entering the site,
- Arrangements for consulting with and taking views of people on site,
- Arrangements for preparing site rules and drawing them to the attention of the those affected and ensuring their compliance,
- Monitoring procedures to ensure compliance with site rules, health and safety standards and statutory requirements.

c) In addition, all statutory health and safety requirements should be included as part of the Health and Safety Plan.

2.4 Environmental Management

2.4.1 Noise Control

Construction activities shall be carried out in a manner that minimizes noise disturbance to adjacent properties and site users. All equipment and machinery shall be properly maintained and operated in compliance with applicable noise regulations.

2.4.2 Pollution

The Contractor shall implement appropriate measures to prevent air, water, and soil pollution arising from construction activities. Dust, fuel, chemicals, and other pollutants shall be controlled to avoid adverse environmental impacts.

2.4.3 Nuisance

Construction operations shall be managed to minimize nuisance caused by noise, dust, vibration, odours, and site traffic. The Contractor shall take all necessary precautions to reduce disruption to surrounding developments and public areas.

2.4.4 No Dumping of Material in Surrounding Areas

The dumping, stockpiling, or disposal of construction materials, debris, excavated soil, or waste outside designated areas is strictly prohibited. All materials shall be stored and disposed of in approved locations only.

2.4.5 Fire Prevention

Adequate fire prevention measures shall be maintained throughout the construction period. Flammable materials shall be stored safely, and appropriate fire-fighting equipment shall always be readily available.

2.4.6 Burning on Site

The burning of waste materials, vegetation, packaging, or any other construction-related materials on site shall not be permitted. All waste shall be removed and disposed of in accordance with the approved Waste Management Plan and applicable regulations.

3 Site Protection and Waste Management

3.1 Moisture Protection

Protect all materials, equipment, and completed works from excessive moisture, water ingress, and damp conditions during storage, handling, and installation. Any material damaged due to inadequate protection shall be replaced at the Contractor's expense.

3.2 Contaminated materials

Any contaminated soil, debris, or material encountered on site shall be isolated and handled in accordance with applicable environmental regulations and project requirements. Contaminated materials designated for removal shall be promptly transported and disposed of at approved facilities.

3.3 Site Housekeeping

The Contractor shall maintain the site in a clean, safe, and orderly condition throughout the construction period. Debris, unused materials, packaging, and temporary works shall be regularly cleared to prevent obstruction, hazards, or damage to adjacent works.

3.4 Waste Management and Disposal

All waste generated from landscape construction activities shall be collected, segregated, transported, and disposed of in accordance with local authority regulations and the approved Waste Management Plan. No waste shall be buried, burned, or allowed to accumulate on site. Recyclable materials shall be separated and recycled wherever practicable.

4 Existing Site Features, Vegetation and Utility Management

4.1 Preservation of Existing Features, Vegetation & Services

- All existing features identified as to be retained by client's representative should be dealt with in accordance with the below listed procedures.
- Existing features include hard landscape structures as well as trees and other feature soft landscape elements.
- Hard landscape elements which have been identified as important element by the client shall be protected from all on going site works.
- No structural elements should be removed / relocated without written permission of Client's representative.
- All protected elements should be clearly identified and labelled, site team should be aware of all the items to be protected.
- No existing trees should be cut/pruned without written permission of Client representative/PM;
- All works shall be carried out in coordination with experienced horticulturalist;
- All works to trees shall be in accordance with relevant local standards;

4.2 Guidelines for Trees to be removed

Any existing trees identified as "to be removed" or any dead trees:

- Contractor shall cut and fell, as close to the ground as possible;
- Trunks to be cut to convenient lengths;
- Root stumps to be removed to a minimum depth of 800mm below ground level;
- Any debris or material that comes from the above works shall be utilised in accordance with Waste Management Plan.

4.3 Guidelines for Trees to be retained

- All retained trees should be clearly identified "TO BE RETAINED" and information signs should be displayed on site in prominent positions at each entrance;
- All retained trees shall be marked by visible, durable tags, lettered to tree number or symbol (if any) on the drawings.
- Trees should be fenced off the works area, if possible, in all cases tree trunk and roots should be protected from site works;
- Protected area should be in a shape of a circle around each tree with radius of 3m, measured from tree trunk.
- Do not allow for soil compaction under the tree;
- Do not store any materials or site equipment under or near the trees.
- Do not allow for any vehicles to be parked near retained trees or to pass under the trees;
- Prevent damage to tree bark; do not attach any items to trees.
- Do not expose tree roots;
- When works under the tree:
  - Do not add or remove topsoil within the drip line of trees, do not fill against tree trunks even temporarily;

- Open excavation under tree canopy should be carried for as short period as possible. If exposing roots unnecessary temporarily line with polyethylene sheet to reduce evaporation;
- Use only hand methods to locate, expose, and cleanly remove the soil around roots on the line of excavation. Root systems should be preserved intact.
- When it is necessary to cut the roots bigger than 25mm diameter, make sure the cutting does not disturb remaining root system. Cut should be smooth with no ragged edges. Clean cut surface should be immediately treated with bituminous fungicidal sealant.

4.4 Guidelines for Existing Services

a) Special precautions shall be taken by the Contractor to avoid damage to existing sewerage pipes, storm water drains, and pipes, storm water grids, and inlets, manholes, valve casings, water pipes and taps, fire hydrants, irrigation pipes and equipment, cables, completed landscaping works, telephone and light poles, vegetation and other services.
b) Where manholes, valve castings and other services must be adjusted to fit in with the construction work or for any other reason, the CR or Client's Representative shall be notified with 14 days' notice to CR, so that the necessary arrangements can be made. Manholes, valve casings, meter casings, fire hydrants etc., shall always be easy to reach and visible.

4.5 Protection of Existing Property

a) The Contractor shall take all necessary precautions against damage that might occur to any person, animal, building, structure, services, vegetation, vehicles etc.
b) Enough warning signs, railings, lighting etc. shall be placed around excavations, obstacles, and heaps.
c) Foot bridges shall be placed over trenches, where necessary for the convenience of the public.
d) Construction activity is to be limited to pre-designated areas and with the prior approval of the client's representative.

5 Specific Landscape Requirement

5.1 Scope of Work

a) The work in this contract covers the supply and installation of all hard landscape works. The Contractor shall furnish all labour, material, tools and equipment necessary to complete the works as indicated on the drawings. Any item not specifically shown in the drawings or specified but normally required to confirm to such intent should be considered part of the work. Contractor shall include and price for such item in the BOQ accordingly;

b) All works indicated in the Drawings by notes will be provided, whether mentioned in this specification. Any item not specified nor specifically shown in the drawings, but are normally required to conform to such intent, are considered part of the work and deemed to be included in this contract and their execution shall be covered by the contract price, in the same manner as if they have been expressly shown on the drawings and described in the specifications.

c) The works shall be completed within the scheduled time and shall be certified by the Client's Representative in consultation with the Engineer-in-Charge upon practical completion;

d) The Contractor shall submit for approval, his proposed Work Programme based on the criteria of the overall programme showing the intended sequences, stages and order of proceeding with the works together with the period he has estimated for each and every stage of the progress.

e) The Contractor shall complete the works within or by the date of completion as set forth in the Contract. The Contractor shall undertake all responsibility for rectification of defects of the landscape for a period of twelve (12) months from the issuance of Practical Completion Certificate.

f) The item includes the cost of all inputs of labour, materials (including stainless steel rods, welding, brazing, concrete, protective film, weather silicone sealant etc including cost of providing and fixing M.S. frames), T & P other incidental charges, wastages etc. The items also included providing and fixing stainless steel anchor fasteners for fixing rods.

g) The finished surface shall be free of any defects like dents, waviness, scratches, stains etc. and shall have uniform brushed steel satin finish. Any defective work shall be rejected and redone by the Contractor at his own cost. The finished surface shall therefore be protected using protective tape which shall be removed at the time of completion of the work. The surface shall then be suitably cleaned using nonabrasive approved cleaner for the material. Nothing extra shall be payable on this account

5.2 Site Preparation

Prior to the start of any construction works on site contractor should make sure that the below listed items have been executed.

5.2.1 Site Survey

a) Prior to commencing the works Contractor shall carry out own survey and inform the Client's Representative/Engineer-in-Charge of any discrepancies with the Construction Drawings.
b) Site survey shall be carried out by skilled and experienced team for the type of work.
c) If any unforeseen/unrecorded hazards or items have been discovered Contractor shall give notice to the PMC/Client's Representative. **No works** shall be carried out until the issue has been resolved.

5.2.2 Site Investigation

a) General

- Contractor shall be solely responsible for obtaining all the information on the nature of the site and sub-surface soil conditions for the purpose of preparing tender and the subsequent execution of the contract.
- Site investigation shall provide data to allow Contractor to proceed with works.
- Extent of the investigation shall be determined by the PMC/Client's Representative and the Contractor.
- Site investigation shall include:
  - Establish records of mean water table;
  - Identify all previous known uses of the site;
  - Identify site features to be preserved;
  - Identify areas of limited access, incomplete work by others or any other issues which may hamper the execution of the works;
  - Locate and identify all known land and water contaminants;
  - Locate and identify soil types to a depth of 4.0m below existing ground level;
  - Recommendations for further investigations.

b) Public and Safety

- During any temporary works during the investigation, area investigated shall be secured and public access shall be limited;
- Erect temporary fences, footpaths, warning lights etc. Before starting the investigation.
- Area of any investigation shall be kept clean and protected from ground and surface waters.

c) Field test General

- Each test shall be recorded and following data shall be provided:
  - Project name and reference;
  - Date and time of test;
  - Weather conditions;
  - Soil types and description;
  - Location and detail of the sample;
  - Site photograph
  - If any feature should be encountered, provide description and depth of:
    - Changes in soil strata,
    - Drains,
    - Foundations/structures;

- Hard strata;
- Services

d) Field test - Soils

- Soil test shall be carried out in accordance with relevant Indian standards;
- Tests shall be carried out at every test pit;
- Method of testing to be proposed by contractor.
- Test shall provide the information on the following:
- Permeability; Geophysical conditions; Any special features, as advised should be undertaken in an approved manner, by the contractor.

e) Samples

- When taking samples make sure the following:
  - Method should be undertaken in an approved manner, by the contractor. It should include information on: depth, frequency and locations.
  - Samples should be collected and stored in a manner that prevents exposure to direct heat and sunlight, extreme temperatures;
  - Samples should not be contaminated;
  - Ensure samples are a typical representation of the zone from which they were taken;
  - Retain samples for 28 days post submission of the final report.

f) Site test - water

- Tests should identify ground water levels and pressures.
- Method to be undertaken in an approved manner, by the contractor.

g) Laboratory tests

a) Mechanical and Chemical properties shall be tested;
b) Method of testing should be undertaken in an approved manner, by the contractor and at the contractor's expense. Records are to be kept of all Testing in a ledger noting time, date and type of test with result kept in a secure, lockable location in the site office.

c) Final Report

- Final site investigation report should include:
  - All known land and water contaminants;
  - Identify all previously known uses of the site;
  - Locate and identify soil types to a depth of the 4.0m below existing ground level
  - Mean water table;
  - Recommendations for further investigation;
  - Features to be included:
    - All above and below ground features;
    - All underground services;
    - Topography

5.2.3 Demolition & Site Clearance

a) General

- Contractor to survey and agree with the Client representative/PMC extent of demolition and methodology for elements which have been identified on the Demolition Plan or drawings.

- Extent of works should be within site boundary, otherwise notify and agree with Client representative/PMC;
- Contractor to submit details of the demolition works prior to proceeding. The document should include:
  - Location and types of structures, site and surrounding area,
  - Extent;
  - Removal method;
  - Information on adjoining premises which may be affected;
  - Information on below and above ground services, including arrangements for disconnection/removal;
  - Health and safety procedures for protecting public and site workers;
  - Proposed programme of workplace
  - Any special requirements.

b) Services affected by Demolition

- Contractor shall give notice at least 24 hours prior so that the Client's representative may inspect existing services which might be affected by demolition work.

c) Material arising

- All components and materials arising from the demolition works shall be utilised as per Waste Management Plan procedures.

d) Site Clearance general guidelines

- Contractor will be responsible for clearing all planting areas of existing vegetation not specified to remain and all other debris and foreign materials considered a hindrance to the planting operation and/or unsightly in appearance.
- Contractor will be responsible for cleaning the planting areas after completion of civil and other works in that area and turning them over to the horticulturalist suitable for planting.
- Carefully remove items indicated to be salvaged and stored the site where indicated. Except for stripped Subsoil or other materials indicated to remain on Client's property, cleared materials shall become the Contractor's property and shall be removed from the project site, on a periodic basis and on completion of site works.
- Contractor will take care and maintain previously established grades and swales.

5.3 Earthworks

Prior to the start of any construction works on site contractor should make sure that the below listed items have been executed.

5.3.1 General items

a) General notes

- The section refers to excavation grading and filling of soil across the site as part of the works.

b) Setting Out

- Before start of excavation works Contractor shall carry out preliminary setting out of key items pertaining to the construction and excavation works;
- Contractor will be fully responsible for establishing and locating at site all grid lines, base lines, levels and limits for project.
- Qualified surveyor should be engaged to prepare the above works;
- All setting out information established by Contractor on site should conform accurately with information in the Drawings
- Client's Representative shall approve all setting out and locations prior to any excavation works;
- Prior to start of further works, Contractor should do a Quality check and any errors/noncompliance with Drawings should be highlighted to the Client's Representative. If the setting out will be a cause of errors in further execution of works, Contractor should seek clarification from the Client's Representative. Any works done which cause obstruction to future works, without approval from the Client's Representative, shall be demolished and reconstructed at the expense of the Contractor;
- The Contractor shall follow the datum set out by the Main Civil Works Contractor. Contractor shall be responsible for providing, maintaining and safeguarding the position and levels of all survey pillars/pegs and benchmarks existing on site or added;
- Contractor shall maintain enough pillars/pegs for checking/monitoring of the works for the entire duration of the project.

5.3.2 Preservation of Existing topsoil

a) Stripping topsoil

- For the extent/depth of the topsoil refer to site investigation report;
- Before beginning general excavation or filling, Contractor shall strip topsoil from areas where there will be regrading, paving/roads and other areas shown on drawings.
- Topsoil shall be removed to an average depth of 300mm, if the depth of topsoil is difficult to determine Contractor shall give notice to PM/Client's Representative
- Stripped topsoil to be reused immediately after stripping or removed from site;
- **Location of stockpile**: To be agreed - topsoil shall be stored in an area of the site where it should not interfere with other site operations so that it can be left undisturbed during the construction process.
- The area that is to be used for storing the topsoil shall be cleared of vegetation and any waste arising from the development e.g. building rubble and fill materials.
- **Protection** - Contractor to make sure the following treatment has been applied to remove topsoil:

- Topsoil not to be mixed with subsoil, stone, hardcore, rubbish or material from demolition, other soil or materials containing aggressive weeds or non-soil forming materials, oil, fuel cement or other substances harmful to plant growth;
- Do not place any other material on top of storage heaps.
- Do not allow construction plant to pass over storage heaps.
- Prevent compaction and contamination, by fencing and covering as appropriate.

5.3.3 Excavation

a) **General**

- All excavation works shall be in accordance with relevant Indian standards or equivalent international standards;
- Any features like: pavement wearing surface, concrete paths, kerbs, channels or alike, should be cut by saw to give clean break line along the edge of excavation.
- If excavating next to existing features (existing boundary wall, signage, existing structures, pillars, ramps, services, trees etc.) Contractor to ensure all health and safety procedures are strictly followed to avoid disturbance of foundations, tree roots etc.
- All excavation shall be carried out by mechanical equipment, unless specified otherwise by Client representative. Contractor can suggest alternative methodology for Client's Representative approval. However, any consequent loss or damage will be still under Contractor's liability.

b) Extent

- Excavate over the site to give correct levels and profiles as the basis for construction, paving, filling and other relevant works. Make allowance for compaction and settlement.
- Excavate for footings, pits and alike, to the required size and depths. Confirm the bedding capacity is as specified.

c) Accuracy and Permissible Deviation

- All excavation works shall be taken up to such widths, lengths, depths and profiles as are shown on the drawings or such other lines and grades as specified by Client's Representative.
- All excavation shall be done to minimum dimensions as required for safety, quality and efficiency.
- Any deviation from formation levels beneath mass concrete foundations, ground bearing slabs, embankments and cuttings, external walls etc. shall be consulted with Engineer.
- General permissible deviation from linear dimension to be 25mm.

d) Excavation to existing foundations and structures

- Prior to commencing excavation excavate trial pits adjacent to existing foundations to determine extent and formation level
- Agree with engineer formation level in the new excavation for the safety of the structure;
- Backfill material to excavation to be determine by structural engineer;
- Provide support to adjacent structures, if necessary, sufficient to prevent damage arising from works;
- Supports should be lateral (shoring) and vertical (piling or underpinning);
- If permanent support required give notice to PM/Client's Representative.

e) Adjacent excavation

- Where excavation encroaches below a line drawn at 45 angles from the nearest formation level of another higher excavation, the lower excavation, all work within it and backfilling thereto must be completed before higher excavation is made.

f) Dewatering/ Drainage

- All excavations should be kept free of water.
- Grading to the excavation should be such as to exclude rain/surface water draining into excavated areas.
- Any water in the excavated areas should be pumped out by Contractor; this should be continued until area is clear of water and up till foundation work is completed and backfilled.
- Do not disturb excavated faces or stability of adjacent ground or structures during pumping. Pumped water should be discharged without flooding adjacent property outside the site. Sumps made for dewatering shall be clear of excavations and fill on completion.

g) Inspection

- Contractor to give 5 days' notice for inspections of formations for foundations and filling formations, service trenches, roads and paving.
- Seal the approved formation with blinding concrete within 4 hours of inspection.

5.3.4 Filling

a) Fill Material - General

- Fill material specification should be according to relevant Indian standards or under the guidance of technical expert.
- Submit full details of proposed fill materials, including:
  - Type and source of imported fill;
  - Proposals for processing and reuse of material excavated on site;
  - Test reports as required;
- Submit the above at least 21 days before starting filling.

b) Fill Material Properties and types of Fill material

- Any fill material used for filling should be free of hazardous, aggressive or unstable content.
- Within the top 1000mm of any area to receive topsoil, do not use fill materials which would, either in themselves or in combination with other materials or ground water, give rise to a health hazard, damage to building structures or instability in the filling;

c) **Sulphur content:** Do not use filling with sulphur content exceeding 0.5% within 0.5 m of cement bound elements (for example concrete structures or masonry), unless such elements are protected by impermeable membranes or by other suitable means.

d) **Sources:**

- Where directed, re-use material recovered from excavations on the site. Dry out recovered material as necessary prior to use.
- **Fill types of recommendations:**
  - General fill: Well-graded material, maximum particle size 75 mm, plasticity index ≤ 55%.
  - Select fill: Granular material complying with the following properties:
    - Particle size: 75 mm maximum.
    - Proportion passing 0.075 mm sieve: 25% maximum.
    - Plasticity index: ≥ 2%, ≤ 15%.
    - Soaked CBR: Not less than 15.
  - Maximum depth of fill to be compacted not too exceeds 300mm at any one time.
  - **Road embankment fill:** Well graded material with maximum plasticity index 35% and maximum particle size determined by location and layer thickness but not exceeding two-thirds of the uncompact layer thickness.
  - Fill sub grade: Use class 3 materials or select fill.

e) Testing of suitability of Fill Materials

- If required, the Client's Representative may request for a laboratory test of the proposed fill material.
- Samples should be submitted to accredited laboratory by Contractor.
- Report to be submitted by Contractor to Structural engineer.

f) Preparation of Filling

- General: Remove loose material, debris, rubbish, standing water and organic matter.
- Benching:
  - If filling is to be placed against a ground surface that has slopes more than 1:4, bench into the natural surface for at least 1 m at every 1 m change of level to form a key for the filling.
- Underground slabs, pavements and other load bearing elements:
  - For under filling that will support slabs, pavements and other load-bearing elements, compact the stripped surface as for filling. If necessary, loosen the material to a depth of 200 mm and adjust the moisture content.
- Under earth mounds:
  - Cultivate the ground by ripping to a depth of 200 mm before mound formation.
- Rock:
  - Remove any loose or unstable blocks of rock.

g) Placing fill

- Place and compact fill material in layers;
  - Place so that only one type of material occurs in each layer.
  - Each layer to be min 150mm, max 300mm thick
- Site grading shall be carried out as indicated in the drawings and as directed by the Employer's Representative.
- Adjacent structures, membranes and buried services:
  - Do not overload, destabilise or damage.
  - Submit proposals for temporary support necessary to ensure stability during filling. Remove support progressively as backfilling proceeds.
  - Allow 14 days (minimum) before backfilling against in situ concrete structures.
- **Compaction**
  - Compact fill as soon as possible after placing.
  - After compaction surface of each layer must be well closed, showing no movement under compaction plant, and without cracks, holes, ridges, loose material and the like.
  - Defective areas: Remove existing material from site and re-compact to full thickness of layer using new material.
  - To ensure that the fill has been compacted as specified, the Contractor at his cost shall carry out field and laboratory tests. Field compaction test shall be carried out at different stages of filling and also after the fill to the entire height have been completed. This shall hold good for embankments as well. Reports to be provided to Client's representative and Engineer-in-Charge.
  - The fill shall be carried out such dimensions and levels as indicated on the drawings after the stipulated compaction. The fill will be considered as incomplete if the desired compaction has not been obtained.
- The Contractor shall protect the earth fill from being washed away by rain damaged in any other way. Should any slip occur, the contractor shall remove the affected material and make good the slip occur. The Contractor shall remove the affected material and make good the slip at his cost.

h) **Reuse of material for fill**

- As specified in 2.3.4(e), the rock as obtained from excavation may be used for filling and levelling to indicate grades without further breaking.
- In such an event, filling shall be done in layers not exceeding 300 mm approximately.
- After rock filling to the approximate level, indicated above has been carried out, void in rocks shall be filled with finer materials such as earth, broken stone etc. and the area flooded so that the finer materials fill up the voids. Care shall be taken to ensure that the finer fill material does not get washed out.
- Over the layer so filled, a 100 mm thick mixed layer of broken material and earth shall be laid and consolidation carried out by a 12-tonne roller. No less than twelve passes of the roller shall be accepted before subsequent similar operations are taken up.
- To ensure that the fill has been compacted as specified, the Contractor at his own expense shall carry out field and laboratory tests to validate standards of compaction achieved. Field compaction test shall be carried out at different stages of filling and also after the fill to the entire height have been completed.

i) Tolerance of cut & fill

- Unless otherwise specified, no portion of the earth cutting shall vary from the specified or proposed level by an amount exceeding 150mm. The tolerance of the fill level or those on slope shall not be more than 75mm from the proposed level. The same tolerance shall be applicable to the limits and lines of cut and fill. All levels are those applicable at the end of the Defects Liability Period. The Contractor should therefore make the necessary allowance for shrinkages, consolidation, settlement and any other losses and to include all expenses for this in his quoted rates.
- Notwithstanding the above, all cut or fill area shall be such that there is no stagnation of water. Should there be any local depressions, the Contractor shall be required to re-grade or fill up the depressions as necessary. The Contractor shall be responsible for making good all settlements or erosion in the filling and cut area whenever the defects occur or as directed by the Client's - Representative up to the end of the maintenance period.

5.4 Anti-Termite Treatment

This section covers the general requirements for Anti-Termite Treatment measures, chemical treatment of soils for the protection of features & buildings attack of subterranean termites, Chemicals to be used with their minimum rates of application and procedure to be followed for treatment of Foundation.

5.4.1 Chemicals

- The chemical used for soil treatment shall be any one of the following:

Chemical	Relevant Indian Standard	Concentration by Weight, Percent (Active Ingredient)
Chlorpyrifos 20 EC	IS 8944	1.0
Lindane 20 EC	IS 632	1.0

Source: IS 6313 (Part 2): 2001, Clause 5.3 – Soil Treatment

5.4.2 Application

- The method of application and the stages it will be applied shall be submitted for approval and this shall conform to relevant Indian standard or equivalent.
- All works related to application of the Chemicals shall strictly follow Health and Safety procedures as mentioned in section 2.3. Health and Safety Plan.
- Workers shall be properly protected during application and shall wear the necessary clothes, masks, goggles and other gear to avoid direct contact and inhalation of chemicals;
- No work shall be carried out under unsuitable weather conditions, these include:
  - Rain or when the soil is wet due to rain or sub-soil water;
  - Strong winds;
  - Heat waves;
- Chemicals shall be brought to the site of work in sealed original containers. The materials shall be brought in at a time, in adequate quantity to suffice for the work. The material shall be kept in cool and locked stores. The empties shall not be removed from the work site till the relevant item of work has been completed and permission granted by the Client/ Employer's Representative.

- Chemicals available in concentrated forms with concentration indicated on the sealed containers shall only be used. Chemicals shall be diluted with water in the desired quantity before use, using graduated containers to achieve the desired percentage of concentration.
- Hand operated pressure pump with graduated containers shall be used to ensure uniform spraying and to facilitate proper penetration of the chemical. Continuous check shall be kept ensuring that the specified quantity of chemicals is used for the required area during the operation.
- Soil treatment shall start when the foundation trenches and pits are ready to receive mass concrete in foundations. Laying of mass concrete will start when the chemical emulsion has been absorbed by the soil and the surface is quite dry. The above mentioned also applies in the case of treatment to the filled earth surface within the plinth before laying the sub grade for the floor. The treated soil barriers shall not be disturbed after they are formed. If by chance, treated soil barriers are disturbed, immediate steps shall be taken to restore the continuity and completeness of the barrier system.

5.5 Hardscape Specification

a) This section covers the general specifications of basic materials which are part of landscape civil work which includes Brickwork, Stone masonry, Concrete work; woodwork, bamboo work, steel work and related treatment procedures.

b) All materials and workmanship shall comply with the relevant Indian Standards and Codes or latest CPWD specifications, 2009.

5.5.1 Brickwork/ masonry work

a) **Brickwork classification:** Class 1 for exposed brick work; Class 2 for compound wall with plastering

b) **Strength:** For class 1 - average compressive strength should not be less than 10.7 N/mm^2 For Class 2 - 75 which means average compressive strength should not be less than 7.5 N/mm^2 and not more than 10 N/mm^2 .

c) **Manufacturer:** from Suppliers Schedule provided or equivalent approved.
- Quality: Well, burnt F.P.S. bricks
- Special shapes: The bricks shall have smooth rectangular faces with sharp corner and shall be uniform in colour and emit clear ringing sound when struck
- Size: (229 x 110 x 70) mm – nominal size.

d) **Mortar:** The mortar for the brick work shall be as specified and conform to accepted standards. Lime shall not be used where reinforcement is provided in brick work because it will allow corrosion of metal. More details are given in section 5.5.4.

e) **Sampling of brick samples:**

Samples of bricks shall be subjected to the following tests:
- Dimensional tolerance.
- Water absorption.
- Efflorescence.
- Compressive strength.

f) **Soaking of Bricks:**
- Bricks shall be soaked in water before use for a period for the water to just penetrate the whole depth of the bricks based on field test.
- Alternatively, bricks may be adequately soaked in stacks by profusely spraying with clean water at regular intervals for a period not less than six hours.
- The bricks required for masonry work using mud mortar shall not be soaked.

- When the bricks are soaked, they shall be removed from the tank sufficiently early so that at the time of laying they are skin-dry.

g) **Laying:**
- Bricks shall be laid in English bond unless otherwise specified.
- For brick work in half brick wall, bricks shall be laid in stretcher bond.
- All loose materials, dirt and set lumps of mortar which may be lying over the surface on which brick work is to be freshly started, shall be removed with a wire brush and surface wetted.
- Bricks shall be laid on a full bed of mortar.

h) **Joints:**
- The thickness of all types of joints including brick wall joints and cross joints shall be such that four course and three joints taken consecutively not more than 31mm. Specified thickness of joints shall be of 1 cm. Deviation from the specified thickness of all joints shall not exceed one-fifth of specified thickness.
- Flushed joint. Plumb at every fifth cross joint.

i) **Curing:** 7 days.

j) **Brick Quality:**

Class 1 Bricks:
- Plain surface, sharp edges and size with tolerance in dimensions +-3%
- Uniform red or brownish coloured.
- High crushing strength, not less than 10.7 N/mm2
- Machine moulded
- Efflorescence- NIL
- Water absorption less than 15%.
- Application: used for the exterior wall brick works, short columns and arches.

Class 2 Bricks:
- Slightly uneven faces and edges with tolerance in dimensions +-8%
- Uniform coloured but may be slightly over burnt.
- High crushing strength, not less than 7 N/mm2
- Hand moulded
- Efflorescence- Little
- Water absorption less than 20%.
- Application: used for internal walls and compound walls.

Class 3 Bricks:
- May be distorted with blunt edges.
- Over burnt or under burnt and non-uniform colour.
- High crushing strength, not less than 3.5N/mm2
- Hand moulded
- Efflorescence- Large
- Water absorption less than 25%.
- Application: flooring, paving, small brick foundations and brick bat lime concrete (B.B.L.C.).

5.5.2 Stonework

c) **Stone type:** Granite, Kota Stone, Sandstone, Cobble Stone, Stonecrest.0

d) **Source:** shall be obtained from the quarries, approved by the Client's representative.

e) **Sampling:** To match approved material sample produced by contractor which should be approved by Client's representative and Engineer-in-Charge.

f) Stone shall be hard, sound, durable and free from weather decay and defects like cavities, cracks, flaws, sand holes, injurious veins, patches of loose or soft materials and

other similar defects that may adversely affect its strength and appearance.

g) **Sizes of stone:** the length of stones for stone masonry shall not exceed three times the height and the breadth on base shall not be greater than three-fourths of the thickness of wall, or not less than 150 mm. The height of stone for rubble masonry should not be less than 200mm.

h) **Dressing:** Each stone shall be hammer dressed on the face, the sides and the beds. Hammer dressing shall enable the stones to be laid close to neighboring stones such that the bushing in the face shall not project more than 25 mm on the exposed face.

i) **Thickness of joints:** For thickness of joints refer to the drawings.

j) **Mortar:** As section 5.5.4.

k) **Laying:**

- The stone shall be wetted before laying. They shall then be fixed with mortar in position without the use of chips or underpinning of any sort.
- The walls shall be carried up truly plumb. All courses shall be laid truly horizontal and all vertical joints truly vertical. The stone shall break joints on the face for at least half the height of the course, unless otherwise shown in the drawings. The stone shall be laid in regular courses not less than 200mm height and all the stones shall be of the same height unless otherwise specified. No stone shall be less in length than one and a half times its height unless otherwise specified.

l) **Joints**

- The joints shall be done with cement mortar 1: 3 (1 cement: 3 coarse sand). All joints shall be full of mortar. Special care shall be taken to see that the groundings for veneer work are full of mortar.
- The thickness of joints shall be as small as possible, not exceeding 5 mm. For a close butt jointed facing the thickness shall not exceed 1.5 mm.
- The face joints shall be uniform throughout.

5.5.3 Stampe concrete

Stamp concrete Type: Stamped concrete shall consist of cast-in-situ reinforced or unreinforced concrete pavement finished with an approved stamped pattern and texture to replicate natural stone, slate, brick, cobblestone, wood plank, or other approved decorative finishes as indicated on the drawings.

The stamped concrete system shall comprise:

- Concrete base course.
- Integral colour admixture or dry-shake colour hardener (where specified).
- Surface release agent.
- Pattern stamping using approved stamping mats.
- Protective sealer coating.

The pattern, colour, texture, and finish shall be subject to approval by the Engineer/Client prior to execution.

Material Sourcing:

- Cement shall conform to applicable Indian Standards and shall be sourced from approved manufacturers.
- Aggregates shall be clean, durable, well-graded, and free from organic impurities.
- Water shall be clean and suitable for concrete production.

- Pigments, colour hardeners, release agents, curing compounds, and sealers shall be obtained from approved manufacturers specializing in decorative concrete systems.
- Reinforcement steel, where specified, shall conform to relevant Indian Standards.
- All materials shall be accompanied by manufacturer certificates, technical data sheets, and quality compliance documents.
- Materials from different manufacturers shall not be mixed without prior approval.

Sampling and Mock-Up:

The Contractor shall submit the following for approval before commencement of works:

- Colour samples.
- Pattern samples.
- Texture samples.
- Sealer samples.

Surface Preparation:

- Subgrade shall be properly compacted and graded to the required levels and slopes.
- Unsuitable materials shall be removed and replaced with approved fill.
- Compaction shall achieve the specified density requirements.
- Formwork shall be aligned accurately and securely fixed.
- Reinforcement, where specified, shall be placed in accordance with approved drawings.

Laying and Installation

Concrete Placement

- Concrete shall be placed continuously to avoid cold joints.
- Concrete grade shall be as specified in the drawings, but not less than M30 unless otherwise approved.
- Concrete shall be vibrated adequately without causing segregation.
- Surface shall be screeded and floated to achieve the required levels and finish.

Colour Application:

- Colour hardener shall be uniformly broadcast over the fresh concrete surface.
- Application rate shall be in accordance with manufacturer's recommendations.
- The surface shall be floated to ensure proper integration of colour.

Release Agent:

- Release agent shall be applied uniformly prior to stamping.
- Colour release agents shall be used where antique or highlighted finishes are specified.

Stamping:

- Stamping shall commence when the concrete reaches the appropriate plastic consistency.
- Approved stamping mats shall be used to produce uniform patterns and textures.

- Pattern alignment shall be maintained throughout the installation.
- Stamping operations shall not damage edges, joints, or adjacent finishes.

Curing and Sealing:

- Stamped concrete shall be cured in accordance with approved curing procedures.
- Surface shall be thoroughly cleaned after curing.
- A protective sealer shall be applied uniformly after the concrete has adequately cured.
- Sealer shall provide protection against abrasion, moisture penetration, staining, and weathering

Joints:

Construction joints:

- Construction joints shall be located as indicated on the approved drawings or as directed by the Engineer.
- Joint locations shall be coordinated with the stamped pattern to minimize visual disruption

Control joints:

- Control joints shall be provided to control shrinkage cracking.
- Joint spacing shall generally not exceed 3.0 m to 4.5 m in either direction unless otherwise approved.
- Joint depth shall be a minimum of one-quarter (1/4) of the slab thickness.
- Saw cutting shall be carried out within the recommended time after concrete placement.

Expansion Joints:

- Expansion joints shall be provided where stamped concrete abuts buildings, walls, columns, kerbs, utility structures, and other fixed elements.
- Approved compressible filler material shall be installed within expansion joints.
- Joint sealants shall be UV-resistant, weather-resistant, and suitable for external applications.

Tolerances:

- Finished levels: ±10 mm.
- Surface regularity: Maximum deviation of 6 mm under a 3 m straightedge.
- Pattern alignment: Uniform and consistent throughout the work.
- Colour variation: Within approved mock-up tolerance.

5.5.4 Concrete pavers

Concrete pavers shall be precast concrete paving units manufactured under controlled factory conditions and used for pedestrian walkways, plazas, landscape areas, streetscapes, parking areas, and other paved surfaces as indicated on the drawings.

Pavers may be:

- Interlocking Concrete Pavers (ICP)

- Rectangular Pavers
- Square Pavers
- Permeable Concrete Pavers (where specified)
- Textured or Shot-Blasted Pavers
- Coloured Concrete Pavers

The size, thickness, colour, texture, and laying pattern shall be as specified in the drawings and approved by the Engineer.

Typical thickness:

- Pedestrian Areas: 60 mm minimum
- Light Vehicular Areas: 80 mm minimum
- Heavy Duty Areas: As specified in the design drawings

Material Sourcing:

- Concrete pavers shall be sourced from an approved manufacturer with demonstrated experience in precast paving products.
- Pavers shall comply with relevant Indian Standards, including IS 15658 (Precast Concrete Blocks for Paving).
- Cement, aggregates, pigments, and admixtures shall be obtained from approved sources.
- Pigments shall be UV-resistant and suitable for exterior use.
- Bedding sand and jointing sand shall be clean, well-graded, and free from clay, organic matter, and deleterious substances.
- Manufacturer's test certificates and product data sheets shall be submitted for approval.

Material Samples:

- Full-size paver samples.
- Colour samples.
- Surface texture samples.
- Manufacturer's technical data sheets.
- Test certificates

Subgrade and Base Preparation:

Subgrade:

- The subgrade shall be trimmed, graded, and compacted to the required levels.
- Soft or unsuitable material shall be removed and replaced with approved fill.
- Compaction shall achieve the specified density requirements.

Granular Sub-Base:

- Granular sub-base material shall be placed and compacted in layers.
- Finished surface shall be true to line, grade, and cross-fall.

Laying:

- Pavers shall be laid in the approved pattern and orientation shown on the drawings.
- Pavers from multiple pallets shall be blended during installation to achieve a uniform appearance.
- Damaged, chipped, cracked, or stained pavers shall not be used.

Joints:

- Concrete kerbs, metal edging, stone edging, or cast-in-place concrete restraints shall be provided around the perimeter of paved areas.
- Edge restraints shall be securely fixed to prevent lateral movement of pavers.
- Expansion joints shall be provided where paving abuts buildings, retaining walls, columns, utility structures, and other fixed elements.
- Joint filler and sealant shall be installed where specified.
- Movement joints shall be provided in accordance with approved drawings and manufacturer's recommendations.
- Joint locations shall align with adjacent pavement joints wherever possible.

Tolerances:

- Surface level tolerance: ±10 mm.
- Maximum deviation under a 3 m straightedge: 6 mm.
- Joint width variation: ±2 mm.
- Finished paving shall be uniform in appearance and free from rocking units.

5.5.5 Concrete work

a) **Procurement:**

- Concrete work shall be done with Design Mix Concrete or Ready Mixed Concrete from reputed and approved suppliers approved by contractor or Engineer in charge.
- The Design Mix Concrete will be designated based on the principles given in Indian standards. The contractor shall design mixes for each class of concrete such that the concrete ingredients and proportions will result in concrete mix meeting specified requirements. In case of admixtures and or white cement, the mix shall be designed with these ingredients as well. The specification mentioned herein below shall be followed for Design Mix Concrete.

b) **Ingredients**

- All ingredients selected should be as per relevant Indian Standards and CPWD specifications, 2009.
- Coarse Aggregate
- Fine Aggregate
- Water – It shall conform to requirements laid down as per standards.
- Cement – Cement arranged by the contractor will be slag or Portland Pozzolana Cement (PPC). Cement of grade lower than that used for mix design shall not be allowed to be used in the work. The Indian standards for PPC Cement are as follows and is highly recommended.
    - IS 1489 (Part 1) 1991, Portland Pozzolana Cement – specification (fly ash based).
    - IS 1489 (Part 2) 1991, Portland Pozzolana Cement – specification (Calcined clay based)
    - IS 3812 1981 – specification for fly ash as pozzolana and admixture IS 1344 1981
- **Admixtures** – Wherever required, admixtures of approved quality shall only be mixed with concrete as specified. The admixtures shall conform to relevant Indian Standards along with the approval of Client's representative.

- **Grade of Concrete** – The Characteristic compressive strength of various grades of concrete shall be M20 Grade in the case of plain concrete and M30 in case of reinforced concrete.
- Special attention shall be given to the design of the mix to obtain the densest possible concrete: slag, broken brick, soft limestone, soft sandstone, or other porous or weak aggregates shall not be used.
- In reinforced concrete structures, care shall be taken to protect the reinforcement from exposure to saline atmosphere during storage, fabrication and use. It may be achieved by treating the surface of reinforcement with cement wash or by suitable methods.

c) **Laying concrete**

- Surfaces on which concrete is to be placed should be free from debris and standing water.
- Pre-moist the base material prior to placing concrete.
- Timing: Place as soon as practicable after mixing and while sufficiently plastic for full compaction. After discharge from the mixer do not add water or retemper.
    - Temperature of concrete at point of delivery:
        - In hot weather (maximum): 30°C.
        - In cold weather (minimum): 5°C.
            - ✓ Do not use frozen materials.
            - ✓ Do not place concrete against frozen or frost covered surfaces.
            - ✓ Do not place concrete when air temperature is below 3°C on a falling thermometer. Do not resume placing until rising air temperature has reached 3°C.
- Placing in final position:
    - Place in one continuous operation up to construction joints.
    - Do not place concrete simultaneously on both sides of movement joints.
- Spreading: Spread and strike off with surcharge sufficient to obtain required compacted thickness.
- **Joints**: Cracking of concrete takes place when curing takes place and secondly when concrete shrinks with change in temperature. There are four different types of joints which are introduced depending on structural requirement of the concrete slab.
    - **Contraction joints** – are intended to create weakened planes in the concrete and regulate the location where cracks, resulting from dimensional changes, will occur.
    - **Isolation or expansion joints** – separate or isolate slabs from other parts of the structure, such as walls, footings, columns, driveways and patios from sidewalks, stairs, light poles, other point of restraint.
    - **Construction joints** – are surfaces where two successive placements of concrete meet. The location of construction joint should be planned.
    - **Guidelines for executing joints**:
        - Refer relevant standards and structural consultant guidelines before executing joints in concrete slabs.
        - The maximum joint spacing should be 24 to 36 times the thickness of the slab as basic thumb rule. Consult structural consultant for technical details.
        - For contraction joints, the joint groove should have minimum depth of ¼ the thickness of the slab as basic thumb rule.
        - Tooled joints must be run early in the finishing process and rerun

later to ensure groove bond has not occurred.

- Early-entry-dry-cut joints are generally run 1 to 4 hours after completion of finishing of concrete setting.
- Conventional saw-cut joints should be run within 4 to 12 hours after the concrete has been finished.
- Use pre-moulded joint filler such as compressible foam strips for isolation joints to separate slabs from building wall or footings. At least 50mm of sand over the top of a footing will also prevent bond to the footing.
- If the slab contains wire mesh as reinforcement, cut out alternate wires, or preferably discontinue the mesh, across contraction joints.

d) Construction joints, use Connelly joints https://www.connollykeyjoint.com/ or similar approved at all joints keying the two edges of the slab together. **Compaction of Concrete**

- Concrete shall be compacted during placing so that:
  - A monolithic mass is created between the ends of the member, planned joints or both;
  - The formwork is completely filled to the intended level;
  - The entrapped air is expelled;
  - All reinforcement, tendons, ducts, anchorages and embedment are surrounded;
  - The specified finish to the formed surfaces of the member is provided;
  - The required properties of the concrete can be achieved.

- **Compaction Methodology:**
  - **Hand compaction:** this method is used for non-structural items. Workability should be decided to minimize the chances of honey combing. Rodding and Tamping are two common methods which can be used for pathways and paved areas.
  - **Mechanical Compaction:** Vibration is imparted to the concrete by mechanical means. It causes temporary liquefaction so that air bubbles come on the top and expelled ultimately.

- Concreting shall be carried out in one operation between the expansion joints and construction joints without any break at the dummy joints.
- Concrete shall be deposited on the base as near the joints as possible without touching them. It shall then be shovelled against the sides, maintaining equal pressure and deposited approx. 50 mm higher than the depth of the joints, care being taken that it is worked well around the joints. The concrete shall not be dumped from the bucket directly upon or against the joints.

e) **Finishing of Concrete**

- During compaction, any low or high spots shall be made up by adding or removing concrete.
- After longitudinal floating has been completed but while concrete is still plastic, the slab surface shall be tested for trueness with a 3 m straight edge.
- Any depressions or high spots showing departure from the true surface shall be immediately rectified. High spots shall be cut down and refinished. Depressions shall be enlarged to about 8-10 cm and filled up with fresh concrete, compacted and finished.

- Adjacent work: Form neat junctions and prevent damage. Keep clean all channels, kerbs, inspection covers, etc to be installed and kept clean during the installation process.

5.5.6 Mortar

(a) Desirable properties of mortars for use in masonry are:

- **Workability**
  - Water retentivity
  - Rate of stiffing
  - Strength
  - Resistance to rain penetration
  - Durability

(b) **Standards:** All materials and workmanship shall comply with the relevant Indian Standards and Codes or latest CPWD specifications.

(c) Contractor to follow Health and Safety procedures set in Section 2.3. on Health and Safety Plan.

(d) Material specifications

- **Water**
  - Water used for mixing and curing shall be clean and free from injurious quantities of alkalise, acids, oils, salts, sugar, organic materials, vegetable growth or other substance that may be deleterious to bricks, stone, concrete or steel. Potable water is generally considered satisfactory for mixing.
  - The Ph value of water shall be not less than 6.
  - The physical and chemical properties of ground water shall be tested along with soil investigation and if the water is not found conforming to the requirements as mentioned in IS codes, the contractor has to arrange good quality water for construction indicating the source.
  - Water found satisfactory for mixing is also suitable for curing.
  - Sea water shall not be used for mixing or curing.
  - Water from each source shall be tested before the commencement of the work and thereafter once in every three months till the completion of the work. In case of ground water, testing shall also be done for different points of drawdown. Water from each source shall be got tested during the dry season before monsoon and again after monsoon.
- **Cement**
  - The cement used shall be grade as mentioned in Indian Standards and the type selected should be appropriate for the intended use.
  - Portland cement is a hydraulic binder and a finely ground inorganic material. When mixed with water, it forms a paste which sets and hardens by means of hydraulic reactions. India has made great strides in producing world class cement.
  - **Blended cements:** Blended cements or composite cements are those cements in which a mineral additive has been added to Portland cement. Blended cement is a hydraulic cementitious product, similar to ordinary Portland cement, but due to the addition of blending material it has certain improved properties compared to OPC.

- **Portland pozzolana cement (PPC)** is manufactured either by grinding intimately together Portland cement clinker, gypsum and a pozzolana such as fly ash, or by intimately and uniformly blending Portland cement and fine pozzolana. The BIS has differentiated PPC based on the pozzolana added to the mix. As per updated IS standards, the proportion of fly ash as a pozzolana used can vary between 15 and 35 percent by weight of cement, as stipulated by IS 1489:(Part I) 1991. The physical requirements of OPC and PPC are similar.
- Increased impermeability, lower heat of hydration, lower plastic shrinkage, reduced alkali aggregate expansion, and improved resistance to aggressive chemical agents and corrosion are some of the major benefits to be derived from the use of PPC.
- The use of PPC is, thus desirable for enhancing durability in different construction jobs, especially for structures subjected to aggressive environments.
- The Indian standards for PPC Cement are as follows and is highly recommended.

    - IS 1489 (Part 1) 1991, Portland Pozzolana Cement – specification (fly ash based).
    - IS 1489 (Part 2) 1991, Portland Pozzolana Cement – specification (Calcined clay based)
    - IS 3812 1981 – specification for fly ash as pozzolana and admixture IS 1344 1981

◦ **Sand**

- Type and grading of sand to be used shall be specified. It shall be coarse sand, fine sand. Use of sea sand shall not be allowed.
- **Coarse sand** shall be either river sand or pit sand or a combination of the two.
- **Fine sand** shall be either river sand or pit sand or a combination of the two.
- Sand must be checked for organic impurities such as decayed vegetation humps, coal dust etc.

(a) Preparation of Mortar

- This shall be prepared by mixing cement and sand with or without the addition of pozzolana in 1:3 proportions as per relevant Indian standards.
- **Proportioning**: Proportioning on weight basis shall be preferred taking into account specific gravity of sand and moisture content. Boxes of suitable size shall be prepared to facilitate proportioning on weight basis. Cement bag weighting 50 kg shall be taken as 0.035 cubic metre. Other ingredients in specified proportion shall be measured using boxes of size 40 x 35 x 25 cm. Sand shall be measured on the basis of its dry volume in the case of volumetric proportioning.
- **Mixing:** The mixing of mortar shall be done in mechanical mixers operated manually or by power as decided by Engineer-in-Charge.

5.5.6.1 Quality Assurance

a. Ensure proper mix for the type of work specified. Ensure compliance with the following codes as applicable:

IS: 269 - 33 grade ordinary Portland cement

IS: 712 - Building limes

IS: 1489 - Portland Pozzolana Cement

IS: 1542 - Sand for Plaster

IS: 2116 - Sand for masonry mortars

IS: 2250 - Code of practice for preparation and use of masonry mortar

IS: 3025 - Method of sampling and test for water

IS: 3466 - Masonry cement

IS: 6932 - Method of test for building lime

IS: 8112 - 43 grade ordinary Portland cement.

b. Test water from each source before commencement of work. Test water once every three months during execution.

5.5.7 Cement Plastering

(a) Cement Plaster mortar type and quality to Engineer's specification and to comply with relevant Indian standards and regulations. Plastering of the surface to be performed to Engineer's specification or have a deviation of less than <5mm at a vertical and horizontal angles.

(b) Contractor to submit samples of cement, coarse and fine aggregate. For external work and undercoat work, the fine aggregate shall conform to grading IV. For finishing coat work the fine aggregate conforming to grading zone V shall be used.

(c) Preparation of surface: The joints shall be raked out properly. Dust and loose mortar shall be brushed out. Efflorescence if any shall be removed by brushing and scrapping. The surface shall then be thoroughly washed with water, cleaned and kept wet before plastering commences.

(d) The mortar shall be prepared using the mix and type of fine aggregate specified in the description of the item shall be used for the respective coats

(e) Thickness: 12mm, 15mm and 20mm as specified in the item.

(f) Application:

Plastering shall be started from the top and worked down towards the floor. To ensure even thickness and a true surface, plaster about 15 × 15 cm shall be first applied, horizontally and vertically, at no more than 2 metres intervals over the entire surface to serve as gauges.

(g) Curing

The plaster shall be kept wet for a period of at least 7 days. During this period, it shall be suitably protected from all damages at the contractor's expense by such means as the Engineer-in-Charge may approve.

(h) Finish

The plaster shall be finished to a true and plumb surface and to the proper degree of smoothness as required. The work shall be tested frequently as the work proceeds with a true straight edge not less than 2.5 m long and with plumb bobs.

5.5.7.1 Applicable Codes

Indian Standards to be followed are:

All relevant standards as specified elsewhere in this volume are applicable.

IS 383 Specification for coarse and fine aggregates for natural sources for concrete.
IS 412 Specifications for expanded metal steel sheets for general purposes
IS 1542 Specifications for sand for plaster
IS 1661 Code of practice for application of cement and cement-lime plaster finishes
IS 2402 Code of practice for external rendered finishes
IS 2645 Specifications for integral cement water proofing compound

5.5.8 Woodwork

a) **Standards:** All materials and workmanship shall comply with the relevant Indian Standards and Codes or latest CPWD specifications.
b) **Timber procurement**
   - Timber (including timber for wood-based products): Obtained from well managed forests/ plantations in accordance with:
     - The laws governing forest management in the producer country or countries.
     - International agreements such as the Convention on International Trade in Endangered Species of wild fauna and flora (CITES).
   - Documentation: Provide either: Documentary evidence (which has been or can be independently verified) regarding the provenance of all timber supplied, or Evidence that suppliers have adopted and are implementing a formal environmental purchasing policy for timber and wood-based products.

c) **Seasoning Timber:**
   - The process of drying timber under controlled conditions is called seasoning of timber.
   - Timber shall be either air seasoned, or kiln seasoned and in both cases moisture content of the seasoned timber should be achieved as per relevant Indian Standards.
   - Air seasoned timber shall be used.
   - Kiln seasoning of timber, where specified, shall be done as per IS standards in a plant approved by Engineer in-Charge.

d) **Preservation of Timber**
   - Preservative treatment does not improve basic properties of timber but gives varying degree of protection against deterioration due to attacks by fungi, termites, borers and marine organisms.
   - Preservative treatment, where specified, shall be done using Oil type, Organic solvent type or Water-soluble type preservative. Oil type preservatives shall be used if the timber is not required to be polished or painted. Before preservative treatment, the timber shall be sawn and seasoned.
   - All surfaces exposed after treatment, except due to planning, shall be thoroughly brushed with the preservation before jointing.
   - Preservative treatment of timber shall be done as per relevant Indian Standards in a plant approved by the Engineer-in-Charge.

e) **Material:**
   - **Timber**
     - Timber panels shall be preferably made of timber of larger width. The minimum width and thickness of a panel shall be 150 mm and 15 mm

respectively. When made from more than one piece, the pieces shall be joined with a continuous tongue and groove joint, glued together and reinforced with metal dowels.
- The grains of timber panels shall run along the longer dimensions of the panels.

f) **Application:**

- **For Framework:**
  - The work shall be carried out as per detailed drawings and as directed by the Engineer-in-Charge, specified timber shall be used.
  - Sawing shall be truly straight and square, and in the direction of the grains.
  - The scantlings shall be accurately planed smooth to the full dimensions and rebate rounding and mouldings shown in the drawings, before the same are framed.
  - Patching or plugging of any kind shall not be permitted.
  - A tolerance of +3 mm and -2 mm shall be allowed in the finished cross-sectional dimension.
  -
- **Timber Panels**
  - Timber panels shall be preferably made of timber of large width; the minimum width and thickness of the panel shall be 100 mm, and 15 mm respectively. When made from more than one piece, the pieces shall be jointed with a continuous tongued and grooved joint glued together and reinforced with headless nails at regular intervals not exceeding 100 mm. Depth and thickness of such joint shall be equal to one-third of thickness of panel. The panels shall be designed such that no single panel exceeds 0.5 square metre in area. The grains of timber panels shall run along the longer dimensions of the panels. All panels shall be of the same species of timber unless otherwise specified.
- **For Fitting**
  - Fitting shall be of stainless steel. These shall be well made, reasonably smooth, and free from sharp edges and corners, flaws and other defects. Screw holes shall be counter sunk to suit the head of specified wood screws.

g) **Timber Decking**

- **Seasoning and Preservation**
  - All timber used for decking and paving shall be thoroughly seasoned in accordance with relevant Indian Standards as mentioned in point (c). After seasoning the timber shall be treated with preservative in accordance with relevant Indian Standards as mentioned in point (d).
  - Seasoning and preservative treatment shall be paid for separately unless otherwise specifically included in the description of the item of flooring.

- **Boards/ Planking**
  - It shall be of the class of timber and thickness specified in the description of the item. The timber shall be as specified in section 5.5.6. Only selected

boards of uniform width shall be used. Unless otherwise specified or shown in the drawings.

- The minimum length of boards shall be such that the boards shall rest at least on three supports, except where otherwise required by the pattern specified in the drawings or as directed by the Engineer-in-Charge.
- The boards shall be planed true on the outside face only unless otherwise specified in the description of the item.
- Butt joint should be provided where it lies over a vertical beam.
- Iron Screws: Iron screws shall be of the slotted counter sunk head type, of length not less than the thickness of planks plus 25 mm, subject to a minimum of 40 mm, and of designation No. 9 conforming to Indian Standards.

◦ **Fixing**

- The joists on which the planks shall be fixed shall be checked and corrected to levels. The end boards shall be accurately fixed with the sides parallel and close to the walls. Each adjoining board shall be carefully jointed and shall be tightened in position and screwed.
- Pre- drill holes for end screws.
- For fixing the boards to the joists, two screws shall be used at each end of the boards and one screw at each of the intermediate joists in a zig zag manner. The screws shall be countersunk and screw holes filled with approved stopping.
- The flooring shall be truly level and plane. The joints shall be truly parallel and or perpendicular to the walls, unless otherwise specified.
- The floor shall be planned in both directions and made perfectly even, true and smooth.

5.5.9 Steel work

a) **Material supply:**
- General requirements relating to supply of structural steel shall conform to IS standards.

b) **Grades:**
- There are nine grades of steel as given in Indian Standards. While placing the order the steel should be designated by 'Designation'.

c) **Manufacture:**
- The whole work shall be representative of the highest class of workmanship. The greatest accuracy shall be observed in the design, manufacture and erection of every part of the work to ensure that all parts will fit accurately together on erection.
- The processes used in the steel making and further hot rolling into steel plates, strips, sections, flats, bars, etc., are left to the discretion of the manufacturer/supplier and it should meet relevant standards and product requirement.

d) Fabrication:
- Fabrication shall generally be done as specified in Indian standards. In major works or where so specified, shop drawings giving complete information for the fabrication of the component parts of the structure including the location, type, size, length and details of all members, shall be prepared in advance of the actual fabrication and approved by the Engineer-in-charge.
- Great accuracy shall be observed in the fabrication of various members, so that these can be assembled without being unduly packed, strained or forced into position and

when built up, shall be true and free from twist, kinks, buckles or open joints.

- All the steel sections used in the fabrication must have mill test certificate clearly indicating the specification to which the steel conforms and whether steel is killed and normalized.
- Use of steel of any quality other than those mentioned above would require the prior approval of the Structural Engineer.
- **Processes which are involved in Fabrication of MS components are given below:**

- **Surface Cleaning**
  - All finished materials shall be well and cleanly rolled to the dimensions, sections and masses specified. The finished material shall be reasonably free from surface flaws; laminations; rough/ jagged and imperfect edges and all other harmful defects prior to fabrication or painting.
  - There are three different types of methods involved in surface cleaning. Such as, Hand preparation using wire brush, blast cleaning & Flame cleaning depending on requirement and skills.

- **Cutting and Machinery**
  Following surface preparation, cutting to length is always the first process to be carried out, and this is done by any of the following methods:
  - Shearing and cropping
  - Cold Sawing

- **Punching and Drilling**
  - Wooden or metal sheet templates shall be made to correspond to each member and position of rivet/ bolt holes shall be marked accurately on them and holes drilled. The templates shall then be laid on the steel members, and holes for riveting and bolting marked on them. The ends of the steel members shall also be marked for cutting as per required dimensions.
  - The base of steel columns and the positions of anchor bolts shall be carefully set out at the required location.

- **Straightening, Bending and Rolling**
  - Rolled steel may get distorted after rolling due to cooling process. Further during transportation and handling operations, materials may bend or may even undergo distortion. Therefore, before attempting further fabrication the material should be straightened. In current practice, either rolls or gag presses are used to straighten structural shapes.
  - All steel materials, plates, bars and structural' s shall have straight edges, flat surfaces and be free from twist. If necessary, they shall be cold straightened or flattened by pressure before being worked or assembled unless they are required to be of curvilinear form. Pressure applied for straightening or flattening shall be such as it would not injure the material and adjacent surfaces or edges shall be in close contact or at uniform distance throughout.

- **Fitting and Reaming**
  - Before final assembly, the component parts of a member are fitted up temporarily with bolts or small number of welds.
  - In bolted work, especially when done manually, some holes in the connecting material may not always be in perfect alignment and small amount of reaming may be required to permit insertion of fasteners.

- **Connections or Fastening Method**
  - The strength of the entire structure depends upon the proper use of fastening

methods. There are two methods of fastening approved namely bolting and welding.

- Welding is the most common method of shop fabrication of steel structures. In addition to being simple to fabricate, welded connection considerably reduces the size of the joint and the additional fixtures and plates.

- **Specifications for welding:**
  - Welding shall be carried out by qualified welding personnel in accordance with the relevant Indian standards and code of practice.
  - The work shall be positioned for downward welding wherever possible.
  - The sequence of welding shall be such as will avoid undue distortion and minimize residual shrinkage stresses. Recommendation of IS 9595 shall be followed.
  - The welds shall be free from cracks, discontinuity in welding and other defects such as (i) under-size (ii) over-size, (iii) under-cutting and (iv) over-cutting in the case of fillet welds and defects (ii), (iii) & (iv) in the case of butt welds.
  - As far as possible every effort shall be made to limit the welding that must be done after the structure is erected.
  - All welds shall be cleaned of slag and other deposits after completion. Till the work is inspected and approved painting shall not be done.
  - All operation connected with welding and cutting equipment shall conform to the safety requirements given in IS 818 for safety requirements and Health provision in Electric and gas welding and cutting operations.
-
- **Specifications for bolted connections:**
  - The Contractor shall carry all field connection work as per the shop drawings prepared. All bolts, nuts, washers, rivets, electrodes required for the Contractor shall supply field connections.
  - Bolts and nuts shall be galvanised conforming to the requirement given in the following Indian specifications.
  - In case of bolted connections, taper washers or flat washers or spring washers shall be used with bolts as necessary.
  - The length of the bolt shall be such that at least one thread of the bolt projects beyond the nut.
  - In all cases where bearing is critical, the unthreaded portion of bolt shall bear on the members assembled.
  - A washer of adequate thickness may be provided to exclude the threads from the bearing thickness, if a longer grip bolt has to be used for this purpose.
  - All connections and splices shall be designed for full strength of members or loads.
  - Column splices shall be designed for the full tensile strength of the minimum cross section at the splice.
  - Splicing shall be avoided at critical locations and be done only after the approval of Engineer-in-charge as per the splice drawing submitted by Contractor and approved by Engineer-in-charge.
  - All members likely to collect rainwater shall have drain holes provided.

- **Surface Finishing**
  - Structural members whose ends must transmit loads by bearing against one another are usually finished to a smooth even surface. Finishing is performed by sawing, milling or other suitable means.

- **Surface Treatment**
  - Materials and products, including fixings, concealed and structural components, shall be corrosion resistant or protective coated to prevent corrosion in a marine

environment.

- Structural steelwork is protected against corrosion by galvanization in the shop or at site. Preferably in the shop, same can be decided as per site requirement.
- Approved method of applying metal coating to steel surfaces is Hot-dip galvanising.
- In Galvanising method, the cleaned and fluxed steel is dipped in molten zinc at a temperature of about 4500C. The steel reacts with molten zinc to form a series of zinc or iron alloys on its surface. As the steel workpiece is removed, a layer of relatively pure zinc is deposited on top of the alloy layers.
- Structural Steelwork exposed to weather, embedded into concrete or masonry, or in contact with chemically treater timber shall be hot dip galvanized based on Indian standards codes given for proper workmanship.
- For most applications galvanised steel does not require painting.

- **Erection**
  - The Contractor shall provide at his/her own cost all tools, machinery, equipment and erection material necessary for the expeditious execution of the work and shall erect the structural steel and iron work, in every respect as covered by the contract and in accordance with the drawings and specifications.
  - The contractor however shall be fully responsible for the work being carried out in a safe and proper manner without unduly stressing the various members and proper equipment such as derricks, lifting tackles, winches, ropes etc. shall be used.
  - The work of erection may be done in suitable units as may be directed by the Engineer-in-charge.
  - Steel members shall be hoisted and erected in position carefully, without any damage to itself, other structures and equipment and injury to workmen.
  - The method of hoisting and erection proposed to be adopted by the contractor shall be got approved from the Engineer-in-charge in advance.

  - Fabricated members shall be lifted at such points so as to avoid deformation or excessive stress in members. The structure or part of it placed in position shall be secured against over-turning or collapse by suitable means.
  - Where necessary mechanical appliances such as lifting tackle winch etc. shall be used. It should be inspected for safety prior to use.
  - During execution, the steel members shall be securely bolted or otherwise fastened, when necessary, temporarily braced to provide for all loads including those due to erection equipment's and its operation to be carried safely by structure during erection. The steel members shall be placed in proper position as per approved drawing, final riveting or permanent bolting shall be done only after proper alignment has been checked and confirmed.
  - Columns and stanchions shall be erected truly vertical with the necessary cross bracing etc. and the base shall be properly fixed with the foundation concrete by means of anchor bolts etc. as per drawing.
- Anchor bolts to be placed in the concrete foundation should be held in position with a wooden template. At the time of concreting anchor bolt locations shall be provided with suitable timber mould or pipe sleeve to allow for adjustment which shall be removed after initial setting of concrete. The spaces left around anchor bolts shall be linked to a stopping channel in the concrete leading to the side of the pedestal and on the underside of the base plate to allow the spaces being grouted up after the base plate is fixed in the position along with the column footing. Grouting shall be of cement mortar 1:3 (1 cement: 3 coarse sand) or as specified.

- **Bedding of Column, Stanchions etc.**

  Bedding shall not be carried out until the steel work has been finally levelled, plumbed and connected. The stanchion shall be supported on steel wedges and

adjusted to make the column plumb. For multi-storeyed buildings, the bedding shall not be done until enough bottom lengths of stanchions have been properly lined, levelled and plumbed and sufficient floor beams are fixed in position. The base plates shall be wedged clear of the bases by M.S. wedges and adjusted where necessary to plumb the columns. The gaps under the base plate may be made up to 25 mm which shall be pressure grouted with cement grouts.

- **Completion Process**

  - **Cleaning**
    - ✓ General: Leave the works in a clean, tidy condition.
    - ✓ Surfaces: Clean immediately before handover.
  - **Fixings**
    - ✓ All components: Tighten.
    - ✓ Timing: Before handover.

5.5.10 Stainless Steel Works

a) **Steel type:** Type 316 Stainless Steel

b) **Characteristics:** Type 316 stainless steel has better corrosion resistance to most chemicals, salts and acids and is more resistant to marine atmosphere because of an addition of 2.0 to 3.0% molybdenum. This addition improves the corrosion resistance of austenitic steels and imparts hot strength characteristics.
Type 316 stainless steel is high creep strength at elevated temperatures.

c) **Fabrication:** Roll formed, spun, deep drawn, hot and cold forged or bent and folded with a strong force, owing to the material's high strength and work hardening rate as per IS standards.

d) **Dimensions:**
Stainless steel sheets and strips shall be supplied in the following standard dimensions:
Sheets 60mm (min.) to 1200mm (max.) (Refer structural consultant for specific sheet size).
Thickness of sheets and strips ranges between (1.25mm to 0.20mm). (Refer structural consultant for specific sheet size).

e) **Freedom from Defects:** Stainless steel sheets and strips shall be free from harmful defects, such as scale, rust, blister, laminations, cracked edges and seams.

f) **Physical and Chemical properties:** Stainless steel sheets and strips should undergo some check analysis and tensile tests to achieve standards as mentioned in IS standard code.

g) Tolerances
The rolling tolerances for stainless steel sheets and strips shall be as follows:
Width (±1.5mm); Length (±10.0mm); Thickness 2.20 to 0.40(±0.04mm); 0.40 to 0.80(±0.10mm); 0.80 to 1.00(±0.12mm); 1.00 to 1.25(±0.14mm);

h) Application
316 Stainless Steel is specified for use with high purity products where product contamination must be held to a minimum. Typical applications are Chemical Processing, Pharmaceutical and Textile Finishing Equipment and Marine Exterior Trim.

5.5.11 Concrete Grass Paver

a) **Compressive Strength**: Ranges depending on grade, but commonly 30 MPa to 55 MPa according to OM Concrete Products. M-40 with 40 compression strength and thickness of 80 mm.
b) **Load Bearing Capacity**: Can range from 200 tons to very high, depending on thickness and application.
c) **Water Absorption:** Typically, less than 6% to 7%.
d) **Product Life:** Can last for 10 years or more.
e) **Paver type:** Concrete
f) **Sizes of pavers**: 150X`150X80mm to be used.
g) **Paver installation:** Place the grass paver blocks in a desired pattern, often a staggered or brick pattern to ensure minimal gaps.

5.5.12 Terrazzo

a) **Material**- It is a composite material poured in place or precast. It consists of chips of marble, quartz, granite, glass, or other suitable material poured with a cementitious binder (chemical binding).
b) **Laying-** Terrazzo topping shall be laid while the under layer is still plastic, but it hardened sufficiently to prevent cement from rising to the surface; this is normally achieved between 18 to 24 h after the under layer has been laid. A cement slurry, preferably of the same colour as the topping shall be brushed on the surface immediately before laying is commenced. If possible, the entire work of laying the topping shall be completed at one stretch.
c) **Thickness-** The combined thickness of under layer and terrazzo topping shall not be less than 20 mm to max. of 40mm.
d) **Finish**- Brushed finish for the terrazzo used on the vertical terrazzo application.

5.5.13 Wood Plastic Composite

a) **Composition**: Hybrid materials combining wood powder (typically 15-70%) and thermoplastic polymers (like polyethylene, polypropylene, or PVC).
b) **Water Resistant**- The WPC is a water-resistant material perfect for outdoor as well as indoor use.

6 Landscape Elements Specifications

6.1 Kerbs and edges

a) To be read with Preliminaries/ General Conditions and Engineer's details and specifications.
b) All materials and workmanship shall comply with the relevant Indian Standards and Codes or CPWD specifications.
c) Contractor to follow Health & Safety procedures set in Health & Safety Plan (as per section 2.3.) at any time during the work.

6.1.1 Relevant Drawing and Documents

The section to be read in conjunction with relevant drawings:

Contractor is responsible to have most recent Drawings in his possession (e.g. relevant structural details) and discard superseded drawings upon revision. A drawing register is to be kept in the site office noting current plans current plans changes to plans during the work programme.

6.1.2 General quality

a) The quality of materials method and control of manufacture and transportation of all concrete work in respect of mix, were reinforced or otherwise, shall conform to the applicable portions of these specifications.
b) The Engineer-in-charge shall have the right to inspect the sources of materials, the layout and operation of procurement and storage of materials, the concrete batching and mixing equipment and the quality control system. Such an inspection shall be arranged by the contractor, and the Engineer-in-charge's approval shall be obtained prior to starting the concrete work.

6.1.3 Material Samples Required

The ingredients to be used in the manufacture of standard concrete shall consist solely of a standard type Portland cement, clean sand, natural coarse aggregate, clean water and admixtures if specially called for as per drawings or schedule of quantities.

6.1.4 Delivery, Storage, and Handling

d) Kerbstone units to be delivered on site in suitable packaging free from cracks, chippings or discolorations of the material.
e) Store materials on elevated platforms, under cover, and in a dry location. Do not use materials that have become damp.
f) Store all accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.
g) All materials shall be stored in a secured location and in accordance with Health and Safety Plan (as per "2.3. General Requirements, Section on Health and Safety").
h) Contractor to be responsible for the safekeeping of all materials delivered to site and replacement at own cost as required.

6.1.5 Natural Precast Concrete Flushed Kerb

a) **Manufacturer**: from Suppliers Schedule provided or equivalent approved.

b) Application: For all typical edges with level drop of 150mm average;
c) Concrete type: Manufactured by using M-30 grade of concrete using vibro-compaction process using jointless moulds.
d) Size (width x length x height): Refer the Relevant Drawings & Schedule
e) Special shapes: Refer the Relevant Drawings & Schedule
f) Finish: Smooth
g) Plan dimension deviation class: ± 2mm.
h) Diagonal deviation class: ± 2mm.
i) Thickness deviation class: ± 2mm.
j) **Color:** Refer the Relevant Drawings & Schedule. To match approved samples held by Employers Representative.
k) **Bedding**: approved Kerbstone is to be laid onto a concrete base/ footing. The base should typically be as per structure consultant advice. It should compose of compacted semi-dry concrete (typically in 1:2:4 cement: sand: aggregate) mix. A minimum of one-third of the unit must be fully bedded into the mortar mix.
l) **Joints:** 5mm wide joint, Mortar color to match edge color.
m) Sealant movement joints: Refer to relevant Indian standards and updated CPWD specification.
n) Fixing of the kerb and any structural related details to Engineer's specification.
o) Contractor to reject any kerb units that do not comply with the above requirements. Client's Representative to reserve right to reject products that do not comply to specifications.

6.1.6 Laying Concrete Kerbs

a) **Excavation:** the depth of the excavation depends on height of the Kerbstone. Which way will it be laid and upstand is intended. Refer section 5.3.3 for more details.
b) Do not install adverse weather conditions. Adequately protects foundations, bedding and haunching against extreme temperatures and rapid drying by wind and sun.
c) Concrete used for foundations or haunching should comply with Indian standards and relevant Designated mix: Not less than **GEN - 0 or Standard mix ST1**, Workability: Very low.
d) All cuts need to be machine cut. Cutting to be neat and accurate, without spalling. From neat junctions. Minimum cut as specified on Drawings. If minimum cut not possible use oversized unit;
e) Use special corner and radii units at bends, corners and junctions as per location on drawings.
f) Units to be positioned true and levelled along top and front faces, in a mortar bed on accurately cast foundations; responding to site levels provided by the Engineer-in-Charges.
g) Ends of units buttered with bedding mortar as laying proceeds. Joints filled, 5mm wide mortar joint and surplus mortar removed immediately.
h) After bedding is set, secure units with a continuous haunching of concrete; Refer point no. 6.1.5. (i), (j), (k) for Deviation in finish kerb levels.

6.2 Paving

6.2.1 Scope

a) This section of the Specification covers the general requirements for concrete paving, natural stone paving, bituminous surfaces, tactile paving and allied works including all materials, Labour, curing, scaffolding, tools etc.
b) All items and works related to the section shall be compliant with relevant Indian standards or equivalent standards;
c) Contractor to follow Health & Safety procedures set in Health & Safety Plan (as per section 2.3.) at any time during the work.

6.2.2 Relevant Drawing and Documents

a) All sections of this document to be read in conjunction with the relevant drawings & schedules provided as part of the landscape package:
b) Contractor is responsible to have most recent Drawings in his possession (e.g. relevant structural details) and discard superseded drawings upon revision. A drawing register is to be kept in the site office noting current plans changes to plans during the work program.

6.2.3 Quality Assurance

a) All paving materials to be obtained from single source, and supplied preferably, in one lot to keep variations to the minimum as per approved Supplier's list or approved alternate – submitted by Contractor and approved by Client's Representative.
b) The Contractor shall also segregate and sort the paving material according to color, shade, texture and size of grains etc. to keep variation(s) in material used at anyone paving to the minimum.
c) Any paving material with variation in the color, shade, texture and size of grains etc., not acceptable to the Engineer-in-Charge, shall not be used in the work and shall be removed and replaced by the Contractor.
d) Source Limitations for Other Materials: Obtain sample for each type of cementitious material, mortar, and other material from single source or producer for each aggregate.
e) Use manufacturer's standard test methods to determine whether mortar and grout materials will obtain optimum adhesion with, and will be non-staining to, installed paving stones and other materials constituting stone paver installation.
f) Pre-installation Inspection: Conduct inspection at Project site with Client's Representative as per approved Works Programme.

g) **Mock-ups.**
- Construct Mock-ups to set quality standards for materials and execution as coordinated and approved by Client's Representative.
- Construct Mock-ups for each type of paving, each Mock-up shall be to scale, and surface areas as dimensioned as stipulated in the Drawings'. Notes for each Mock-up to be provided.
- Contractor to submit the drawing showing layout, location and dimensions for 'on-site' Mock-up area, for Client's Representative's approval prior to construction of Mock-up.
- Mock-up should include kerbs, recessed manhole covers, paving transitions, interface with lighting and any additional feature as required;
- Approval of mock-ups should include quality of finish, materials, mortars & P.C.C. and workmanship;
- Approval of mock-ups is also for other material and construction qualities that the Client's Representative specifically approves in writing. Approval of mock-ups does

not constitute approval of deviations from the Contract Documents unless Client's Representative specifically approves such deviations in writing.

- If any major item has been rejected, mock-up panel shall be removed or corrected and presented again for approval.
- If minor items have been rejected, notes shall be taken and followed during the construction programme in respect to mentioned items.

6.2.4 Delivery, Storage, and Handling

a) Paving units to be delivered on site in suitable packaging free from cracks, chippings or discolorations of the material.
b) Store materials on elevated platforms, under cover, and in a dry location. Do not use materials that have become damp.
c) Store all accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.
d) All materials shall be stored in a secured location and in accordance with Health and Safety Plan (as per "2.3. General Requirements, Section on Health and Safety").

6.3 Paving Types

6.3.1 Concrete Pavers –paving type

a) Refer to the Relevant Drawings & Schedule
b) **Granular sub-base:** Thickness and specifications as per structural consultant
c) **Sand bed:** 50mm thk; specifications as per structural consultant compacted to remain true to level.
d) **Paving type** – Pre-cast Concrete pavers; S-locking/ (Basant Beton's Lock Pavers or equivalent). Refer the Relevant Drawings & Schedule

k) **Manufacturer:** from Suppliers Schedule provided or equivalent approved. Manufacturer to produce schedule of materials. Refer to Basis of the Design
l) **Size** – Refer the Relevant Drawings & Schedule
m) **Shape** – irregular or partly rounded.
n) **Colour-** Grey
o) **Finish –** Sand blasted.
p) Plan dimension deviation class: ± 2mm.
q) Diagonal deviation class: ± 2mm.
r) Thickness deviation class: ± 2mm.
s) **Joints:** 5mm joint filled with self-binding polymeric sand (as recommended by manufacturer). Flush finish. All joints to align as shown in drawings Contractor to provide samples for approval.

6.3.2 Exposed Aggregate Concrete Finish – paving type

a) Refer the Relevant Drawings & Schedule
b) **Supplier**: Concrete supply should be finalized and approved by Client's representative prior to commencement of works. Concrete batching plant to provide batching details for records.
c) Concrete type and quality to Engineer's specification and to comply with relevant Indian standards and regulations; reinforced as per structural consultant guidance. Refer section 5.5.3 for more details on concrete work.
d) M25 grade of concrete in 1:1.5:3 ratio or as specified as per standards.
e) Cement for concrete should be PPC depending on marine condition adjacent to site.
f) Slab thickness and galvanized reinforcement mesh sizes and specifications (as per relevant Indian standards & structural consultant).
g) Slump of concrete should be as recommended by the structural consultant.
h) Slab length should not be larger than 4.5m in any direction.
i) Joints: expansion joints at 4.5m c/c; construction joints @2.25m c/c.

6.3.2.1 Aggregate for Concrete:

a) Limitations on contaminants: Free from absorbent particles which may cause 'popouts', and other particles such as coal and iron sulphide which may be unsightly or cause unacceptable staining.
b) Supply: From a single source and maintained throughout the contract.
c) Colour: consistent.
d) Aggregates should be single sized aggregate, 10 – 12mm in diameter, coarse/ rounded edge.
e) Sample should be submitted and approved prior to placement.
f) Surface should undergo steel floating process to get IPS (Indian Patent Stone Flooring) Finish using steel trowel. Application of retardant and removal of retardant as per vendor and Engineer's specification. Exposure of aggregate should be 5mm maximum.

6.3.3 Stamped concrete- paving type

a. Refer to the Relevant Drawings & Schedule.
b. Granular sub-base thickness and specifications as per Structural Consultant's drawings and recommendations.
c. Reinforced Cement Concrete slab of specified grade and thickness as indicated in the drawings, compacted and finished to required levels and slopes.
d. **Paving Type – Cast-in-Situ Stamped Concrete Paving** complete with approved texture, pattern, colour hardener, release agent and protective sealer.
e. Refer to Relevant Drawings & Schedule.
f. Manufacturer: Approved specialist supplier of decorative/stamped concrete systems or equivalent approved.
g. Contractor to submit product data sheets, technical specifications, colour charts and manufacturer's recommendations for approval prior to execution.
h. Refer to Relevant Drawings & Schedule.
i. Pattern: Ashlar Slate / Random Stone / Cobblestone / Wood Plank or as specified in Landscape Drawings.
j. Colour: As per approved Landscape Palette and Drawings.
k. Finish: Textured stamped finish with anti-skid surface treatment.
l. Thickness: As indicated on drawings (minimum 100 mm RCC paving slab unless otherwise specified).
m. Surface Tolerance: Maximum deviation of ±6 mm under a 3 m straight edge.
n. Slope: As indicated on drawings to ensure positive drainage.
o. Control Joints: Saw-cut control joints at maximum 3.0 m to 4.5 m spacing or as approved by the Engineer.
p. Expansion Joints: Provide expansion joints adjacent to buildings, walls, kerbs, utility structures and other fixed elements.
q. Joint Sealant: UV-resistant polyurethane sealant or approved equivalent.
r. Sealer: Two coats of approved acrylic or polyurethane protective sealer applied in accordance with manufacturer's recommendations.
s. Mock-Up: Contractor shall provide a minimum 3 m × 3 m sample panel showing colour, texture, pattern and joint treatment for approval prior to commencement of works.

6.3.4 Cobble stone – paving type

a. Refer to the Relevant Drawings & Schedule.
b. Granular sub-base thickness and specifications as per Structural Consultant's drawings and recommendations.
c. Sand bed: 30 mm thick bedding sand layer, compacted and screeded to required levels, grades and cross-falls.
d. **Paving Type – Natural Cobblestone Paving** complete with approved stone units, bedding layer, jointing material and edge restraints.
e. Refer to Relevant Drawings & Schedule.
f. Manufacturer/Supplier: Approved supplier of natural granite/basalt cobblestones or equivalent approved.
g. Contractor shall submit stone samples, technical data, quarry source information and test certificates for approval prior to procurement.

h. Refer to Relevant Drawings & Schedule.
i. Material: Natural Granite / Basalt Cobblestone.
j. Shape: Hand-cut / Machine-cut cubical or rectangular cobblestone units.
k. Colour: Grey / Charcoal Grey / Mixed Grey or as specified in Landscape Drawings.
l. Finish: Natural split face / flamed finish / bush hammered finish with anti-skid characteristics.
m. Size: Refer to Relevant Drawings & Schedule (Typical size 100 × 100 × 80 mm or 100 × 100 × 100 mm).
n. Plan Dimension Deviation Class: ±5 mm.
o. Thickness: As indicated in drawings and schedule.
p. Laying Pattern: Running Bond / Fan Pattern / Radial Pattern / Random Pattern as shown on drawings.
q. Joints: 5–10 mm wide joints filled with polymeric sand, fine aggregate mortar, or approved jointing compound.
r. Edge Restraints: Precast concrete kerbs, granite kerbs, metal edging or cast-in-place concrete restraints as indicated on drawings.
s. Surface Tolerance: Maximum deviation of ±10 mm under a 3 m straight edge.
t. Slope: As shown on drawings to facilitate positive drainage and prevent water ponding.
u. Mock-Up: Contractor shall provide a minimum 3 m × 3 m sample panel indicating stone type, colour, laying pattern and joint treatment for approval prior to commencement of works.
v. All cobblestones shall be sound, durable, free from cracks, laminations, excessive chipping, weathering defects or other imperfections affecting performance or appearance.

6.3.5 Pedestrian Ramp

a) Refer to the Relevant Drawings & Schedule

6.3.5.1 Civil Material:

b) **Granular sub-base:** Thickness and specifications as per structural consultant
c) Brick tow wall: 230mm thk, Class – ‘1’ -Brickwork; Exposed; (Refer section 5.5.1 for Brick work for sizes and other details; refer drawing for quantities and details).
d) Footing for brickwork – In 100mm thk. PCC. (For ratio and details refer section 5.5.3 for Concrete work construction and structural consultant).

6.3.5.2 Ramp Surface:

- Concrete type and quality to Engineer’s specification and to comply with relevant Indian standards and regulations; reinforced as per structural consultant guidance. Refer section 5.5.3 for more details on concrete work.
- Concrete slab: Slab thickness as per structural advice; concrete base using appropriately sized reinforcement mesh; (sizes and specifications as per relevant Indian standards & structural consultant advice).
- Surface finish: Brushed concrete finish (Refer section 6.3.3 on Brushed Concrete finish details and specifications).

6.3.5.3 Miscellaneous items:

e) Railing. Refer the Relevant Drawings & Schedule and section 6.8.3. for detail specifications).

6.3.6 Steps

a) Refer the Relevant Drawings & Schedule.

6.3.6.1 Civil Material:

b) **Technical Specification**

- **Size:**
- Refer to the Relevant Drawings & Schedule

- **Material:**
  - **Granular sub-base:** Thickness and specifications as per structural consultant
  - Brickwork: Class – '1' -Brickwork; Exposed; (Refer section 5.5.1 for Brick work for sizes and other details; refer drawing for quantities and details).
  - Footing for brickwork – In 100mm thk. PCC. (For ratio and details refer section 5.5.3 for Concrete work construction and structural consultant).
- **Surface:**
  - Concrete type and quality to Engineer's specification and to comply with relevant Indian standards and regulations; reinforced as per structural consultant guidance. Refer section 5.5.3 for more details on concrete work.
  - **Thickness:** concrete thickness as per structural advice; (sizes and specifications as per relevant Indian standards & structural consultant advice).
  - **Surface Finish:** Brushed Concrete finish. (Refer section 6.3.3 on Brushed Concrete finish details and specifications).
- **Colour**: Refer the Relevant Drawings & Schedule

Special requirements:

- **Nosing:** Bull nose; 10mm in radius/ Refer the Relevant Drawings & Schedule

- Step Tread Grooves parallel to face; set of four (5X5) mm groove placed 50mm from face of riser as slip resistant measurement of pedestrian surface as per IS standards.

6.3.7 Stage

a) Refer the Relevant Drawings & Schedule

6.3.7.1 Civil Material:

b) **Technical Specification**

- **Size:** Refer the Relevant Drawings & Schedule

- **Material:**
  - **Granular sub-base:** Thickness and specifications as per structural consultant.
  - **Brickwork:** Class – '1' -Brickwork; Exposed; (Refer section 5.5.1 for Brick work for sizes and other details; refer drawing for quantities and details).
  - **Footing for brickwork** – In 100mm thk. PCC. (For ratio and details refer section 5.5.3 for Concrete work construction and structural consultant).

Concrete slab:

- Concrete type and quality to Engineer's specification and to comply with relevant Indian standards and regulations; reinforced as per structural consultant guidance. Refer section 5.5.3 for more details on concrete work.

- **Thickness:** concrete thickness as per structural advice; (sizes and specifications as per relevant Indian standards & structural consultant advice).
  Surface Finish: Brushed Concrete finish. (Refer section 6.3.3 on Brushed Concrete finish details and specifications).
  Color: Natural.

Special requirements:

- **Nosing:** Bull nose; 10mm in radius. Refer to the Relevant Drawings & Schedule

- Step Tread Grooves parallel to face; set of four (5X5) mm groove placed 50mm from face of riser as slip resistant measurement of pedestrian surface as per IS standards.

c) **Technical Specification for Platform/ Stage**

- **Material:**
  - **Granular sub-base:** Thickness and specifications as per structural consultant.
  - Brick wall: 300mm thk. Class – '1' -Brickwork; Exposed; (Refer section 5.5.1 for Brick work for sizes and other details; refer drawing for quantities and details).
  - RCC pedestal for fixing existing columns – Sizes as per structural consultant. (For ratio and details refer section 5.5.3 for Concrete work construction and structural consultant).
  - PCC base – Thickness as per structural consultant. (For ratio and details refer section 5.5.3 for Concrete work construction and structural consultant).
    Concrete slab:
  - Concrete type and quality to Engineer's specification and to comply with relevant Indian standards and regulations; reinforced as per structural consultant guidance. Refer section 5.5.3 for more details on concrete work.
  - **Thickness:** Slab thickness as per structural advice; concrete base using appropriately sized reinforcement mesh; (sizes and specifications as per relevant Indian standards & structural consultant advice).
- **Surface finish:**
  - Platform surface finish – Smooth Concrete Finish.
  - Wall Finish – Cement Plaster. (Refer section 5.5.5 on Cement Plastering.
  - Finish - Smooth
  - Color – Light grey
  - Acrylic emulsion exterior paints (Refer CPWD specifications and relevant Indian standards for execution guidelines along with manufacturer's recommendation).

6.3.8 Miscellaneous items used in execution of Paving

a) **Mortar**

- Refer section 5.5.4 for details being used in Paving and wall construction.

b) **Tooled colored joints in mortar bedded units**

- Joints: Filled with bedding mortar as work proceeds. Tooled to neat flush profile.
  - Joint width: 5 to 7mm.
- Pointing: 1:3 cement: sand mortar with pigment, colour to match stone colour. Refer to 2.5.4.
- Depth: 10mm.

c) **Cementitious bases and sub-bases**

- General: Protect from moisture loss, if not covered by another pavement course within 2 hours of completion.

d) **Sealant movement joints in mortar bedded units**
   - Spacing: 10-12m or as per structural consultant or relevant Indian standards; aligned with paving pattern to minimize cutting at construction joints.
   - Extent of joints: Through edge units, haunching and foundation.
   - Joint filler: Compressible cellular rubber or plastics compatible with specified sealant. Build in as work proceeds.
     - Joint width: 10mm.
   - Barrier (joint breaker): As recommended by sealant manufacturer. Position filler and barrier accurately to fully support sealant at recommended distance from exposed faces of units.
   - Sealant: Submit proposals.
     - Colour: Colour to match adjacent paving. Contractor to source to source up to 3 samples of suitable colours and submit for approval from client representative and Client.

6.4 Execution of Pavement Work

6.4.1 Laying Concrete

a) Refer Section 5.5.3 for Concrete work details.

6.4.2 Laying Natural Stone/ Tile Paving

a) Do not install adverse weather conditions. Adequately protect foundations, bedding and haunching against extreme temperatures and rapid drying by wind and sun, heavy rainfall.
b) Subbase and bedding to be laid to Engineer's specification.
c) Bedding to be firm and properly compacted before proceeding with paving and it should meet minimum Indian standards for compaction.
d) Cutting to be neat and accurate, without spalling to form neat junctions with edging and adjoining finishes. Minimum cut as specified on Drawings. If minimum cut not possible use oversized unit;
e) Levels and lines of finished surface should be smooth and even with falls to prevent ponding.
f)When laying on the slope, lay paving units from the bottom of slope, upwards.
g) Paving should appear even and regular with joint widths and free of mortar and sand stains.
h) Deviation in finish paving levels should be no more than ±2mm. Allowed deviation in height of finished paving features (gullies/drainage channels/Krebs) to be no more than ±3mm, sudden irregularities are not permitted. Variation in levels between adjacent block/pavers sets to be no more than ±2mm.
i)Paving to be always kept clean. All deleterious materials to be removed immediately.
j) Do not overload previously laid paving with stacks of materials. Avoid damage to unit corners, surfaces etc.
k) After laying do not allow for any pedestrian traffic for 24h, vehicular traffic for 28days.

6.5 Wall Coping and Cladding

6.5.1 Scope

a) This section of the Specification covers the general requirements for masonry works, natural stone cladding, paints, mosaic tiling and allied works including all materials, labour, curing, scaffolding, tools etc.
b) All items and works related to the section shall be compliant with relevant Indian standards or CPWD specifications, 2009 for all items and related work.
c) Contractor to follow Health & Safety procedures set in Health & Safety Plan (as per section 2.3.) at any time during the works.

6.5.2 Relevant Drawing and Documents

d) The section to be read in conjunction with the Relevant Drawings & Schedule

e) Contractor is responsible to have most recent Drawings in his possession (e.g. relevant structural details) and discard superseded drawings upon revision. A drawing register is to be kept in the site office noting current plans current plans changes to plans during the work programme.

6.5.3 Quality assurance

a) Installer Qualifications: Registered Contractor;
b) All cladding materials to be obtained from single source and supplied preferably, in one lot to keep variations to the minimum, as per approved Supplier's list – submitted by Contractor and approved by Client's Representative.
c) Any cladding material with variation in the color, shade, texture and size of grains etc., not acceptable to the Engineer-in-Charge, shall not be used in the work and shall be removed and replaced by the Contractor
d) All Masonry materials to be obtained from single source, as per approved Supplier's list – submitted by Contractor and approved by Client's Representative and in conformance with applicable Indian Standards IS.
e) Source Limitations for Other Materials: Obtain each type of cementitious material, mortar, grouts and other material from single source or producer for each aggregate.
f) Use relevant Indian standard test methods to determine whether mortar and grout materials will obtain optimum adhesion with, and will be non-staining to, installed cladding and other materials constituting cladding installation.
g) Pre-installation Inspection: Conduct inspection at Project site with Client's Representative as per approved Works Program to determine suitability of the site for proposed works.

Mockups:

- Construct Mock-ups to set quality standards for materials and execution as coordinated and approved by Client's Representative.
- Construct Mock-ups for each type of cladding, each Mock-up shall be to actual scale, and surface areas as dimensioned as stipulated in the Drawings'. Notes for each Mock-up to be provided.
- Contractor to submit the drawing showing layout, location and dimensions for 'on-site' Mock-up area, for Client's Representative's approval prior to construction of Mock-up.
- Mock-up should include cladding, coping, cladding transitions, interface with lighting and any additional feature as required.
- Approval of mock-ups should include quality of finish, materials, mortars & P.C.C. and workmanship.

- Approval of mock-ups is also for other material and construction qualities that the Client's Representative specifically approves in writing. Approval of mock-ups does not constitute approval of deviations from the Contract Documents unless Client's Representative specifically approves such deviations in writing.
- If any major item has been rejected, mock-up panel shall be removed or corrected and presented again for approval.

h) If minor items have been rejected, notes shall be taken and followed during the construction program in respect to the items mentioned.

6.5.4 Delivery, Storage, and Handling

a) Cladding units to be delivered on site in suitable packaging free from cracks, chippings or discolorations of the material.
b) Store materials on elevated platforms, under cover, and in a dry location. Do not use materials that have become damp.
c) Store all accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.
d) All materials shall be stored in a secure location and in accordance with Health and Safety Plan.

6.6 Wall Types

6.6.1 Brick Wall

a) Refer the Relevant Drawings & Schedule

Technical Specifications:

b) Wall Size: Refer the Relevant Drawings & Schedule

c) Refer section 5.5.1. on Brick work construction.
d) Manufacturer: Machine molded from Suppliers Schedule provided or equivalent approved.
e) Brick type: Class 1 Bricks; Average compressive strength should not be less than 10.7 N/mm^2
f) Water absorption is less than 15%.
g) Size (length x width x height): Refer the Relevant Drawings & Schedule
h) Finish: Refer the Relevant Drawings & Schedule

i) Plan dimension deviation class: ± 2mm.
j) Diagonal deviation class: ± 2mm.
k) Thickness deviation class: ± 2mm.

l) Colour: Refer the Relevant Drawings & Schedule. To match approved samples held by Employers Representative.

m) **Wall Base Finish:**

- Surface finish: Acrylic emulsion exterior paints (Refer CPWD specifications and relevant Indian standards for execution guidelines along with manufacturer's recommendation)
- Colour: Light Grey (As per manufacturer).
- Finish: Smooth (As per manufacturer). 20mm thk. Cement Plaster; Deviation: ± 2mm (Refer section 5.5.5 on Cement Plaster)

n) **Coping-** Refer to the Relevant Drawings & Schedule.

6.7 Landscape Elements, Site Furniture/ Equipment

6.7.1 Scope

This section needs to be read with Preliminaries/ General Conditions and Engineer's details and specifications provided in different sections of the document.

6.7.2 Relevant Drawing and Documents

a) The section to be read in conjunction with below listed Drawings:
b) Contractor is responsible to have most recent Drawings in his possession (e.g. relevant structural details) and discard superseded drawings upon revision. A drawing register is to be kept in the site office noting current plans current plans changes to plans during the work programme.

6.7.3 Quality Assurance

a) Specialist landscape element, Site/ Street furniture supplier to complete and develop landscape elements provided in drawing schedule and submit shop drawings and material schedules for approval by client representative. Components and performance to be designed to a life span of at least 20 years. Contractor submits proposed guarantee period.
b) Contractor to ensure all materials, methodologies and mixes are suitable for the local climate conditions.
c) The supplier/subcontractor must complete the design and detailing and submit detailed design including shop drawings and calculations to the Engineer-in-Charge/Client's representative for comment before production. The Client's representative and Client are to approve prior to manufacture.
d) The supplier/subcontractor is to prepare designs such that they form a family of coordinated furniture that share the same materials, finishes, patterns and design solutions.
e) The works shall comply with the most recently published at time of construction Indian Standard for Construction or equivalent approved standard. Contractors who do not have a copy of these standard specifications may obtain a copy from BIS Bureau of Indian Standards (www.bis.org). The supplier/subcontractor's attention is directed to the fact that high standards of work are required.
f) The supplier/subcontractor must carry out all fixing, reinforcement and foundation details.
g) Environment: The supplier/subcontractor must select materials and carry out workmanship that is resistant to affects by local climatic and environmental conditions and provide a minimum lifespan of 20 years for all permanent furniture. All materials and finishes are to be agreed and must not become excessively hot to touch during typical daytime conditions.
h) Material samples: The supplier/subcontractor must prepare samples of all other surfaces that finish prior to manufacture. Obtain approval of appearance and finish prior to manufacture.
i) Prototypes: After finalization of all details, the supplier/subcontractor must prepare prototypes and obtain approval of appearance and fixings before proceeding with prototype testing and manufacture of the final samples. Supplier/contractor is to provide relevant design and methods for the safe lifting and installation of furniture items.

j) Prototype testing (Client's representative to confirm details): After the first stage of prototype approval, the contractor is to arrange for the testing of all prototypes within a comparable location over a minimum of 3 months. The contractor will prepare a series of tests to demonstrate that prototypes are suitable for purpose.
k) Tests will include, but not exhaustive of the following: Material suitability within local climate, regular cleaning with water and approved cleaning substances, requirements of maintaining and use by campus service personnel, regular use by the public and agreed tests for durability. Any further tests proposed to be agreed with the Client's representative.
l) The contractor should take into consideration the specialist design, production and transport duration of obtaining landscape items when developing his program.
m) Control Samples: After finalization of all details, comments and approvals of prototypes the supplier/subcontractor must prepare samples and obtain approval of appearance and fixings before proceeding with manufacture of the remaining quantity.
n) The contractor should take into consideration the specialist design, production and transport duration of obtaining landscape items when developing his program.
o) The Client's representative and Engineer-in-Charge retain the right to reject prototypes, samples and final furniture pieces until they achieve the highest standards required by this specification and associated drawings or are damaged due to transportation and installation. All prototypes, samples and final furniture pieces not achieving the approved standard will be replaced at the Contractor's own cost.
p) The Contractor shall appoint a specialist to install furniture pieces to the specified location. The Contractor is to provide details of their proposed sub-consultant for the installation of furniture to the Client's representative for approval prior to appointment.

6.7.4 Delivery, Storage, and Handling

a) All landscape elements, fixtures to be delivered on site in suitable packaging free from cracks, chippings or discolorations of the material.
b) Store materials on elevated platforms, under cover, and in a dry location. Do not use materials that have become damp.
c) Store all accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.
d) All materials shall be stored in a secure locked location and in accordance with Health and Safety Plan.

6.8 Landscape Elements

6.8.1 Handrail

a. Refer the relevant drawings & schedule for Handrail Details.

b. **Technical Specification**

- **Structural members** (Hollow box sections, Hollow circular section, Flat Plate used for railing frame structure, railing single post and vertical bars & handrail) of varying sizes given as per drawing should be in stainless steel and fabricated (For standards, Fabrication and Surface treatment of Stainless Steel refer section 5.5.8; consult structural consultant for technical advice & drawing for location and details).

c. Material – Stainless Steel / Refer the relevant drawings & schedules.

d. Finish – Non – directional SS brushed finish / Refer the relevant drawings & schedule

e. Fixing and connections: Under supervision of structural consultant. Finish and color to match adjacent material.

f. Installation: As per structural consultant and manufacturer's specification.

6.8.2 Tensile structure

a) Refer to the Relevant Drawings, Structural Drawings & Schedule.
b) Foundations, anchor bolts, base plates and structural supports shall be designed and certified by the Structural Consultant.
c) Tensile Structure Type: Pre-engineered tensile membrane structure complete with steel support framework, tensioning system, membrane fabric, connections and accessories.
d) Structure shall be designed to withstand applicable dead loads, wind loads, seismic loads and other design criteria as per relevant Indian Standards.
e) Manufacturer: Approved specialist tensile structure manufacturer or equivalent approved.
f) Contractor shall submit shop drawings, structural calculations, fabrication drawings, membrane specifications and installation methodology for approval prior to commencement.
g) Refer to Relevant Drawings & Schedule.
h) Supporting Structure: Hot-dip galvanized structural steel members comprising columns, rafters, edge beams, cables, brackets and connection assemblies as required.
i) Steel Grade: As per Structural Consultant's recommendations and approved structural drawings.
j) Membrane Material: PVC-coated polyester fabric / PTFE-coated fiberglass fabric / HDPE shade fabric as specified in drawings.
k) Fabric Weight: As per approved design and manufacturer's recommendations.
l) Fabric Colour: White / Off White / Beige / Grey or as indicated in Landscape Drawings.
m) Fabric Finish: UV-resistant, waterproof, fungal-resistant, dirt-resistant and self-cleaning where specified.
n) Tensile Cables: High-strength galvanized steel cables complete with turnbuckles, end fittings and tensioning devices.
o) Connections: Stainless steel or hot-dip galvanized fittings, bolts, nuts and accessories.
p) Fabrication: All steel members shall be factory fabricated and protected against corrosion prior to delivery to site.
q) Galvanizing: Minimum 80 micron hot-dip galvanized coating or as specified by the Structural Consultant.

r) Installation: Tensile membrane shall be installed strictly in accordance with approved shop drawings and manufacturer's recommendations.
s) Drainage: Structure shall be designed to prevent water ponding and facilitate efficient rainwater drainage.
t) Tolerances: Installed structure shall be plumb, level and free from wrinkles, sagging, distortions or visual defects.
u) Mock-Up/Sample: Contractor shall submit membrane samples, steel finish samples and connection details for approval prior to procurement.
v) Warranty: Minimum 10-year warranty for membrane fabric and 5-year warranty for fabrication and installation unless otherwise specified.
w) All materials shall be new, free from defects, and sourced from approved manufacturers.
x) Completed installation shall include all accessories, tensioning devices, flashings, fixings, anchors and ancillary components required for a complete operational system.

6.8.3 Pergola

a) Refer to the Relevant Drawings, Structural Drawings & Schedule.
b) Foundations, anchor bolts and supporting members shall be designed and certified by the Structural Consultant.
c) **Pergola Type:** Freestanding or attached pergola comprising structural columns, beams, rafters, purlins and associated fixing systems complete as shown on drawings.
d) Pergola shall be constructed from Powder-Coated Mild Steel, Hot-Dip Galvanized Steel, Aluminium, WPC, Hardwood Timber, or a combination thereof as specified in the drawings.
e) Manufacturer/Fabricator: Approved specialist pergola manufacturer or equivalent approved.
f) Contractor shall submit shop drawings, fabrication details, structural calculations, material samples and finish samples for approval prior to fabrication.
g) Refer to Relevant Drawings & Schedule.
h) Structural Frame: Hot-dip galvanized steel sections / aluminium sections as detailed in approved drawings.
i) Steel Grade: As per Structural Consultant's recommendations.
j) Timber/WPC Members: Exterior grade, weather-resistant, UV-stabilized and suitable for outdoor applications.
k) Finish:
Steel: Hot-dip galvanized and powder-coated.
Aluminium: Powder-coated finish.
Timber: Exterior-grade protective coating.
WPC: Factory-finished UV-resistant surface.
l) Colour: As indicated in Landscape Drawings and approved material palette.
m) Roof Members: Open rafters, decorative battens, louvers or WPC slats as indicated on drawings.
n) Fixings: Stainless steel grade SS304 or hot-dip galvanized bolts, screws, brackets and connectors.
o) Fabrication: All members shall be factory fabricated to approved dimensions and tolerances.
p) Galvanizing: Minimum 80 micron hot-dip galvanized coating for steel components unless otherwise specified.
q) Installation: Pergola shall be installed plumb, level and true to line, securely anchored to foundations.

r) Drainage: Any concealed drainage provisions, where applicable, shall be integrated within the structure.

s) Surface Finish: All exposed surfaces shall be smooth, free from sharp edges, burrs, cracks, dents and visible defects.

t) Tolerances:

Vertical Alignment: ±5 mm.

Horizontal Alignment: ±5 mm.

Level Tolerance: ±5 mm.

u) Mock-Up: Contractor shall submit material samples and, if requested, a prototype section for approval prior to commencement of works.

v) Warranty:

Powder Coating: Minimum 5 years.

WPC Components: Minimum 10 years.

Structural Fabrication: Minimum 5 years.

w) All materials shall be new, structurally sound, weather-resistant and suitable for exterior landscape applications.

x) Completed installation shall include all brackets, connectors, anchor bolts, fasteners, foundations, coatings and accessories necessary for a complete installation.

6.8.4 Railing

a. Refer the relevant drawings & schedule for Railing Details.

b. Technical Specification

- **Structural members** (Hollow box sections, Hollow circular section, Flat Plate used for railing frame structure, railing single post and vertical bars & handrail) of varying sizes given as per drawing should be in stainless steel and fabricated (For standards, Fabrication and Surface treatment of Stainless Steel refer section 5.5.8; consult structural consultant for technical advice & drawing for location and details).

c. Material – Stainless Steel / Refer the relevant drawings & schedules.

d. Finish – Non – directional SS brushed finish / Refer the relevant drawings & schedule

e. Fixing and connections: Under supervision of structural consultant. Finish and color to match adjacent material.

f. Installation: As per structural consultant and manufacturer's specification.

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OUTLINE SPECIFICATIONS

SOFT LANDSCAPE

SPECIFICATION DOCUMENT FOR LANDSCAPE

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1 PRELIMINARIES

1.1 Project Details

1.1.1 General Description

The project is located within GIFT City, a world-class smart urban development integrating commercial, residential, institutional, and public realm spaces. The landscape scope includes streetscapes, plazas, open spaces, pedestrian corridors, green networks, and associated site amenities. The proposed landscape development aims to create a connected, sustainable, and user-oriented public realm that enhances walkability, comfort, accessibility, and environmental quality. The design incorporates tree-lined streets, shaded pedestrian spaces, activity areas, and urban open spaces, contributing to the overall vision of GIFT City as a vibrant and globally recognized urban destination.

1.2 Purpose of the specification

The Softscape specification defines the requirements and gives guidance for implementation and maintenance of the soft landscape works.

1.3 Scope of the specification

The specification describes the general requirements for soft landscape elements in landscape works. The works under this section include but are not limited to the following:

- EARTHWORKS

  Ground works general, site clearing, supply & soil placement for all planting areas, fine grading, mounding, excavation of pits and erosion control;
- PLANTING

  Section includes plant procurement, delivery & storage, installation of plant materials, maintenance during execution, plant replacement, gap filling, pruning, tree staking operations, pest and weed control etc.
- POST-CONSTRUCTION

  Section includes maintenance during Defects Liability Period, Operations and Maintenance Manual and as-built drawings.

1.4 List of related documents

Specification to be read in conjunction with:

- Bills of Quantities as prepared by appointed Quantity Surveyor;
- Relevant Indian Standards as listed in Annexure.

Note: If work item is not included in Indian Standards, appointed contractor should refer to relevant international standard (BS or equivalent). This should be approved by Client's representative prior to commencing any works on site.

1.5 Terminology

In the Specification and other Documents forming part of the Contract, the following expressions and words shall, unless the context otherwise requires, have the meaning hereby respectively assigned to them:

"Approved" or "approval"	means approved by or approval of, the Client's Representative
"Submitted" or "submit"	means submitted to or submit to the Client's Representative in writing prior to commencing works
"Accepted" or acceptance"	means accepted by or acceptance of, the Client's Representative
"As shown on Drawings"	means all works required to conform with the intent shown on the landscape drawings whether or not specifically described in these documents/drawings but are necessary for the full and satisfactory completion of the Contract Works
"As required"	means as required to satisfactory standard match the description in the Specification and other Documents forming part of the Contract
"As directed"	means as directed by the Client's Representative

2 GENERAL LANDSCAPE REQUIREMENTS

2.1 General soft works requirements

2.1.1 Scope of works

(a) The work in this contract covers the supply, installation and maintenance of all soft landscape works. The scope of works of the Softscape Contractor covers all horticultural operations and services including labour, material, tools, equipment and transport necessary to complete and maintain the work as indicated on the drawings and in this specifications document.

(b) All works indicated in the Drawings by notes will be provided, whether mentioned in this specification. Any item not specified nor specifically shown in the drawings, but are normally required to conform to such intent, are considered part of the work and deemed to be included in this contract and their execution shall be covered by the contract price, in the same manner as if they have been expressly shown on the drawings and described in the specifications. In case of discrepancy, drawings will override the plant lists.

(c) As mentioned in sub section 2.1.3. The works shall be completed within the scheduled time and includes maintenance of the entire softscape works for one year after practical completion of the work, when certified by the Client's Representative in consultation with the Engineer-in-Charge.

(d) The Softscape Contractor will provide landscape planting in the areas shown in the Drawings with plants in a healthy and vigorous growing condition.

(e) The Contractor shall submit for approval, his proposed Work Programme based on the criteria of the overall programme showing the intended sequences, stages and order of proceeding with the works together with the period of time he has estimated for each stage of the progress.

(f) The Contractor shall complete the works within or by the date of completion as set forth in the Contract.

2.2 Adjustment to Scope

(a) The Engineer-in-Charge reserves the right to make field adjustment and reasonable substitution to ensure proper implementation of the landscape concept in relation to the field condition.
(b) If any material or installation specified is not available or achievable, the Contractor shall submit a written proposal to the Engineer-in-Charge within two (2) weeks of award of the contract. This request may present an alternative material or process which fulfils the same design intent, with the proposed adjustment to the contract price for each item due to the change.
(c) Substitution of plant materials is not permitted unless authorised in writing by the Engineer-in-Charge & Client.

2.3 Timelines

The Contractor shall complete the works within or by the date of completion as set forth in the Contract.

2.4 Defects & Maintenance

The Contractor shall undertake all responsibility for defects and maintenance of the landscape for a period of twelve (12) months from the date of practical completion.

2.5 Discrepancies

The Contractor to study the drawings at the time of the tender and notify Client's Representative of any discrepancy at the time of the tender submission.

2.6 Progress of work

(a) Progress of all the works related to Landscaping shall be in line with the Main Civil Contract works like roads, external drains, paving and all other works. All works are to be completed within the time schedule of the Main Contract or as agreed within the Landscape contract. All the works related to Landscaping shall be carried out in full co-ordination with Related Works Contractors and Relevant Authorities.
(b) The work front for Landscaping shall be provided in phases, and contractor needs to take up the work in the areas as and when they are made available.

Note: The general description of the works mentioned above is only for the guidance of the Contractor and any error or omission shall not constitute ground for claim by the Contractor. The onus for investigating and ensuring the actual extent and nature of the works comprised in this Contract prior to the submission of the quotation is solely with the Contractor. Any doubts should be clarified with the Client's Representative before the quotation is submitted. No claim arising out of lack of clarity or availability of information will be entertained. Allowance for any or all of these provisions shall be made in the quotation.

2.7 Quality standards and control

2.7.1 Products and execution

2.7.1.1 Incomplete Documentation

- Where and to an extent that products are not fully documented they should be of standard appropriate to the nature and character of that part of works where they will be used; suitable for the purpose of stated or reasonably to be inferred from the project documents;
- Omissions or errors in description or quantity shall not vitiate the Contract nor release the Contractor from any obligations or liabilities.

2.7.1.2 Installer Qualification and Skills

- A qualified landscape installer whose work has resulted in successful establishment of plants. Installers should be able to produce evidence of their qualifications when requested;
- Installer is required to maintain an experienced full-time Foreman on Project site;
- Installers should be appropriately skilled and experienced for the type and quality of work.
- Installers should be able to produce evidence of their qualifications when requested.

2.7.1.3 Products

- Samples are required prior to installation and approval of Engineer-in-Charge or Client's representative required. Entire quantity of all products and plant materials should be of consistent kind, size, quality and overall appearance;
- Where critical, measure enough to determine compliance;
- Deterioration should be prevented - products and plant materials should be ordered in suitable quantities to a programme and stored appropriately to be used in appropriate sequence.

2.7.1.4 Execution

- Generally, install all plant material level to the finished grades neatly and in specified alignment;
- Use plants of similar specifications within the same bed;
- Check on-site dimensions;
- Finished work should be free of defects e.g. no gaps in planting, trees and palms not upright or out of alignment.

2.7.1.5 Protection

- The Contractor shall exercise extreme care in the execution of his work; he will provide all necessary safeguards and exercise caution against injury or defacement of existing site. He will ensure that his works in no way shall adversely affect the work of others or adjoining properties.
- The Softscape Contractor will prevent vehicles of any kind from passing over sidewalks, curbs, etc., unless adequate protection is provided. If any damage to existing roads or kerbs is incurred, they shall be rectified and made good immediately by the contractor at his own cost.
- Pre-commencement photos of site will be required to be provided by the contractor.
- The Softscape Contractor is responsible for any damages resulting from landscape planting operations and will repair all damages and return the area to its previous condition at his own expense.

2.7.1.6 Compliance

- Contractor shall provide quality, size, genus, species, and variety of plants and sod as indicated on drawing, complying with applicable requirements as specified herein and drawing;
- Proprietary specifications should be followed;
- Evidence that the proprietary product specified has been supplied and used on site should be retained by Contractor;
- Selection of plants and sod purchased under allowances will be made by Client's Representative.
- If plants specified being not available, notify the Client's Representative with both available substitution and reasonable explanation for approval of Client's Representative. Refer sub point 2.1.1 for reference.

2.7.1.7 Inspection

- Notify Client's Representative in writing 2 days in advance when reasonable sections of the following stages are ready for inspection of the works compliance. Obtain confirmation from Client's Representative before proceeding to next stage. Inspections should be done minimum at the following stages:
    - Delivery of each shipment of plants to site
    - After Subsoil preparation, "Ripping"
    - After spreading and levelling of Soil Mix
    - After setting out of trees, planting beds and any additional features
    - After completion of tree planting pits
    - At the time of initial installation of trees
    - Tree staking mock-up.
    - After completion of all planting installation.
    - At ready for Practical Completion inspection.
    - At completion of every three-months of maintenance period.
    - Inspection or any other action must not be taken as approval unless confirmed in writing. Written statement should include:
    - Date of the inspection;
    - Part of the work inspected;
    - Characteristics which are approved;
    - Extent and purpose of the approval;
    - Any associated conditions.

2.7.1.8 Related or new work

- Provide the site installation team with all necessary details of the work;
- Before commencing new type/section of work ensure previous work is :
    - Appropriately complete;
    - In accordance with project documents and requirements;
    - To suitable standard;
    - In suitable condition to receive new work;
- Ensure all necessary preparatory work has been carried out.

2.7.1.8.1 Manufacturers recommendation/ Instructions

- Always comply with manufacturers printed recommendations and instructions current on the date of the invitation to tender;
- If there are any changes to recommendations or instructions – submit details to Engineer-in-Charge and Client's representative.

2.7.1.8.2 Soil test laboratory Qualifications

An independent laboratory, recognized by the Government of NCT and / or Government of India based on the geographical location of the site and approved by Client's Representative with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed. Results to be provided to Engineer-in-Charge and Client's representative prior to installation.

2.7.1.8.3 Soil Sampling and Analysis

- Take soil sample under the supervision of Client's Representative.
- One Composite Sample should be taken for every batch of volume agreed for each soil type to be used. Each composite sample should be made up of 10 No. sub-samples taken from evenly spaced locations across the field/stockpile. The sub-samples should be mixed together and quartered down to form a 1kg composite sample.
- The composite sample(s) should be placed in a clean plastic bag(s) and labelled with the source reference and date of sampling.
- Take sample of existing surface soil from at 200-300mm depth of existing sub grade at each major planting area as designated by Client's Representative;
- Report suitability of local soil material for plant growth.
- Take samples of Imported Planting Soil for every batch mixed. Mixing shall be performed either off-site or on-site at a designated area approved by Client's Representative
- Furnish soil analysis on the samples by a qualified soil-testing laboratory as stated here-in to the Client's Representative.
- The result should state percentages of organic matter, gradation of sand, silt, and clay content; cat ion exchange capacity; sodium absorption ratio; deleterious material; pH; heavy metals and plant-nutrient values N, P, K copper.
- Report recommended quantities of nitrogen, phosphorus, and potash nutrients and soil amendments to be added to Local soil material/imported soil to meet plant growth requirements as agreed with the Client's Representative.

2.7.2 Samples and approvals

2.7.2.1 General

Products or installations should comply with all specification requirements and in respect of the stated or implied characteristics to match a sample expressly approved as a standard for the purpose.

2.7.2.2 Approval of Products

- Submissions, samples, inspections and tests should be undertaken and arranged to suit the Works programme;
- Do not confirm orders or use the product until approval of the sample has been obtained.
- Approved sample should be documented and retained in good, clean condition on site. Remove when no longer required.

2.7.2.3 Approval for procurement

- Procurement plan should be submitted post tender stage. This will identify the procurement and delivery schedule for all plant material.
- All plant samples shall be approved by Client's Representative/Engineer-in-Charge (either at pre-arranged nursery visit prior to delivery or on site). As required, take photos and tag approved plants with waterproof label indicating their species, size, serial number and nursery source. Submit list of

approved plants together with photo taken to Client's Representative at least 7 days before delivery to site.

- Plant materials identified as specimen will be subject to inspection and approval by the Engineer-in-Charge at the place of growth and after it's delivery at site for conformance with the specification as stated in the Bill of Quantities. All plant materials not conforming to the specification will be rejected.
- Notify Client's Representative in writing 1 week in advance to arrange for any nursery visits. As the plants are ready to deliver in each shipment, notify the Client's Representative at least 7 days prior to the delivery on site.
- All plants supplied on site should be of same or similar specifications as the selected plant sample. No substitution to plant species or alternate specifications of plants shall be permitted. Plants that are not approved shall be replaced with properly conforming materials.
- Plant materials that are:
    - dead or dying and not in a vigorous thriving condition;
    - improperly installed;
    - infested with pests and/or showing signs of disease

will be replaced immediately with a healthy, vigorous thriving plant of the same species and size as originally planned.

2.7.2.4 Approval of Execution

- Submissions, samples, inspections and tests should be undertaken and arranged to suit the Works programme;
- Do not proceed with affected work until compliance with requirements is confirmed.

2.7.3 Work related to or around services

2.7.3.1 Compliance with regulations

- Any tree felling or transplanting operations should comply with the Bylaws and Regulations of the relevant statutory authority.
- Any relevant documentation required to start the work or at the completion to be submitted to relevant statutory authorities. This should be included in Detailed Programme of Work.

2.7.3.2 Co-ordination of Engineering services

- Prior to commencing extensive execution, the softscape contractor will ascertain the exact location of all underground utilities and other obstructions that may affect the work. Any services and obstruction encountered will be reported to the Engineer-in-Charge immediately.
- The Softscape Contractor shall exercise due care and precaution for works related to or around any existing or new services and repair all damages to any known services or other underground obstructions at his/her own expense, whether accidental or otherwise. The Softscape Contractor will report all damages to any services to the Client's Representative immediately.
- The contractor is responsible for coordinating with the respective agencies or other works' contractors working alongside, included but limited to electrical, hard landscape works, irrigation etc.
- Site organisation staff must include one or more persons with appropriate knowledge and experience of mechanical and electrical engineering services to ensure compatibility between engineering and the Works.

- Submit when requested CVs or other documentary evidence relating to the staff undertaking.

2.8 Health and safety

2.8.1 General

The safe completion of the works is a primary aim of the contract. All works should be executed in compliance with all applicable statutory requirements. Below listed are general requirements and items contractor should take care of and provide in respect to Health and Safety on site.

Contractor should always liaise with Client's Health and Safety Representative during pre-construction, construction and post construction/maintenance stage of work.

Client's Health and Safety Representatives' responsibilities include the following:

(a) Advise and assist the Client, Contractor and Consultants involved in project with their Health and Safety duties;
(b) Notify details of the project to respective Health and Safety authorities;
(c) Co-ordinate health and safety aspects of construction work and co-operate with others involved with the project;
(d) Facilitate good communication between the client, designers and contractors;
(e) Liaise with the principal contractor regarding ongoing work;
(f) Identify, collect and pass on pre-construction information;
(g) Prepare/update the health and safety file.

2.8.2 Pre-construction Health & Safety Information

(a) Health and Safety Plan to be submitted by Contractor to the Client/Client's Representative prior to commencement of works for written approval;
(b) Following items should be included as part of the plan:
- Method statements on how risks from hazards identified in pre-construction information and other hazards identified by the Contractor will be addressed;
- Details of management structure and responsibilities, with clearly stated point of contact in case of emergency;
- Arrangements for issuing health and safety directions;
- Selection procedures for ensuring competency of other contractors;
- Procedures for informing other contractors and employees of health and safety hazards;
- Procedures for communications between the project team, other contractors and site operatives;
- Arrangements for coordination and cooperation between contractors;
- Procedures for carrying out risk assessments and for managing and controlling the risks;
- Emergency procedures including those for fire prevention and escape;
- Arrangements for ensuring that all accidents, illness and dangerous occurrences are recorded;
- Arrangements for welfare facilities;
- Procedures for ensuring that all persons on site have all the required safety gear and have received relevant health and safety information and training;

- Arrangements for ensuring that all visitors to site receive the required safety gear and training prior to entering the site;
- Arrangements for consulting with and taking views of people on site;
- Arrangements for preparing site rules and drawing them to the attention of the those affected and ensuring their compliance;
- Monitoring procedures to ensure compliance with site rules, health and safety standards and statutory requirements.

(c) In addition, all statutory health and safety requirements should be included as part of the Health and Safety Plan.

2.9 Construction stage Health and Safety Information

2.9.1 Site Preparation – General

- All health and safety measures and procedures as stated in Health and Safety Plan should be followed during site preparation and subsequent works;
- Construction site should be fenced off from general public. No unauthorised access should be possible;
- Any fencing and barriers should be clearly visible during the day and night;
- If public pedestrian/vehicular roads are blocked due to construction works, alternative route should be provided and clearly labelled;
- Any excavated areas, particularly pits and deep excavation, should be fenced off and clearly identified.

2.9.2 General Execution Hazards

All common hazards during execution should be identified and controlled by good management and common practice.

2.9.3 General Product hazards

When dealing with hazardous substances site personnel levels must not exceed occupational exposure standards (upper limit on the acceptable concentration of a hazardous substance in workplace) and maximum exposure limits stated in the relevant local regulations.

2.9.4 Security

- Safeguard the site, the Works, products, materials, and any existing buildings affected by the Works from damage and theft.
- Take all reasonable precautions to prevent unauthorized access to the site, storage areas, site facilities, the Works and adjoining property.
- Liaise with Client's Health and Safety Representative.

2.9.5 Stability

Maintain the stability and structural integrity of the Works and adjacent structures during the Contract.

2.9.6 Occupational Premises

- Any existing buildings on or along the site will be occupied and/ or used during the Contract as follows need to be secured and provided an access if required;
- All works should be carried out without undue inconvenience and nuisance and without danger to occupants and users.

2.9.7 Communication

- Clear communication procedures should be established and followed as per Health and Safety Plan on daily basis.
- Health and Safety information should be provided across the site by clearly marked access points, emergency exits, medical points etc.

3 SITE MANAGEMENT

3.1 General

Prior to site handover to the Contractor for commencement of works, the Softscape Contractor should prepare and get written approvals of the Site Management Plan.

After the handover of the site to the Softscape Contractor, site preparation measures have to be taken up before the commencement of work.

3.1.1 Site Management Plan

- Plan to be prepared by Contractor and approved by the Client/Client's representative prior to handover of the site.
- Plan should be followed during Construction.
- Plan should comply with all relevant statutory regulations as well as Health and Safety requirements (as per 'B. General Requirements, Section 2.3. Health and Safety', of this Specification)
- Plan should include and detail the following items;
  - Detailed information on site preparation measures to be taken up before commencement of works as well as during the works and maintenance period;
  - Clear site arrangement layout for temporary structures, storage, water, electricity supply, vehicular circulation and parking areas etc.
  - Method statements on how site management will be carried out;
  - Details of management structure and responsibilities, with clearly stated points of contact;
  - Communication procedure within site team;
  - Procedures for informing other contractors and employees of site management issues;
  - Procedures for communications between the project team, other contractors and site operatives;
  - Procedures for keeping the records of site queries, obtained approvals, tests, any documentation that affects the site works etc.
  - Storage of the materials and equipment on site;
  - Any additional information required by statutory regulations.

3.2 Environmental Management Plan

3.2.1 Noise control

Comply with local regulations and minimise the noise level where possible.

3.2.2 Pollution

Protect the site, the Works and the general environment including the atmosphere, land, streams and waterways against pollution. If pollution occurs

inform immediately, including to the appropriate authorities and provide relevant information.

3.2.3 Nuisance

Prevent nuisance from smoke, dust, rubbish, vermin and other causes. Prevent hazardous build-up on site, in excavations and to surrounding areas and roads,
No dumping of material in the surrounding areas is permitted.

3.2.4 Asbestos containing materials

Report immediately any suspected materials discovered during execution of the Works. Agree methods for safe removal or encapsulation.

3.2.5 Fire prevention

Prevent personal injury or death and damage to the Works or other property from fire. Comply with local statutory fire regulations.

3.2.6 Burning on site

Burning on site not permitted.

3.2.7 Moisture

Prevent from wetness and dampness where this may cause damage to the works.

3.2.8 Contaminated materials

Where instructed to remove material affected by contamination from the site, minimize the risk of infecting other parts of the site.

3.2.8.1 Waste

Waste includes rubbish, debris, spoil, containers and surplus material. Keep site and works clean and tidy,
Remove waste frequently and dispose off site in a manner approved by Waste Regulation Authority and as per Waste Management Plan.

4 WATER CONSERVATION MEASURES

To minimize potable water consumption, improve irrigation efficiency, and promote sustainable landscape management practices in accordance with GIFT City sustainability objectives.

4.1 Use of Recycled Water

- Treated wastewater from the Sewage Treatment Plant (STP) shall be used as the primary source of irrigation water wherever available and approved by the relevant authorities.
- The quality of treated water shall comply with applicable standards for landscape irrigation and shall not adversely affect soil, plants, or irrigation infrastructure.

4.2 Efficient Irrigation Systems

- Drip irrigation systems shall be provided for trees, shrubs, hedges, groundcovers, and planter areas to ensure efficient water application directly to the root zone.

- Sprinkler irrigation shall be limited to lawn areas and shall utilize high-efficiency sprinkler heads with uniform distribution characteristics.
- Irrigation systems shall be designed to minimize water loss through evaporation, runoff, and overspray.

4.3 Hydro zoning

- Plant species shall be grouped according to their water requirements to create hydrazones.
- High, moderate, and low water-demand species shall be irrigated through separate irrigation zones to optimize water use efficiency.
- Native and drought-tolerant species shall be prioritized in low-water-use zones.

4.4 Automatic Irrigation Controls

- Irrigation systems shall be equipped with automatic controllers capable of scheduling irrigation based on seasonal requirements.
- Controllers shall allow adjustment of irrigation frequency and duration for individual hydrazones.

4.5 Soil Moisture Monitoring

- Soil moisture sensors and/or rain sensors shall be integrated into the irrigation system where specified.
- Irrigation shall be automatically adjusted or suspended during adequate soil moisture conditions or rainfall events.

4.6 Mulching

- Organic mulch shall be applied around trees, shrubs, and planting beds at a minimum thickness of 75 mm unless otherwise specified.
- Mulch shall be maintained throughout the maintenance period to reduce evaporation, suppress weeds, and improve soil moisture retention.

4.7 Water Use Management

- The Contractor shall regularly inspect the irrigation system for leaks, malfunctioning equipment, and inefficient water application.
- Any defects identified shall be rectified immediately to prevent water wastage.

5 CLIMATE RESILIENT LANDSCAPING

To enhance the resilience of the landscape against climate change impacts, reduce urban heat island effects, improve biodiversity, and ensure long-term sustainability of the landscape environment.

5.1 Plant Selection

- Plant species shall be selected based on their suitability to local climatic conditions, soil characteristics, and long-term maintenance requirements.

- Preference shall be given to native, adaptive, and drought-tolerant species that demonstrate high survival rates under regional climatic conditions.

5.2 Reduction of High-Water Demand Species

- Species requiring excessive irrigation, intensive maintenance, or significant chemical inputs shall be minimized.
- Water-intensive seasonal planting shall be limited to designated feature areas only.

5.3 Urban Heat Island Mitigation

- Landscape design shall maximize tree canopy coverage and vegetative shading to reduce surface and ambient temperatures.
- Trees shall be strategically located along pedestrian routes, plazas, parking areas, streetscapes, and open spaces to improve thermal comfort.

5.4 Tree Canopy Enhancement

- Landscape works shall aim to achieve a minimum tree canopy cover of 30–40% within open landscape areas wherever site conditions permit.
- Tree species shall be selected to provide broad canopy spread, effective shading, and long-term environmental benefits.

5.5 Soil Health and Carbon Sequestration

- Organic soil amendments and compost shall be incorporated into planting soils to improve soil fertility, water retention, and carbon storage capacity.
- Soil disturbance shall be minimized wherever practical.

5.6 Biodiversity Enhancement

- Planting schemes shall promote ecological diversity through the use of varied tree, shrub, groundcover, and flowering species.
- Habitat-supporting species beneficial to pollinators, birds, and local biodiversity shall be encouraged where appropriate.

5.7 Resilience to Extreme Weather

- Plant species shall be capable of tolerating periods of high temperature, drought, intense rainfall, and wind conditions typical of the project region.
- Planting layouts shall consider long-term climate adaptability and future environmental conditions.

5.8 Sustainable Landscape Management

- Maintenance practices shall support resource conservation, reduced chemical dependency, and long-term plant health.
- Integrated Pest Management (IPM) principles shall be adopted wherever feasible.

6 PRESERVATION OF EXISTING FEATIRES, VEGETATION & SERVICES

6.1 Existing topsoil and subsoil

(a) Prevent over compaction of existing topsoil and subsoil in those areas which may be damaged by construction traffic, parking of vehicles, temporary site accommodation or storage of materials and which will require reinstatement prior to completion of the Works. Before starting work submit proposals for protective measures.

(b) Stripping Topsoil

- Before beginning general excavation or filling, Contractor shall strip topsoil from areas where there will be working;
- Topsoil shall be removed to an average depth of 300mm, if the depth of topsoil is difficult to determine Contractor shall give notice to Client's Representative;
- Stripped topsoil may be reused immediately after stripping or stockpiled in the on-site topsoil dump as directed by the Client's Representative for later use;
- **Location of stockpile:** To be agreed - topsoil shall be stored in an area of the site where it should not interfere with other site operations so that it can be left undisturbed during the construction process.
- **Site Clearance:** The area that is to be used for storing the topsoil shall be cleared of vegetation and any waste arising from the development e.g. building rubble and fill materials.
- **Protection:**
  - Topsoil not to be mixed with subsoil, stone, granular aggregate, rubbish or material from demolition, other soil or materials containing aggressive weeds or non-soil forming materials, oil, fuel cement or other substances harmful to plant growth.
  - Do not place any other material on top of storage heaps.
  - Do not allow construction plant to pass over storage heaps.
  - Prevent compaction and contamination, by fencing and covering as appropriate.

- **Height:**
  - If the topsoil is reasonably dry and friable, the topsoil shall be heaped to a maximum height of 3m. Compaction of the surface to be done.
  - If the topsoil is moist and plastic, the topsoil shall then be heaped up further to a maximum height of 2m. No further compaction required.
- Stock-piled topsoil should be planted with rough grasses etc. to limit erosion of soil if left for a period of more than two weeks.

6.2 Preservation of trees – General notes

(a) No existing trees should be cut/pruned without written permission of Client representative/PM;
(b) All works shall be carried out in coordination with experienced horticulturalist;
(c) All works to trees shall be in accordance with relevant Indian standards;

6.3 Guidelines for trees to be removed

(a) Any existing trees identified as "to be removed" or any dead trees:

- Contractor shall cut and fell, as close to the ground as possible;
- Trunks to be cut to convenient lengths;
- Root stumps shall be removed to a minimum depth of 800mm below ground level;
- Any debris or material that comes from the above works shall be utilised in accordance with Waste Management Plan.

(b) All works shall follow Health and Safety procedures.

6.4 Guidelines for trees to be retained

(a) Trees identified as “to be retained”:
(b) All retained trees should be clearly identified and information signs should be displayed on site in prominent positions at each entrance;
(c) All retained trees shall be marked by visible, durable tags, lettered to tree number or symbol (if any) on the drawings.
(d) Trees should be fenced off the works area if possible, in all cases tree trunk and roots should be protected from site works;
(e) Protected area should be in a shape of a circle around each tree with radius of half the tree's height, measured from tree trunk.
(f) Do not allow soil compaction to occur under the tree;
(g) Do not store any materials or site equipment under or near the trees.
(h) Do not allow for any vehicles to be parked near retained trees or to pass under the trees;
(i) Prevent damage to tree bark, do not attach any items to trees.
(j) Do not expose tree roots;
(k) When works under the tree:

- Do not fill against tree trunks even temporarily;
- Open excavation under tree canopy should be carried for as short period as possible. If exposing roots is necessary, temporarily line with polyethylene sheet to reduce evaporation;
- Use only hand methods to locate, expose, and cleanly remove the soil around roots on the line of excavation. Root systems should be preserved intact.
- When it is necessary to cut the roots bigger than 25mm diameter, make sure the cutting does not disturb remaining root system. Cut should be smooth with no ragged edges. Cut surface should be immediately treated with bituminous fungicidal sealant.

6.5 Guidelines for transplantation of matured trees

(a) Transplanting is the process of bodily lifting of mature and large plants from their position to a new position.
(b) The contractor should appoint specialised person for the relocation of existing trees. He shall have minimum 10 years’ experience in relocation of existing plant materials and be recognized by IS standards.
(c) Protect existing trees to remain during construction phases as mentioned in 2.5.4. Provide tree protection barriers for those existing trees adjacent to tree transplantation operations. Any trees scarred or destroyed, designated to remain, will be replaced at the Contractor's expense, with similar species, size, and quality.
(d) Remove other vegetation as necessary and as directed by the consultant to accommodate new plantings as mentioned in 2.5.3.
(e) Prepare areas to be planted according to relevant drawings and documents submitted
(f) Best time for Transplantation:

Transplanting is done when there is enough moisture in the soil. Hence, monsoon is the right time as there is enough moisture in the soil. This may vary based on the local site condition and specific plant species requirement.

(g) Relocated site selection criteria:

- Select location and orientation where light, moisture, soil pH, and wind exposure are appropriate for the species;
- Consider size of tree for root and crown development and then choose the site.
- Soil test should be performed to check soil drainage quality.
- Resulting tree pits of relocated material shall be backfilled with clean fill and brought back flush with surrounding grade, unless the pits are to be immediately replanted. Stabilize grade if required. Correct problems caused by erosion, wind, etc., in the reclaimed area.

(h) Quality Assurance

- Tree transplantation should be done with supervision of well experienced Horticulturalist recommendation and guidelines.
- Pruning and removal of branches from tress should be done under supervision of specialist and following recommendations.
- Recommend procedures to compensate for loss of roots (if any) and perform initial pruning of branches and stimulation of root growth were removed to accommodate new construction.
- Evaluate existing trees and verify trees are free of disease and ready to survive relocation from the site to their new location on-site or off-site.
- Protect tree crowns with shade cloth to prevent desiccation and wind burn. Crowns shall be periodically sprayed with water to help ensure against desiccation.
- Provide routine progress evaluation reports on relocated trees until the end of the maintenance period.
- Cost shall be based on actual replacement value assessed by Client/PMC and approved schedule of rates.

(i) Delivery, Storage and Handling

- Properly handle trees and palms during moving so trunks will not be scarred or damaged and to avoid broken limbs. Broken limbs not causing the tree to be rejected shall be repaired as follows:
  - Properly prune dead, dying, or damaged branches with clean, sharp equipment.
  - Remove injured bark and wood of a tree would with a clean, sharp knife to a point where healthy bark and wood make contact at their margins. Inspect and treat wound for insect and disease.
  - Seal wounds with bituminous base wound paint for all oak limbs greater than 3-inch diameter.
- Transport trees on vehicles of adequate size to prevent overcrowding, broken limbs, foliage damage, or root ball damage.
- Keep root balls moist during relocation.
- Handle plant material only in ways and means accepted by the landscaping industry and accepted by governing and updated standards.
- Plant material shall be planted the same day it is dug. Coordinate preparation of planting pits or beds to ensure this schedule.

(j) Maintenance

- If rainfall is inadequate, the soil around the plant's roots should be deeply watered approximately every 2 - 3 days post installation.
- Maintain relocated plant materials immediately after each item is planted and continued until the 90-day watering period is completed, upon which time the

client will take over maintenance of materials following procedures and recommendations of contractor and specifications.

- For relocated trees or palms that die, contractor has to replace their canopy area with new trees as specified in Planting list or document.
- Replacements shall be provided at no additional cost to the client.
- Cost shall be based on actual replacement value assessed by Client/PMC and approved schedule of rates.

(k) Execution

- Digging, Wrapping, and Handling: Plants shall be dug and prepared for moving in a manner that will not cause damage to branches, shape, root system, and development.
- **Balled and Bur lapped Plants:**
  - Balls shall be firmly wrapped with burlap or accepted cloth substitute.
  - No bald plant will be acceptable if the ball is cracked and broken or if the stem or trunk is loose in the ball, either before or during transplanting.
  - Bald plants shall be lifted and handled from the bottom of the ball.
  - Protect ball and deliver to the site, plant immediately, and water thoroughly.
  - Ball sizes shall be as recommended in standards.
  - Bur lapping is required. Trees that are bur lapped for relocation shall comply and be handled in same manner as new plant material as specified by specialist.

(l) **Precautions before relocation**

- **Watering**
  - Following transplantation, water trees daily for the first two weeks, every other day for the next three weeks, and every third day for the balance of the three-month watering/maintenance period. Such watering shall thoroughly saturate the root ball to its full depth.
- **Root Preparation**
  - Trees to be relocated shall be root pruned at least 45 days before digging with clean, sharp equipment.
  - Maintain root pruned materials by watering, weeding, mowing, spraying, fertilizing, and other horticulture practices.
  - After root pruning, backfill with good rooting medium, fertilize with organic fertilizer to promote root growth.
  - Mulch tree pits to reduce weeds, discourage foot traffic, conserve moisture, and minimize temperature fluctuation.
  - Feed with a diluted solution of N-P-K in solution form
- **Crown preparation**
  - Shade and flowering trees: Selectively prune and thin crown to remove approximately one third of the branches. Preserve the basic shape and form of the tree, eliminate cross-branching and dead or diseased branches.
  - Palms: Follow standard procedure for transplantation of palms.
- **On-site relocation**
  - On-site relocation shall include root pruning, canopy pruning, on-site transportation, hauling and dumping of debris, and 90-day maintenance.
  - If the tree or palm dies within the 90-day maintenance period, remove the tree, replace the material, and restore the site at no additional cost to the Board.

7 SPECIFIC LANDSCAPE REQUIREMENTS

7.1 Site preparation

Prior to the start of any construction works on site, the Contractor should make sure that the below listed items have been executed.

7.1.1 Site survey

(a) Prior to commencing the works Contractor shall carry out own survey and inform the Client's Representative/Engineer-in-Charge of any discrepancies with the Construction Drawings.
(b) Site survey shall be carried out by skilled and experienced team for the type of work.
(c) If any unforeseen/unrecorded hazards or items have been discovered Contractor shall give notice to the PMC/Client's Representative. No works shall be carried out until the issue has been resolved.

7.1.2 Site Investigation

(a) General

- Contractor shall be solely responsible for obtaining all the information on the nature of the site and sub-surface soil conditions for the purpose of preparing tender and the subsequent execution of the contract.
- Site investigation shall provide data to allow Contractor to proceed with works.
- Extent of the investigation shall be determined by the PMC/Client's Representative and the Contractor.
- Site investigation shall include:
  - Establish records of mean water table;
  - Identify all previous known uses of the site;
  - Identify site features to be preserved;
  - Identify areas of limited access, incomplete work by others or any other issues which may hamper the execution of the works;
  - Locate and identify all known land and water contaminants;
  - Locate and identify soil types to a depth of 4.0m below existing ground level;
  - Recommendations for further investigations.

(b) Public and Safety

- During any investigation works on site, the area investigated shall be secured and public access shall be limited;
- Erect temporary fences, footpaths, warning lights etc. Before starting the investigation.
- Area of any investigation shall be kept clean and protected from ground and surface waters.

(c) Field test General

Each test shall be recorded and following data shall be provided:

- Project name and reference;
- Date and time of test;
- Weather conditions;
- Soil types and description;
- Location and detail of the sample;

- Site photograph
- If any feature should be encountered, provide description and depth of:
  - Changes in soil strata,
  - Drains,
  - Foundations/structures;
  - Hard strata;
  - Services

(d) Samples and Analysis

- Refer section 2.2.1 (j) and 2.2.1 (k) for procedure and analysis

(e) Final Report

Final site investigation report should include:

- All known land and water contaminants;
- Identify all previously known uses of the site;
- Locate and identify soil types to a depth of the 4.0m below existing gorund level
- Mean water table;
- Recommendations for further investigation;
- Features to be included:
- All above and below ground features;
- All underground services;
- Topography

7.2 Demolition and Site Clearance

7.2.1 General

(a) The Softscape Contractor will clear all planting areas of existing vegetation not specified to remain and all other debris and foreign materials considered a hindrance to the planting operation and/or unsightly in appearance.
(b) The Softscape Contractor will maintain previously established grades and swales.
(c) The Main Contractor will be responsible for cleaning the planting areas after completion of civil and other works in that area and turning them over to the Softscape Contractor suitable for planting. It is to the responsibility of the Softscape Contractor to ensure that this is done. Failing this, clean-up will be the responsibility of the Softscape Contractor.
(d) The Softscape Contractor will arrange to have all cleared materials moved to areas on site as directed by the Main Contractor.

7.3 Earthwork and Grading

7.3.1 General

(a) The section refers to excavation, grading and filling of soil across the site as part of the works.
(b) Contractor should carry out own survey to identify levels and services, prior to start of works.
(c) If significant variations in site levels or ground water levels in compare to site investigation report or Drawings, Contractor shall notify Client Representative.

7.3.2 Setting out

(a) Before start of excavation works Contractor shall carry out setting out works;
(b) Contractor will be fully responsible for establishing and locating at site all grid lines, base lines, levels and limits for project;
(c) Qualified surveyor should be engaged to prepare the above works;
(d) All setting out information established by Contractor on site should conform accurately with information in the Drawings. Position of individual plants and outlines of all planting areas shall be staked and set out according to the Drawings.
(e) The Engineer-in-Charge will approve all planting areas and locations prior to any excavation of planting pits, trenches or beds;
(f) In the event that site conditions necessitate relocation of planting areas or locations, due to subsurface utilities, pipes, structures, impervious materials or inadequate drainage, the Engineer-in-Charge will designate new locations;
(g) Prior to start of further works, Contractor should do a Quality check and any errors/non-compliance with Drawings should be highlighted to the Client's Representative. If the setting out will be a cause of errors in further execution of works, Contractor should seek clarification from the Client's Representative. Any works done which cause obstruction to future works, without approval from the Client's Representative, shall be demolished and reconstructed at the expense of the Contractor;
(h) The Contractor shall follow the datum set out by the Main Civil Works Contractor. He shall be responsible for providing, maintaining and safeguarding the position and levels of all survey pillars/pegs and benchmarks existing on site or added;
(i) Contractor shall maintain sufficient number of pillars/pegs for checking/monitoring of the works for the entire duration of the project.

7.3.3 Excavation

(a) General

- All excavation works shall be in accordance with relevant local standards;
- The work shall include the hauling and satisfactory disposal of surplus excavated or deleterious material;
- Notify Client's Representative if unexpected rock, hardpan or obstructions detrimental to trees or shrubs are encountered in excavations.
- Hardpan Layer: Drill 150-mm diameter holes, 600 mm apart, into free-draining strata or to a depth of 10 feet (3 m), whichever is less, and backfill with free-draining material.
- If excavating next to existing features (metro pillars, ramps, services, trees etc.) Contractor to ensure all health and safety procedures are strictly followed to avoid disturbance of foundations, tree roots etc.;
- Protect, structures, utilities, sidewalks, pavements and other facilities and lawns and existing plants from damage caused by settlement, lateral movement, washout and other hazards crated by Excavation Works;
- Provide erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways;
- All excavation shall be carried out by mechanical equipment, unless specified otherwise by Client's representative. Contractor can suggest alternative methodology for Client's Representative approval. However any consequent loss or damage will be still under Contractor's liability;
- Remove any rubbish or debris from the planting surfaces. Grades, which have been established, shall be maintained in a true and even condition;
- Maintenance shall include any necessary repairs to previous graded areas;

- Remove obstructions, debris, rubbish, rocks greater than 100mm in diameter, trees, shrubs, grass, and other vegetation to permit installation of soil layers during the Filling works;
- Side slopes shall be as steep as will withstand safely for actual site conditions encountered for planting beds;
- The following actions need to be followed during this process:
  - Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
  - Cut minor roots and branches of trees indicated to remain in a clean and careful manner where such roots and branches obstruct installation of new construction. Ensure adequate protection is provided to any exposed roots.
  - Grind stumps and remove roots, obstructions, and debris extending to a depth of 800 mm below exposed sub-grade.
  - Chip removed tree branches and stockpile or dispose in areas approved by Client's Representative.
  - The type of soil to be excavated for pits will cover all soil types such as soft soil, hard murrum and soft rock as is incident on site.

7.3.4 Preservation of existing topsoil

(a) Stripping topsoil

Refer section 2.5.1 (a) and (b) for details.

(b) Disposal Materials

- Surplus subsoil to be stockpiled in temporary storage heaps or spread and level on site as per Contractor's proposal. Protection from wind and disturbance shall be provided.
- Never rise soil levels within root spread and above the root flare of existing trees that are to be retained.

(c) Inspections

Contractor to give 2 days' notice for inspections of excavated areas and tree/palm pits.

(d) Sizes and Depth

- **Pits and Trenches:** Excavate square or circular pits for trees and palms, and circular pits for large shrubs, with side slopes vertical. Where impractical to do so due to non-cohesive nature of the soil, they shall be so excavated as to provide not less than the specified plan size at the bottom of the excavation. Trim base leaving central area slightly raised to support root ball and assist in drainage. Break base to 100mm depth. Scarify sides of plant pit smeared or smoothed during excavation.
- Fill excavations with water and allow percolating away before positioning trees and shrubs.
- Pest control treatment to be done as required in pits before planting, with approval of Client's Representative.

(a) The minimum size of tree & shrub pits and planting beds shall be as follows:

- Trees/ Palms: 1.2m x 1.2m x 1.0m or as specified in the Drawings.
- Large Shrubs: 0.6m x 0.6m x 0.6m
- Shrub beds: 0.6m depth x area as per Drawings
- Ground cover beds: 0.3m depth x area as per Drawings
- Turf areas: 0.3m depth x area as per Drawings

7.3.5 Grading & Filling

(a) General

- The work shall consist of grading, contouring, smoothing or otherwise shaping areas beyond the planting beds and lawns at the locations shown on the drawings, including earth mounds.
- Roadway shoulders and soil areas left exposed after planting shall be graded as required to leave a generally smooth appearance conforming to the general shape and cross section indicated on the drawings. The final surfaces shall be raked. All objectionable material, trash, brush, weeds and stones larger than 2 inches/ 50 mm in diameter shall be removed from the site and disposed of in an approved manner.
- Make up any deficiency of existing sub-grade level on site with approved backfill to achieve required sub-grade levels.
- Landscape levels will be tied to existing conditions such as existing trees, palms, landscape features, utility lines, pavement and kerbs, etc. Finished grades will bear proper relationship to such control. The Contractor will adjust all works as necessary to meet the conditions and fulfill the intention of the Drawings.
- For areas below earth mounds, cultivate the ground by ripping to a depth of 200mm before mound formation.
- All grades shall provide for natural run off of water without low spots or pockets, flow lines shall be accurately set and shall not be less than 2% gradient, unless otherwise noted. Grades will be smooth and even on a uniform plane without abrupt changes or pockets and slope it away from all buildings.
- The Contractor will verify the surface drainage of all planting areas and notify the Client's Representative of any discrepancies, obstructions, or other conditions considered detrimental to proper execution of the work and plant growth. The Contractor will adjust finished grading with screened soil as necessary.

(b) Ripping

- Light and non-cohesive sub-grade: When ground conditions are reasonably dry, rip sub-grade thoroughly to a minimum depth of 300 mm.
- Stiff clay and cohesive sub-grade: When ground conditions are reasonably dry, rip sub-grade thoroughly to a minimum depth of 450 mm.
- Remove stones larger than 25mm in any dimension and sticks, roots, rubbish, weeds and other extraneous matter harmful to plants growth and legally dispose of them outside the Project Site.
- Roughly grade to form free flowing contour without humps and water retaining hollows. Operate along with contour when on slope area to avoid significant alteration of formed sub grade level.
- **Ripping on slope:**
  - Sub-grade at slope between 15 and 27 degree (2:1) shall be ripped parallel to the contour lines of existing sub grade.
  - Sloped sub-grade exceeding 27 degree (2:1) shall not be ripped.

(c) Mixing

- Thoroughly blend top soil/ imported sub-standard planting soil applied with the recommended soil amendments and fertilizers to form General Planting Soil Mix. Mixing to be done at approved site area as approved by Client's Representative, before spreading on surface of specific planting area.
- Delay mixing fertilizer with planting soil if planting will not proceed within a few days.

(d) Filling

- Planting pits and beds shall be filled carefully to fill all voids and to avoid breaking or bruising roots. Pack backfill firm to prevent settlement. When pit or bed is nearly filled, water thoroughly and allow water to soak away. If settling of the fill occurs after watering, add more fill to bring to level.
- Sloped surfaces steeper than 1 vertical to 4 horizontal should be ploughed, scarified, or broken up sloped so fill material will bond with existing material.
- Spread specified Planting Soil Mix corresponding to planting types and as indicated in the Drawings to meet finish grades after natural settlement. Place and compact fill material in layers as follows:
  - Under planted areas, place specified soil material;
  - Over Drainage Cells place specified soil material;
  - In raised planter areas place specified soil material.
- Do not spread if planting soil or sub-grade is muddy, or excessively wet.
  - Spread approximately one-half the thickness of planting soil mix over loosened sub-grade. Compact the layer reasonably. Spread remainder of planting soil mix.
  - Do not mix or spread specified Planting Soil Mix until sample from each blended batch has analysed, reported and is submitted and approved by Client's Representative.
  - Cover and temporarily store prepared plant mix on site area designated by Client's Representative during the period of soil testing; Take measure to prevent degradation, fermentation, puddling and pest of the soil during the period.

(e) Finished Grading

- Grade planting beds to a smooth, uniform surface plane with loose, uniformly fine texture. Water the plant bed thoroughly and allow settlement of planting soil mix. Finishing level and finished contouring profile as indicated on the drawings.
- Unless otherwise specified, finishing grade for planting areas shall be:
  - Planting bed 50mm below hard finish level
  - Lawn area 25mm below hard finish level
  - Raised planters 100mm below adjoining hard finish level
  - Adjoining soil areas Merge
- Before planting, restore planting beds if eroded or otherwise disturbed after finished grading.

(f) Tolerance

The tolerance of the fill level or those on slope shall not be more than 75mm from the proposed level. The same tolerance shall be applicable to the limits and lines of cut and fill. All levels are those applicable at the end of the Defects Liability Period. The Contractor should therefore make the necessary allowance for consolidation, settlement and any other losses and to include all expenses for this in his quoted rates.

(g) Preparation of Turf

- Check and ensure drainage of lawn area is in place and working properly; report to Client's Representative if any irregularity is spotted.
- Fill the planting bed with the Soil Mix to the required depths as per drawings and meet Final Grade as indicated on drawing.

- Level the soil in gradient as indicated and tread or roll to firm up soil to prevent any settling of soil mass but without compaction; never firm up soil when it is wet.
- Rip through the Top soil to remove impurity, materials harmful to plant growth, stones over 25mm in diameter and to form a fine tilth. If carpet or seeding is not installed on the same day, rake the area again just before sod is laid.
- Protect the prepared plant bed from soil erosion or soil compaction if carpet is not installed on the same day of preparation works.

7.4 SPECIFIC TREATMENT OF PITS/ BEDS

7.4.1 Pre-Planting Weed Control

- The Softscape Contractor will remove all visible weeds before any soil placement.
- Herbicides and weedicides are not allowed.

7.4.2 Anti-termite Treatment

(a) Any of the following chemicals (conforming to relevant Indian Standards) in water emulsion shall be applied by pressure pumps, uniformly over the area treated:

Sl. No.	Chemical	Relevant Indian Standard	Concentration by Mass, Percent (Active Ingredient)	Dosage
i)	Chlorpyrifos 20% EC	IS 8944	1.0%	250 ml in 5 litre water50 ml in 1 litre water
ii)	Imidacloprid 30.50% SC	IS 16131	0.075%	10.5 ml in 5 litre water2.1 ml in 1 litre water
iii)	Bifenthrin 2.5% EC	See Note 3	0.05%	100 ml in 5 litre water20 ml in 1 litre water

Source: IS 6313 (Part 3): 2022, clause 4.1.1- soil treatment

(b) The method of application and the stages it will be applied shall be submitted for approval and this shall conform to relevant IS codes.

(c) All works related to application of the Chemicals shall strictly follow Health and Safety procedures;

(d) No work shall be carried out under unsuitable weather conditions, these include:
- Rain or when the soil is wet due to rain or sub-soil water;
- Strong winds;
- Heat waves.

(e) Chemicals shall be brought to the site of work in sealed original containers. The materials shall be brought in at a time, in adequate quantity to suffice for the work. The material shall be kept in cool and locked stores. The empties shall not be removed from the work site till the relevant item of work has been completed and permission granted by the Client's Representative.

(f) Chemicals available in concentrated forms with concentration indicated on the sealed containers shall only be used. Chemicals shall be diluted with water in the desired quantity before use, using graduated containers to achieve the desired percentage of concentration.

(g) Hand operated pressure pump with graduated containers shall be used to ensure uniform spraying and to facilitate proper penetration of the chemical. Continuous check shall be kept to ensure that the specified quantity of chemicals is used for the required area during the operation.

(h) The treated soil barriers shall not be disturbed after they are formed. If by chance, treated soil barriers are disturbed, immediate steps shall be taken to restore the continuity and completeness of the barrier system.

7.5 Soils

7.5.1 Soil materials

7.5.1.1 Local Soil Material

- **Availability:** Topsoil to be used for planting mixes is to be transported from the on-site topsoil dump. The location of the top-soil dump will be provided by the Client's Representative.
- **Composition:** Topsoil obtained shall generally be reasonably loose and friable in form containing not more than 10-15% of moisture content. Client's Representative will reject topsoil delivered in a wet and soggy condition. Where required, the Topsoil may be used as sub soil as well.
- **Uses:** Topsoil from on-site dump is to be improved by addition of soil nutrients to comply to form the Soil Mix.
- **Testing:** Planting Soil shall be tested for N.P.K. value, organic matter content, Cation Exchange Capacity ratio, organic carbon, pH value, Electrical Conductivity (EC), Sodium Adsorption Ratio (SAR), Boron, Chlorides, physical content of sand, silt and clay and water content. Soil testing shall be arranged by the Contractor and carried out by an approved reputable firm or institute at Contractor's cost, and the Report shall be submitted to the Client's Representative for approval.

7.5.2 Imported Subsoil

The imported sub-soil shall be evenly textured local soil as per specifications, that meet the following as minimum requirements:

- pH range of 6.0 to 7.5
- Free of grass or weed growth of any kind, sticky clays, or stones 100 mm or larger in any dimension and extraneous materials harmful to plant growth
- Total percentage of stones should be less than 30% in volume
- Salinity range of 2.0 – 4.0 ECe (dS/m)

7.5.3 Imported Planting Soil

- **Availability**: Planting Soil is prepared off-site for on-site use. The Contractor has to ensure that the prepared soil is mixed as per the requirements for planting mixes specified in this Specification.
- **Composition:** Imported Planting Soil shall be evenly textured, fertile, dark brown or black coloured medium loam free from weeds, deleterious matter and stones larger than 25mm in any dimension and shall not be excessively sandy, gritty or waterlogged.
- **Uses:** Imported Planting Soil may need to be amended per the specification here-in to produce specialty Planting soil Mixes for Palms, seasonals and lawn areas, upon approval of the Client's Representative.
- **Testing:** Imported Planting Soil shall be tested for N.P.K. value, organic matter content, Cation Exchange Capacity ratio, organic carbon, pH value, physical content of sand, silt and clay and water content. Soil testing shall be arranged by the Contractor and carried out by an approved reputable firm or institute at

Contractor's cost, and the Report shall be submitted to the Client's Representative for approval. The soil analysis report shall be submitted to the Client's Representative at least 6 weeks in advance of the programme date for the start of filling operations. Upon approval by the Project Manager the Contractor would be able to prepare the soil stock mix.

- Imported Planting Soil for General Planting Soil purposes shall comply with the following minimums:

pH value	: 5.5 – 7.5
% Organic Matter	: not less than 7.5%
% Organic Carbon	: 2.0 – 3.0
% Total Nitrogen	: 0.09 – 0.15
Carbon / Nitrogen ratio	: 25:1 – 45:1
Available P2O5	:7mg/100 – 10mg/100g
Exchangeable K2O	:15mg/100g – 30mg/100g
Cation Exchange Capacity	: 16 – 20 m.e. %
Soil Texture	: Sandy loam preferable

- **Source:** The Contractor should submit details of the source of Imported Planting Soil to the Client's Representative. No change in the source of Imported planting Soil shall be allowed at a later date without the prior approval of the Client's Representative based on such tests and samples as specified here-in.

7.5.4 Soil amendments

7.5.4.1 Inorganic Soil Amendments

- **Charcoal:** Horticultural charcoal, size not more than 10mm.
- **River Sand:** Clean, washed, natural or manufactured quartz sand, free of toxic materials, brick and other building materials and wastes, plant matter, roots of perennial weeds and any other foreign matter or material or substance that would render the sand unsuitable for use.

7.5.4.2 Fertilizers

N-P-K 15:15:15 chemical fertilizer as per approval and as recommended by soil analysis. Will be uniformed in composition, free flowing and suitable for application with approved equipment. It will be delivered to the site in un-opened containers, each fully labelled and conforming to the applicable fertilizer laws. It will bear the name or mark of the manufacturer.

7.5.4.3 Organic Compost

Farm yard manure (FYM): Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 13mm sieve; soluble salt content of 5 to 10 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings.

7.5.4.4 Mulches

- **Organic Mulch:** Organic mulch, free from deleterious materials and suitable as a top dressing of trees and shrubs, consisting of one of the following:

  - Type: Shredded hardwood.
  - Type: Coco peat or coconut husk
  - Type: Ground or shredded bark.
  - Type: Pine straw.
  - Type: Salt hay or threshed straw.

- Type: Wood and bark chips.
- Type: Pine needles.
- Type: Peanut, pecan, and cocoa-bean shells.

- **Mineral Mulch:** Hard, durable stone, washed free of loam, sand, clay, and other foreign substances, of following type, size range, and colour:

  - Type: Rounded riverbed gravel or smooth-faced stone.
  - Type: Crushed stone or gravel.
  - Type: Marble or granite chips.
  - Size Range: 40mm maximum, 20mm minimum.
  - Size Range: 20mm maximum, 6mm minimum.
  - Colour: Uniform tan-beige colour range, acceptable to Engineer.
  - Colour: Readily available natural gravel colour range.

- **Mulch thickness :** The mulch layer shall be replenished as necessary during the maintenance period to ensure continuous moisture conservation and soil protection

Plant Type	Mulch Thickness
Trees	75–100 mm
Shrubs	50–75 mm
Groundcover	50 mm

7.5.4.5 Planting soil mixes

- **General Requirements**
  - Planting soil mix shall be fertile, friable soil. It shall be free draining, non-toxic and capable of sustaining healthy plant growth.
  - Planting soil mix shall be reasonably free from calcium carbonate, subsoil, refuse, roots, heavy clay, clods, noxious weed seeds, phytotoxic materials, coarse sand, rocks, sticks, brush, litter and other deleterious substances. It shall have a pH not lower than six or greater than eight.
  - The Softscape Contractor shall submit a sample to be approved by the Client's Representative/ Engineer-in-Charge prior to commencement of work. This approved sample shall be used as reference for the whole project.
  - Topsoil and all planting media shall be free from any termite infestation, whether sub-terranean termites or dry wood termites. In the event termite infestation is found due to any softscape material (which shall be decided by the Engineer-in-Charge, whose decision shall be final and conclusive), the Softscape Contractor shall carry out all necessary replacements and remedial works and make good all defects, damages or other faults (including but not limited to damage to any adjoining surfaces and /or finishes or any other works and properties caused directly or indirectly by the termite infestation).
  - Any other organic matter and additives to balance the pH value of the soil mix will not be more than 15% of the total soil mix.
- **SOIL MIX A**

For use of tree pits, low shrubs and planting areas, comprise the following components in proportions by volume, which shall be mechanically cultivated to the correct proportions, prior to installation or backfilling:

- Good quality, loamy topsoil 50%
- Coco peat 20%
- River sand (no salty materials) 20%
- Organic compost 10%
- NPK 15-15-15 Chemical Fertilizer 5 kg/10m³
  (as per approval by Client's Representative/ Engineer-in-Charge)

- **SOIL MIX B**

For use as potting compost in containerized planters the following components in proportions by volume, which shall be mechanically cultivated to the correct proportions, prior to installation or backfilling:

- Good quality, loamy topsoil 40%
- River sand (no salty materials) 30%
- Charcoal 20%
- Organic compost 20%
- Water-retention crystals – according to manufacturer's specifications

- **SOIL MIX C**

For use as raised planters and planting areas with slab below for shrubs and trees to be planted on the podium level the following components in proportions by volume, which shall be mechanically cultivated to the correct proportions, prior to installation or backfilling:

- Good quality, loamy topsoil 50%
- Cocopeat 30%
- Vermiculite 5%
- Perlite 5%
- Compost 10%

7.5.5 Execution

(a) The work shall consist of furnishing, hauling and placing general planting soil mix in accordance with the details shown on the drawings and the requirements of these Specifications.

(b) Planting soil mix shall be spread uniformly on the designated areas to the required depths. When necessary, the area shall be cultivated to a sufficient depth to break up any materials which may have been compacted as a result of the spreading operations.

(c) The finished surface shall be free of all rocks and stones larger than one inch 25 mm in diameter.

(d) The Softscape Contractor will mix the soil mix composition thoroughly before placing it into the planting pit.

(e) Clean all subsoil areas to be filled free of rubbish and foreign materials and remove all stones exceeding 25mm in diameter and builders' debris from site. Any areas contaminated by petrol, oil or other toxic builders' chemical substances shall be immediately, fully and completely removed from site before filling commences.

(f) Excavated silty-clay site materials must not be used in backfilling. Dispose all excavated materials at the location as indicated by the Client's Representative.

(g) The soil mix must be free from heavy clay or coarse sand, stones, lumps, other vegetation, roots, sticks and other foreign material larger than 25 mm in diameter.
(h) The soil mix will be of the same composition and structure throughout and will not be delivered, handled or placed in a muddy condition.

8 PLANTING

The softscape work is intended to achieve an instant, visually lush effect. All plant materials are to be of an instant, well-grown quality that is free from any infestation &/or defects. The installation is to be executed to the best of professional horticultural standards thereby achieving the required visual effect – well-established, lush-looking with full, bushy plant specimens & materials.

8.1 General

8.1.1 Site Conditions

- Weather Limitations:
  - Proceed with plant bed establishment, planting and related works only when existing and forecasted weather conditions permit the works to be performed. Notify Client's Representative of any works delay and/or any deviation from Works Program approved due to weather limitations.
  - Planting operations shall be conducted under favourable weather conditions during the next season or seasons which are normal for such work as determined by accepted practice in the locality of the project. At the Softscape Contractor's option and full responsibility, planting operations may be conducted under unseasonable conditions without additional compensation.
- Coordination with Lawns: Plant trees and shrubs after finish grades are established and before planting lawns unless otherwise acceptable to Client's Representative. When planting trees and shrubs after lawns, protect lawn areas and promptly repair damage caused by planting operations.
- All planting shall be done during the time specified by the Engineer-in-Charge.
- Planting shall not be done in soil that is excessively moist or otherwise in a condition not satisfactory for planting in accordance with accepted horticultural practice.
- Plants in containers shall be planted and watered the same day the plant is potted.
- Plants shall be removed from containers in such a manner that the root ball is not broken. Plants with broken root balls or with root balls that fall apart while being planted may be rejected.

8.1.2 Pre –Planting Meeting

Contractor shall coordinate a Meeting with the Client's Representative prior to the installation of any of the works here-in.

8.1.3 General Quality Standards for Plant Material

- All plants shall be supplied by the Contractor unless prearranged in writing by the Engineer-in-Charges.
- The Contractor must immediately review all stock received and inform the Engineer-in-Charges in writing if the plants are not suitable for any reason. The following applies to all plants. They shall:

- Meet or exceed – All Plants and trees specimen should meet the require standards recommended or as per the specifications given by the Landscape Consultant.
- Plant species should be free of pests and disease including of viruses, nematodes, phytopthera, scale, mealy bug, red spider, aphids, white fly and thrips.
- Plant species should be free of mechanical or insect damage including leaf burn, chewing insects and stem marks.
- Plant species should be healthy and showing consistent vigour during the growth period.
- Plant species should be well hardened with consistent even growth typical of the species.
- Plant species should be fully acclimated to light and climatic conditions for interior operations, where applicable.
- Plant species should be correctly and clearly labelled with plant scientific name, size, and production and approval reference numbers.
- Plant species should be supplied in approved recyclable containers'. "Spring Ring" to provide room for root pruning during root growth.
- All plant material shall be sourced from nurseries accredited by the Engineer-in-Charge approved.

8.1.4 General Quality Standards for trees

- Trees shall be vigorous, healthy trees that can be easily trained into attractive trees with structurally strong roots and crowns:

  - All trees shall be true to type or name as ordered or shown on the plans and are to individually tag or tagged in groups by species and cultivar (variety).
  - All trees shall be healthy, have a form typical for the species or cultivar, be well-rooted, and properly trained.
  - The root-balls of all trees shall be moist throughout and their crown is to show no signs of moisture stress.
  - For trees in pedestrian areas, be properly and adequately pruned to acceptable clear stem height prior to installation.

8.1.5 Delivery, Storage and Handling

- Deliver freshly dug trees and shrubs. Do not prune before delivery, except as approved by Engineer. Protect bark, branches, and root systems from sun scald, drying, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy natural shape. Provide protective covering during delivery. Do not drop trees and shrubs during delivery.
  - Immediately after digging bare-root stock, pack root system in wet straw, hay, cocopeat or other suitable material to keep root system moist until planting.

- Handle balled and bur lapped stock by the root ball, not to damage or break the root ball during handling.

- Deliver trees and shrubs after preparations for planting have been completed and install immediately. If planting is delayed more than 6 hours after delivery, set trees and shrubs in shade, protect from weather and mechanical damage, and keep roots moist.
  - Heel-in bare-root stock. Soak roots in water for 2 hours if dried out.

- Set balled stock on ground and cover ball with soil, peat moss, sawdust, or other acceptable material.
- Do not remove container-grown stock from containers before time of planting.
- Water root systems of trees and shrubs stored on site with a fine-mist spray. Watering as often as necessary to maintain root systems in a moist condition.

8.2 Products

8.2.1 Trees and Palms

- **Trees:** Provide all trees with single sturdy straight trunk (or as indicated on drawing), branching spread equal or greater than indicated in the Plant Schedule (or as indicated on Drawings), well-balanced crown with sufficient branches and spread dimension as indicated on drawing, intact leader, with height, calliper and form as required.
- **Palm Trees:** Provide Palm Trees with form according to natural development of species and type or special form requirements as indicated in the Plant Schedule or on the Drawings, with relationship of calliper and height according to health growth stock of species and type, with upright habit (unless otherwise specified) and balanced crown form, with trunk height or total height, spread, number of fronds as specified in the Plant Schedule, with trunk free of lesions, sign of deterioration and damaged or deformed leave scale and with a health and sound meristem.
- All Trees & Palm Trees shall fulfil requirement of as listed in the Plant Schedule or as indicated in the Drawings.
- All plants shall be typical of their species or variety. All plants shall have normal, with developed branches and vigorous root systems. Trees and palms will be straight and have uniformed shape without damage. They shall be sound, healthy, vigorous, and free from defects, plant disease, insect eggs, borers, and all other forms of infections. Trees with abrasions on the bark, sunscalds, disfiguring knots or damaged limbs over 25mm diameter which have not been pruned, will be rejected.
- All plants shall be nursery grown unless otherwise stated and shall have been growing under the same climatic conditions as the location of this project after the award of Sub-Contract. Refer to the drawings for specific forms and branching of plant material.
- The minimum acceptable size of all trees after pruning, with branches in normal positions, will conform to the measurement specified in the Bill of Quantities unless stated otherwise.
- Calliper measurement will be taken at a point on the trunk 1.0 meter above the ground.
  - Plants that meet the specified measurement, but do not possess a normal configuration or balance of height and spread will be rejected. All trees supplied will be branched as specified in the Bill of Quantities. Natural form of the trees must be kept after pollarding. De-topped trees will be rejected. All trees supplied must have terminal shoots.
  - Plant materials larger in size than specified may be used, but are subjected to the approval of the Engineer-in-Charge. The use of larger plant material will make no change in the contract price. Height will not be substituted for balanced form.
  - All plant materials will have a root ball of sufficient size to support the plant's recovery from transplanting. Any plant materials delivered with

small or inadequate root balls will be rejected. In all cases, the decision of the Engineer-in-Charge will be final.

- All trees and palms will be transplanted from growing site and planted at project site by mechanical crane whenever possible.
- All specimen trees must have a minimum crown spread of not less than half the size of the overall height.
- All instant trees must have minimum four main branching from the trunk with a minimum crown spread of not less than half the size of overall height.
- In case discrepancy between specification given in the Plant Schedule and indication on the Drawings, Drawings shall take precedent.

8.2.2 Shrubs

- Shrubs: Provide shrubs grown from transplanted seedling or rooted cutting, pruned to encourage bushiness, with minimum of 3 numbers of canes/stems, with spread dimension at least two-third of height, and with well-developed root system.
- Shrub sizes indicated are sizes after pruning.

8.2.3 Groundcover Plants

- Provide ground covers of species, height, spread as indicated in the Plant Schedule or on the Drawings, established and well rooted in pots or similar containers of reasonable size.

8.2.4 Seasonal

Provide seasonals of species, height, spread as indicated in the Plant Schedule or on the Drawings, established and well rooted in pots or similar containers of reasonable size.

8.2.5 Climbers

Provide climbers of species as indicated on drawing and complying with requirements as follows:

- Two-year plants with heavy, well-branched tops, with not less than 3 runners(shoots) 450 mm or more in length (or as indicated on drawing), and with a vigorous well-developed root system.
- Provide field-grown climbers. Climbers grown in pots or other containers of adequate size and acclimated to outside conditions will also be acceptable.

8.2.6 Bamboos

Provide healthy, field-grown plants from a commercial nursery, of species, variety and size as indicated on drawing complying with requirements as below:

- Height as per Plant Schedule (or Drawings)
- Vigorous rhizome system.
- Minimum 8 numbers of culms (or as indicated in the Plant Schedule) supplied with branches and leaves.
- Provide field-grown bamboo in pot, container, or fabric bag of adequate size.

8.2.7 Turf Grass Carpet

Provide viable carpet of uniform density, colour, and texture, strongly rooted, free of disease, pest and weeds, and capable of vigorous growth and development when planted.

- Turf grass Species: Turf species as indicated in the Plant Schedule;
- Carpet Dimension: 500mm(Length) x 300mm(Width) x 25mm(Thickness)
- Tolerance: 10% difference.

8.2.8 Guying for Large / Specimen Trees & Palms

- Guy Cables: 5-strand, 4.8 mm diameter, galvanized-steel cable, with zinc-coated turnbuckles, a minimum of 75 mm long, with two 10-mm galvanized eyebolts per Detail.
- Deadman Anchor: Pressure-Preservative (alternate material to be suggested) with thickness by length as indicated, pointed at one end per Detail.
- Hose Chafing Guards: Reinforced rubber hose at least 12 mm in diameter, black, cut to lengths required to protect tree trunks from damage per Detail.

8.2.9 Staking for Trees & Palms

- Wooden/Bamboo Stakes: Wooden/Bamboo with at least 50mm diameter flat cut at both end with length as per detail.
- Trunk Padding: Rubber sheath cut to lengths to protect tree trunks from damage as per Detail.
- Rubber Ties per Detail.
- Bamboo Stake Foot Plate: For Tree installation with-in Tree Grates.

8.3 Execution Planting – Preparation

- Examine areas to receive soil, plants and lawns for compliance with requirements and conditions affecting installation and performance.
- Locate and clearly flag utilities, trees or vegetation to remain or to be relocated
- Proceed with installation only after unsatisfactory conditions have been corrected
- Lay out individual tree and shrub locations and areas for multiple plantings as set out in the Drawings. Stake locations, outline areas, adjust locations when requested, and obtain Client's Representative's acceptance of layout before planting. Make minor adjustments as required.

8.3.1 Tree, Palm and Large Shrubs

- **Trees & Shrubs:** Set Trees and Shrubs plumb and in centre of pit or trench with root ball resting on a soil bench as per Drawings.
- **Palms:** Set Palms plumb and in centre of pit or trench with top of root ball 25mm below adjacent finish grades.
- Before planting, verify that root collar is not visible at top of root ball covered by 25mm of soil.
- Remove covering from tops of root balls and partially from sides, but do not remove from under root balls or carefully remove root ball from container/ fabric bag. Do not use planting stock if root ball is cracked or broken before or during planting operation.
- Place appropriate Planting Soil Mix around root ball in layers, tamping to settle mix and eliminate voids and air pockets. When pit is approximately one-half backfilled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed. Water again after placing and tamping final layer of planting soil mix. Soil material shall be carefully firmed around the roots or the ball of the plant so as to eliminate air pockets. Soil

shall be compacted around the roots or ball of the plants after planting operations to stabilise the rootball and ensure the tree is upright and vertical.

- Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water, as per detail drawing.
- Remove any wrapping and tying materials on trees/shrubs.
- Remove any wrapping and tying materials from palms; if planting is not during planting season, keep fronds tied until establishment at location.
- Immediately after planting, all plants shall be thoroughly irrigated until the soil fill around and below the roots or the root ball of each plant is saturated.

◦ **Tree and Palm Planting on Slope:** Planting should be carried out as soon as excavation or loosening of the prepared plant bed and immediately is fully supported as specified. Formed saucer indentation around tree or planting basin should be made with fall to drain as indicated on drawing.

8.3.2 Shrubs, Ground covers, Seasonals, Climber, Bamboos

Plant **Ground Cover, Seasonals, Climber** and **Bamboo** as following as general requirement:

- Set out and space as indicated on drawing.
- Dig holes large enough to allow spreading of roots and backfill with planting soil type as indicated in the Drawings.
- Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.
- Water thoroughly after planting, taking care not to cover plant crowns with wet soil.
- Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

8.3.3 Turfing

- Harvest turf (carpet grass) with turf cutter. Lay turf within 24 hours of harvesting. Do not lay turf if dormant or if ground is muddy.
- Lay turf pieces to form a solid mass with tightly fitted joints. Butt ends and sides of each piece; do not stretch or overlap. Stagger turf strips or pads to offset joints in adjacent courses. Avoid damage to sub-grade or turf during installation. Tamp and roll lightly to ensure contact with sub-grade, eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks between pieces of turf if and when shrinkage occurs; remove excess to avoid smothering turf and adjacent grass.
- Laying on slopes:
  - Lay turf pieces across angle of slopes exceeding 1:3.
  - Anchor turf pieces on slopes exceeding 1:6 with wood pegs or steel staples spaced as recommended by the grass carpet manufacturer, not less than 2 anchors per carpet strip to prevent slippage.
- Saturate turf with fine water spray within half hour of planting. During first week after planting, water as necessary to maintain moist soil and moisten 100-150mm deep of soil below turf layer as watered every time.
- The top dressing media for all turf will consist of the following:
  - 100% good quality, loamy topsoil
  - 5kg/m^3 of NPK 15-15-15-fertilizer

8.3.4 Guying and Staking

- **Guying for Large Palms and Semi-Mature Trees:** Unless otherwise indicated, securely attach no fewer than 3 guys to stakes 500 mm long, driven to grade.
  - For trees more than 150 mm in calliper, anchor guys to pressure-preservative-treated Deadman, 100 mm in diameter and 500 mm long buried at least 450 mm below grade. Provide turnbuckle for each guy wire and tighten securely.
  - Secure trees with guy wire looped as detailed with-in reinforced rubber hose at contact points with tree trunk and reaching to turnbuckle. Allow enough slack to avoid rigid restraint of tree.
  - Paint turnbuckles with luminescent white paint.
- **Stakes for Standard Trees & Palms:** Unless otherwise indicated, provide bracing system with stakes around perimeter of trunk as form of tripod to secure until established.
  - Place 2 X 2 stakes on either side of the tree trunk. Supporting point should be at one third of the trunk height. Firmly press end of all four bamboo stakes against finished grade and into the ground for stability but without disturbing root ball area. Care should be taken that the stakes remain firm and stable throughout the staking period.
  - Cushion contact area between stake and trunk with 5mm thick, 150 x 150 rubber tire trunk protection sheath.
  - Secure Bamboo stakes together where they join at contact area at trunk with rubber ties in an '8' profile, as detailed in the drawings and mock-up approved by the Engineer-in-Charge/ Client's Representative.
  - For Tree Grate installations, secure stakes to Stake Foot Plate as per detail.
- **Staking for Climbers:** For staking against walls, pergolas and other as indicated. Provide 25mm diameter by 2000 ht. Bamboo poles driven 300mm depth to soil.
- Attached and twist runner of climbers around bamboo pole.
- Tie climbers to building wall or vertical members of pergola or railing as available.
- **Bamboo on slope:** For bamboo planted on slope area or over 2 meter in height; provide support by tying and staking with bamboo poles of minimum 50mm diameter**.**

8.3.5 Tree and Shrub Pruning

- Remove only dead, dying, or broken branches. .
- Prune, thin and shape trees and shrubs as directed by Client's Representative.
- Prune, thin and shape trees and shrubs according to standard horticultural practice. Prune trees to retain required height and spread. Unless otherwise indicated by Client's Representative, do not cut tree leaders; remove only injured or dead branches from flowering trees. Prune shrubs to retain natural character or achieve desired form as specified in the drawing.
- Clean all wounds with an approved fungicidal.

9 OPERATIONS AND MAINTENANCE

9.1 Maintenance

9.1.1 General

Maintain and establish plantings by carrying out the Maintenance Works as described here.

(a) Scope

- Planting Maintenance will continue for twelve (12) months upon receiving the Handover Certificate from the Engineer-in-Charge under the Main contract.
- Care of the plant materials during installation is not considered part of the maintenance period.
- The Contractor shall be responsible for the care and protection of trees, shrubs and plants planted. He will maintain all installation areas in optimum growing condition and appearance at all times. Such care and protection shall include, but not be limited to, the watering of stock, removal of trash and debris, controlling weeds, repairing, adjusting or replacing stakes and guying, furnishing and applying sprays and dust to combat diseases and insects and taking such precautions as necessary to prevent damage from sunburn or other hazards.
- The Landscape Sub-Contractor shall remove and replace, at his expense, all dead plants and all plants that show signs of failure to grow or which area so injured or damaged as to render them unsuitable for the purpose intended, as determined by theEngineer-in-Charge.

(b) Submittals

- Operations & Maintenance Manual: This should be submitted upon commencement of the maintenance period and shall include schedule and instructions for all activities to be undertaken for operations and maintenance of established works.
- **As-built drawings:**
  - The Contractor shall prepare As-built drawings and certify on these drawings that the drawings reflect the actual works installed.
  - The As-Built Drawings shall be submitted to the ProjectEngineer-in-Charge at Practical Completion for checking before submission.
  - Three sets of these drawings (hardcopy and softcopy) shall be submitted to the client post approval and record.
  - The Contractor shall ensure that this submission of As-Built drawings will not delay subsequent inspections and tests by the relevant authorities; otherwise, he shall be fully responsible for any consequence due to his delay.

(c) Maintenance schedule and monthly status report:

- Provide Maintenance Schedule and Monthly Status Report.
- The Contractor will assume the responsibility of maintenance including watering, fertilizing, spraying, weeding, forking, repairing and straightening stakes, etc. upon completion of planting until the end of the Maintenance period.
- Contractor shall visit and walk around the site with the Client's Representative to observe and document existing site condition and to clarify scope of maintenance in addition to routine maintenance works.

9.1.2 Care and Protection of Plants

(a) Tools and equipment:

- Do not use tools and equipment at the site which has not been thoroughly cleaned of mud, sap, residue etc., after previous use elsewhere.
- Sterilize pruning tools previously used on diseased plant materials at other sites prior to their use at the site. When pruning diseased plant materials at the site, sterilize equipment after each cut to prevent the spread of disease.

(b) Daily inspections:

- Daily inspection should be part of the maintenance routine. In addition, a comprehensive inspection should be conducted on a monthly basis to analyse plant materials for signs of stress, damage and potential form the following:
  - Infestation: Moles, rats or other gnawing rodents, snails, slugs, insects, etc.
  - Disease: Withering of leaves, die-back, blackened or galled branches, wilt, fungus growths, cancer, bleeding bark, root rot, stunted growth, discoloured or blotchy foliage.
  - Loss of vigour: In normal healthy plants, this is seen as a failure to thrive, a dropping of unopened flowers, leaves that are small for the species, or thin or leggy growth. These symptoms may have many causes: heat stress, desiccation, wind damage, improper irrigation, incorrect installation, damage from construction or maintenance vehicles, or altered growing condition. Treat each instance individually when determining cause of decline and treatment.
  - Fertilizer or soil chemical imbalance: Fertilizer 'burn' at leaf margins, unusually light green or yellowish-green leaf colour (chlorosis), yellow/brown salt 'burn' at leaf margin, or other symptoms. Make sure that spraying an application of fertilizers and soil chemical is done discriminately and in accordance with manufacturers' recommendations and confined to the areas affected.

(c) Clearing up

- Remove dead and/ or over hanging branches of existing trees, palm, shrubs and groundcovers.
- Remove any garbage and unsightly foreign materials.
- Remove dead vines and plant materials.

(d) Weeding

- Keep planting areas free of weeds and undesirable grasses through daily weeding if required. Remove the entire root system of all weeds.
- Dispose off all weeds in appropriate trash container.

(e) Pruning

- Pruning Procedures: Carry out pruning using sharp tools to give a clean cut, free form ragged edges and:
  - Prune all trees as directed by the Engineer-in-Charge to establish desired form, habit and appearance.
  - Ensure cuts are immediately above buds or branches and slope away from an outward facing bud.
  - Prune back branches, to the main stem to encourage bushy growth and improve flowering.
  - Remove dead, damaged or crossing branches and dead flower heads.
  - Retain the individual habit and shape of the plant, unless otherwise directed or the intention of the design is to form a clipped hedge.
  - Prune flowering shrubs by removing the shoots bearing the dead flower heads and/or the new growth dependant on species.
- Do not clip shrubs into balled or boxed forms unless specifically called for in the design. Only shrubs designated as “hedges” are to be sheared. Periodically pinch back ‘wild’ growth on shrubs to maintain uniform habit.
- Immediately dispose of pruning and trimming debris from trees and shrubs off site at an approved dumpsite.
- Edge groundcover adjacent to walks to keep in boundary. When appropriate, trim top growth in spring by mow to renew growth, improve density and attractiveness, and to achieve an overall even appearance. Do not mow until plants have been firmly established and have formed a dense mat. The Client’s Representative will determine mowing height. Dispose of groundcover clippings off site.

(f) Thinning

- Where instructed by Client’s Representative reduced the number of plants due to overcrowding as follow:
  - Dig up plants, transport and replant in locations as directed or remove from site as approved by Client’s Representative.
  - Backfill the excavated void with Planting Soil Mix.

(g) Aeration

- Shrub areas, including bamboos, climbers, and perennial: immediately after fertilizing, cultivate the soil by hand using fork to a depth of 100mm.
- Ground cover areas: immediately after fertilizing lightly break up the soil by hand using a fork to a depth of 75mm.
- Grass areas: immediately before fertilizing aerate the soil by inserting a fork to a depth of 100mm at 200mm centres.

(h) Watering

- The contractor shall be supplied with non-toxic water for irrigation at pre-defined locations by the client. The Contractor shall always provide a supply of non-toxic water to the planting area from the provided water source. The Contractor shall make do allowance in this rate for importing non-toxic water

during periods of restrictions or pipe work failure if a piped supply has been laid on.

- Water all planted areas to maintain a moist soil (not saturated) through the depth of the soil profile adequate to ensure satisfactory establishment and as minimum:
  - Adjust watering as per rainfall and weather conditions.
  - Water desert origin plants at a much lower frequency to keep their growing medium reasonably dry to suit their species-specific habit; avoid over watering which might cause rotting of root and trunk
  - Carry out watering either early mornings or late afternoon or both.
  - Regulate watering as necessary to avoid erosion and gulling.

(i) Control of pest and disease

- Fertilize as needed in accordance with the manufacturer's recommendations and five days prior to the Final Inspection.
- Regularly inspect any sign pest invasion, fungal growth or disease outbreak, report and take immediate counteraction to prevent further spread and reduce damages to plants.
- Immediately effect remedial measures by spraying with solution of pesticide or germicide approved in strict accordance with the manufacturer's instruction
- Remove by corrective pruning plant material infested by pest or disease immediately after being identified.
- Transport diseased or infested plant materials or plant material cuttings completely off the site immediately after their removal. Do not permit pruned materials from diseased planting to be stockpiled anywhere on site at any time.
- Inspect new plant materials for signs of insect infestation or disease upon delivery to the site. If possible, quarantine new materials in the nurseries for 3 weeks prior to installation.
- Immediately wash off sprayer drippings and materials accidentally spilled on plants.
- Exercise caution, proper supervision and take necessary measures to avoid scorching of plants.

(j) Lawn Maintenance

- Maintain all lawn areas by watering, fertilizing, weeding, mowing, aeration, replanting, and other operations. Roll, re-grade, and replant bare or eroded areas and re-mulch to produce a uniformly smooth lawn. Provide materials and installation the same as those used in the original installation.
- Watering: Provide and maintain temporary piping, hoses, and lawn-watering equipment to convey water from sources and to keep lawn uniformly moist to a depth of 100 mm.
- Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
- Water lawn with fine spray as required unless rainfall precipitation is adequate.
- Mow the lawn as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than 1/3 of grass height. Remove no more than 1/3 of grass-leaf growth in initial or subsequent mowing. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowing to maintain the following grass height:

- Mow the grass to a height of 25 mm whenever the average height exceeds 50mm
- Grass will be cut according to the contours of the ground.
- All clippings must be removed on the same day.

- Lawn installations shall meet the following criteria as determined by Client's Representative:
- Satisfactory Lawn: At the end of maintenance period, a healthy, well-rooted, even-coloured, viable lawn has been established, free of weeds, open joints, bare areas, and surface irregularities.
- Use specified materials to re-establish lawns that do not comply with requirements and continue maintenance until lawns are satisfactory.

(k) Tree Stabilization Materials

- Re-stake, straighten, tighten, repair, reset guys and stakes to proper grades or upright position for any plants that are not in their proper growing position.
- Remove all tree stabilization materials toward the end of maintenance period upon approval of the Client's Representative.

(l) Defective Plants & Materials

- The expense of replacement of defective materials during the maintenance period will be borne by the Landscape Contractor and shall be included for in his price for this section of the work. The Engineer-in-Charge shall be at liberty to reject any installation, materials and workmanship not complying with the requirements of the sub-contract specification or which are in any way unsuitable and to order their removal and replacement, without increase to the contract sum.
- All plants shall be guaranteed to remain alive and healthy for the Maintenance period.
- Plant materials with pest infestations and/or in diseased conditions during the maintenance period shall have additional warranty period of twelve (12) months from the end of the Maintenance Period. The Engineer-in-Charge shall determine the non-conformance of the plant materials and notify the Contractor.
- Upon receipt of written notice from the Engineer-in-Charge of rejection of any plant materials during the warranty period due to death, diseased or unacceptable/ defective growth pattern, the plant materials will be promptly replaced with the same species as originally planned. The replacement made will be of similar size as if normal growth had occurred since the original planting. Replacement will be subjected to all requirements as stated in this Specification and Bill of Quantities. All replacement works shall be completed within seven (7) working days from the date of the end-Maintenance Inspection.
- When plants are replaced, the Contractor will advise the Engineer-in-Charge, in writing, of the necessary establishment maintenance which must be performed. If this information is not provided, the Contractor will be liable for the total cost of replacement should the replaced plant die.

Gujarat International Finance Tec-City (GIFTCL)

EPS - Building no. 49A, Block 49, Zone 04,
Gyan Marg, GIFT City Gandhinagar,
Taluka & District Gandhinagar – 382050

TECHNICAL SPECIFICATION

IRRIGATION

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1 GENERAL

The workmanship shall be best of its kind and shall conform to the specifications, as below or Indian Standard Specifications in every respect or latest trade practices and shall be subject to approval of the Owner's Site Representative. All materials and/or Workmanship which in the opinion of the Owner's Site Representative / Engineer-in-Charge / Consultant is defective or unsuitable shall be removed immediately from the site and shall be substituted with proper materials and/or workmanship forthwith.

All materials shall be of the best-approved quality obtainable and unless otherwise specified they shall conform to the respective Bureau of Indian Standard specifications.

Samples of all materials shall be got approved before placing order and the approved samples shall be deposited with the Employer.

In case of non – availability of materials in metric size, the nearest size in FPS units shall be provided with prior approval of the Employer / Consultants for which neither extra will be paid nor shall any rebate be recovered.

If directed / found necessary, materials shall be tested in any testing laboratory selected by the Employer and the Contractor shall produce the test results to the Consultant for his scrutiny and approval. The entire charges for original as well as repeated tests shall be borne by the Contractor. If required, the Contractor shall arrange to test portion of work at his own cost in order to prove the soundness of the same, to the Employer / Consultant or their representatives. The work or portion of work if found to be not satisfactory in the opinion of the Employer / Consultant or their representatives, Contractor shall pull down and re – do the same at his own cost. All defective materials shall be removed from the site immediately as ordered.

It shall be obligatory for the contractor to furnish certificates, if so demanded by the Employer/ Consultant from manufacturer or the material supplier, that the work has been carried out by using their material and installed / fixed as per their recommendations. Equipment offered for supply and installation shall include the following:

All minor items and incidental work, equipment accessories and materials may not be specifically mentioned but are required for the proper completion of the installation in accordance with the true intent and meaning of this specification.

All necessary safety devices for the protection of personnel against injury and the protection of plant and equipment against damage including relief valves, belt guards, fan inlet and / or discharge guards, safety railing effective earthing of electrical components, electrical interlocks, warning lights and alarms.

Readily accessible, dust-proof including facilities on all moving parts and equipment including provision for cleaning all lubricating lines and bearings and charging same with the correct lubricants after installation but prior to testing and commissioning.

Clearly visible and robust manufacturer's name-plates permanently fitted each item of equipment and showing the manufacturer's name, type and/or model number, serial number, and all essential operating data such as speed, capacity, voltage, current draw, etc.

The contractor also shall allow provision for the inspection of all plant and equipment by the manufacturer or his licensed representative, at least twice during the course of the installation.

1.1 Materials

All materials shall be best of their kind and shall conform to the latest Indian Standards. All materials shall be of approved quality as per samples and origins approved by the Owner's Site Representative / Engineer-in-Charge / Consultants.

As and when required by the Owner's Site Representative / Consultant, the contractor shall arrange to test the materials and/or portions of works at his own cost to prove their soundness and efficiency. If after tests any materials, work or portions or work are found defective or unsound by the Owner's Site Representative / Consultant, the contractor shall remove the defective material from the site, pull down and re-execute the works at his own cost to the satisfaction of the Owner's Site Representative / Consultant. To prove that the materials used are as specified the contractor shall furnish the Owner's Site Representative with original vouchers on demand.

1.2 Abbreviations and Irrigation Terms

Control Valve	Valves that connect mainlines to laterals or sub-mains. On/off & pressure control.
Mainline	Pipes that are constantly pressurised when irrigation feed water to control valves.
Lateral	Intermittently pressurised pipe work with outlets attached, downstream from control valves.
Submain	Manifold of controlled pressure to feed laterals
PVC	Poly Vinyl Chloride
HDPE	High Density Polyethylene (AS4130 & AS2033)
LDPE	Low Density Polyethylene (Type 30 to AS2698)
BSP	British Standard Pipe
RBY	Pressure-regulating filter
ICV	Irrigation Control Valve
LSP	Line Surge Protection
DBRY	Direct Bury (Red/Yellow) Wire Joiner
CST	Creative Sensor Technology
QCV	Quick Coupling Valve
VQA	Valve Quick Action or Flushing Valve
PC	Pressure Compensating
AS	Anti-Siphoning
XR	Extra Root Resistant
OTR	Office of the Technical Regulator
BPD	Backflow Prevention Device
RPZ	Reduced Pressure Zone
PRV	Pressure-reducing valve
DU	Co-efficient of Distribution Uniformity
GAP	'Glenelg to Adelaide' Recycled Water
PE	Polyethylene
PN	Pressure Rating
EFW	Electro-Fusion welding
SWJ	Solvent weld joint
RRJ	Rubber ring joint
SDR	Standard Dimension Ratio
ELV	Extra Low Voltage: Not exceeding 50V AC or 120V ripple-free DC*
GSM	Global System for Mobile Communications
DN	Outside Diameter

Source: S3000

1.3 Existing Services

1.3.1 Existing Services Locations

The Contractor shall by investigation and using the 'Dial before You Dig' services, accurately locate and expose all existing services at least 25 metres ahead of any excavation. The Contractor shall seek advice from the Council (CoA) and other relevant Service Authorities regarding the location of any existing services. Information provided to the Contractor shall not diminish the Contractor's responsibility to locate all existing services.

1.3.2 Protection of or Damage to Existing Services

The Contractor must take precautions necessary to protect private & public services during the course of the works. If any existing service is damaged, the Contractor shall immediately:

- Notify the council of any damage to an existing service;
- Contact the relevant Services Authority concerned to advise of the damage and arrange for required isolation of the service;
- Make arrangements for any repairs required to the service by qualified and
- Licensed trade workers.

Damage to any existing services, previously identified, shall be made good at the Contractor's expense.

1.3.3 Salvaged Materials

Any existing irrigation components required to be removed and/or re-used for the installation of the new or amended system (excluding PVC/HDPE & LDPE pipe work) shall be exhumed, cleaned and returned to the Council – London Road Depot. Mile End. Any excavations required shall be reinstated to the same condition that existed prior to the excavation.

The CoA Irrigation Technical Officer shall determine the suitability of each item for re-use and hand back to Contractor.

Any existing irrigation components deemed not suitable by the CoA Irrigation Technical Officer, for the new or amended system shall be decommissioned and disposed of by the Contractor at his or her cost.

1.4 Products and Approvals

All installed materials & products shall be new and unused.

1.4.1 Brands and Trade References

Where specific brand names and/or supplier catalogue or reference numbers are nominated, they indicate the product to be installed. Alternative products shall not be installed without the prior written approval of the council.

1.4.2 Products certified for use

Where service authorities require that equipment be approved for connection to their utilities, the Contractor shall validate that certification/ approval is current for all equipment proposed for use. Evidence of such certification/approval shall be provided to the council on request and form part of the 'as constructed' documentation package.

1.4.3 Notification of Product Reservations

Where the Contractor has any reservations regarding their ability to provide warranty, or suitability of any specified product, they shall notify the council in writing, prior to installation.

1.5 Anomalies

The Contractor shall become familiar with the project drawings, CoA Standard Details, CoA Irrigation Specification and instructions prior to any works being undertaken. Any errors, omissions or contradicting detailing / clauses discovered in any of the above-mentioned documents shall be referred to the Project Manager immediately.

The Contractor will not wilfully install the irrigation system as diagrammatically shown when it is obvious that obstructions, grade differences or site dimensions exist that may not have been foreseen or considered in the irrigation system design.

If this notification is not performed, the contractor shall assume full responsibility and costs for any revision or repair work where necessary.

1.5.1 Setting Out and Checking Of Work

If the Contractor becomes aware of any discrepancy or ambiguity in or between the drawings, Specification and actual conditions on the site, it must notify the Project Manager as soon as practicable and before commencing work on the affected part of the Work. The Council is not obliged to make payment for additional work undertaken by the Contractor as a result of the Contractor's failure to comply with this Clause.

The Contractor shall clearly identify the location of mainline and lateral pipe runs, using paint or pegs for approval by the CoA Irrigation Technical Officer prior to trenching.

In general, sprinkler and drip tube locations are critical for uniform coverage however variations in pipework may be approved to avoid obstacles.

The Contractor shall give 24 hours notice for the Principal to make inspections at each of the following stages:

- Point of connection assemblies
- Excavation of trenches prior to pipework placement
- Mainline & master control valve set-out
- First control valve (ICV) and valve box installation
- Dripper set-out (garden bed, tree ring & sub-surface)
- Sprinkler head layout (new & relocated)
- Mainline/submain & lateral pipe installation prior to backfill
- Excavation around trees within a tree protection zone
- Installation of backflow prevention devices prior to backfill
- Mainline/sub main & lateral flushing
- Location of irrigation controller
- Mainline pressure test

2 TRENCHING

2.1 General

The Contractor shall excavate all trenches to the dimensions and depths indicated on the drawings and described in this specification. The Contractor to allow for all bedding, fittings, cables and valve box assemblies.

Trench bases shall be flat, smooth and free from rocks or other debris that could be injurious to pipes and control cables.

No trenches are to be left open overnight or while the site is unoccupied under any circumstance.

The Contractor shall provide all necessary equipment for the back-filling of trenches, compacting, levelling and shall be responsible for top dressing trenches. This shall include trenches that have subsided after completion of works.

No variations shall be approved and paid for excavations except where material cannot be removed by reasonable methods – rock.

The definition of rock for the purpose of this specification is any material that in the Project Manager's opinion cannot be removed by hand tools or a 76kW backhoe with 300mm wide bucket. The Contractor shall advise the Project Manager before attempting to remove the rock by other means. The Contractor and Project Manager shall agree upon a method and price for removal. The price will reflect the type of rock and the methodology required for its removal.

2.2 Layout

Trenches shall be pegged out using a Total Survey System by the Contractor and checked by the CoA Irrigation Technical Officer, on behalf of the council, before trenching is undertaken. Trench layout shall only be altered where necessary and with the written approval of the CoA Irrigation Technical Officer.

2.3 Trench Alignment

- The Contractor shall peg all mainline and lateral paths and use string lines for all straight-line trenching.
- Trenches shall follow the alignments indicated on the drawings, unless noted otherwise.
- Trenches shall align with fixed items such as buildings, kerbs, paths, sprinklers or valve locations.
- Trenches shall be straight and less than a trench width deviation from true, unless sweeping arcs are required to avoid obstacles.
- When there is a requirement to divert around an obstacle, the trench shall be offset parallel to the first trench and 45 degree angles used to join the pipe work.
- Pipe deflections will only be allowed where the deflected radius is within pipe manufacturer's tolerances or is greater than 130 times the nominal pipe diameter.
- Where existing trees are to be retained, any works adjacent to trees shall be performed without causing damage to roots or limbs. Council shall be notified prior to any trenching or excavation suspected to involve cutting of roots >50mm in diameter. The roots must be clean cut with no tearing behind the cut.
- The CoA Arborist will visit the site and inspect the tree roots and determine the best approach, which may require a combination of: -

- Hydrovac excavation around roots
- Hand digging where appropriate
- Tree roots being cut back

- Contractor shall provide a schedule of rates in Clause 24 for the above-mentioned tasks/activities.

2.4 Trench Width

- Trenches for all pipe work up to and including 50mm in diameter shall be installed in a minimum 75mm wide trench, unless noted otherwise.
- 63 ~100mm diameter pipe work shall be installed within a minimum 300mm wide trench.
- If 2off pipes (up to and including 50mm diameter) are laid in the same trench, a minimum 300mm wide trench shall be provided.
- If 2off pipes greater than 50mm are laid in the same trench, the trench shall be 450mm wide.
- Where multiple pipes are laid in 1off trench, pipes must be apart by at least 1off diameter of the largest pipe and trench width adjusted to suit.

2.5 Trench Depth

The Contractor shall allow for trench depths, including allowances for fittings, valve assemblies, valve-boxes to ensure the resultant cover is achieved.

2.6 Trench Adjustments

Trench adjustment changes, where required, shall be increased or decreased by gradual changes to the satisfaction of the CoA Irrigation Technical Officer.

2.7 Excavated Material

Excavated material shall be deposited in such a manner as to not obstruct any drain, roadway, footpath, right of way or building access and shall not be deposited against a wall of any building or fence.

Any excavated topsoil shall be kept separate from other material to allow for the respreading at the completion of the trench. Where different materials are excavated from the trench, the Contractor shall keep the best quality material separable for use as backfill and/or bedding where permitted by the Irrigation Technical Officer.

The Contractor shall remove surplus excavated materials from the site as soon as practical and any dumping fees shall be absorbed by the Contractor. Excavated rock shall not be used for back fill.

2.8 Backfilling

- The Contractor shall generally apply bedding, backfill and top finishes to trenches and excavations.
- The base of trenches shall be laid & prepared with 60mm deep bedding sand. Contractor to allow for imported bedding sand as part of the tender and include as a separate price (supply & delivery only).
- At the time of excavation, if it is agreed with the Project Manager and CoA Irrigation Technical Officer that the excavated spoil is suitable for bedding sand, it shall be used in

lieu of the tendered bedding sand. Adjustments to the Contract Sum shall be made through a variation order, as required by the Contractor and assessed by the Project Manager.

- Unless noted otherwise, the first backfill to 200mm over any pipe shall be selected bedding material from excavated spoil or bedding sand. The remaining trench depth can be filled with selected site spoil excavated from site.
- Backfilling of trenches shall occur in layers of not more than 150mm thereafter. Each layer shall be compacted prior to the application of the next layer.
- Trench compaction shall be by the use of manual tamping for up to the first 200mm above the top of pipe and mechanical tamping thereafter.

2.9 Top Finish Treatments

All trenches, holes and other areas affected by the Contractor's works shall be reinstated to the same condition that existed prior to the excavation. The reinstated pavement shall not be of a lesser standard and thickness than the existing pavement. (Refer to CoA Construction Standard Details for turf, garden beds, various pavers, concrete or bitumen surfaces – CoA 400 series) . The Contractor shall level off surfaces removing all stones and other debris.

Contractor to replace excavated sod-cut turf greater than or equal to 300mm with new and matching instant turf that is top-dressed (sandy loam: 80/20) and watered in. For trench widths less than 300mm, replace with 'CoA seed mix' in lieu of new roll out turf.

Subsidence of trenches during construction and after completion of works shall remain the responsibility of the Contractor.

The Contractor shall ensure trenches are maintained, topped up and re-compacted to the satisfaction of the CoA Irrigation Technical Officer, for the duration of the defects liability period.

2.10 Pipes under Roadways and Concrete Footpaths

No pipe work or wiring shall be laid beneath a concrete footpath or bitumen/concrete roadway unless contained within a suitable conduit pipe.

Conduits shall be a minimum of 80mm in diameter. Pipe shall be Class 18 PVC pressure pipe or an approved alternative.

Conduits shall be installed at the same depth as the pipework it is to house, ensuring that no deviation in pipe level occurs, where possible. Refer to CoA 628 for further detailing information.

No joins in either wiring or pipes shall occur within 150mm of the sleeved section.

3 DRIP IRRIGATION

3.1 General

All dripper tube shall be solid lilac in colour and the brand, type and emitter spacing as described in the following clauses and project drawings.

Sizes to be used shall be 13mm, 19mm, 25mm and 32mm only.

All connections between LDPE header/ flushing tubes and drip tube must be made using barbed tees or elbows secured with stainless steel grade 304 clamps using a compatible crimping tool. No push-in type off-take fittings are allowed.

Header and flushing pipes shall be designed for each zone.

A flushing valve (VQA series) shall be installed at the low point of a dripper grid (garden bed or sub-surface irrigation system), either along the flush pipe or no more than 500mm from last 13mm drip line lateral. Flush valve shall match the diameter of the header & flush pipes. The flush valve shall be housed within a Rainbird 150mm spotter box that is to match final surface grade level. A dripper grid (garden bed or sub-surface irrigation system), either along the flush pipe or no more than 500mm from the last 13mm drip line lateral. Air Relief Valve shall match the diameter of the header & flush pipes. The Air Relief Valve shall be housed within a Rainbird 150mm spotter box that is to match final surface grade level.

3.2 Garden bed drip systems

Supply and install inline 16/25 mm drip tube (pressure compensating) at 0.4m spacing with flow rate of 12 Litres per day and 0.4m dripper emitter spacing along tube, unless noted otherwise Dripper tube shall be laid above finished soil grade and underneath the mulch layer. Drip tube shall be pinned every 3m with a galvanised 150mm long U-pin.

Refer to manufacturer's recommendations regarding tailored emitter and drip tube spacing for different soil types.

For drip tubes to randomly spaced plants: Maximum run length of drip tube not to exceed 120m.

Any tree planting situated within dedicated garden bed areas may be part of the same irrigation zone only where indicated on the drawings or as directed by the CoA Irrigation Technical Officer.

3.3 Turf sub-surface drip systems

Supply and install inline 16/25 mm drip tube at 0.4m spacing with flow rate of 12 Litres per day and 0.4m dripper outlet spacing along tube, unless noted otherwise. Dripper tube shall be laid at a depth of 150mm below finished grade level.

Refer to manufacturer's recommendations regarding tailored emitter and drip tube spacing for different soil types. Contractor to liaise with CoA Irrigation Technical Officer to confirm specific site requirements prior to undertaking the sub-surface drip tubing.

Typically only apply sub-surface irrigation systems where turf areas are too small (less than 4m in width) and/or irregular shaped to accommodate pop-up sprinklers and with prior approval.

No solenoid valve assemblies associated with a sub-surface drip irrigation system to connect with any tree ring irrigation loops or garden bed arrangements.

3.4 Tree ring systems

Supply and install inline 16 /25mm drip tube (pressure compensating) at 0.3m spacing with flow rate of shall be integrated with Landscape areas and 0.3m dripper emitter spacing along tube. Dripper tube shall be installed above finished soil grade and under mulch layer. Drip tubes shall be pinned with galvanised 150mm long U-pins at location as shown on the detail.

Any arrangement of new trees assigned a ‘tree ring’ irrigation loop and that form part of the overall irrigation design, must all be connected to a separate and dedicated control valve assembly, unless noted otherwise.

4 WATER SUPPLY

4.1 Scope

The scope of this section comprises the supply, installation, testing and commissioning of piping network for water supply for internal services as follows:

- Domestic Water Supply.
- Flushing Water Supply

Delivery lines from UG tanks to OH tanks through an independent pumping System (as required).

Connection to various mechanical equipment's to be supplied and installed by the other specialist contractors.

The Contractor shall make all necessary application and arrangements for his work to be inspected by the Local Authorities.

The Contractor shall be solely responsible for obtaining the Authorities approval of his works prior to the handing over of the complete water supply / distribution installation to the Owner.

4.2 Piping Materials

The piping system shall consist of CPVC SDR 11.0 piping from 15 mm to 50 mm for toilet / kitchen internal concealed & exposed works hot & cold application.

For terrace & shaft down comers Unplasticize Polyvinyl Chloride pipes (UPVC) schedule 40 ASTM IPS confirming to ASTM D 1785 & fittings and specials (schedule 80) such as tees, elbows, couplers, bends, enlargers etc shall be used. Up to dia 50mm pipe shall be schedule 40 & dia 65mm onwards shall be schedule 80.

DIMENSIONS CPVC SDR -11 shall confirm to the following thickness and weight for various dimensions.

Nominal Pipe Size (Inch)	Mean Outside Diameter Inch	mm	Minimum Walll Thickness Inch	mm	Nominal Weight Kg / m
½	0.840	21.34	0.147	3.73	0.337
¾	1.050	26.67	0.154	3.91	0.457
1	1.315	33.40	0.179	4.55	0.671
1- ¼	1.660	42.16	0.191	4.85	0.928
1- ½	1.900	48.26	0.200	5.08	1.13
2	2.375	60.33	0.218	5.54	1.56

Outside Diameters, Wall Thickness & Pressure Rating For CPVC 4120, Schedule 40 Piping System As per ASTM F 441

Nominal Size (in.)	(mm)	Outside Diameter, in. (mm) Average	Tolerance	I.D. Average	Wall Thickness, in. (mm) Minimum	Tolerance	Pipe - Pr. R, PSI (Kg/Cm²) 73.4°F	(23°C)	Fitting - Pr. R. PSI (Kg/Cm²) 73.4°F	(23°C)
2½	(65)	2.875 (73.0)	±0.007 (0.18)	2.444 (62.07)	0.203 (5.16)	+0.024 (0.61)	300	(21.10)	180	(12.65)
3	(80)	3.500 (88.9)	±0.008 (0.20)	3.041 (77.26)	0.216 (5.49)	+0.026 (0.66)	280	(18.28)	156	(10.96)
4	(100)	4.500 (114.3)	±0.009 (0.23)	3.998 (101.55)	0.237 (6.02)	+0.028 (0.71)	220	(15.47)	132	(09.28)

Pr. R. = Pressure Rating

Outside Diameters, Wall Thickness & Pressure Rating For CPVC 4120, Schedul 80 Piping System As per ASTM F 441

Nominal Size		Outside Diameter, in. (mm)		I.D.	Wall Thickness, in. (mm)		Pipe-Pr. R. PSI (Kg/Cm²)		Fitting-Pr. R. PSI (Kg/Cm²)	
(in.)	(mm)	Average	Tolerance	Average	Minimum	Tolerance	73.4°F	(23°C)	73.4°F	(23°C)
2½	(65)	2.875 (73.0)	±0.007 (0.18)	2.288 (58.14)	0.276 (7.01)	+0.033 (0.84)	420	(29.53)	252	(17.71)
3	(80)	3.500 (88.9)	±0.008 (0.20)	2.864 (72.75)	0.300 (7.62)	+0.036 (0.91)	370	(26.01)	222	(15.60)
4	(100)	4.500 (114.3)	±0.009 (0.23)	3.778 (95.97)	0.337 (8.56)	+0.040 (1.02)	320	(22.50)	192	(13.49)
6	(150)	6.625 (168.3)	±0.011 (0.28)	5.710 (145.04)	0.432 (10.97)	+0.052 (1.32)	280	(19.69)	168	(11.81)
8	(200)	8.625 (219.1)	±0.015 (0.38)	7.565 (192.15)	0.500 (12.70)	+0.060 (1.52)	250	(17.57)	150	(10.54)
10	(250)	10.750 (273.1)	±0.015 (0.38)	9.493 (241.12)	0.593 (15.06)	+0.071 (1.80)	230	(16.17)	138	(09.70)
12	(300)	12.750 (323.90)	±0.015 (0.38)	11.294 (286.87)	0.687 (17.45)	+0.082 (2.08)	230	(16.17)	138	(09.70)

Pr. R. = Pressure Rating

4.3 Pipes & Fittings

The pipes shall be CPVC (Chlorinated Poly Vinyl Chloride) material for hot & cold water supply piping system with pipes as per CTs SDR -11 at a working pressure of 320 PSI at 23 deg C and 80 PSI at 82 deg.C, using solvent welded CPVC fittings i.e. Tees, Elbows, Couples, Unions, Reducers, Brushing etc. including transition fittings (connection between CPVC & Metal pipes / GI) i.e. Brass adapters (both Male & Female threaded and all conforming to ASTM D-2846 with only CPVC solvent cement conforming to ASTM F-493, with clamps / structural metal supports as required /directed at site including cutting chases & fitting the same with cement concrete / cement mortar as required, including painting of the exposed pipes with one coat of desired shade of enamel paint. All termination points for installation of faucets shall have brass termination fittings. Installation shall be to the satisfaction of manufacturer & Project Manager. Pipes from 65 mm to 150 mm dia shall be Schedule 80 For duct down take Terrace ring main and pump delivery pipe (GI) as well.

4.3.1 Cutting, Joining Pipes & Fittings

a. Cutting: Pipes shall be cut either with a wheel type plastic pipe cutting or hacksaw blade and care shall be taken to make a square cut which provides optimal bonding area within a joint.
b. Deburring / Beveling: Burrs and fittings should be removed from the outside and inside of pipe with a pocket knife or file otherwise burrs and fittings may prevent proper contact between pipe and fittings duringassembly.
c. Fitting preparation: A clean dry rag/cloth should be used to wipe dirt and moisture from the fitting sockets and tubing end. The tubing should make contact with the socket wall 1/3 or 2/3 of the way into the fitting socket.
d. Solvent Cement Application: Only CPVC solvent cement confirming to ASTM-F493 should be used for joining pipe with fittings. An even coat of solvent cement should be applied on the pipe end and a thin coat inside the fitting socket, otherwise too much of cement solvent can cause clogged water ways.
e. Assembly: After applying the solvent cement on both pipe and fitting socket, pipe should be inserted into the fitting socket within 30 seconds, and rotating the pipe ¼ to ½ turn while inserting so as to ensure even distribution of solvent cement with the joint. The assembled system should be held for 10 seconds (approximately) in order to allow the joint to set up. An even bead of cement should be equipment around the joint and if this bead is not continues remake the joint to avoid potential leaks.

4.3.2 Set & Cure times

Solvent cement set and cure times shall be strictly adhered to as per the below mentioned table.

Minimum Cure prior to pressure testing at 150 PSI, Solvent cement set and cure times are a function of pipe size, temperature, and relative humidity. Curing time is shorter for drier environments, smaller size, and higher temperatures. Refer to the following table for minimum cure time after the last joint has been made of before pressure testing can begin.

MINIMUM CURE PRIOR TO PRESSURE TESTING AT 150 PSI (10 BAR)

AMBIENT TEMPERATURE DURING CURE PERIOD	PIPE SIZES ½" – 1"	PIPE SIZES 1 ¼" – 2"	PIPE SIZES 2 ½" – 3"
Above 15^0 C	1 Hour	2 Hours	3 Hours
4-15^0 C	2 Hours	4 Hours	3 Hours
Below 4^0 C	4 Hours	8 Hours	9 Hours

Special care should be exercised when assembling Flow Guard systems in extremely low temperature (below 4^0 C) or extremely high temperature (above 38^0 C). In extremely hot temperatures, care should be taken to ensure both surfaces to be jointed are still wet with cement when putting them together.

4.4 Testing

Once an installation is completed and cured as per above mentioned recommendations, the system should be hydrostatically pressure tested at 150 psi(10 Bar) which will be 1.5 time pressure of actual line pressure, for one hour. During pressure testing, the system should be filled with water and if a leak is found, the joint should be cut out and replacing the same with new one by using couplers.

4.5 Primer / Cleaner Application

Primer or cleaner shall be applied for preparing the bonding area for the addition of cement and subsequent assembly. A proper applicator shall only be used. A dauber or natural bristle paint brush approximately ½ the size of the tubing diameter shall be appropriate. Apply primer to both the outside of the tubing end and in the fitting socket. Primer should not be allowed to puddle in the fitting.

4.6 Solvent Cement Application

Only CPVC solvent cement conforming to ASTMF 493 should be used for joining pipe with fittings and valves. When the primed pipe and fitting surfaces are dry, apply a thin coat inside the fitting socket. CPVC cement solvent have a minimum shelf life of 1 year. Aged cement solvent will often change color or being to thicken and become gelatinous or jelly like and when this happens, the cement should not be used. The cement solvent should be used within 30 days after opening the company's seal and tightly close the seal after using in order to avoid its freezing. The freezed cement solvent should be discarded immediately and fresh one should be used. The CPVC solvent cement usage should be adhered to as given in table below

Diameter of pipe in inch (flow guard)	½"	¾"	1"	¼"	1½"	2"
Approx. nos. of joints which can be mode per litre of solvent cement.	200 Nos	180 Nos	150 Nos	130 Nos	100 Nos	70 Nos

4.7 Laying and Jointing

The defective pipe shall be rejected. Where the pipes have to be cut or jointed the ends shall be carefully filed, so that no obstruction to bore is offered. The jointing to be dry fit checked. A thick coat of solvent cement shall be applied to the Inner surface of the socket by mean of a brush. Solvent cement shall be of approved and of good quality ASTM – F493. The pipe shall be then inserted in to the fitting and turned 90 degree to ensure even distribution of solvent cement with in the joint. Excess solvent cement shall be wiped off. Properly align the fitting. Hold the assembly for approximately 10 seconds, allowing the joint to set – up. An even bead of cement should evident around the joint. If this bead is not continuous around the socket edge, it may indicate that insufficient cement was applied. In this case, remake the joint to avoid potential leaks. Wipe excess cement from the tubing and surfaces for an attractive professional appearance. Clamps / pipe hooks a required size shall be used for clamping the pipe to the walls.

4.8 Testing

Once an installation is completed and cured per these recommendations, the systems should be hydrostatically pressure tested. 10bar (150 PSI) which will be 1.5-time pressure of actual line pressure, for Five hour is recommended. When pressure testing, the system should be filled with water and all air bled from the highest and farthest points in the run. If a leak is found, the joint must be cut out and discarded. A new section should be installed using couplings. During sub – freezing temperatures, water should be blown out of the lines after testing to eliminate potential damage from freezing.

4.9 Handling and storage

CPVC is a tough, corrosion resistant material, but it does not have the mechanical strength of metal. Reasonable care should be exercised in handling CPVC pipes and fittings. They should not be dropped, stepped on, or have objects thrown on them. If improper handling or heavy impact results in cracks, splits, or gouges, the damaged section shall be discarded. Pipes & fittings should be covered with a non-transparent material when stored outdoors for long periods of time.

4.10 Hangers and Supports

For vertical runs supports shall be provided a at each floor level, plus a mid – story guide. For horizontal runs, supports shall be provided at three-foot (90-cm) intervals for diameters of one inch and below and at four-foot (1.2 m) intervals for larger sizes. Piping should not be anchored tightly to supports, but rather secured with smooth straps or hangers that allow for movement caused by expansion and contraction. Most hangers designed for metal pipe are suitable for Flow Guard. Hangers shall not have rough or sharp edges which come in contact with the tubing.

4.11 Horizontal and Vertical Support

A typical Cold-water distribution system operating at 260-300 C supports shall be provided for horizontal lines at every 3’(90cm) for sizes ½” – 1”, and every 4’ (120 cm) on sizes larger than 1”. However, the following spacing shall be used at water temperatures indicated.

SCHEDULE - 40

Recommended Support spacing (in feet)

Nom. Pipe Size		Temperature °C					
(In)	(mm)	23	38	49	60	71	82
2 ½	65	7 ½	7	7	6 ½	6	3 ½
3	80	8	7	7	7	6	3 ½
4	100	8 ½	7 ½	7 ½	7	6 ½	4
6	150	9 ½	8	8	7 ½	7	4 ½
8	200	9 ½	8	8	7 ½	7	5

Size of Pipe	21°C	49°C	71°C	82°C
Inch	Ft.	Ft.	Ft.	Ft.
½"	5.5	4.5	3.0	2.5
¾"	5.5	5.0	3.0	2.5
1"	6.0	5.5	3.5	3.0
1¼"	6.5	6.0	3.5	3.5
1½"	7.0	6.0	3.5	3.5
2"	7.0	6.5	4.0	3.5

SCHEDULE - 80

Recommended Support spacing (in feet)

Nom. Pipe Size		Temperature °C					
(In)	(mm)	23	38	49	60	71	82
2 ½	65	8	7 ½	7 ½	6 ½	4 ½	4
3	80	8	8	7 ½	7	4 ½	4
4	100	9	9	8 ½	7 ½	5	4 ½
6	150	10	9 ½	9	8	5 ½	5

For internal concealed water supply pipe shall be fixed with GI clamp.

5 VALVES

All valves (gate, globe, check, safety) shall be suitable for the particular service as specified. All valves shall be of the particular duty and design as specified. Valves shall either be of screwed type or flanged type, as specified, with suitable flanges and non-corrosive bolts and gaskets. Tail pieces as required shall be supplied along with valves. Gate, globe and check valves shall conform to Indian Standard IS:776 and non-return valves and swing check type reflux to IS:5312.

Sluice valves, where specified shall be flanged sluice valves of cast iron body. The spindle, valve seat and wedge nuts shall be gunmetal. They shall generally have non-rising spindle and shall be of the particular duty and design as specified. The valves shall be supplied with suitable flanges, non-corrosive bolts and asbestos fiber gaskets. Sluice valves shall conform to Indian standard IS:780 and IS:2906.

Ball valves with floats to be fixed in storage tanks shall consist of cast brass lever arm having plastic balls screwed to the arm integrally. The copper ball shall have bronze welded seams. The closing/opening mechanism incorporating the piston and cylinder shall be non-corrosive metal and include washers. The size and construction of ball valves and float shall be suitable for desired working pressure operating the supply system. Where called for brass valves shall be supplied with brass hexagonal back nuts to secure them to the tanks and a socket to connect to supply pipe.

Globe valves on Hot-water line shall be union bonnet with stem/disc and body seat ring of SS. Suitable for temperature up to 80° C.

S.No	Type of Valve	Size	Construction	Ends
a.	Isolating Valve	15 mm to 50 mm 65 mm and above	Gun Metal Gun Metal	Screwed Flanged
b.	Sluice Valve & Butterfly Valve	65 mm and above	Cast Iron	Flanged
c.	G.M. non return valve	15 mm to 50 mm 65 mm above	Gun Metal Gun Metal	Screwed Flanged
d.	Flap Type – Non return valve	65 mm and above	Cast Iron	Flanged

All valves shall be suitable for the working pressure involved.

5.1 Motorized Butterfly Valve with Float Switch

Motorized Butterfly Valves (MBFV) with float switch for auto On/Off function, complete system automation. (MBFV) 230V On/Off type with Manual Over Ride, IP67, 2 aux switch and with inbuilt thermal protection against moisture, connected with Float Switch (High & Low) with relay controller box with 1.5sq.mm 3core cable to required length & necessary connecting fittings.

5.2 Brass full way Valve

Full way valve is a valve with suitable means of connection for insertion in a pipeline for controlling or stopping the flow. The valve shall be of brass fitted with a cast iron wheel and shall be of gunmetal gate valve type opening full way of the size as specified. The valve shall be of best quality approved by the Consultants \ Engineer-in-Charges.

5.2.1 Butterfly/Ball Valves:

Valves up to 50 mm dia and below shall be Nickel plated Gun metal body heavy stainless-steel ball, lever operated, as per require tested pressure with female screwed ends. All ball valves shall be of full-bore type.

Valves from 50mm up to 150mm dia shall be of cast of iron body butterfly valves lever operated with flange ends. Valves shall carry IS certification mark.

All valves shall be approved by consultants before they are used on work.

All globe and check valves shall have working parts suitable for hot and cold water, as required. Valves shall be tagged with permanent label under hand wheel indicating type or duty.

5.2.2 Check Valves (Non return valves)

- Check valves of 50 mm and smaller size shall be gun metal conventional swing/lift check valve type used in all water services.
- Check valves larger than 50mm shall be wafer / Dual plate with CI body check valve type used in all water services. The valves shall be supplied inclusive of M.S. Pipe flanges and high tensile steel bolts of dimension recommended by suppliers of valves.

5.2.3 Foot Valves:

Provide cast iron body with brass disc and strainer of approved quality, wherever shown.

5.3 "Y" Strainers

''Y'' strainers up to 50mm shall be of gunmetal and above 50mm shall be of cast iron body. Strainers shall incorporate a removable bronze screen with mm (1/8'') perforations and a permanent magnet. Strainers shall be provided with flanges at both inlet and outlet. They shall be designed to enable blowing out of accumulated dirt and facilitate dirt and facilitate removal and replacement of the screen without disconnection of the main pipe.

5.4 Pressure Reducing Valve Set

Each pressure reducing valve set shall be complete with pressure reducing or pressure regulating valve, isolating valves, pressure gauges on inlet and outlet, pressure relief valve on outlet and filter on inlet.

Each pressure reducing valve shall contain loading neoprene diaphragm and a full floating, self aligning, ignition resistant seat and shall be of the single stage, pressure reduction type with provision for manually adjusting the delivery pressure. The valve shall fail safe to the low pressure.

Valve shall be capable of operating at the maintaining automatically the respective delivery pressure and flow rates as indicated and shall not be liable to creep. Valve shall also be capable of maintaining the pre – set down stream pressure under static condition.

The filter on each inlet to a pressure-reducing valve shall be of replaceable porous sintered metal type.

5.5 Pressure Relief Valves

Each pressure relief valve shall be of the fully enclosed type and fitted with hand easing gear.

Each pressure relief valve in a pressure reducing station shall have a flow capacity equal to that of the pressure-reducing valve.

Pressure relief valves in locations other than reducing stations shall have flow capacities equal to that of the associated equipment.

5.6 Pressure Gauge

The pressure gauge shall be constructed of die cast aluminum and enameled. It shall be weather proof with an IP 55 enclosure. It shall be a stainless bourdon tube type pressure gauge with a scale range from 0 to 16 kg / cm square and shall be constructed as per IS: 3524. Each Pressure gauge shall have a siphon tube connection. The shut off arrangement shall be by ball valve.

5.7 Water Fittings

Unless otherwise specified all Gunmetal fittings such as gate, globe, check & safety valves shall be fitted in pipe line in workman like manner. Necessary unions shall be provided on both ends of the valves for easy replacement. The joints between fittings and pipes shall be leak proof when tested to desired pressure rating. The defective fittings and joints shall be replaced or redone.

5.8 Measurements

The lengths shall be measured in running meter correct to a cm for the finished work, which shall include pipes and sockets, fittings such as bends, tees, elbows, reducers, crosses, plugs, sockets, nipples and nuts, but exclude brass or gunmetal taps (cocks), valves, lead connection pipes and shower rose. The length shall be taken along the central line of the pipefitting. All pipes and fittings shall be classified according to their diameter of the internal bore. The pipe shall be described as including all cuttings and wastage. In case of fittings of unequal bore, the largest bore shall be measured.

Digging and refilling of trenches shall be measured separately or clubbed with main item as called for in the item specification/tender bill of quantities.

5.9 Drawings

a.	Contract drawings duly signed by Engineer-in-Charge / Consultant are diagrammatic but shall be followed as closely as actual construction permits. Any deviations made shall be in conformity with the Engineer-in-Chargeural and other services drawings and with the prior approval of Engineer-in-Charge.
b.	Engineer-in-Chargeural drawings shall take precedence over services drawings in regard to all Dimensions.
c.	Contractor shall verify all dimensions at site and bring to the notices of Engineer-in-charge / Consultant discrepancies if any Engineer-in-charge‘s decision in this respect shall be final.
d.	Large size details and manufactures’ dimensions for materials to be incorporated shall take precedence over small-scale drawings.

5.10 Work to be Carried Out by Licenced Persons / Firms

All service installations namely water supply plumbing drainage and sewerage electrical fire detection and fire protection works shall be carried out by technically competent persons holding valid license

to carry out their respective trade at the site and having a minimum experience of five years in their relevant trades.

5.11 Drilling, Cutting, Etc.

All cutting and drilling of walls or other elements of the building for the proper entry / installation of pipes, and other equipment shall be carried out using electrically operated tools, only. Manual drilling, cutting, chiseling, etc shall be cut or chased with the written permission of the project engineer.

6 INTERNAL DRAINAGE (SOIL, WASTE, VENT & RAIN WATER PIPES)

6.1 Scope

The scope of this section comprises the supply, installation, testing and commissioning of internal drainage services. Work under this section shall consist of furnishing all labour, materials, equipments and appliances necessary and required to completely install all soil, waste, vent and rainwater pipes and fittings as required by the drawings, and given in the schedule of quantities.

6.2 Basic Piping System

Soil, waste and vent pipes in shafts, ducts and in concealed areas i.e. false ceilings etc. shall consist of Upvc SWR 'B' class pipes & fittings as called for. In general wastes and vents smaller than and upto 50mm dia shall be of Upvc high pressure pipe.

The soil pipes shall be circular with a minimum diameter of 100mm. Pipes shall be fixed by means of GI clamps in two sections, bolted together, built into the walls, wedged and neatly jointed as directed and approved by the Owner's site representative / Engineer-in-Charge. All bends, branches, swan neck and other parts shall conform to the requirement and standards as described for the pipes. Pipes shall be rested against the walls on suitable

m.s 80 micron galvanized coated with 2 coats of approved enamel paint 3" bracket. Local authority regulations applicable to the installations shall be strictly followed. Where indicated, the soil pipes shall be continued upwards without any diminution in its diameter, without any bend or angle to the height shown in the drawings. Joints throughout shall be made with solvent weld or rubber ring as described under jointing of Upvc SWR 'B' Class pipes.

Every waste pipe shall discharge above the grating of properly trapped gully. The contractor will ensure that this requirement is adequately met with. Wherever floor traps are provided, it shall be ensured that at least one wash is connected to such floor traps to avoid drying of water seal in the trap. Ventilating pipes shall be of Upvc SWR 'A' Class pipes, conforming to the requirements laid down earlier. The pipes shall be of the diameter shown on the drawings.

All traps on branch soil and waste pipes shall also be ventilated at a point not less than 75mm or more than 100mm from their highest part and on the side nearest to the soil pipe or waste pipes.

Access doors for fittings and clean outs shall be so located that they are easily accessible for repair and maintenance. Any access panel required in the civil structure, false ceiling or marble cladding etc. shall be clearly reported to the Owner in the form of shop drawings so that other agencies are instructed to provide the same.

All the fittings used for connections between soil, waste and ventilation pipes and branch pipes shall be made by using pipe fittings with inspection doors for cleaning. The doors shall be provided with 3mm thick rubber insertion packing and when closed and bolted shall be air and water tight.

Where soil, waste and ventilating pipes are accommodated in shafts ducts, adequate access to cleaning eyes shall be provided.

Head (starting point) of drains and sewage / wastewater sumps (as and where applicable) having a length of greater than 4 m up to it connection to the main drain or manhole shall be provided with a 80 / 100 mm vent pipe.

6.3 Piping Materials

6.3.1 UPVC SWR 'B' CLASS Pipes and Fittings

1. Wherever specified in BOQ un-plasticized Poly vinyl Chloride (UPVC) B class pipe or Ultra Violet Stabilized (UVS) pipes of high density conforming to IS: 13592 & IS 4985 shall be used for internal Kitchen / toilet / refuge area & down takes. UPVC type A shall be used for vent within plumbing shaft.
2. UPVC pipes shall be bent cold to a radius of not less than eight times their external diameter. Pipes bent for smaller radius may be made by not bending.
3. Fittings used for PVC pipes shall be compression moulded fittings matching the above specifications.
4. Jointing for UPVC pipes shall be made by means of solvent cement for detachable joints (or screwed joints). The type of joints used shall be as per the site condition/direction of the Project Manager. Where UPVC pipes are used for rain water pipes, the pipe shall be finished with G.I. adaptor for insertion in the RCC slab for a waterproof joint complete as directed by the Project Manager.

Note: Testing of pipes shall be done as per IS 12235.

6.3.2 Storage and Handling

PVC Pipes: The pipes should be given adequate support at all times. Pipes should be stored in a reasonably flat surface free from stones and sharp projection so that the pipe is supported throughout its length. In storage, pipes racks should provide continuous support and sharp corners of Metal Racks should be avoided. Socket and spigoted pipes should be stacked in layers with sockets placed at alternate ends of the stacks to avoid top sided stacks. It is recommended not to store pipe inside another pipe.

On no account pipes shall be stored in a stressed or bent condition or near the source of heat. Pipes should not be stacked more than 1.5M high and pipes of different sizes and classes should be stacked separately. The ends of pipes should be protected from abrasion particularly those specially prepared for jointing either by spigot or socket solvent welded joints or soldered for use with couplings. If due to unsatisfactory storage or handling a pipe becomes kinked' the damaged portion should be cut out completely.

6.3.3 Jointing Of Unplasticised P.V.C. Pipes:

Methods of Jointing:

- Solvent Welded Joints
- White cement & linseed oil mixture (Connection of U.P.V.C. to Cast Iron Pipes)
- Screwed or threaded Joints
- Rubber ring joints

6.3.4 Solvent Welded Joints

This technique is used with spigot and socket type joints, in which the socket is made specially to form a close fit on the pipe end and with injection moulded/fabricated fittings.

Solvent Cement of approved make shall be used as per the recommendations of the manufacturers. The dust, oil, water grease etc. should be wiped out with dry cloth from the surface to be coated with solvent cement. The coating of solvent cement shall be applied evenly on the inside of the fittings for full length of insertion and then on the outside of the pipe end up to the marked line and the pipe twisted to a quarter of a turn to spread the cement evenly at the same time ensuring the pipe, pushed home fully into the socket. The pipe should be pushed into the fitting socket and held for one to two minutes as otherwise the pipes comes out of the fitting due to slippery quality of cement and the tapering inside bore of the fitting.

The surplus cement on the pipe surfaces shall be wiped out. In most of the cases the pipe inserted should be up to the marked line and in no case shall be less than 2/5 of the diameter of the pipe and up to marked line.

When the joint is made, the remaining cement on the pipe surfaces shall be wiped off immediately without fail as the continued action of solvent cement will weaken the wall on the pipe and cause failure under pressure.

Since solvent cements are inflammable they should not be used near the naked flames. In certain cases, fumes given off from cement may be a source of danger if not carried in a well-ventilated area.

When not in use containers of cement should be kept closed tightly to avoid loss of solvent or entry of dirt. Cement which has gelled or hardened should be discarded and removed from site.

RUBBER RING JOINTS OR 'O' RING SHRINK JOINTS (SHAFT PIPING)

Unplasticized P.V.C. Pipe may be joined by employing approved rubber ring to provide the water tight seal. The ring may be housed in groove formed in a plastic or metallic housing. The rubber is compressed and makes a seal between the pipe and the housing.

UPVC Pipes to be connected to cast iron pipes shall be joined by using putty (mixture of white cement and linseed oil) as directed by Engineer-in-charge and as shown in the Drawing.

RAINWATER PIPES

All open terraces shall be drained by rain water down takes. Rainwater down takes are separate and independent of the soil and waste system and will discharge into the underground rainwater harvesting drainage system of the complex. Rainwater in open courtyards shall be collected in catch basins and connected to the Storm Water Drains. Any dry weather flow from waste appliances, e.g. AHU's pump rooms shall be connected to storm water drainage systems. Stp waste water sumps shall connected to waste water drainage after traps and not in the storm water drainage systems.

All rain water and fittings used within the plumbing shafts vertical run, shall be PVC pipes of SWR quality of pressure rating 6kg / sq. cm. They shall be made of polyvinyl chloride (UPVC) and shall be sound with good surface finish, mechanical strength and capacity.

During manufacture only those additives may be added to produce the above characteristics. No additives shall be added separately or together in quantities sufficient to constitute a toxic hazard, or impair the fabrication or welding properties of the pipe or impair its physical or chemical properties. All pipes shall be spigot and socket type.

I) Pipe Sizes and wall thickness:

Pipe dia (mm)	Wall Thickness (mm)
110mm	2.2mm
75mm	1.8mm

II) Tolerances:

Tolerances on diameters and wall thickness shall be as per IS 4985.

III) Fittings:

All fitting shall be injection moulded socket fittings with or without inspection doors as specified and shall be in accordance with the requirements of the relevant IS 7834. Pressure ratings and Tolerances shall be as per IS 4985.

BALCONY / PLANTER DRAINAGE

Wherever required, all balconies, terraces, planters and other frontal landscape areas will be drained by vertical down takes or other type of drainage system shown on the drawings and directed by the Project Manager.

6.3.5 TRAPS

Floor Traps

PVC Multi Inlet Floor Trap & Nahani trap as per drgs requirements of self-cleansing design molded or fabricated, with or without vent arm jointing with rubber ring / solvent cement followed by application of leak proof adhesive like FRP paste including making good the floors etc. The trap and waste pipes when buried below ground shall be set and encased in cement concrete blocks firmly supported on firm ground or when installed on a sunken RCC structural slab. The blocks shall be in 1:2:4 mix (1 cement: 2 coarse sand: 4 stone aggregate 20 mm nominal size).

FLOOR TRAP GRATING

Floor and urinal traps shall be provided with 100 – 150 mm square or round stainless steel gratings, with frame and rim of approved design and shape or as specified in the schedule of quantities approved by the Owner's site representative.

a) General: Provide traps on all fixtures connected to the waste system, except for fixtures having integral traps. All traps shall have a seal of not less than 40mm and not more than 100mm. All traps shall have the same internal diameter as the fixture's waste outlet.
b) Exposed Traps: Exposed traps for fixtures shall be heavy quality chromium plated cast brass.

6.3.6 Laying and Jointing

The pipes shall be laid and clamped to wooden plugs fixed above the surface of the wall. Alternatively plastic clamps of suitable designs shall be preferred. Provision shall be made for the effect of thermal movement by not gripping or disturbing the pipe at supports between the anchors for suspended pipes. The supports shall allow the repeated movements to take place without abrasion.

Jointing for UPVC pipes shall be made by means of solvent cement for horizontal lines and rubber ring 'O' for vertical line. The type of joint shall be used as per site conditions / direction of the Owner's site representative. Where UPVC pipes are to be used for rain water pipes, the pipe shall be finished with GI adopter for insertion in the RCC slab for a water proof joint complete as directed by Owner's site representative.

6.3.7 Supports

UPVC pipes require supports at close intervals. Recommended support spacing for unplasticised PVC pipes is 1400 mm for pipes 50 mm dia and above. Pipes shall be aligned properly before fixing them on the wooden plugs with clamps. Even if the wooden plugs are fixed using a plumb line, pipe shall also be checked for its alignment before clamping, piping shall be properly supported on, or suspended from clamps, hangers as specified and as required. The Contractor shall adequately design all the brackets, saddles, anchors, clamps and hangers and be responsible for their structural sufficiency. Pipe supports shall be primer coated with rust preventive paint. Repairs While temporary or emergency repairs may be made to the damaged pipes, permanent repairs shall be made by replacement of the damaged section. If any split or chip out occur in the wall of the pipe, a short piece of pipe of sufficient length to cover the damaged portion of the pipe is cut. The sleeve is cut longitudinally and heated sufficiently to soften it so that it may be slipped over the damaged hard pipe.

MAXIMUM DISTANCE BETWEEN SUPPORTS IN VERTICAL RUN

PIPE DIA.(mm)	25	32	40	50	65	80	100	150	200
DISTANCE (M)	3.0	3.0	3.6	3.6	4.5	4.5	4.5	4.5	5.0
U –BOLT	6mmø	6mmø	6mmø	8mmø	10mmø	10mmø	10mmø	16mmø	16mmø

MAXIMUM DISTANCE BETWEEN SUPPORTS IN HORIZONTAL RUN

PIPE DIA.(mm)	25	32	40	50	65	80	100	150	200
DISTANCE (M)	3.0	3.0	3.0	3.0	3.6	3.6	4.0	4.5	5.0
U –BOLT	8mmø	8mmø	8mmø	8mmø	10mmø	10mmø	12mmø	12mmø	12mmø
HANGER ROD	8mmø	8mmø	8mmø	8mmø	10mmø	10mmø	10mmø	12mmø	12mmø

6.4 Pipe Sleeves

Pipe sleeves, next larger diameter than pipes shall be provided wherever pipes pass through walls & slabs and annular space filled with fiberglass & finished with retainer rings. All pipes shall be accurately cut to the required sizes in accordance with relevant BIS codes and burrs removed before laying. Open ends of the pipe shall be closed as the pipe is installed to avoid entrance of foreign matter.

6.5 Pipe Protection

Cast iron soil and waste pipes under floor in sunken slabs and in wall chases (when cut specially for the pipe) shall be encased in cement concrete 1:2:4 mix (1 cement : 2 coarse sand : 4 stone aggregate of

12 mm size) 10 cm bed and around. When pipes are running well above the structural slabs, the encased pipes shall be supported with suitable cement concrete pillars of required height and size at intervals directed by the Project Manager.

6.6 Cutting and Making Good

Pipes shall be fixed and tested as building proceeds. The contractor shall provide all necessary holes, cutouts and chases in structural members as building work proceeds. Wherever holes are cut or left originally they shall be made good with cement concrete 1:2:4 (1 cement: 2 coarse sand : 4 stone aggregate 20 mm nominal size) or cement mortar 1:2 (1 cement : 2 coarse sand). Cured and the surface restored to original condition.

6.7 Testing

Testing shall be done in accordance with IS:1172 and IS:5329 except as may be modified herein under. Entire drainage system shall be tested for water tightness and smoke tightness during and after completion of the installation. No portion of the system shall remain untested. Contractor must have adequate number of expandable rubber bellow plugs, manometers, smoke testing machines, pipe and fitting work tests, All materials obtained and used on site must have manufacturer's hydraulic test certificate for each batch of materials used on the site.

Before use at site all CI pipes shall be tested by filling up with water for at least 30 minutes. After filling, pipes shall be struck with a hammer and inspected for blow holes and cracks. All defective pipes shall be rejected and removed from the site within 48 hours. Pipes with minor sweating may be accepted at the discretion of the Project Manager.

Soil and waste pipes shall be tested in sections after installation, by filling up the stack with water. All openings and connections shall be suitably plugged as approved by the Project Manager. The total head in the stack shall be 4.5 m at the highest point of the section under test. The period of test shall be minimum for 30 minutes or as directed by the Project Manager. If any leakage is visible, the defective part of the work shall be cut out and made good.

6.7.1 Water Test

a) Horizontal Piping – Full of Pipe with water with head of 1.50 Meter
b) Vertical Piping – Pouring of water in pipes & checking for leakage.

All C.I. Pipes & fittings including joints shall be tested by a smoke test and left in working order after completion. The smoke test shall be carried out as stated below:

Smoke shall be pumped into the drains at the lowest and from a smoke machine which consists of a Blower and a Burner. The materials usually burnt are greasy cotton waste which emits clear pungent smoke to be easily detectable by light as well as by smell if leaking at any point of the drain. During testing if any joint is found leaking the same shall be rectified by the contractor at no extra cost.

If tests are made with air, a pressure of not less than 1.5kg/sqcm shall be applied with a smoke machine and maintained for at least 15 minutes without leakage.

The contractor shall give a final smoke test for the entire system after the fixtures have been connected and their traps filled with water. Smoke shall be produced by a smoke machine and a pressure equal to 25mm water column shall be maintained for 15 minutes before inspection starts.

All soil, waste, vent and drainage piping shall be tested by the contractor and got approved before acceptance. Drainage and vent piping shall be tested with water or air before the fixtures are installed.

After the plumbing fixtures have been set and their traps filled with water, the entire system shall be submitted to a final water test.

Water test shall be applied to the drainage and venting system either in its entirety or in sections. If the entire system is tested, all openings in the pipes shall be tightly closed except the highest opening, and the system filled with water to the point of overflow. If the system is tested in sections, each opening except the highest opening of the section under test shall be tightly plugged and each section filled with water and tested with at least the upper 3m of the next preceding section shall be tested so that each joint or pipe in the building except the uppermost 3m of the system shall be submitted to a test of at least 3m head of water. The water shall be kept in the system or in the portion under test for at least 15 minutes before the inspection starts.

A test register shall be maintained and all entries shall be signed and dated by the Contractor and the Project Manager or his representative.

These tests shall not relieve the contractor from responsibility for leaks which may develop after the tests are made.

6.8 Painting

All pipes and fittings exposed shall be painted with 3 coats of anticorrosive paint as per identification colour code.

Soil, waste and vent pipes in exposed location, in shafts and pipe spaces shall be painted with 3 coats of anticorrosive paint as per identification color code**.** Before painting, all dust and extraneous matter shall be removed.

Paint shall be of approved make and quality and shade. Where directed pipes shall be painted in accordance with approved pipe color code.

Pipe in chase shall be painted with two coats of bitumen paint, covered with polythene tape and a final coat of bitumen paint. Exposed pipes shall be painted with one or two coats of synthetic enamel paint after removing dust end extraneous matter.

C.I. soil and waste pipes below ground and covered cement concrete pipes shall not be painted.

7 COMMISSIONING AND GUARANTEE

7.1 SCOPE OF WORK:

Work under this section shall be executed without any additional cost. The rates quoted in this tender shall be inclusive of the works given in this section.

Contractor shall provide all tools, equipment, metering and testing devices required for the purpose.

On award of work, contractor shall submit a detailed proposal giving methods of testing and gauging the performance of the equipment to be supplied and installed under this contract.

All tests shall be made in the presence of the Engineer-in-Charge or his representative or any inspecting authority. At least five working days notice in writing shall be given to the inspecting parties before performing any test.

Water flow rates of all equipment and in pipe lines through valves shall be adjusted to design conditions. Complete results of adjustments shall be recorded and submitted.

Contractor shall ensure proper balancing of the hydraulic system and for the pipes / valves installed in his scope of work by regulating the flow rates in the pipeline by valve operation. The contractor shall also provide permanent tee connection (with plug) in water supply lines for ease of installing pressure gauge, temperature gauge and rotameters. Contractor shall also supply all required pressure gauge, temperature gauge and rotameters for system commissioning and balancing. The balancing shall be to the satisfaction of consultant / project manager.

Three copies of all test result shall be submitted to the engineer in A4 size sheet paper within two weeks after completion of the tests.

7.2 Pre-commissioning

On completion of the installation of all pumps, piping, valves, pipe connections, installation etc., the contractor shall proceed as follows:

a)	Prior to start – up and hydraulic testing, the contractor shall clean the entire installation including all fitments and pipe work and the like after installation and keep them in a new condition. All pumping systems shall be flushed and drained at least once through to get rid of contaminating materials. All pipes shall be rodded to ensure clearance of debris, cleaning and flushing shall be carried out in sections as the installation becomes completed.
b)	All strainers shall be inspected and cleaned out or replaced.
c)	When the entire systems are reasonably clean, a pre – treatment chemical shall be introduced and circulated for at least 8 hours. Warning signs shall be provided at all outlets during pre – treatment. The pre – treatment chemical shall:
	Remove oil, grease and foreign residue from the pipe work and fittings.
	Pre – condition the metal surfaces to resist reaction with water or air.
	Establish an initial protective film.
	After pre – treatment, the system shall be drained and refilled with fresh water and left until the system is put in to operation.

	Details and procedures of the pre – treatment shall be submitted to the Engineer-in-Charge for approval.
d)	Check all clamps, supports and hangers provided for the pipes.
e)	Check all the equipment, piping and valves coming under hot water system and operate each and every valve on the system to see if the valves are functioning properly. There after conduct and hydro test of the system as for (b) above.
f)	Fill up pipes with water and apply hydrostatic pressure to the system as given in the relevant section of the specification. If any leakage is found, rectify the same and retest the pipes.

8 STATUTORY AUTHORITIES TESTS AND INSPECTIONS:

As and when notified in writing or instructed by the Engineer-in-Charge, the contractor shall submit shop drawing and attend all tests and inspections carried out by local fire authorities, water authority and other statutory authorities, and shall forth with execute free of charge any rectification work ordered by the Engineer-in-Charge as a result of such tests and inspections where these indicate non – compliance with statutory regulations. Some of these tests may take place after the issue of practical completion of the main contract and the contractor shall make all allowances in this respect.

The contractor shall be responsible for the submission of all necessary forms and shop drawings to the statutory authorities, which shall conform in layout to the latest Engineer-in-Chargeural plans submitted to and kept by these authorities.

Fixing screws shall be half round head chromium plated (CP) brass screws, with CP brass washers unless otherwise specified.

Fixtures shall be installed by skilled workman with appropriate tools according to the best trade practice.

All appliances, fittings and fixtures shall be fixed in a neat workman like manner true to level and to heights shown on the drawings and in accordance with the manufactures recommendations. Care shall be taken to fix all inlet and outlet pipes at correct positions. Faulty locations shall be made good and any damage to the finished floor, tiling, plaster, paint, insulation or terrace shall be made good by the contractor at his own cost. Fixtures shall be mounted rigid, plumb and true to alignment.

All materials shall be rustproof Materials in direct or indirect contact shall be compatible to prevent electrolytic or chemical (bimetallic) corrosion.

Wall flanges shall be provided on all walls, floors, columns etc. wherever supply and disposal pipes pierce through them. These wall caps shall be of chromium plated brass fittings and the receiving pipes and shall be large enough to cover the punctures properly.

Sanitary appliances, subject to the type of appliance and specific requirements, shall be fixed in accordance with the relevant standards and the following:

a)	Contractor shall, during the entire period of installation and afterwards protect the appliances by providing suitable cover or any other protection so as to absolutely prevent any damage to the appliances until handing over (the original protective wrapping shall be left in position for as long as possible).
b)	The appliances shall be placed in correct position or marked out in order that pipe work can be fixed or partially fixed first.
c)	The appliance shall be fixed in a manner such that it will facilitate subsequent removal if necessary.
d)	The appliance shall be securely fixed. Manufacturer's brackets and fixing methods shall be used wherever possible. Compatible rust – proofed fixings shall be used. Fixing shall be done in a manner that minimize noise transmission.
e)	Appliances shall not be bedded (e.g. WC pans, pedestal units) in thick strong mortar that could crack the unit (e.g. ceramic unit)

f)	Pipe connections shall be made with demountable unions. Pipe work shall not be fixed in a manner that it supports or partially supports and appliance.

The submission shall comply with the requirements set forth in the current codes of practice and circular letters of the statutory authorities. The shop drawings to be submitted shall be forwarded to the Engineer-in-Charge for checking before submission.

The contractor shall allow for at least two submissions of complete sets of shop drawings to the authorities, one to be made within six months after the award of the contract but not less than six weeks before the inspection. The Engineer-in-Charge may at his discretion instruct the contractor for additional submissions to the local authorities wherever necessary.

The contractor shall notify the Engineer-in-Charge at least seven days in advance of his application for local authority tests and inspections. On receipt of a confirmed date for test and inspection the contractor shall inform the Engineer-in-Charge without delay.

8.1 Maintenance (Defects Liability Period)

All work required during the defects liability period including work of obtaining clearances and repair of damage to property becoming evident during the defects liability period shall be carried out before final certification and the defects liability period shall be extended accordingly.

During the maintenance period the Contractor shall attend to all emergency calls as quickly as possible. If during the maintenance period the Contractor does not promptly attend to the emergency, the Council reserves the right to engage others to rectify the problem and recover costs from the Contractor.

During the maintenance period, if it is found that theft or vandalism has occurred, the cost of the works required to repair the damage shall be borne by the Council. All such cases shall be immediately reported to the Project Manager.

In the event of any defective work not being rectified within 2 working days (or shorter time if conditions are created that are hazardous to persons or the irrigated area) of the need arising, the Council may have the same work carried out by others and the cost will be deducted from any moneys due to the Contractor under this Contract.

8.2 Final Acceptance Tests

Following commissioning and inspection of the entire installation, and prior to issue of the completion certificate, the contractor shall carry out final acceptance test in accordance with a programme to be agreed with the Engineer-in-Charge.

Should the results of the acceptance tests show that plant, systems and / or equipment fail to perform it the efficiencies or other performance figures as given in this specification, the contractor shall adjust, modify and if necessary replace the equipment without further payment in order that the required performance is obtained.

Where acceptance tests are required by the relevant authorities having jurisdiction, these tests shall be carried out by the contractor prior to the issue of completion certificate to the acceptance of the authorities.

8.3 Rejection of Installation / Plant

Any items of plant or system or component which fails to comply with the requirements of this specification in any respect whatsoever at any stage of manufacture, test, erection or on completion at site may be rejected by the Engineer-in-Charge either in whole or in part as he considers necessary / appropriate.

Adjustment and / or modification work as required by the Engineer-in-Charge so as to comply with the authority's requirements and the intent of the specification shall be carried out by the contractor at his own expense and to the satisfaction of the authority / Engineer-in-Charge.

After works have been accepted, the contractor may be required to carry out assist in carrying out additional performance tests as reasonably required by the Engineer-in-Charge / employer.

8.4 Warranty and Handover

The contractor shall warrant that all plant, materials and equipment supplied and all workmanship performed by him to be free from defects of whatsoever nature before handover to the owner.

8.5 Handing over of Documents

All testing and commissioning shall be done by the contractor to the entire satisfaction of the owner's site representative and all testing and commissioning documents shall be handed over to the owner's site representative.

The contractor shall also hand over all maintenance and operation manuals, all certificates and all other documentation as per the terms of the contract to the owner's site representative.

9 LIST OF BUREAU OF INDIAN STANDARDS CODES:

All equipment, supply, erection, testing and commissioning shall comply with the requirements of Indian Standards and code of practices given below:

9.1 General

SP: 6 (1)	Structural steel sections
IS: 27 IS: 325 IS: 554	Pig Lead Three phase induction Motors Dimensions for pipe threads where pressure tight joints are required on the threads.
IS: 694	PVC insulated cables for working voltages unto & including 1 100 V.
IS: 779	Specification for water meters (domestic type).
IS: 782	Specification for caulking lead.
IS: 800	Code of practice for general construction in steel
IS: 1068	Electroplated coatings of nickel plus chromium and copper plus nickel plus chromium.
IS: 1172	Code of Basic requirements for water supply drainage and sanitation.
IS: 1367(part1)	Technical supply conditions for threaded steel fasteners: part 1 Introduction and general information.
IS: 1367(part2)	Technical supply conditions for threaded steel fasteners: part 2 product grades and tolerances.
IS: 1554(part1	PVC insulated (heavy duty) electric cables: part 1 for working voltages unto and including 1 100 V.
IS: 1554(part2)	PVC insulated (heavy duty) electric cables: part 2 for working voltages from 3.3 KV up to and including 11 KV.
IS: 1726	Specification for cast iron manhole covers and frames.
IS: 1742	Code of practice for building drainage.
IS: 2064	Code of practice selection, installation and maintenance of sanitary appliance.
IS: 2065	Code of practice for water supply in buildings.
IS: 2104	Specification for water meter for boxes (domestic type)
IS: 2373	Specification for cater meter (bulk type)
IS: 2379	Color code for identification of pipelines
IS: 2527	Code of practice for fixing rainwater gutters and down pipes for roof drainage.
IS: 2629	Recommended practice for hot dip galvanizing on iron and steel.
IS: 3114	Code of practice for laying of cast iron pipes
IS: 4111(Part–1)	Code of Practice for ancillary structures in sewerage system: part 1 manhole.

IS: 4127	Code practice for laying glazed stoneware pipes.
IS: 4853	Recommended practice for radiographic inspection of fusion welded butt joints in steel pipes.
IS: 5329	Code of practice for sanitary pipe work above ground for buildings.
IS: 5455	Cast iron steps for manholes.
IS: 6159	Recommended practice for design and fabrication of material, prior to galvanizing.
IS: 7558	Code of practice for domestic hot water installations.
IS: 8321	Glossary of terms applicable to plumbing work.
IS: 8419(part-1)	Requirements for water filtration equipment: Part 1 filtration medium sand and gravel.
IS: 8419 (part-2)	Requirements for water filtration equipment: part 2 under drainage system.
IS: 9668	Code of practice for provision and maintenance of water supplies and fire fighting.
IS: 9842	Preformed fibrous pipe installation.
IS: 9912	Coal tar based coating materials and suitable primer for protecting iron and steel pipelines.
IS: 10221	Code of practice for coating and wrapping of underground mild steel pipelines.
IS: 10446	Glossary of terms relating to water supply and sanitation.
IS: 11149	Rubber Gaskets.
IS: 11790	Code of Practice for preparation of butt – welding ends for pipes, valves, flanges and fittings.
IS: 12183 (part – 1)	Code of practice for plumbing in multistoried buildings: part 1 water supply
IS: 12251	Code of practice of drainage of building basements.
IS: 5572	Code of practice for sanitary pipe work.
BS: 6700	Specification for design, installation, testing and maintenance of services supplying water for domestic use within buildings and their cartilages.
BS:8301	Code of practice for building drainage.
BSEN: 274	Sanitary tap were, waste fittings for basins, bidets and baths. General technical specifications.

9.2 Pipes and Fittings

IS: 458	Specification for per cast concrete pipes (with and without reinforcement)
IS: 651	Salt glazed stone ware pipes and fittings
IS: 1239 (part –1)	Mild steel tubes, tubular and other wrought steel fittings part 1 mild steel tubes.
IS: 1239(part-2)	Mild steel tubes, tubular and other wrought steel fittings part 1 mild steel tubes.
IS: 1536	Centrifugally cast (spun) iron pressure pipes for water, gas and sewage.
IS: 1537	Vertically cast iron pressure pipes for water, gas and sewage.
IS: 1538	Vertically cast iron pressure pipes for water, gas and sewage.
IS: 1729	Sand cast iron spigot and socket soil, waste and ventilating pipes, fittings and accessories.
IS: 1879	Malleable cast iron pipe fittings.
IS: 1978	Line pipe.
IS: 1979	High test line pipe
IS: 2501	Copper tubes for general engineering purposes.
IS: 2643 (part –1)	Dimensions for pipe threads for fastening purposes Part 1 basic profile and dimensions.
IS: 2643(part -2)	Dimensions for pipe threads for fastening purposes Part 2 Tolerances.
IS: 2643(part-3)	Dimensions for pipe threads for fastening purposes Part 3 limits of sizes.
IS: 3468	Pipe nuts
IS: 3589	Seamless or electrically welded steel pipes for water, gas and sewage (168.3 mm to 2032 mm outside diameter).
IS: 3989	Centrifugally cast (sun) iron spigot and socket soil, waste and ventilating pipes, fittings and accessories.
IS: 4346	Specifications for washers for use with fittings for water services.
IS: 4711	Methods for sampling steel pipes, tubes and fittings.
IS: 6392	Steel pipe flanges
IS: 6418	Cast iron and malleable cast iron flanges for general engineering purposes.
IS: 7181	Specification for horizontally cast iron double flanged pipe for water gas and sewage.

9.3 Valves

IS: 778	Specification for copper alloy gage, globe and check valves for water works purposes.

IS: 780	Specification for sluice valves for water works purposed (50 mm to 300 mm size).
IS: 1703	Specification copper alloy float valves (horizontal plunger type) for water supply fittings.
IS: 2906	Specification for surface valves for water works purposes (350 mm to 1200 mm size)
IS: 3950	Specification for surface boxes for sluice valves.
IS: 5312 (part-1)	Specification for swing check type reflux (non-return) valves part 1 muilti door Pattern
IS: 5312 (part-2)	Specification for swing check type reflux (non return) valves part 1 muilti door pattern.
IS: 12992 (part - 1)	Safety relief valves, spring loaded design.
IS: 13095	Butterfly valves for general purposes.

9.4 Sanitary Fittings

IS: 771(part to 3)	Specification for glazed fire clay sanitary appliances.
IS: 744	Specification for flushing cistern for water closets and urinal (other than plastic cistern)
IS: 775	Specification for cast iron brackets and supports for wash basins and sinks
IS: 781	Specification for cast copper alloy screw down bib taps and stop valves for water services.
IS: 1700	Specification for drinking fountains.
IS: 2548 (part –2)	Specification for plastic seats and covers for water closets part 1 thermo set seats and covers.
IS: 2556 (part -1)	Specification for vitreous sanitary appliances (vitreous china) part 1 general requirement.
IS: 2556 (part -2)	Specification for vitreous sanitary appliances (vitreous china) part 2 specific requirements of wash – down water closets.
IS: 2556 (part -3)	Specification for vitreous sanitary appliances (vitreous china) part 3 specific requirements of squatting pans.
IS: 2556 (part -4)	Specification for vitreous sanitary appliances (vitreous china) part 2 specific requirements of washbasins.
IS: 2556 (part 6 Sec 2)	Specification for vitreous sanitary appliances (vitreous china) part 3specific requirements of urinals, section 2 half stall urinals.
IS: 2556 (part 6 Sec 4)	Specification for vitreous sanitary appliances (vitreous china) part 4 specific requirements of urinals, section 4 partition slabs.

IS: 2556 (part 6 Sec 5)	Specification for vitreous sanitary appliances (vitreous china) part 5 specific requirements of urinals, section 5waste fittings.
IS: 2556 (part 6 Sec 6)	Specification for vitreous sanitary appliances (vitreous china) part 6 specific requirements of urinals, section 6 water spreaders for half stall urinals.
IS: 2556 (part -7)	Specification for vitreous sanitary appliances (vitreous china) part 7 specific requirements of half round channels.
IS: 2556 (part -8)	Specification for vitreous sanitary appliances (vitreous china) part 8 specific requirements of siphoning wash down water closets.
2556 (part -7)	Specification for vitreous sanitary appliances (vitreous china) part 11 specific requirements of shower rose.
IS: 2556 (part -12)	Specification for vitreous sanitary appliances (vitreous china) part 12 specific requirements of floor traps.
IS: 2556 (part -15)	Specification for vitreous sanitary appliances (vitreous china) part 15 specific requirements of universal water closet.
IS: 2692	Specification for ferrule for water services.
IS: 2717	Glossary of terms relating to vitreous enamel ware and ceramic metal system.
IS: 2963	Specifications for waste plug and its accessories for sinks and wash basins.
IS: 3311	Specification for waste plug and its accessories for sinks and wash basins.
IS: 5961	Specification for cast iron gratings for drainage purposes.
IS: 6249	Specification for gel-coated glass fiber reinforced polyester resin bath tubs.
IS: 6411	Specification for gel-coated glass fiber reinforced polyester resin bath tubs.
IS: 8931	Specification for copper alloy fancy single taps, combination tap assembly and stop valves for water services.
IS: 9758	Specification for flush valves and fitting for water closets and urinals.

9.5 Water Quality Tolerance:

IS: 3025 (part 1to 44)	Method of sampling and test (physical and chemical) for water and waste water.
IS: 4764	Tolerance limits for sewages effluents discharged into island surface waters.
IS: 10500	Drinking water

9.6 Pumps and Vessels:

IS: 1520	Specification for horizontal centrifugal pumps for clear cold fresh water.
IS: 2002	Steel plates for pressure vessels for intermediate and high temperature service including boilers.

IS: 2825	Code of unfired pressure vessels.
IS: 4648(part -1)	Code of practice for lining of vessels and equipment for chemical processes part 1 Rubber lining.
IS: 5600	Specification for sewage and drainage pumps.
IS: 8034	Specification for submersible pump sets for clear, cold, fresh water.
IS: 8418	Specification for horizontal centrifugal self priming pumps.

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TECHNICAL SPECIFICATION

ELECTRICAL

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1 GENERAL INSTRUCTIONS FOR ELECTRICAL WORKS

1.1 Preamble:

The scope of this section is to describe materials and systems for electrical installation works which form together with the project documents, a complete volume of work and quality description.

All electrical installations shall be of high quality, safe, complete and fully operational including all necessary items and accessories whether or not specified in details. All electrical works shall be completed in accordance with the regulations and standards as per the statutory requirement to the satisfaction of the Employer. The general provisions, special provisions and general requirements apply to all items of this specification.

The work shall be carried out simultaneously with landscape work, civil work, etc. and shall be continued till it is completed satisfactorily along with the completion of essential portions of the building works.

During the progress of work, completed portion of the building may be occupied and be put to use by Employer but the contractor will remain fully responsible for the maintenance of electrical installations till the entire work covered by this contract is satisfactorily completed by contractor and handed over to Employer.

It is the intention of the specification and drawings to call for finished work, tested and ready for operation. Whenever the words “Supply” or “Provide” are used, it shall mean delivery of material as specified in an assembled manner, ready for installation. Any apparatus, material or work not shown on drawings but mentioned in the specification or vice versa, or any incidental accessories necessary to make the work complete and perfect in all respects and ready for operation, even if not particularly specified, shall be furnished, delivered and installed by the contractor without additional expenses to Employer. Minor details not usually shown or specified, but necessary for the proper installation and operation, shall be included in the work and in the contract.

Civil Contractor shall provide the MOU signed with Lighting supplier vendors (Government Approved) with Technical bid during bidding process.

1.2 Interpretation of Project Documents

The Specification, Drawings and Bill of quantity (BoQ) shall be interpreted in accordance with good installation practice defined in the appropriate regulations and standards whether specifically referred to or not. If there are any discrepancies or shortfall in the application of the regulations to any aspect of this contract or the contractor considers there is anything detrimental to the standards or inconsistent with his obligations and guarantees, Employer shall be informed prior to signing the contract and thereafter inform the contractor in writing the course to be followed. Where the drawings are to a small scale or are expressed in symbolic terms or are in the form of a diagram, then exact location of items shall not be inferred and in all cases, the work shall be fully integrated with the work of other traders and with the fabric of the building. The contractor shall appraise the duties of all plants and equipments taking account of any additions or variations and shall inform the Employer of any matters which may affect the design. In all cases the equipment installed shall be of appropriate rating for the duty it performs.

The Specifications and bill of quantity shall be considered as part of this contract and any work or material shown on BOQ and not called for in the specification or vice versa, shall be executed as if specifically called for in both.

If any discrepancy is noticed between General Conditions of Contract, specification, Bill of quantity and Drawings, the most stringent of the above shall apply. Bill of quantities, for electrical items, shall be read in conjunction with respective specification. However, in case of conflict between bill of quantities and the specification, former shall govern.

1.3 System Particulars

LV	:	433 V, 3 Phase, 4 wire, 50 Hz.
Neutral earthing	:	Solid

1.4 Abbreviations

The following abbreviations have been used in the accompanying specifications, drawings and bill of quantity.

IS	:	Indian Standard
BS	:	British Standard
HRC	:	High Rupturing Capacity
GI	:	Galvanised Iron
CU	:	Copper
MS	:	Mild Steel
MV	:	Medium Voltage
LV	:	Low Voltage
PVC	:	Polyvinyl Chloride
AMP	:	Amperes
V	:	Volts
KV	:	Kilo Volts
HV	:	High Voltage
KW	:	Kilo Watt
KVA	:	Kilo Volt Ampere
PF	:	Power Factor
Hz	:	Frequency
KWH	:	Kilo Watt Hour
XLPE	:	Cross Linked Polyethylene
ACB	:	Air Circuit Breaker
LED	:	Light Emitting Diode
PLC	:	Programmable Logic Controller
UPS	:	Uninterrupted Power Supply DP
	:	Double Pole
IEE	:	Institute of Electrical Engineers, London

MCB	:	Miniature Circuit Breaker
TPN	:	Triple Pole and Neutral
SP	:	Single Pole
MCCB	:	Moulded Case Circuit Breaker
VCB	:	Vacuum Circuit Breaker
CT	:	Current Transformer
DB	:	Distribution Board
DG	:	Diesel Generator
BOQ	:	Bill of quantity
SITC	:	Supply, Installation, Testing and Commissioning
L.O.I.	:	Letter of Intent / Acceptance letter
ELV	:	Extra Low Voltage System
MP	:	Mega Pixels
CCTV	:	Close Circuit Television
PA	:	Public Address System
FACP	:	Fire Alarm Control Panel
NVR	:	Network Video Recorder
NVMS	:	Network Video Monitoring Software

1.5 Regulations and Standards

The installation shall conform in all respects to Indian Standard Code of Practice for Electrical Wiring Installation IS: 732-1983 and IS: 2214 – 1983 (Silver Nitrate Pure and analytical reagent). It shall also be in conformity with the current Indian Electricity, Rules, Indian Electricity Act, National Electrical Code and Regulations of the Local Electrical Supply Authority in so far as these become applicable to the installation. Wherever this specification calls for a higher standard of material and/or workmanship than those required by any of the above regulations then this specification shall take precedence over the said regulations and standard. In general, the materials equipment and workmanship not covered by the above shall conform to the relevant Indian Standards.

The electrical installation work shall follow Codes, Indian Standard specifications and rules (Within the best meaning of the same) under this contract.

The following list is given for general guidance only in addition to list given in each individual section, however all other latest editions of Codes, Indian Standard specifications and Rules shall also be followed when it is required.

i. IS: 8623 Low voltage switchgear & control gear assemblies

ii. IS: 10118 Code of Practice for selection, installation and maintenance of switchgear and control gear

iii. IS: 4237 General requirement for switch gear and control gear for Voltage not exceeding 1000 Volt A.C. or 1200 Volt D.C.

iv. IS: 13947 Low voltage switchgear and control gear IS: 9224 Low voltage fuses

v. IS: 8828 Circuit breakers for out protection for household and similar installations

vi. IS: 12640 Earth leakage circuit breaker

vii. IS: 1248 direct acting indicating analog electrical measuring Instruments

viii. IS: 2705 Current transformers

ix. IS: 4201 Application guide for voltage transformers

x. IS: 6875 Control switches for voltage up to and indicating 1000 V

a. A.C. and 1200 V D.C.

xi. IS: 5578 Guide for marking of insulated conductors

xii. IS: 11353 Guide for uniform system of marking and identification of Conductors and apparatus transmission

xiii. IS: 8197 Terminal markings for electrical measuring instruments and their accessories

xiv. IS: 694 Specifications for PVC insulated cables for working Voltage up to and including 1100 volts

xv. IS: 2551 Danger notice plates

xvi. IS: 3043 Code of practice for earthing

xvii. IS: 5216 Guide for safety procedures and practices in electrical work

xviii. IS: 1646 Code of practice for fire safety of building: Electrical Installation

xix. Indian Electricity Act as amended up to date

xx. Indian Electricity Rules as amended up to date

xxi. Rules and Regulations of Bombay Regional Council of Fire Insurance & Association of India for Electrical wiring.

1.6 Fees, Permits and Tests

The Contractors shall pay for any and all fees and obtain permits required for the installation work. On completion of the work, the contractor shall obtain and deliver to the Employer, certificates of final inspection and approval by the local electric supply authority and the Electrical Inspector.

1.7 Actual Route of Cable

The location of the cables, panel boards etc. is only indicative, therefore, the actual route of cables and the location of panel boards may differ from the plans according to the details of the building construction and the conditions of executions of the installations.

The contractor shall supply and install at his expense all secondary materials and special fittings found necessary to overcome the interference and to supply the modifications on the route of cables and conduits that are found necessary during the work, to the complete satisfaction of the Employer's representative.

1.8 Material and Equipment

All material and equipment shall conform to the relevant standards and shall be new, good quality, of the approved make and design. The materials and equipment shall confirm to relevant Indian Standards. The Contractor shall be responsible for the safe custody of all materials and shall insure them against theft, damage by fire, earthquake etc. A list of items of materials and equipment, together with sample of each shall be submitted to the Employer within 10 days of the award of the contract. Any item which is proposed as a substitute, shall be accompanied by all technical details giving sizes, particular of materials and the manufacturer's name and shall be submitted along with the tender or bid offer. At the time of the submission of proposed substitute the Contractor shall state the credit, if any due to the Employer. In the event the substitution is approved, all changes and substitutions shall be requested in writing and approvals obtained in writing from Employer. Employer's decision in the matter shall be final.

All materials of the same kind of service shall be identical and made by the same manufacturers. Any deviation to this rule shall be approved by the Consultant. Top priority shall be given to the products that have a permanent agent providing spare parts and maintenance facilities in the same city where the project is situated.

The make of electrical equipments, components, accessories etc. have been mentioned in Tender document. However, Client / Electrical Consultant reserves the right to select from the specified make. Contractor shall clearly indicate in the bid document, the make they have considered. No extra claim shall be applicable if client / consultant suggests from the alternative make specified in the tender document.

1.9 Manufacturers

Where manufacturers have furnished specific instructions relating to the materials used in this job, covering points not specifically mentioned in these documents, these instructions shall be followed in all cases.

Where manufacturer's names and/or catalogue numbers are given, this is an indication of the quality, standards and performance required.

When interfacing occurs, equipment shall be mutually compatible in all respects.

1.10 Rating

Rating of all items shall be appropriate for the conditions on the particular site on which the items will be used. All the equipment shall be fit for continuous work under the worst conditions of site and shall be rated for the following ambient condition.

- Outdoor temperature 50 deg.c.
- Temperature under shed 45 deg.c.
- Salty, dusty and humid
- Coastal area

1.11 Inspection and Testing

Employer's representative reserves the right to request inspection and testing at manufacturer's works at all reasonable times for this contract. Tests on site of completed works shall demonstrate, among other things:

1. That the equipment installed complies with specification in all particulars and is of the correct rating for the duty and site conditions.
2. That all items operate efficiently and quietly to meet the specified requirements.
3. That all circuits are correctly fused and protected and that protective devices are properly co-ordinated.
4. That all non-current carrying metal work is properly and safely grounded in accordance with the specifications.
5. The contractor shall provide all necessary instruments and labour for testing, shall make adequate records of test procedures and readings, shall repeat any tests requested by the Employer and shall provide test certificates signed by a properly authorised person. Such test certificates shall cover all works.
6. If tests fail to demonstrate the satisfactory nature of the installation or any part thereof then no claims for the extra cost of modifications, replacements or re-testing will be considered. Employer's decision as to what constitutes a satisfactory test shall be final.
7. The above general requirements as to testing shall be read in conjunction with any particular requirements specified elsewhere.

1.12 Test certificates

The contractor shall submit test certificates for all the electrical material / system installed. These shall be issued by a government recognized inspection office certifying that all equipment, materials, construction and functions are in agreement with the requirements of these specifications, ISI and when ISI is not applicable other approved certifying agencies.

1.13 Instruction Manual

The contractor shall prepare and produce instruction, operation and maintenance manuals in English for the use, operation and maintenance of the supplied equipment and installations, and submit 3 sets to Employer, at the time of handing over.

1.14 Samples and Catalogues

Before ordering the material necessary for these installations, the contractor shall submit to Employer for approval, a sample of every kind of material such as cables, conductors, conduits, switches, socket outlets, circuit breakers, lighting fixtures, boxes etc. along with the catalogues.

For big items such as switchboards, the submission of catalogues shall be enough. Prior to ordering any electrical equipment / material / system, the contractor shall submit to Employer, the catalogues, along with the samples, at least from three different manufacturers. After the selection of manufacturer by Employer, the contractor shall arrange inspection and testing at the manufacturer's factory or assembly shop for final approval. No material shall be procured prior to the approval of the Electrical consultant & Data sheets shall be signed and stamped by consultant and one copy to be submitted to Client.

1.15 Vendor and Shop Drawings

The contractor shall prepare and submit to Employer, for his approval, two sets of vendor detailed drawings of all distribution boards, switch boards, outlet boxes, special pull boxes and other likewise material, equipment to be fabricated by the contractor, or other vendor within 15 days of signing of the contract.

Before starting the work, the contractor shall submit to Employer for his approval in the prescribed manner, the shop / execution drawings for the entire installation, specially the main connections and junctions, the route of conduits and cables, no. and size of wires drawn through the conduits, location of all the outlet points, and switch boards and distribution boards and any other information required by Employer. Employer reserves the right to alter or modify these drawings if they are found to be insufficient or not complying with the established technical standards or if they do not offer the most satisfactory performance or accessibility for maintenance.

1.16 AS BUILT Drawings

At the completion of work and before issuance of certificate of virtual completion the contractor shall submit to Employer, three sets of layout drawing drawn at appropriate scale indicating the complete wiring system “as installed”. These drawings must provide (in plan, folded elevation and section);

a) Location and details of distribution boards, main switches, switchgear and other particulars.
b) Location of all earthing stations, route and size of all earthing conductors, manholes etc.
c) Route and particulars of all cables.
d) Lighting layout plans with conduit routing layout/cable tray for all the floors along with circuit distribution details.
e) External Area Lighting Plan

1.17 Guarantee

At the close of the work and before issuance of final certificate of virtual completion by Employer, the contractor shall furnish written guarantee indemnifying Employer against defective materials and workmanship for a period of one year after completion. The contractor shall hold himself fully responsible for reinstallation or replacement, free of cost to Employer, the following:

a) Any defective work or material supplied by the contractor.

b) Any material or equipment supplied by Employer, which is damaged or destroyed as a result of defective workmanship by the contractor.
c) Any material or equipment damaged or destroyed as a result of defective workmanship by the contractor.

1.18 Special Notes for Bidder

a) All the major electrical components like Transformers, DGs, HT MV LT switchgears, DBs, UPS, etc including the external & internal electrical distribution system, earthing systems & various equipment (which is supplied &/or installed by the contractor) shall be maintained for 2 years from the date of virtual completion of work at free of cost.

b) The contractor should cooperate & coordinate for LT connections to LT panel board of various blocks, so that day-to-day work should not suffer.

c) It is in the scope of the Contractor to preparing necessary drawing submitting to authorities (i.e. Local supply co., pollution control board, Electrical Inspector, etc), getting their approval / sanction and final certificate to energize the sub-station equipment's. Filling the necessary application to supply co. following up and getting the supply filling the necessary test report to the supply co. inclusive. All official / statutory fees shall be paid by clients & all other required expenses shall be on the contractors account; no extra payment shall be paid to contractor for said job.

d) LT Panels shall be approved on site by Engineer in Charge & Electrical Consultant.

e) Contractor shall submit Shop drawings for approval to Electrical consultant based on tender drawings before execution which shall not be on chargeable basis.

f) The MCB and MCB DBs must be of same make.

g) Make of components required to be used by contractor to complete the installation, if not mentioned anywhere, shall be required to GOT IT APPROVED by Client/Engineer-in-Charge/Consultant before installation in writing manner.

h) Within a week of work order, the contractor shall submit the sample of each item / component of above mentioned approved make for the approval of the Client/Engineer-in-Charge/Consultant

2 TECHNICAL SPECIFICATION FOR LT PANELS

2.1 SCOPE OF WORK

1. Main Distribution Panels, Sub-Distribution Panels and Final Distribution shall be covered under this section. Panels/Boards shall be suitable for operation on 3 Phase/single phase, 415/240 volts, 50 cycles, 4 wire system with neutral grounded at transformer. All Distribution panels shall be CPRI tested design and manufactured by an approved manufacturer. CPRI certificate shall be made available.
2. Distribution panels shall comply with the latest Relevant Indian Standards and Electricity Rules and Regulations and shall be as per IS-13947-1991.

2.2 Construction Features

1. Distribution panels shall be 2 mm thick sheet steel cabinet for indoor installation, dead front, floor mounting/wall mounting type and shall be form as per site construction requirements.
2. The Distribution panels shall be totally enclosed, completely dust and vermin proof and shall be with hinged doors and folded covers, Neoprene gasket, padlocking arrangement and bolted back.
3. All removable/ hinged doors and covers shall be grounded by flexible standard connectors.
4. Distribution panel shall be suitable for the climatic conditions as specified in Special Conditions. Steel sheets used in the construction of Distribution panels shall be 2 mm thick and shall be folded and braced as necessary to provide a rigid support for all components.
5. Joints of any kind in sheet metal shall be seam welded, all welding, slag shall be rounded off and welding pits wiped smooth with plumber metal.
6. The general construction shall confirm to IS-8623-1977 (Part-1) for factory built assembled switchgear & control gear for voltage up to and including 1100 V AC.
7. All panels and covers shall be properly fitted and square with the frame, and holes in the panel correctly positioned.
8. Fixing screws shall enter into holes tapped into an adequate thickness of metal or provided with wing nuts.
9. Self threading screws shall not be used in the construction of Distribution panels.
10. A base channel of 75 mm x 40 mm x 5 mm thick shall be provided at the bottom for floor mounted panels.
11. Minimum operating clearance of 300 mm shall be provided between the floor of Distribution panels and the lowest feeder compartment.
12. Distribution panels shall be of adequate size with a provision of spare switchgear as indicated on the Single Line Diagram. Feeders shall be arranged in multi-tier.
13. Knockout holes of appropriate size and number shall be provided in the Distribution panels in conformity with the location of cable/conduit connections.
14. Removable sheet steel plates shall be provided at the top to make holes for additional cable entry at site if required.
15. Every cabinet shall be provided with Trifoliate or engraved metal name plates.
16. All panels shall be provided with circuit diagram engraved on PVC sheet.
17. All live accessible connections shall be shrouded and shall be finger touch proof and minimum clearance between phase and earth shall be 20 mm and phase to phase shall be 25 mm.

2.3 Busbar Connections

1. Bus bar and interconnections shall be of high conductivity electrolytic grade aluminium / copper as indicated in the bill of quantities complying with requirement of IS : 5082 – 1981 and of rectangular cross section suitable for carrying the rated full load current and short circuit current and shall be extendable on either side.
2. Bus bars and interconnections shall be insulated with heat shrinkable sleeve of 1.1 KV grade and shall be colour coded.
3. Bus bars shall be supported on glass fiber reinforced thermosetting plastic insulated supports at regular intervals to withstand the force arising from in case of short circuit in the system.
4. All bus bars shall be provided in a separate chamber and all connections shall be done by bolting.
5. Additional cross sectional area to be added to the bus bar to compensate for the holes.
6. All connections between bus bars and breakers shall be through solid copper / aluminium strips of proper size to carry full rated current and insulated with insulating sleeves.
7. Maximum current density for the bus bars shall be 0.8-1A/sq.mm for aluminium and 1.4 A/sq.mm for copper bus bars.
8. The busbar shall be housed in a separate compartment. The busbar shall be isolated with 3
9. mm. thick bakelite sheet to avoid any accidental contact. The busbar shall be arranged such that minimum clearance between the busbar are maintained as below :

Between phases	:	25 mm. minimum
Between phases and neutral	:	25 mm.
Between phases and earth	:	25 mm.
Between neutral and earth	:	20 mm. minimum

Maximum allowable temperature for the Bus bar to be restricted to 85 deg C

2.4 TEMPERATURE – RISE LIMIT

1. Unless otherwise specified, in the case of external surface of enclosures of bus bar compartment which shall be accessible but do not need to be touched during normal operation, an increase in the temperature rise limits of 25° C above ambient temperature shall be permissible for metal surface and of 15° C above ambient temperature for insulating surfaces as per IS 8623(Part-2) 1991.
2. All main distribution panels and sub distribution panels shall be provided with MCCB of appropriate capacity as per Single Line Diagram.
3. All final Distribution boards shall be provided with Miniature Circuit Breakers.
4. Final Single Phase Distribution boards shall be connected to the incoming supply through double pole MCB units & earth leakage circuit breakers.
5. All wiring for final distribution boards shall be concealed behind 5 mm thick bakelite sheet or M S sheet cover.
6. All Distribution boards shall be completely factory wired, ready for connection.
7. All the terminals shall be of proper current rating and sized to suit individual feeder requirements.
8. Each circuit shall be clearly numbered from left to right to correspond with wiring diagram.
9. All the switches and circuits shall be distinctly marked with a small description of the service installed.

10. Continuous earth bus sized for prospective fault current shall be provided with arrangement for connecting to station earth at two points. Hinged doors/ frames shall be connected to earth through adequately sized flexible braids.

2.5 Cable Compartments

Cable compartment of adequate size shall be provided in the Distribution panels for easy clamping of all incoming and outgoing cables entering from the top/bottom. Adequate supports shall be provided in cable compartment to support cables.

2.6 Switchgears

2.6.1 Moulded Case Circuit Breaker (MCCB)

1. The MCCB should be current limiting type with trip time of less than 10 msec under short circuit conditions. The MCCB should be either 3 or 4 poles as specified in BOQ. MCCB shall comply with the requirements of the relevant standards IS13947 – Part 2/IEC 60947-2 and should have test certificates for Breaking capacities from independent test authorities CPRI
2. / ERDA or any accredited international lab.
3. MCCB shall comprise of Quick Make -break switching mechanism, arc extinguishing device and the tripping unit shall be contained in a compact, high strength, heat resistant, flame retardant, insulating moulded case with high withstand capability against thermal and mechanical stresses
4. The breaking capacity of MCCB shall be as specified in the schedule of quantities.
5. The rated service breaking capacity (Ics) should be equal to rated ultimate breaking capacities (Icu).
6. MCCBs for motor application should be selected in line with Type-2 Co-ordination as per IEC-60947-2, 1989/IS 13947-1.
7. The breaker as supplied with ROM should meet IP54 degree of protection.

2.6.2 CURRENT LIMITING & COORDINATION

1. The MCCB shall employ maintenance free minimum let-through energies and capable of achieving discrimination up to the full short circuit capacity of the downstream MCCB. The manufacturer shall provide both the discrimination tables and let-through energy curves for all.

2. MCCBs with ratings up to 200 A shall be equipped with Thermal-magnetic (thermal for overload and magnetic for short-circuit protection) trip units (as per Single line diagram).
3. Microprocessor MCCBs with ratings 250A and above shall be equipped with microprocessor based trip units (as per Single line diagram).
4. Microprocessor and thermal-magnetic trip units shall be adjustable and it shall be possible to fit lead seals to prevent unauthorised access to the settings
5. Microprocessor trip units shall comply with appendix F of IEC 60947-2 standard (measurement of rms current values, electromagnetic compatibility, etc.)
6. Protection settings shall apply to all poles of circuit breaker.
7. All Microprocessor components shall withstand temperatures up to 125 °C.
8. Rotary handles to be provided for operation where ever required as indicated in Single line diagram.

2.6.3 Testing

i. Original test certificate of the MCCB as per IEC 60947-1 &2 or IS13947 shall be furnished.

ii. Pre-commissioning tests on the switch board panel incorporating the MCCB shall be done as per standard specifications.

2.6.4 Interlocking

i. Moulded, case circuit breakers shall be provided with the following interlocking devices for interlocking the door of a switch board.

1. Handle interlock to prevent unnecessary manipulations of the breaker.

2. Door interlock to prevent the door being opened when the breaker is in ON position.

3. Defeat-interlocking device to open the door even if the breaker is in ON position.

4. PLC controller to operate the Motorized Breakers in sequence as indicated logic diagram in SLD.

ii. The MCCB shall be current limiting type and comprise of quick make – Break switching mechanism. MCCBs shall be capable of defined variable overload adjustment. All MCCBs rated 200 Amps and above shall have adjustable over load & short circuit pick-up both in Thermal magnetic and Microprocessor Trip Units.

iii. All MCCB with microprocessor based release unit, the protection shall be adjustable Overload, Short circuit and earth fault protection with time delay.

iv. The trip command shall override all other commands.

2.6.5 Miniature Circuit Breaker (MCB)

i. Miniature Circuit Breaker shall comply with IS-8828-1996/IEC898-1995. Miniature circuit breakers shall be quick make and break type for 240/415 VAC 50 Hz application with magnetic thermal release for over current and short circuit protection.

ii. The breaking capacity shall not be less than 10 KA at 415 VAC. MCBs shall be DIN mounted. The MCB shall be Current Limiting type (Class-3). MCBs shall be classified (B, C, D ref IS standard) as per their Tripping Characteristic curves defined by the manufacturer.

iii. The MCB shall have the minimum power loss (Watts) per pole defined as per the IS/IEC and the manufacturer shall publish the values.MCB shall ensure complete electrical isolation & downstream circuit or equipment when the MCB is switched OFF.

iv. The housing shall be heat resistant and having high impact strength. The terminals shall be protected against finger contact to IP20 Degree of protection. All DP, TP, TPN and 4 Pole miniature circuit breakers shall have a common trip bar independent to the external operating handle.

2.6.6 RESIDUAL CURRENT CIRCUIT BREAKER CURRENT OPERATED TYPE (RCCB)

System of Operation

1. Residual Current Circuit Breaker shall confirm to IEC 61008.RCCB shall work on the principle of core balance transformer.

2. The incoming shall pass through the torroidal core transformer. As long as the currents in the phase and neutral shall be the same, no electro motive force shall be generated in the secondary winding of the transformer.
3. In the event of a leakage to earth, an unbalance shall be created which shall cause a current to be generated in the secondary winding, this current shall be fed to a highly sensitive miniature relay, which shall trip the circuit if the earth leakage current exceeds a predetermined critical value. RCCB shall be current operated independent of the line voltage, current sensitivity shall be of 30 mA at 240/415 volts AC and shall have a minimum of 20,000 electrical operations.

Mechanical Operation

1. The moving contacts of the phases shall be mounted on a common bridge, actuated by a rugged toggle mechanism. Hence, the closing /opening of all the three phases shall occur simultaneously. This also shall ensure simultaneous opening of all the contacts under tripping conditions.

Neutral Advance Feature

1. The neutral moving contact shall be so mounted on the common bridge that, at the time of closing, the neutral shall make contact First before the phases; and at the time of opening, the neutral shall breaks last after allowing the phases to open first. This is an important safety feature which is also required by regulations.

Testing Provision

1. A test device shall be incorporated to check the integrity of the earth leakage detection system and the tripping mechanism. When the unit is connected to service, pressing the test knob shall trip the ELCB / RCCB and the operating handle shall move to the "OFF" position.

2.6.7 Electrical Power and Control Wiring Connection

1. Terminal for both incoming and outgoing cable connections shall be suitable for 1100 V grade, aluminium / copper conductor PVC insulated and sheathed, armoured cable and shall be suitable for connections of solderless sockets for the cable size as indicated on the appended drawings for the Panels.

2. Power connections for incoming feeders of the main Panels shall be suitable for 11000 V grade aluminium conductor (XLPE) cables.

3. Both control and power wiring shall be brought out in cable alley for ease of external connections, operation and maintenance.

4. Both control and power terminals shall be properly shrouded.

5. 10% spare terminals shall be provided on each terminal block. Sufficient terminals shall be provided on each terminal block, so that not more than one outgoing wire is connected to per terminal.

6. Terminal strips for power and control shall preferably be separated from each other by suitable barriers of enclosures.

7. Wiring inside the modules for power, control, protection and instruments etc. shall be done with

use of 660 / 1100 V grade, PVC insulated copper conductor cables conforming to IS : 694 and IS : 8130. Power wiring inside the starter module shall be rated for full current raring of respective contactor, but not less than 4.0 sq.mm. cross-section area. For current transformer circuits, 2.5 sq.mm. copper conductor wire shall be used. Other control wiring shall be done with 1.5 sq.mm. copper conductor wires. Wires for connections to the door shall be flexible. All conductors shall be crimped with solderless sockets at the ends before connections are made to the terminals. All wires shall be FRLS grade.

8. Control power for the Motor starter module shall be taken from the respective module switchgear outgoing. Control power wiring shall have control fuses, (HRC fuse type) for circuit protection. All indicating lamps shall be protected by HRC fuses.

9. Particular care shall be taken to ensure that the layout of wiring is neat and orderly. Identification ferrules shall be filled to all the wire termination for ease of identification and to facilitate checking and testing.

10. "CUPAL" washers shall be used for all copper and aluminium connections.
11. Final wiring diagram of the Panels power and control circuit with ferrules numbers shall be submitted alongwith the Panels as one of the documents against the contracts.

2.6.8 Terminals

The outgoing terminals and neutral link shall be brought out to a cable alley suitably located and accessible from the panel front. The current transformers for instruments metering shall be mounted on the disconnecting type terminal blocks. No direct connection of incoming or outgoing cables to internal components of the distribution board is permitted, only one conductor may be connected in one terminal.

2.6.9 Wire ways

A horizontal PVC wire way with screwed covers shall be provided at the top to take interconnecting control wiring between different vertical sections.

2.6.10 Labels

Engraved PVC labels shall be provided on all incoming and outgoing feeders. Single line circuit diagram showing the arrangements of circuit inside the distribution board shall be pasted on inside of the panel door and covered with transparent laminated plastic sheet.

2.6.11 Name Plate

a. A name plate with the Panels designation in bold letters shall be fixed at top of the central panel. A separate name plate giving feeder details shall be provided for each feeder module door.

b. Inside the feeder compartments, the electrical components, equipments, accessories like switchgear, control gear, lamps, relays etc. shall suitably be identified by providing stickers.

c. Engraved name plates shall preferably be of 3 ply,(Red-White-Red or Black-White-Black) lamicold sheet. However, black engraved perpex sheet name plates shall also be acceptable. Engraving shall be done with square groove cutters.

d. Name plate shall be fastened by counter sund screws and not by adhesives.

2.7 DANGER NOTICE PLATES

a. The danger notice plate shall be affixed in a permanent manner on operating side of the Panels.

b. The danger notice plate shall indicate danger notice both in Hindi and English and with a sign of skull and bones.

c. The danger notice plate, in general, meet the requirements of local inspecting authorities.

d. Overall dimensions of the danger notice plate shall be 200 mm. wide x 150 mm. high.

e. The danger notice plate shall be made from minimum 1.6 mm. thick mild steel sheet and after due pre-treatment to the plate, the same shall be painted white with vitreous enamel paint on both front and rear surface of the plate.

f. The letters, the figures, the conventional skull and bones etc. shall be positioned on plate as per recommendation of IS : 2551-1982.

g. The said letters, the figures and the sign of skull and bones shall be painted in signal red colour as per IS : 5-1978.

h. The danger plate shall have rounded corners. Location of fixing holes for the plate shall be decided to suit design of the Panels.

i. The danger notice plate, if possible, be of ISI certification mark.

2.8 EARTHING

- Earthing shall be provided as per IS: 3043-1987.

2.9 PAINTING

- All sheet steel work shall undergo a process of degreasing, pickling in acid, cold rinsing, phosphating, passivaiting (seven tank processing) and then painted with electrostatic paint (Powder coating).
- The shade of colour of panel inside/outside shall be as per BOQ confirming to IS Code No.5.

2.10 LABELS

- Engraved PVC labels shall be provided on all incoming and outgoing feeder.
- Circuit diagram showing the arrangements of the circuit inside the distribution panels shall be pasted on inside of the panel door and covered with transparent plastic sheet.

2.11 METERS

1. All voltmeters and indicating lamps shall be through MCB's.
2. Meters and indicating instruments shall be flush type.
3. All CT's connection for meters shall be through Test Terminal Block (TTB).
4. CT ratio and burdens shall be as specified on the Single line diagram/BOQ.

2.12 CURRENT TRANSFORMERS

1. Current transformers shall be provided for Distribution panels carrying current in excess of 60 amps.

2. All phase shall be provided with current transformers of suitable VA burden with 5 amps secondaries for operation of associated metering.

3. The CTs shall confirm to relevant Indian Standards. The design and construction shall be dry type, epoxy resin cast robust to withstand thermal and dynamic stresses during short circuits.

4. Secondary terminals of CTs shall be brought out suitable to a terminal block which shall be easily accessible for testing and terminal connections.

5. The protection CTs shall be of accuracy class 5P10 and measurement CTs shall be of accuracy class I.

2.13 POTENTAIL FREE CONTACTS

1. Potential free contacts shall be provided for connection to Building Automation System in panels indicated in Schedule of Quantities.

2.14 INDICATING PANEL

1. All meters and indicating instruments shall be in accordance with relevant Indian Standards. Meters shall be flush mounted type. Indicating lamps shall be of low burden, and shall be backed up with 2 amps MCB/MPCB as per relevant fault level and toggle switch.

2.15 TESTING

1. Testing of panels shall be as per following codes:

   I. IS: 8623 (Part -I) 1977 for factory built assemblies of switch gear for voltages upto and including 1000 VAC.
   II. IS: 13947 : 1993 Degree of protection
   III. IS: 5578 & 11353:1985 Arrangement of bus bars.

2.16 WIRING

1. In wiring a distribution panel it shall be insured that total load of various distribution panel and/or consuming devices is divided evenly between the phases and number of ways as per Consultants drawing.

2.17 INSTALLATION

1. Installation of all LT panels shall include but not limited to the following to complete the installation, testing and commissioning:

2. Transporting materials from stores to exact location of installation.

3. Supply and installation of required base frame made of MS angle or channel sections and duly painted with black paint.

4. Positioning, aligning, fixing, assembling, and installation of LT panel issued free of cost by Client after carrying out proper cleaning and inspection.

5. Site supervision, testing for proper functioning / operation, and pre-commissioning tests.

2.18 COMMISIONING & ONSITE TESTING

1. All switchboards shall be tested for dielectric test with 1000V megger.
2. All earth connections shall be checked for continuity.
3. All busbar connections shall be checked and tightened properly.
4. All cable terminations and terminal shrouding shall be checked if they are properly done.
5. The operation of protective devices shall be tested by secondary injection test.
6. The operation of circuit breaker shall be tested for all interlocks.
7. Functional test shall be done for all ACBs, MCCBs and other components.
8. Indicating lamps and meters shall be checked for proper working.

2.19 WORKMANSHIP:

1. The contractor shall erect the panel at site in co-ordination with the supplier if required.
2. He should check for loose ends on the part of the supplier and shall inform client and consultant for the same.
3. Physical and continuity tests shall be carried out by contractor.
4. Also the field tests carried out by the supplier shall be recorded by the contractor.

2.20 MODE OF MEASUREMENT:

1. Contractor shall be paid for one panel erection as per BOQ Quantities part.

2.21 APFC Panel

This specification covers the requirements for Low Voltage Capacitors and Control Panel to be used for power factor improvement.

i. CODES AND STANDARDS

- IS: 2834 - Shunt capacitor of power system.
- IS : 13947 - Low voltage switchgear and control gear.(Part 1 to 5)
- IS: 4237 - General Requirements for switchgear and control gear for

voltages Not exceeding 1000 Volts A.C.

- IS : 8623 - Specifications for factory built assemblies of switchgear for and Control gear up to 1000 Volts A.C.
- IS: 9224 - Low voltage fuses.

GENERAL REQUIREMENTS

- Capacitors shall have two layers of polypropylene film with high purity aluminum foil conductors. The films shall be impregnated with bio-degradable, non-PCB, non-hazardous oil with internal fuses on each element.
- Capacitors shall be of long life (minimum 100,000 operating hours) without degradation or loss of capacitance.
- Capacitors shall have low energy loss (less than 0.5W/KVAr) and totally tropicalized. Each capacitor shall have a discharge resister to bring down the residual voltage to 50V within 60 sec.
- The capacitance output shall be guaranteed for a period of 2 years @ +10% & -5% of the rated value. All capacitors shall be type tested for dielectric strength, IR value (min. 50 mega -ohms), losses, surge protection etc. in accordance with the IS standards. Capacitor elements shall be canned in enclosure and sealed to meet IP 52 class. All capacitors shall operate at 135% overload (over voltage or harmonics) without deterioration.
- The control section shall contain Automatic Power Factor Controller Relay to switch the capacitors ON or OFF. The system PF shall be monitored constantly and the switching sequence regulated. The switching sequence shall be capable of being changed or modified so as to ensure that all the capacitor units will have equated run hours. Provision shall be available for manual override through multiple push buttons.
- Capacitor duty contactors to be used for switching operation of the capacitors.
- The capacitor section shall house the capacitors with proper and adequate ventilation so that the capacitors will not be overheated. The enclosure shall also provide easy access to each capacitor unit for maintenance.
- The switch section shall consist of switch fuses, Thyristers, voltmeter, PF meter.
- LV Harmonic Filters shall be used with harmonic filter duty power capacitors to mitigate harmonics, improve power factor and avoid electrical resonance in LV electrical networks.

3 TECHNICAL SPECIFICATION FOR LDB & PDB

3.1 SCOPE OF WORK

1. Distribution Boards (DBs) shall be suitable for operation on 3 Phase/single phase, 415/240 volts, 50 cycles, neutral grounded at transformer. The DB shall be minimum di-electric strength of 1.5 KV / Sec. All Distribution Boards shall manufactured by a manufacturer listed in Appendix-I.
2. LDB's shall comply with the latest Relevant Indian Standards and Electricity Rules and Regulations and shall be as per IS-13947-1991.

3.2 CONSTRUCTION FEATURES

1. DB's shall be made out of 1.6 mm thick high quality CRCA sheet steel and shall be pre-treated and powder coated sheet steel used in the construction of LDB shall be folded and braced as necessary to provide a rigid support for all component.
2. DB shall be suitable for indoor / outdoor installation, wall mounting free standing type, in double door construction.
3. The Final Distribution Boards shall be totally enclosed, completely dust and vermin proof and shall be with hinged doors, Neoprene gasket, padlocking arrangement.
4. All removable/ hinged doors and covers shall be grounded by 1.0 sqm tinned stranded copper connectors.
5. Final Distribution Boards shall be suitable for the climatic conditions. Joints of any kind in sheet metal shall be seam welded, all welding, slag shall be rounded off and welding pits wiped smooth with plumber metal.
6. The general construction shall confirm to IS-8623-1977 (Part-1) for factory built assembled switchgear & control gear for voltage up to and including 1100 V AC.
7. All panels and covers shall be properly fitted and square with the frame, and holes in the panel correctly positioned. Fixing screws shall enter into holes tapped into an adequate thickness of metal or provided with wing nuts. Self threading screws shall not be used in the construction of LDBs.
8. Knockout holes of appropriate size and number shall be provided in the LDB's in conformity with the location of cable/conduit connections. Detachable sheet steel gland plates shall be provided at the top / bottom to make holes for additional cable entry at site if required.

3.3 DISTRIBUTION BOARDS SHALL COMPRISE OF THE FOLLOWING:

1.1 A panel for mounting where appropriate incoming supply circuit breaker & other auxiliaries for Control & distribution as required.

1.2 Installations accessories shall be part of the DB for fixing conductor and rails for mounting MCB's and RCCB's etc. Neutral bus bars & earthing bus bars required in the circuit. All busbars in the LDB shall be insulated type.

1.3 Service cable /interconnection shall be part of the Distribution Boards.

1.4 The board shall be installed at a height such that the operating is within reach of the normal human height i.e. 1.2 to 1.8 meters from finish floor level.

1.5 Degree of protection shall be IP-52 for indoor application, IP-54 for kitchen & laundry and IP-55 for outdoor application.

1.6 All three phase distribution boards shall have 4 rows and single phase distribution boards shall have single rows for housing of MCB's and RCCB's unless noted otherwise.

1.7 Phase segregation to be maintained in all three phase distribution boards.

1.8 Earthing shall be provided in each LDB's.

3.4 MINIATURE CIRCUIT BREAKER (MCB)

1.8.1 MCB's shall have quick make and break no welding self-wiping silver alloy contacts for 10 KA short circuit both on the manual and automatic operation.

1.8.2 Each pole of the breaker shall be provided with inverse time thermal over load and instantaneous over current tripping elements, with trip free mechanism.

1.8.3 In case of multi-pole breakers, the tripping must be on all the poles and operating handle shall be common. Breakers must confirm to BS 3871 with facility for locking in OFF position.

1.8.4 Pressure clamp terminals for stranded/solid conductor insertion are acceptable up to 4 sq.mm. Aluminium or 1.5 sq.mm.

1.8.5 Copper and for higher ratings, the terminals shall be suitably shrouded. Wherever MCB isolators are specified they are without the tripping elements.

3.5 RESIDUAL CURRENT CIRCUIT BREAKER CURRENT OPERATED TYPE (RCCB)

1.8.6 The RCCB should suffices all the requirements of IS as per code IS - 12640 - 1988. The RCA should be current operated and not on line voltage.

1.8.7 The RCCB should ensure mainly the following functions:

- Measurement of the fault current value.
- Comparison of the fault current with a reference value.
- The RCCB should have a torroidal transformer which has the main conductors of primary (P - N) which check the sum of the current close to zero.
- All metal parts should be inherently resistant to corrosion and treated to make them corrosion resistant.

- It should be truly current operated.
- It should operate on core balance torroidal transformer.
- Its accuracy should be ± 5 %.
- It should operate even in case of neutral failure.
- It should trip at a present leakage current within 100 mA
- Its enclosure should be as per IP 30.
- Its mechanical operation life should be more than 20,000 operations.
- It should provide full protection as envisaged by IE rules - 61-A, 71 - ee, 73 - ee, 1985 and also rule 50 of IE rule1956.
- It should conform to all national and international standards like IS: 8828-1993, IS: 12640-1988, BS 4293 - 1983, CEE 27 (International commission Rules for the approved of electrical equipment).

3.6 EARTHING

1. Earthing shall be provided as per IS:3043-1987.

3.7 PAINTING

1. All sheet steel work shall undergo a process of degreasing, pickling in acid, cold rinsing, phosphating, passivaiting (seven tank processing) and then painted with electrostatic paint (Powder coating). The shade of colour of panel inside/outside shall be of Siemens gray paint shade no. RAL-7032 of IS Code No.5.

3.8 LABELS

1. Engraved PVC labels shall be provided on all incoming and outgoing feeder. Circuit diagram showing the arrangements of the circuit inside the distribution panels shall be pasted on inside of the panel door and covered with transparent plastic sheet.

3.9 TESTING

1. Testing of panels shall be as per following codes:

   i. IS: 8623 (Part -I) 1977 for factory built assemblies of switch gear for voltages upto and including 1000 VAC.
   ii. IS: 13947 : 1993 Degree of protection

3.10 WIRING

1. In wiring a distribution panel it shall be insured that total load of various distribution panel and/or consuming devices is divided evenly between the phases and number of ways as per Consultants drawing.

3.11 WORKMANSHIP:

1. The D.B. shall be properly grouted in the wall in concealed manner taking care that the powder coating is not scratched and dents are not formed on the D.B., MCBs and ELCBs.
2. In the distribution boards shall be fixed as per the circuit details provided.
3. All the wires terminating in the MCBs and the ELCBs shall be lugged for proper contact and ferrules depicting the circuit nos shall be provided. D.B.s mounted in concealed manner shall have a groove around it so as to save the finish of the plaster and colour during future opening of the door.
4. The distribution boards shall have circuit chart tagged on the door for future maintenance. Danger notice plates shall be fitted to the distribution boards with screws and not stuck so as to assure its presence for a longer duration.

3.12 MODE OF MEASUREMENT:

1. The distribution boards shall be measured in Nos as per BOQ Quantities.

4 TECHNICAL SPECIFICATION FOR LT CABLES & CABLE TRAY.

4.1 SCOPE OF WORK

1. The Medium voltage cables shall be supplied, laid, connected, tested and commissioned in accordance with the drawings, specifications, relevant Indian Standards specifications, manufacturer's instructions. The cables shall be delivered at site in the original drums with manufacturer's name, size and type clearly written on the drums.
2. All cables shall be adequately protected against any risk of mechanical damage to which they may be liable in normal conditions of handling during transportation, loading, unloading etc.
3. The cable shall be supplied in single length i.e. without any intermediate joint or cut unless specifically approved by the client.
4. The cable ends shall be suitably sealed against entry of moisture, dust, water etc. with cable compound as per standard practise.

4.2 MATERIAL

1. The MV cables shall be cross linked polyethylene (XLPE) insulated PVC sheathed of 1100 volts grade as asked for in the schedule of quantities. Cables upto 10 sq.mm shall be with copper conductor and 16 sq.mm and above shall be with aluminium conductor.

4.2.1 Technical Requirements:

1. All XLPE Aluminium/Copper Power cables shall be 1100 Volts grade, multi core constructed as per IS : 7098 Part-I of 1988 as follows :

1.1 Stranded Aluminium /Copper conductor in case of 10 sq.mm. and above whereas solid conductor in case of 10 sq.mm. and below.

1.2 Cores laid up.

1.3 The inner sheath should be bonded over with thermo-plastic material for protection against mechanical and electrical damage.

1.4 Armoring should be provided over the inner sheath to guard against mechanical damage. Armouring should be Galvanised steel wires or galvanised steel strips. (In single core cables used in A.C. system armouring should be non-magnetic hard aluminium Wires/Strips. Round steel wires should be used where diameter over the inner sheath does not exceed 13 mm; above 13 mm flat steel armour should be used. Round wire of different sizes should be provided against specific request.)

1.5 The outer sheath should be specially formulated heat resistant black PVC compound conforming to the requirement of type ST2 of IS : 5831-1984 extruded to form the outer sheath.

2. Conductor shall be of electrolytic Aluminium/Copper conforming to IS : 8130 and are

compact circular or compact shaped.

3. Insulation shall be of XLPE type as per latest IS general purpose insulation for maximum rated conductor temperature 70 degree centigrade.
4. In Inner sheath laid up cores shall be bonded over with thermoplastic material for protection against mechanical and electrical damage.
5. Insulation, inner sheath and outer sheath shall be applied by extrusion and lapping up process only.
6. Uncoated, annealed copper / aluminium, of high conductivity, upto 4 mm2 size the conductor shall be solid and above 4 mm2 the conductors shall be concentrically stranded as per IEC: 228.
7. Repaired cables shall not be used.
8. Current ratings of the cables shall be as per IS: 3961.
9. The XLPE insulated cables shall conform to latest revision of IS and shall be read along with this specifications. The Conductor shall be stranded Aluminium/Copper circular/ sector shaped and compacted. In multi core cables the core shall be identified by red, yellow, blue and black coloring of insulation.
10. The cables shall be suitable for laying in racks, ducts, trenches, conduits and underground buried installation with uncontrolled back fill and chances of flooding by water.
11. Progressive automatic in line sequential marking of the length of cables in meters at every one meter shall be provided on the outer sheath of all cables.
12. Cables shall be supplied in non-returnable wooden drums as per IS: 10418.
13. Both ends of the cables shall be properly sealed with PVC/Rubber caps so as to eliminate ingress of water during transportation, storage and erection.
14. The product should be coded as per IS: - 7098 Part-I as follows:-

Aluminium Conductor	A
XLPE Insulation	2X
Steel round wire armour	W
Steel strip armour	F
Steel Double round wire armour	WW
Steel Double strip armour	FF
Non-magnetic (Al.) round wire armour	Wa
Non-magnetic (Al.) strip armour	Fa
PVC outer sheath	Y

4.2.2 Core Identifications:

Two core	:	Red and Black
Three core	:	Red, Yellow and Blue
Four core	:	Red, Yellow, Blue and Black
Single core	:	Green, Yellow for earthing.

Black shall always be used for neutral.

1) *InSpection*

1. All cables shall be inspected by the contractor upon receipt at site and checked for any

damage during transit.

4.2.3 Joints in Cables

1. The Contractor shall take care to see that all the cables received at site are apportioned to various locations in such a manner as to ensure maximum utilization and avoid cable jointing.
2. This apportioning shall be got approved by the Owner's site representative before the cables are cut to lengths.
3. Where joints are unavoidable heat shrinkable type joints shall be made.
4. The location of such joints shall be got approved from the Owner's site representative and shall be identified through a marker.

4.2.4 Jointing Boxes for Cables

1. Cable joint boxes shall be installed with heat shrinkable sleeve and of appropriate size, suitable for XLPE armoured cables of particular voltage rating.

4.2.5 Jointing of Cables

1. All cable joints shall be made in suitable, approved cable joint boxes and the filling in of compound shall be done in accordance with manufactures' instructions and in an approved manner. All straight through joints shall be done in epoxy mould boxes with epoxy resin.
2. All cables shall be joined colour to colour and tested for continuity and insulation resistance before jointing commence.
3. The seals of cables must not be removed until preparations for jointing are completed.
4. Joints shall be finished on the same day as commenced and sufficient protection from the weather shall be arranged.
5. The conductors shall be efficiently insulated with high voltage insulating tape and by using of spreaders of approved size and pattern.
6. The joints shall be completely topped up with epoxy compound so as to ensure that the box is properly filled.

4.2.6 Cable End Terminations

1. Cable end termination shall be done in cable terminal box using crimping sockets and proper size of glands of double compression type.
2. Solderiess crimping type Aluminium/Cu lugs conforming to IS suitable for cable size evenly crimped with high pressure tool & connected to switchgear terminals with brass/cadmium plated nut bolts in an approved manner.

4.2.7 Bonding of Cables

1. Where a cable enters any piece of apparatus, it shall be connected to the casing by means of an

approved type of armour clamp and gland.

2. The clamps must grip the armouring firmly to the gland or casing, so that no undue stress is passed on to the cable conductors.

4.2.8 Cable Installation in Cable Trays and Cable Trenches.

1. Cables shall be laid by skilled and experienced workmen using adequate rollers to minimize stretching of the cable.

2. The cable drums shall be placed on jacks before unwinding the cable. Great care shall be exercised in laying cables to avoid forming kinks.

4.2.9 Laying of Cables on Cable Trays

1. The relative position of the cables, laid on the cable tray shall be preserved and the cables shall not cross each other.

2. At all changes in direction in horizontal and vertical planes, the cable shall be bent smooth with a radius as recommended by the manufacturers.

3. All cables shall be laid with minimum one diameter gap and shall be clamped at every meter to the cable tray.

4. Cables shall be tagged for identification with aluminium tag and clamped properly at every 20M.

5. Tags shall be provided at both ends and all changes in directions both sides of wall and floor crossings.

6. All cable shall be identified by embossing on the tag the size of the cable, place of origin and termination.

7. All cables passing through holes in floor or walls shall be sealed with fire retardant Sealant and shall be painted with fire retardant paint upto one meter on all joints, terminations and both sides of the wall crossings by “VIPER CABLE RETARD”.

8. This method may be adopted in places like indoor substations, air-conditioning plantrooms, generator rooms etc. or where long horizontal runs of cables are required withinthe building and where it is not convenient to carry the cable in open ducts.

9. This method is preferred where heavy sized cables or a number of cables are required to be laid. The cable trays may be either of perforated sheet type or of ladder type.

4.3 PERFORATED TYPE CABLE TRAY

1. The cable tray shall be fabricated out of slotted/perforated MS sheets as channel sections, single or double bended. The channel sections shall be supplied in convenient lengths and assembled at site to the desired lengths. These may be galvanished or painted as specified. Alternatively, where specified, the cable tray may be fabricated by two angle irons of 50mmX50mmX6mm as two longitudinal members, with cross bracings between them by 50mmX5mm flats welded/bolted to the angles at 1 m spacing. 2mm thick MS perforated sheet shall be suitably welded/bolted to the base as well as on the two sides.

2. Typically, the dimensions details to be considered as per BOQ.

3. The jointing between the sections shall be made with coupler plates of the same material and thickness as the channel section. Two coupler plates, each of minimum 200mm length, shall be bolted on each of the two sides of the channel section with 8mm dia round headed bolts, nuts and washers. In order to maintain proper earth continuity bond, the paint on the contact surfaces between the coupler plates and cable tray shall be scraped and removed before the installation.

4. The width of the cable tray shall be chosen so as to accommodate all the cables in one tier, plus 30 to 50% additional width for future expansion. This additional width shall be minimum 100mm. The overall width of one cable tray shall be limited to 800mm.

5. Factory fabricated bends, reducers, tee/cross junctions, etc. shall be provided as per good engineering practice. (Details are typically shown in figure 3). The radius of bends, junctions etc. shall not be less than the minimum permissible radius of bending of the largest size of cable to be carried by the cable tray.

6. The cable tray shall be suspended from the ceiling slab with the help of 10mm dia MS rounds or 25mmX5mm flats at a span spacing of 1mtr.

7. Flat type suspenders may be used for channels upto 450mm width bolted to cable trays.

8. Round suspenders shall be threaded and bolted to the cable trays or to independent support angles 50mmX50mmX5mm at the bottom end as specified. These shall be grouted to the ceiling slab at the other end through an effective means, as approved by the Engineer-in-Charge, to take the weight of the cable tray with the cables.

9. The entire tray (except in the case of galvanized type) and the suspenders shall be painted with two coats of red oxide primer paint after removing the dirt and rust, and finished with two coats of spray paint of approved make synthetic enamel paint.

10. The cable tray shall be bonded to the earth Terminal of the switch bonds at both ends.

11. The cable trays shall be measured on unit length basis, along the center line of the cable tray, including bends, reducers, tees, cross joints, etc. and paid for accordingly

4.4 LADDER TYPE CABLE TRAY

12. The ladder type of cable tray shall be fabricated of double bended channel section longitudinal members with single bended channel section rungs of cross members welded to the base of the longitudinal members at a center to center spacing of 250cm.

13. Alternatively, where specified, ladder type cable trays may be fabricated out of 50mmX50mmX6mm (minimum) angle iron for longitudinal members, and 30mmX6mm flat for rungs.

14. Typical details of fabrication and dimensions of both the types of trays are shown in figure 4A,B,C and D.

15. The maximum permissible loading, jointing of channel sections, width of the cable tray, provision of elbows, bends, reducers, horizontal tee/ cross junctions etc. suspension of cable tray from the ceiling slab; painting and measurement of the cable tray shall be as per sub-clauses (ii) to (x) below clause 2.6.11.2, except that the overall width of one cable tray may be limited to 800mm.

4.4.1 Laying of Cables in Ground

Cable trench shall be dug to the minimum depth of 1 mtr and the width shall dependent on the no of cables to be kept with the layer of brick in between two cables.

4.5 EXCAVATION OF TRENCHES

1. The trenches shall be excavated in reasonably straight lines.
2. Wherever there is a change in direction, suitable curvature shall be provided.
3. Where gradients and changes in depth are unavoidable, these shall be gradual.
4. The excavated soil shall be stacked firmly by the side of the trench such that it may not fall back into the trench.
5. The bottom of the trench shall be levelled and shall be made free from stone, brick bats etc. The trench shall then be provided with a layer of clean, dry sand cushion of not less than 100 mm in depth.
6. Prior to laying of cables, the cores shall be tested for continuity and insulation resistance. The cable drum shall be properly mounted on jacks, at a suitable location, making sure that the spindle, jack etc. are strong enough to carry the weight of the drum and the spindle is horizontal.
7. Cable shall be pulled over rollers in the trench steadily and uniformly without jerks and strains. The entire drum length shall be laid in one stretch.
8. However, where this is not possible the remainder of the cable shall be removed by `Flaking' i.e. by making one long loop in the reverse direction.
9. After the cable has been uncoiled and laid into the trench over the rollers, the cable shall be lifted off the rollers beginning from one end by helpers standing about 10 meters apart and laid in a reasonably straight line.
10. Cable laid in trenches in a single tier formation shall have a cover of clean, dry sand of not less than 150 mm. above the base cushion of sand before the protective cover is laid.
11. In the case of vertical multi-tier formation after the first cable has been laid, a sand cushion of 300 mm shall be provided over the initial bed before the second tier is laid.
12. Finally the cables shall be protected by second class bricks before back filling the trench. The buried depth of uppermost layer of cable shall not be less than 750mm.
13. Back Filling: The trenches shall be back filled with excavated earth free from stones or other sharp edged debris and shall be rammed and watered, if necessary, in successive layers not exceeding 300 mm. Unless otherwise specified, a crown of earth not less than 50 mm in the centre and tapering towards the sides of the trench shall be left to allow for subsidence.

4.5.1 Route Marker

1. Route marker shall be provided along straight runs of the cables not exceeding 30 meters also for change in the direction of the cable route and underground joints.
2. Route marker shall be of cast iron painted with aluminium paint.
3. The size of marker shall be 100 mm dia with "Cable" and voltage grade inscribed on it.

4.5.2 Testing of Cables

1. Cables shall be tested at works for all routine tests as per IS including the following tests before being dispatched to site by the project team.

a) Insulation Resistance Test.
b) Continuity resistance test.
c) Sheathing continuity test.
d) Earth test.(in armoured cables)
e) Hi Pot Test.

2. Test shall also be conducted at site for insulation between phases and between phase and earth for each length of cable, before and after jointing.

3. On completion of cable laying work, the following tests shall be conducted in the presence of the Owner's site representative.

d) Insulation Resistance Test(Sectional and overall)
e) Continuity resistance test.
f) Sheathing continuity test.
g) Earth test.

4. All tests shall be carried out in accordance with relevant Standard Code of Practice and Electricity Rules.

5. The Contractor shall provide necessary instruments, equipment and labour for conducting the above tests and shall bear all expenses in connection with such tests.

6. All tests shall be carried out in the presence of the Owner's site representative, results will be noted and signed by all present and record be maintained.

4.6 WORKMANSHIP

1. Cables shall be laid in the routes marked in the drawings. Where the route is not marked, the Contractor shall mark it out on the drawings and also on the site and obtain the approval of the CLIENT AND/OR ITS ENGINEER-IN-CHARGE before laying the cable.

2. Procurement of cables shall be on the basis of actual site measurements and the quantities shown in the schedule of work shall be regarded as a guide only.

3. Cables shall be laid on walls, cable trays, inside shafts or trenches.

4. Saddling or support for the cable shall not be more than 500 mm apart. Plastic identification tags shall be provided at every 30 m.

5. Cables shall be bent to a radius not less than 12 (twelve) times the overall diameter of the cable or in accordance with the manufacturer's recommendations whichever is higher.

6. In the case of cables buried directly in ground, the cable route shall be parallel or perpendicular to roadways, walls etc unless marked on drawing by Engineer-in-Charge / consultant.

7. Cables shall be laid on an excavated, graded trench, over a sand or soft earth cushion to provide protection against abrasion.

8. Cables shall be protected with brick or cement tiles on all the three sides as shown on drawings. Width of excavated trenches shall be as per drawings.

9. Back fill over buried cables shall be with a minimum earth cover of 750 mm to 1000 mm. The cables shall be provided with cables markers at every 10 meters and at all loop points.

10. All cables shall be full runs from panel to panel without any joints or splices.

11. Cables shall be identified at end termination indicating the feeder number and the Panel/Distribution board from where it is being laid.

12. Cable termination for conductors up to 4 sq.mm. may be insertion type and all higher sizes shall have compression type lugs.

13. Cable termination shall have necessary brass glands. The end termination shall be insulated with a minimum of six half-lapped layers of PVC tape. Cable armouring shall be earthed at both ends.

14. In case of cables entering the buildings. It would be done duly only through pipes. The pipes shall be laid in slant position, so that no rainwater may enter the building.

15. After the cables are tested the pipes shall be sealed with M. seal & then tarpaulin, shall be wrapped around the cable for making the entry watertight.

16. Testing : MV cables shall be tested upon installation with a 500 V Meggar and the following readings established:

    16.1 Continuity on all phases.
    16.2 Insulation Resistance.
    16.3 between conductors.
    16.4 all conductors and ground.
    16.5 All test readings shall be recorded and shall form part of the completion documentation.
    16.6 Cable joints shall be done as per regular practice and check shall be carried out for loose connections and leakages. Insulation cutting shall be done properly taking care that no area of the conductor remains exposed. Crimping shall be done with the help of hydraulic tool. Proper insulation tape shall be applied at the cable and lug joint.

17. Format for cable testing certificate :

    a. Drum no. from which cable is taken :
    b. Cable from _____to _____
    c. Length of run of this cable _____mtr
    d. Insulation resistance test
       between core 1 to earth _____mega-ohm
       between core 2 to earth _____mega-ohm
       between core 3 to earth _____mega-ohm
       between core 1 to core 2 _____mega-ohm
       between core 2 to core 3 _____mega-ohm
       between core 1 to core 3 _____mega-ohm
       duration used:
    e. High voltage test: Voltage Duration
       between core and earth
       between individual cores

18. The cable shall be laid side by side in trench with brick covering on all the three sides.

19. The trench shall be such that sharp bends shall be avoided while laying the cable.

20. The bedding of fine sand under the cable shall be not less than 6 mm. The trench shall be terminated in Manholes with specified size of R.C.C. hume pipes as shown in drawing. Cable markers shall be provided through out the route of cable at 10 mtrs distance.

21. The trenches shall be refilled after the cable are laid and the Ground level shall be done as per

original after pressing the same. The cables shall be checked for insulation resistance and continuity tests shall be carried out.

4.7 MODE OF MEASUREMENT

1.1 Mode of Measurement for Cable Trench & Cable Tray.

The cable laying shall be measured in rmt. The trenches dug and refilled shall be measured in cu. Mtr. The bricks and sand bedding shall be measured in rmt. The cable trays shall be measured in rmt.

1.2 Mode of Measurement for Cable and Cable End Terminations.

The cables shall be measured in rmt and terminations on unit basis.

5 TECHNICAL SPECIFICATION FOR INTERNAL WIRING.

5.1 SYSTEM OF WIRING

The system of wiring shall consist of PVC insulated copper stranded conductor flexible FRLS wires in metallic / non metallic (Rigid heavy/Medium Duty ISI -marked fire retarded PVC Conduits of minimum 2mm Wall thickness and Sizes of conduits shall be 25 mm dia. conduits for both mains and point wiring and shall be concealed or surface mounted above false ceiling as called for.

5.2 GENERAL DESCRIPTION

1. Prior to laying and fixing of conduits, the contractor shall mark the conduit route, carefully examine the working drawings prepared by him and approved by the Consultant indicating the layout, satisfy himself about the non interference in the route, sufficiency of number and sizes of conduits, location of junction boxes, sizes and location of switch boxes and other relevant details.
2. Any discrepancy found shall be brought to the notice of the Owner's site representative.
3. Any modifications suggested by the contractor should get written approval before the actual laying of conduits is commenced.
4. In laying of conduits it is important that not more than two right angle bends are provided for each circuit without a pull box.
5. No junction box shall be provided in the entire length of conduit run for drawing of wires.
6. Only switch outlets, lighting fixture outlets, equipment power outlets and socket outlets shall be considered for drawing of wires.

5.3 LIGHTING & POWER WIRING

1. All final branch circuits for lighting and appliances shall be single conductor/ stranded/ flexible wires run inside conduits.
2. The conduit shall be properly connected or jointed into sockets, bends, and junction boxes.
3. Branch circuit conductor sizes shall be as shown in the schedule of quantities and or drawings.
4. All circuits shall preferably be kept in a separate conduit up to the Distribution Board. No other wiring shall be bunched in the same conduit except those belonging to the same phase.
5. Each lighting branch circuit shall not have more than ten outlets or 800 watts whichever is lower. Each conduit shall not hold more than three branch circuits.
6. Flexible cords for connection to appliances, fans and pendants shall be 650/1100 V grade (three or four cores i.e. with insulated neutral wire of same size) with tinned stranded copper wires, insulated, twisted and sheathed with strengthening cord. Colour of sheath shall be subject to the CLIENT AND/OR ITS ENGINEER-IN-CHARGE'S approval.

7. Looping system of wiring shall be used. Wires shall not be jointed. Where joints are unavoidable, they shall be made through approved mechanical connectors.

8. No such joints shall be made unless the length of the sub-circuit, sub-main or main is more than the length of the standard coil.

9. Control switches shall be connected in the phase conductors only and shall be `ON' when knob is down. Switches shall be fixed in 3 mm. thick painted or galvanized steel boxes with cover plates as specified. Cadmium plated brass screws shall be used.

10. Power wiring shall be distinctly separate from lighting wiring. Conduits not less than 25 mm. and wires not less than 1.0 sq.mm. copper shall be used.

11. Every conductor shall be provided with identification ferrules at both ends matching the drawings.

5.4 TESTING

1. The entire installation shall be tested for:

   Insulation resistance.
   Earth continuity.
   Polarity of single pole switches.

2. All the wiring switch board, outlet points shall be done in a concealed manner in wall & slab in PVC conduit of minimum 25 mm dia. (medium gauge) & with 650v / 1100v grade PVC insulated flexible copper conductor wire.

3. The switches should be modular with moulded cover plates, blank plates for outlet boxes.

4. The accessories, connectors, sockets, should be fixed with brass chrome / cadmium plated machine screw. For fan points the rates should be with hum -free type 300 W regulators as required to complete the point wiring.

5. The wiring shall be as per IS: 732 and IS: 4648. The wiring shall be done in a looping manner so as to avoid junction boxes at any place.

6. All the looping shall be done only in the switchboard and outlet points. The size of the wire shall be as per the specification. Colour code shall be strictly followed.

7. The size of wires shall as follow as per BOQ and as per clients requirements:

8. Light, fans, exhaust fan, 5 Amp. On board plug point, two way light points, bell point etc from switch to outlet.

Phase / Neutral	1.5 m m^2
Earth	1.5 m m^2

9. From D.B. to switch board – lighting / 5 A socket etc – i.e. circuit mains part of point wiring Phase

/ Neutral	2.5 m m^2
Earth	1.5 m m^2

10. From D.B. to 16A power point etc – i.e. circuit mains part of point wiring

Phase / Neutral	4.0 m m^2
Earth	1.5 m m^2

11. Separate pipes shall be laid for off wires and circuit mains.

12. Circuit mains of same phase shall be drawn in one pipe with prior permission/discussion with the consultant.

13. Separate phase, neutral and earthing wire of sizes recommended by consultant shall be drawn for each and every circuit mains.

14. Mains for lighting and on board plug points shall be of one-size higher wires than those used in off.

5.5 COMPUTER WIRING

1. Wiring for short extensions to outlets in hung ceiling or to vibrating equipments, motors etc., shall be installed in flexible conduits. Otherwise rigid conduits shall be used. No flexible extension shall exceed 1.25 m.

2. Conduits run on surfaces shall be supported on metal 12 mm. thick G.I. pressure saddles which in turn are properly screwed to the wall or ceiling. Saddles shall be at intervals of not more than 500 mm.

3. Fixing screws shall be with round or cheese head and of rust-proof materials. Exposed conduits shall be neatly run parallel or at right angles to the walls of the building.

4. Unseemly conduit bends and offsets shall be avoided by using fabricated mild steel junction/pull through boxes for better appearances.

5. No cross-over of conduits shall be allowed unless it is necessary and entire conduit installation shall be clean and neat in appearance.

6. Conduits embedded into the walls shall be fixed by means of staples at not more than 500 mm. intervals. Chases in the walls shall be neatly made and refilled after laying the conduit and brought to the finish of the wall but the building Contractor will do final finish.

7. Conduits buried in concrete structure shall be put in position and securely fastened to the reinforcement and got approved by the CLIENT AND/OR ITS ENGINEER-IN-CHARGE, before the concrete is poured.

8. Proper care shall be taken to ensure that the conduits are neither dislocated nor choked at the time of pouring the concrete suitable fish wires shall be drawn in all conduits before they are embedded.

9. Where conduit passes through expansion joints in the building, adequate expansion fittings shall be used to take care of any relative movement.

10. Inspection boxes shall be provided for periodical inspection to facilitate withdrawal and removal of wires. Such inspection boxes shall be flush with the wall or ceiling in the case of concealed conduits. Inspection boxes shall be spaced at not more than 12 meters apart or two 90° solid bends or equal.

11. All junction and switch boxes shall be covered by 6 mm clear plate. These junction boxes shall form part of point wiring or conduit wiring as the case may be including the cost of removing the cover for painting and re-fixing. No separate charges shall be allowed except where specially mentioned.

12. Conduits shall be free from sharp edges and burrs and the threading free from grease or oil. The entire system of conduits must be completely installed and rendered electrically continuous before the conductors are pulled in. Conduits should terminate in junction boxes of not less than 32 mm. deep.

13. An insulated earth wire of copper rated capacity shall be run in each conduit.

The point definition shall be conduiting and wiring from D.B. to S.B. and there from to final outlet point including switches and accessories, junction boxes, fan boxes, zarri work with cement –sand etc of approved make.

5.6 CONDUCTORS

1. All PVC insulated copper conductor flexible FRLS wires shall conform in all respects to Standards as listed under sub-head Indian Standards and shall be IS approved and ISI marked.

5.7 BUNCHING OF WIRES

1. Wires carrying current shall be so bunched that the outgoing and return wires are drawn into the same conduit.

2. Wires originating from two different phases shall not run in the same conduit. All wires shall have ferrules for identification.

3. Lighting and power circuits shall be separate. Each Power/ Light Circuit‘s Neutral shall be individual per Circuit and shall not be looped from any other Circuit.

5.8 LOAD BALANCING

1. Balancing of circuits in three phase installation shall be as planned by the Consultants in the tender drawings and shall be checked by the contractor before the commencement of wiring and shall be strictly adhered to.

5.9 COLOUR CODE OF CONDUCTORS

1. Colour code shall be maintained as indicated by the Consultant for the entire wiring installations. Red, yellow, blue shall be for three phases, black for neutral and green with yellow band shall be for earthing.

5.10 WORKMANSHIP

5.10.1 Drawing Conductors

1. The drawing and jointing of PVC insulated copper conductor wires shall be executed with due regard to the following precautions.

2. While drawing wires through conduits, care shall be taken to avoid scratches and kinks which may cause breakage of conductors.

3. There shall be no sharp bends. Wire reel stands to be used for pulling of wires to avoid kinks.

4. Care shall be exercised while drawing the wires from reels, by taking appropriate measures to ensure that wires are not spread on ground, causing dust and dirt accumulation on the new wires.

5. Maximum permissible number of 1100 volt grade PVC insulated wires that may be drawn into rigid non metallic or PVC Conduits are given below:

Size of wires Nominal Cross Section Area (Sq. mm.)	Maximum number of wires within conduit size(mm)				
	20	25	32	40	50
1.5	7	12	16	--	--
1.5	5	10	14	--	--
4	4	8	12	--	--
6	3	6	8	--	--
10	--	4	5	6	--
16	--	3	3	6	6
25	--	--	2	4	6
35	--	--	--	3	5

6. Insulation shall be removed by insulation stripper only. Few Strands of wires shall not be cut/reduced for convenience in connecting into terminals.

7. The terminals shall have sufficient cross sectional area to take all strands and it's connecting brass screws shall have flats ends.

8. All looped joints shall be connected through terminal block/connectors. The pressure applied to tighten terminal screws shall be just adequate, neither too much nor too less. All light points shall be terminated through a connector.

9. Only licensed wiremen (Before doing the work or before appointing him on site contractor has to submit his wiring licence to Owner) and cable jointers shall be employed to do jointing work.

10. Before entrusting cable jointing work to any technician, or before appointing Cable Jointers or Wiremen on Site, Contractor has to submit such Technicians' / Wireman's / Cable Jointer's licence to Owner.

11. All wires and cables shall be embossed with the manufacturer's label with ISI mark and shall be brought to site in original packing. For all internal wiring. PVC insulated wires of 1100 volts grade (FRLS) shall be used.

12. The sub-circuit wiring for point shall be carried out in loop system and no joints shall be allowed in the length of the conductors.

13. No wire shall be drawn into any conduit until all defective work of conduit installation of any nature that may cause injury to wire is completed.

14. Care shall be taken while pulling out the wires so that no damage occurs to conduits/wire itself, the conduits shall be thoroughly cleaned of moisture, dust , dirt or any other obstruction.

15. The minimum size of PVC insulated copper conductor wires for all sub-circuit wiring for light points shall be minimum 1.0 sq.mm copper. Separate neutral to be pulled for each circuit.

16. Conduits shall be kept at a minimum distance of 100 mm. from the pipes of other non-electrical services. And maintain minimum 300 mm distance between telephones, TV & Computer piping.

17. Separate conduits/raceways shall be used for following points as applicable and as requirements of site conditions:

17.1 Normal lights and 5 A 3 pin sockets on lighting circuit.
17.2 Separate conduit shall be laid from D.B. to switch board.

17.3 Power outlets - 15 A 3 pin 20 A/30 A, 2 pin scraping earth metal clad sockets.
17.4 Emergency lighting.
17.5 Telephones.
17.6 Fire alarm system.
17.7 Public address system & Music system.
17.8 For all other voltages higher or lower than 230 V.
17.9 T.V. Antenna.
17.10 Water level guard.

5.11 FISH WIRE

1. To facilitate subsequent drawing of wires in the conduit, GI fish wires of 1.0 mm (14 SWG) shall be provided along with the laying of recessed conduit.

5.12 MODE OF MEASUREMENT

1. The items shall be measured on unit basis or on mtr basis as per BOQ.

6 TECHNICAL SPECIFICATION FOR LIGHT FIXTURES & ACCESSORIES.

6.1 SCOPE

The scope of work shall cover the supply, installation and testing of various types of LED light fixtures.

6.2 STANDARDS

The following standards and rules shall be applicable :

(a) IS 3646 - 1960 Code of practice for interior illuminator.

(b) IS 1913 - 1969 General and Safety requirements for Electric lighting fittings.

(c) Indian Electricity Act and Rules issued thereunder.

All codes and standards mean the latest. Where not specified otherwise the installation shall generally follow the Indian Standard Code of Practice or the relevant British Standard Code of Practice in the absence of Indian Standard.

6.3 GENERAL REQUIREMENTS

- Tube Light with integral/ non-integral driver 20-22 Watts, Surge - 4KV,IP-20 LED indoor fittings with LEDs of wattage 0.2 Watt to 0.5 Watt assembled on single MCPCB, with housing used as a heat sink shall be made of thick sheet Steel conforming to IS: 513/CRCA polyester powder coated and high U.V. & corrosion resistance with diffuser and/or Polycarbonate optics with company mark/name 120 to 300 V, Power Factor more than 0.9, THD < 10 %,CCT 4000 K to 6500K, Uniformity ratio >0.7,Luminaire efficacy> 100 lumens/watt ,LED driver efficiency > 85 %

- LED Lamps integral type, cool white with PC diffuser suitable for B22 LAMP holder 5 to 8 watts LED indoor fittings with LEDs of wattage 0.2 Watt to 0.5 Watt assembled on single MCPCB, with housing used as a heat sink shall be made of thick sheet Steel conforming to IS: 513/CRCA polyester powder coated and high U.V. & corrosion resistance with diffuser and/or Polycarbonate optics with company mark/name 120 to 300 V,Power Factor more than 0.9, THD < 10 %,CCT 4000 K to 6500K, Uniformity ratio >0.7,Luminaire efficacy> 100 lumens/watt ,LED driver efficiency > 85 %

- LED Panel Light with provision for Plane front frame with translucent cover fixed to housing complete 24 watts, 300 x 300 mm, Surge-4 KV LED indoor fittings with LEDs of wattage 0.2 Watt to 0.5 Watt assembled on single MCPCB, with housing used as a heat sink shall be made of thick sheet Steel conforming to IS: 513/CRCA polyester powder coated and high U.V. & corrosion resistance with diffuser and/or Polycarbonate optics with company

mark/name 120 to 300 V, Power Factor more than 0.9, THD < 10 %,CCT 4000 K to 6500K, Uniformity ratio >0.7,Luminaire efficacy> 100 lumens/watt ,LED driver efficiency > 85 %

- LED Panel Light with provision for Plane front frame with translucent cover fixed to housing complete up to 36 watts, 600 x 600 mm, Surge- 4KV LED indoor fittings with LEDs of wattage 0.2 Watt to 0.5 Watt assembled on single MCPCB, with housing used as a heat sink shall be made of thick sheet Steel conforming to IS: 513/CRCA polyester powder coated and high U.V. & corrosion resistance with diffuser and/or Polycarbonate optics with company mark/name 120 to 300 V, Power Factor more than 0.9, THD < 10 %,CCT 4000 K to 6500K, Uniformity ratio >0.7,Luminaire efficacy> 100 lumens/watt ,LED driver efficiency > 85 %

6.4 DRAWINGS AND DATA:

As per of the proposal the bidder furnish relevant descriptive and illustrative literature on lighting fixtures and accessories and following drawings/ data for the respective lighting fixtures :-

i) Dimensional Drawings.
ii) Mounting details cable entry facilities and weights.
iii) Light distribution diagrams (Zonal & Isokandora)
iv) Light absorption and utilisation factors.
v) Lamp output V/S temp. Curves.

6.5 WORKMANSHIP:

- The fixture shall be installed on wall / ceiling as directed and as per manufacturer's instruction, with necessary accessories for surface, concealed, suspended from ceiling, bracket mounting etc.

- The job also includes connection of fixture with respective outlet point with heat resistant wires through heat resistance sleeve and PVC connector. The exhaust fan shall be installed complete with M.S. angle iron mounting frame/ ring, G.I. louvers, wire mesh and plug at the end of the cord including wiring & earthing etc. Proper earthing shall be provided to the fixtures.

6.6 MODE OF MEASUREMENT:

The unit rate shall be considered for fitting one fixture. The rate shall include following

1 All fixing accessories, mounting bracket, ballast condensers and control gear wherever applicable.

2 Supplying and fixing Ball and socket joints wherever required.

3 Earthing of fittings.

4 Electrical connections to fittings/fans from the junction box/ceiling rose.

5 Installation and interconnection of Electronic regulators for ceiling fans.

6 Supplying and fixing 300 mm. GI down rod for ceiling fans.

7 TECHNICAL SPECIFICATION FOR DATA, TELEVISION & TELEPHONE WIRING.

7.1 GENERAL DESCRIPTION

1. The work shall cover the supply and installation of the TV, Telephone and Computer data points including laying of Cables in 19/20 mm dia PVC Conduit.

7.2 SCOPE

7.2.1 TELEPHONE CABLES AND WIRES:

1. The type of cables and the services shall be as follows:
2. Indoor – Multipair PVC sheath armoured / un-armoured as specified 0.6 mm tin Cu. Cable.
3. Outside -- Multipair PVC sheath armoured / jelly filled as specified 0.6 mm tin Cu. Cable.
4. All multi core cables and wires shall be of tinned copper conductor of not less than 0.6 mm dia and shall be colour coded twisted pairs with rip cord.
5. The conductor resistance shall be less than 150 ohms per KM and the insulation resistance between the conductors not less than 50 mega ohms and the nominal capacitance of about 0.1 microfarad per kilometre.
6. Cables laid underground or locations subject to dampness and flooding shall be filled with polyethylene compound and shall have sufficient protection against moisture and water ingress.
7. All armouring shall be of galvanized steel wires and protected against corrosion by an outer sheath of PVC in the case of indoor cables and polyethylene in the case of outdoor cables. Outer sheathing must be fire retarding and anti-termite.
8. All un-armoured single core cables and inner sheath of armoured cables shall be provided with ripcord.

7.2.2 TELEPHONE TAG BLOCKS:

1. The telephone tag blocks shall be suitable for the multi core telephone cables and shall have two terminal blocks, cross connect type. All incoming and outgoing cables shall be terminated on separate terminal blocks and termination shall be silver soldered. The cross connecting jumpers shall be insulated wires of same diameter and screw connected.
2. The tag blocks shall be mounted inside fabricated sheet steel boxes with removable hinged covers and shall be fully accessible. The enclosure shall be painted with 2 coats of red oxide and stove enamelled.

7.2.3 TELEPHONE OUTLET SOCKET:

1. Telephone outlet socket shall be of the same make as that of the switches and accessories. The outlet sockets shall consist of 2 A 2 Pair polyethene connector in M.S.I / PVC boxes with switch plate of the same make as that of switches and telephone socket. The telephone outlet socket unless and otherwise specified shall be jack type and not pin type.

7.2.4 COMPUTER WIRES:

1. The computer wires shall be of 4 pair enhanced Cat 6 category and shall be of the makes as specified in the tender.

7.2.5 COMPUTER DATA OUTLET SOCKETS:

1. The computer sockets shall be of e Cat 6 category and of the make specified in the tender. The sockets shall be installed in the plates of the modular switches range to be used. The sockets shall be crimped using crimping tool with the Cat 6e wire.

2. For clean room application the plates shall be of SS 316 with no sharp edges.

7.2.6 TELEVISION WIRING & SOCKETS:

1. The Co-axial cable shall be of wide band type with operation capability upto 500 MHz.as of Delton type.

2. The Co-axial cable shall comprise of inner conductor of solid bare copper insulated with Foam PE & Secondary Conductor made of poly-Aluminium film bonded Aluminium braids and having coverage of 65%, overall sheathed with black PVC Insulation.

3. Twisted cables shall be electrolytic grade annealed copper conductor insulated with PE insulation twisted in to pairs with colour combination bunched together in concentric layers so as to minimise cross-talk & wrapped with FR PVC taps and sheathed with FR PVC or HFFR outer jacket suitable for indoor telephone wiring and confirming to C-DOT S/WS-113 / IEC 60189-2, UL-1581 SECTION 1080.

4. The ageing resistance of the co-axial cable shall comply with DIN 47252, Part 2, i.e. max. 5% increase in attenuation at 200 MHz. measured by artificial ageing (14 days at 80 deg. C)

7.3 WORKMANSHIP

1. All cables shall be on cable racks and neatly stitched together.

2. The connection at the tag blocks shall be silver soldered so as to achieve minimum contact resistance.
3. The final branch connections with single pair cables in conduits and the maximum number of cables in each conduit shall be as follows:

Conduit Inch	diameter mm.	Max. No. of cables
3/4"	20	2 Nos. single pair

1"	25	6 Nos. single pair
1¼"	32	12 Nos. single pair
1½"	40	18 Nos. single pair

4. The tag blocks shall be mounted inside fabricated sheet steel boxes with removable hinged covers and shall be fully accessible. The enclosure shall be painted with 2 coats of red oxide and stove enamelled.

7.4 MODE OF MEASUREMENT

1. The wires, conduits and raceways shall be measured in rmt whereas the outlet sockets, junction boxes and tag blocks shall be measured in units.

8 TECHNICAL SPECIFICATION FOR EARTHING SYSTEM.

8.1 GENERAL DESCRIPTION

1. All the non-current carrying metal parts of the electrical installation and mechanical equipments shall be earthed properly.

2. The metal conduits, trunking, cables armour and sheath, electric panels' boards, lighting fixtures, ceiling and exhaust fan and all other parts made of metal shall be bonded together and connected by means of specified earthing system.

3. An earth continuity conductor shall be installed with all the feeders and circuits and shall be connected from the earth bar of the panel boards to the conduit system, earth stud of the switch box, lighting fixture, earth pin of the socket outlets and to any metallic wall plates used.

4. All the enclosures of motors shall be also connected to the earthing system.

8.2 SCOPE OF WORK

1. The scope of work shall cover supply, laying, installation, connecting, testing and commissioning of:

   1.1 Earthing station.
   1.2 Earthing Aluminium/copper strips from earthing station to equipotential bar.
   1.3 Earthing Aluminium / copper strips / wires from equipotential bar to lay feeder mains and circuit to connect power panels, DBs, switchboards etc.
   1.4 Bonding of Non-current carrying parts, and metallic parts of the electrical installation.

8.3 STANDARDS

1. The following standards and rules shall be applicable:

   1) IS: 3043 - 1966 Code of practice for Earthing.

   2) Indian Electricity Act and Rules

   All codes and standards mean the latest. Where not specified otherwise the installation shall generally follow the Indian Standard Code of Practice or the British Standard Codes of Practice in absence of Indian standard.

8.4 TYPE OF EARTHING STATION , CHEMICAL PIPE-IN-PIPE EARTHING

1. The substation earthing shall be with copper plate earthing station unless otherwise specified & earthpit of minimum bore dia. 225mm size ASH or approved make Safe Earthing Electrode consisting Pipe-in-Pipe Technology as per IS 3043-1987 made of corrosion free G.I.Pipes.

2. The earthing station shall be as shown on the drawing. The two earth electrodes shall be 80mm

& 40 mm dia GI pipes plate. The earth resistance shall be maintained with a suitable crystalline conductive materials and back fill compound.

3. The resistance of each earth station should not exceed 1 ohms.

4. The earth lead shall be connected to the earth pipe through copper/brass bolts.

5. The pipe-in –pipe earth station shall be as shown on the drawing and shall be used for equipment protective earth grid.

6. The earth electrodes shall be galvanized pipes 3.0 long with outer pipe 80 mm dia & inner pipe 40 mm dia. The outer pipe shall be plated with 80-200 microns & inner pipe shall be plated with 200-250 microns with connection terminal dia of 14 mm.

7. Crystalline Conductive material-Mixture of nature minerals and a chemical compound, highly conductive and non corrosive, which prevents the inner pipe from corrosion and dissipates the current evenly.

8. Back fill compound - Moisture retaining compound having 13 times more (Hygroscopic) water retaining capacity than its dry volume & shall be 2 bags of 25 kgs.

9. The earth lead shall be fixed to the pipe with a clamp and safety set screws. The clamps shall be permanently accessible.

8.5 WORKMANSHIP INSTALLATION AND CONNECTION

1. The plate/pipe electrode, as far as practicable, shall be buried below permanent moisture level but in no case less than 3 M below finished ground level.

2. The plate/pipe electrode shall be kept clear of the building foundation and in no case, it shall be nearer by less than 2 M from outer face of the respective building wall / column.

3. The plate electrode shall be installed vertically and shall be surrounded with 150 mm. thick layers of Charcoal dust and Salt mixture.

4. 20 mm. dia. G.I. pipe for watering, shall run from top edge of the plate / pipe electrode to the mid level of block masonry chamber.

5. Top of the pipe shall be provided with G.I. funnel and screen for watering the earth / ground through the pipe.

6. The funnel with screen over the G.I. pipe for watering to the earth shall be housed in a block masonry chamber as shown in the drawing.

7. The masonry chamber shall be provided with a Cast Iron hinged cover resting over the Cast Iron frame which shall be embedded in the block masonry.

8. Construction of the earthing station shall in general be as shown in the drawing and shall conform to the requirement on earth electrodes mentioned in the latest edition of Indian Standard IS: 3043, Code of Practice for Earthing Installation.

9. The earth conductors (Strips / Wires, Hot dip G.I.) Inside the building shall properly be clamped / supported on the wall with Galvanised Iron clamps and Hot Dip GI screws / bolts. The conductors outside the building shall be laid at least 600 mm. below the finished ground level.

10. The earth conductors shall either terminate on earthing socket provided on the equipment or shall be fastened to the foundation bolt and / or on frames of the equipment. The earthing connection to equipment body shall be done after removing paint and other oily substances from the body and then properly be finished.

11. Over lapping of earth conductors during straight through in joints, where required, shall be of minimum 75mm. long.

12. The earth conductors shall be in one length between the earthing grid and the equipment to be earthed.

8.5.1 EARTH LEADS AND CONNECTIONS

1. Earth lead shall be bare copper or Galvanised steel as specified with sizes shown on drawings. Copper lead shall have a phosphor content of not over 0.15 %. Galvanised steel buried in the ground shall be protected with bitumen and hessian wrap or polythene faced hessian and bitumen coating. At road crossing necessary Hume pipes shall be laid. Earth lead run on surface of wall or ceiling shall be fixed on saddles so that strip is at least 8 mm away from the wall surface.

2. The complete earthing system shall be mechanically and electrically bonded to provide an independent return path to the earth source.

3. Wherever crossing is required, earthing jumper shall be of insulated wires.

8.5.2 EQUIPMENT EARTHING

1. All apparatus and equipment transmitting or utilising power shall be earthed in the following manner. Copper /G.I. Earth strips/wires shall be used unless other-wise indicated in the Schedule.

8.5.3 TEST

1. The entire earthing installation shall be tested as per requirements of Indian Standard Specification IS: 3041.

2. The following earth resistance values shall be measured with an approved earth megger and recorded.
   2.1 Each earthing station
   2.2 Earthing system as a whole
   2.3 Earth continuity conductors

3. Earth conductor resistance for each earthed equipment shall be measured which shall not exceed 1 ohm in each case.

4. Measurements of earth resistance shall be carried out before earth connections are made between the earth and the object to be earthed.

5. All tests shall be carried out in presence of the consultant / client.

8.6 MODE OF MEASUREMENT

1. Provision of earthing station complete with excavation, electrode, watering pipe, soil treatment, masonry chamber with cast iron cover etc. shall be treated as one unit of measurement.
2. The following items of work shall be measured and paid per unit length covering the cost of the earth wires / strips, clamps, labour etc.
    a) Main equipment earthing grid and connection to the earthing station.
    b) Connection to the switch board, power panels, DB etc.
3. The cost of Earthing the boq. Items shall become part of the cost of the item itself and no separate payment for earthing shall be made.